Defining the Smart Grid
A Maturity Model Project

Benchmarking
-- the process of identifying and learning from global best practices -- is a powerful tool in the quest for continuous improvement and breakthroughs
Why was a Smart Grid Maturity Model Needed?

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

- To establish a shared picture of the Smart Grid journey
- To communicate the Smart Grid vision, internally and externally
  - To assess current opportunities, choices and desired levels
  - To use as a strategic and decision making framework
    - To develop business, investment and rate cases
      - To build an explicit plan to move from one level to another
        - To measure progress using Key Performance Indicators (KPIs)
          - To benchmark and learn from others
What is a Maturity Model?

> A roadmap of activities, investments and best practices that lead to a desired future state

> It is used to guide, appraise and improve toward a known goal through distinct levels of capabilities and associated results
  > Each level identifies characteristics and tasks, and expected results
  > Any level can be, and define, an end state goal
  > If one wants to advance levels, each level lays the foundation for the next

> There are two steps to developing a maturity model
  1. Determine what you would expect to see at each stage along the journey
     > “At Level 1, we would expect to see….”
     > “At Level 5, we would expect to see…”
  2. Develop observable indicators of progress and Key Performance Indicators (KPIs) – measurable outcomes that should come with maturity

The Capability Maturity Model from Carnegie Mellon and the Software Engineering Institute changed software development globally
IUN Coalition adopts SG/MM effort for good of the industry

IUN Coalition SMEs work together to refine maturity levels, characteristics, and identify key measures

APQC creates two surveys with input from IUN Coalition

Surveys piloted with Coalition

GOAL: Widespread industry adoption to help transform the industry
Smart Grid Maturity Model - Levels, Descriptions and Results

**Level 1: Exploring and Initiating**
- Contemplating Smart Grid transformation. May have vision, but no strategy yet. Exploring options. Evaluating business cases, technologies. Might have elements already deployed.

**Level 2: Functional investing**
- Making decisions, at least at functional level. Business cases in place, investments being made. One or more functional deployments under way with value being realized. Strategy in place.

**Level 3: Integrating – Cross Functional**
- Smart Grid spreads. Operational linkages established between two or more functional areas. Management ensures decisions span functional interests, resulting in cross functional benefits.

**Level 4: Optimizing – Enterprise Wide**
- Smart Grid functionality and benefits realized. Management and operational systems rely on and take full advantage of observability and integrated control across and between enterprise functions.

**Level 5: Innovating – Next wave of improvements**
- New business, operational, environmental and societal opportunities present themselves, and the capability exists to take advantage of them.

Vision
- Experiments

Strategy
- Proof of Concepts

Missionaries

Transformation
- Real time corrections
- Broad reuse

Victors

Systemization
- Repeatable practices
- Shared information

Cross LOB Champions

Perpetual Innovation
- Self-healing operations
- Autonomic business

Innovators
<table>
<thead>
<tr>
<th>Level 5:</th>
<th>Fundamental transformation of the utility business can occur</th>
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</thead>
<tbody>
<tr>
<td>Definition</td>
<td>Level 5 organizations extend the capabilities and benefits of level 4 through innovative programs, products and services and new operational and business models. They extend the state-of-the-art and state-of-the-industry, opening opportunities for transformation of end-to-end energy delivery systems and how energy is used.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Level 4:</th>
<th>Widespread use of Smart Grid yields benefits across the enterprise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definition</td>
<td>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.</td>
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</table>

<table>
<thead>
<tr>
<th>Level 3:</th>
<th>A level of Smart Grid has been achieved</th>
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<tr>
<td>Definition</td>
<td>Level 3 organizations have achieved, although potentially limited in scope, a Smart Grid. Key infrastructure and process changes are place which enable the flow of data and control within and across two or more functional areas. Decisions now reflect the increased data and automation for enhanced operation, products and services.</td>
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</table>

<table>
<thead>
<tr>
<th>Level 2:</th>
<th>Implementing Smart Grid strategy within one or more functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definition</td>
<td>Level 2 organizations have at least one Smart Grid project/deployment under way (e.g., AMI). There may be multiple towers of implementation, not necessarily tied together. They have business plans releasing investment dollars and more granular strategies toward end-to-end processes and a integrated vision.</td>
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</table>

<table>
<thead>
<tr>
<th>Level 1:</th>
<th>Developing the foundation and defining the vision for Smart Grid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definition</td>
<td>Level 1 organizations have decided to move toward Smart Grid. They have a vision and evaluation projects, tests or proof of concepts underway. This includes investigating business cases, technologies, environmental and energy resource options, and ways to reshape the customer experience through Smart Grid.</td>
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</table>
A Few Words About Levels

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

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Smart Grid Domains: Important Elements (1 thru 4)

People and Technology Domains
Examines the specific changes brought about through a Smart Grid transformation.

<table>
<thead>
<tr>
<th>Strategy, Management &amp; Regulatory</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Includes: Vision, strategic planning, decision making, strategy execution and discipline, regulatory, investment process</td>
<td>Includes: Communications, culture, structure</td>
</tr>
<tr>
<td><strong>The mission, vision, strategy, and how it is managed must be fully integrated in order to guide the way through a successful Smart Grid transformation.</strong></td>
<td><strong>For Smart Grid to be successful, the organizational structure must promote and reward cross functional planning and design and operations, but still allow for empowered decision making.</strong></td>
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<table>
<thead>
<tr>
<th>Technology</th>
<th>Societal and Environmental</th>
</tr>
</thead>
<tbody>
<tr>
<td>Includes: Information, engineering, integration of information and operational technology, standards, and business analytics tools</td>
<td>Includes: Conservation and green initiatives, sustainability, economics and ability to integrate alternative and distributed energy</td>
</tr>
<tr>
<td><strong>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.</strong></td>
<td><strong>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.</strong></td>
</tr>
</tbody>
</table>
## Smart Grid Domains: Important Elements (5 thru 8)

### Process Domains
Examines the specific changes brought about through a Smart Grid transformation.

<table>
<thead>
<tr>
<th>Domain</th>
<th>Includes:</th>
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<tbody>
<tr>
<td><strong>Grid Operations</strong></td>
<td>Advanced grid observability &amp; advanced grid control, quality and reliability</td>
</tr>
<tr>
<td><strong>Value Chain Integration</strong></td>
<td>Enabling demand and supply management, distributed generation, load management, leveraging market opportunities</td>
</tr>
<tr>
<td><strong>Work and Asset Management</strong></td>
<td>Optimizing the assets and resources (people and equipment)</td>
</tr>
<tr>
<td><strong>Customer Management and Experience</strong></td>
<td>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.</td>
</tr>
<tr>
<td></td>
<td>A solid core foundation of intelligent grid components and operational design, using technology and automation fused with enterprise processes becomes a holistic Smart Grid.</td>
</tr>
<tr>
<td></td>
<td>Extending automation beyond traditional boundaries, and across the entire value chain, opens opportunities for innovation and efficiencies.</td>
</tr>
<tr>
<td></td>
<td>Through Smart Grid, the customer becomes empowered to make their own choices regarding their use and cost of energy.</td>
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</tbody>
</table>


**Conservation and green initiatives, sustainability, economics and ability to integrate alternative and distributed energy**

- Collaboratively engage all stakeholders in all aspects of transformed business
- Organizational changes support new ventures and services that emerge

**Organization & Structure**

- SG drives strategy and influences corporate direction
- SG is a core competency
- External stakeholders share in strategy
- Willing to invest and divest, or engage in JV and IP sharing to execute strategy
- Now enabled for enhanced mkt driven or innovative regulatory funding schemes

**Technology**

- Data flows end to end (e.g. customer to generation)
- Enterprise business processes optimized with strategic IT architecture
- Real world aware systems - complex event processing, monitoring and control
- Predictive modeling and near real-time simulation, analytics drives optimization
- Enterprise-wide security implemented

**Societal & Environmental**

- Actualize the "triple bottom line"
- Customers enabled to manage their own usage (e.g. tools and self-adaptive networks)
- Tailored analytics and advice to customers
- Managing distributed generation
- Collaboration with external stakeholders
- Environmentally driven investments (aligned with SG strategy)
- Environmentally drove investments (aligned with SG strategy)
- Programs to encourage off-peak usage
- Integrated reporting of sustainability and impact
- Synthesize triple bottom line view across LOBs

**Innovating Next Wave**

- Developed energy efficiency programs for customers
- "Tribe bottom line" view – (financial, environmental and societal)
- Customers enabled to manage their own usage (e.g. tools and self-adaptive networks)
- Tailored analytics and advice to customers
- Managing distributed generation

**Optimizing Enterprise Wide**

- Culture of collaboration and integration
- Enterprise-wide security implemented
- Enterprise-wide security implemented

**Integrating Cross Functional**

- Culture of collaboration and integration
- Enterprise-wide security implemented
- Enterprise-wide security implemented

**Exploring and Initiating**

- Developing first SG vision
- Support for experimentation
- Informal discussion with regulators
- Funding likely out of existing budget

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- Developing first SG vision
- Support for experimentation
- Informal discussion with regulators
- Funding likely out of existing budget

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

- Black text = Requirements for this level
- Blue text = Descriptive characteristics or desired traits
Grid Operations
Advanced grid observability & advanced grid control, quality and reliability
- Grid employs self-healing capabilities
- Automated grid decisions system wide (applying proven analytic based controls)
- Optimized rate design/regulatory policy
- Ubiquitous system wide dynamic control

Work & Asset Management
Optimize the assets and resources (people and equipment)
- Optimizing the use of assets between and across supply chain participants
- Just in time retirement of assets
- Enterprise-wide abstract representation of assets for investment decisions
- Enterprise view of assets: location, status, interrelationships, connectivity and proximity
- Asset models reality based (real data)
- Optimization across fleet of assets
- CBM and predictive management on key components
- Efficient inventory management utilizing real asset status and modeling
- Component performance and trend analysis

Customer Management & Experience
Retail, customer care, pricing options and control, advanced services, visibility into utilization, quality, and performance
- Customer management of their end to end energy supply and usage level
- Outage detection at residence/device
- Plug-n-play customer based generation
- Near real-time data on customer usage
- Consumption level by device available
- Mobility and CO2 programs
- Usage analysis within pricing programs
- Circuit level outage detection/notification
- Net billing programs in the home
- Automated response to pricing signals
- Common customer experience integrated across all channels
- Recent customer usage data (e.g. daily)
- Behavior modeling augments customer segmentation

Value Chain Integration
Enabling demand and supply management, distributed generation and load management, leveraging market opportunities
- Coordinated energy management and generation throughout the supply chain
- Coordinated control of entire energy assets
- Dispatchable resources are available for increasingly granular market options (e.g. LMP – Locational Marginal Pricing)

- Energy resources dispatchable/tradable, utility realizes gain from ancillary services (e.g. power on demand)
- Portfolio optimization modeling expanded for new resources and real time markets.
- Ability to communicate with HAN (Home Area Network), incl. visibility and control of customer large demand appliances

- Integrated resource plan includes new targeted resources and technologies (e.g. DR, DG, volt/VAR)
- Enabling market and customer energy mgmt systems
- New resources available as substitute for market products to meet reliability objectives
Smart Grid Maturity Model: *Moving from the “lab” into real life*

The Maturity Model was first used in Australia in a planning workshop for Country Energy, in order to help them set their strategic agenda for Smart Grid.

Sample Planning and Scoring Matrix (hypothetical)

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Putting the Maturity Model to Use …assess, measure, and identify opportunities

Maturity Assessment
• Used to determine Maturity Level
• Describes current state
• Enables roadmap for improvements

Section 2: Reliability

4. Please provide the following information regarding system performance for prior year:
   a. Predicted SAIFI
   b. Actual SAIFI
   c. Predicted SAIDI
   d. Actual SAIDI
   e. Predicted MAIFI
   f. Actual MAIFI

5. Please provide the following information for Mean Time Between Failure (MTBF) by asset class:

<table>
<thead>
<tr>
<th>Mean Time Between Failure</th>
<th>Mean Time to Repair</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Switches</td>
<td></td>
</tr>
<tr>
<td>b. Breakers</td>
<td></td>
</tr>
<tr>
<td>c. Capacitors</td>
<td></td>
</tr>
<tr>
<td>d. RTUs/Sensor</td>
<td></td>
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</tbody>
</table>

Opportunity & Results Survey
• Depicts resulting performance
• Identify trends
• Enables business case and rate case development
Survey Part 2

Examples of Operational and Performance Measures in the Smart Grid Maturity Model Results Survey

> Metrics will be used to understand the current state and associated performance of organizations that are implementing Smart Grid. These metrics span multiple domains.

> Metrics will be classified into the these categories

<table>
<thead>
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<th>Reliability</th>
<th>Strategy &amp; Management</th>
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<tbody>
<tr>
<td>Cost</td>
<td>Revenue</td>
</tr>
<tr>
<td>Operations</td>
<td>Technology</td>
</tr>
<tr>
<td>Customer benefit</td>
<td>Demographic characteristics</td>
</tr>
</tbody>
</table>
# Assessment Scoring Schema

1. **Level 1 Exploring and Initiating**  
   - Score: 0.79

2. **Level 2 Functional Investing**  
   - Score: 0.61

3. **Level 3 Integrating – Cross Functional**  
   - Score: 0.59

4. **Level 4 Optimizing – Enterprise-Wide**  
   - Score: 0.37

5. **Level 5 Innovating – Next Wave of Improvements**  
   - Score: 0.26

## Summary Scores

### Question

<table>
<thead>
<tr>
<th>Question</th>
<th>Value</th>
<th>Answer Score</th>
<th>Domain Score</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>3.3. Grid Operations</strong></td>
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<td></td>
<td></td>
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</table>

#### A. Is new information enabled by IUN flowing across functions and systems?

- a. No  
  - Score: 0
- b. A little  
  - Score: 0.5
- c. Moderately  
  - Score: 0.8
- d. To a great extent  
  - Score: 1

#### B. Has full scale implementation of control schemes been achieved?

- a. No  
  - Score: 0
- b. Planned  
  - Score: 0.5
- c. Partially completed  
  - Score: 0.8
- d. Completed  
  - Score: 1

#### C. Has planning transitioned from estimation to fact-based using grid data?

- a. No  
  - Score: 0
- b. A little  
  - Score: 0.4
- c. Moderately  
  - Score: 0.8
- d. To a great extent  
  - Score: 1
- e. Completely  
  - Score: 1
# Maturity Assessment Results

## Domain Scoring:
- **> 0.7**
- **> 0.4 & < 0.7**
- **< 0.4**

## Level Scoring:
- **> 0.7 (and > 6 Domains)**
- **> 0.4 (and < 6 Domains)**
- **< 0.4**

## SGMM Level Score Grid for Technology and Societal & Environmental

### Company A
<table>
<thead>
<tr>
<th>Level</th>
<th>SGMM Level Score</th>
<th>Strategy and Management</th>
<th>Organization</th>
<th>Grid Operations</th>
<th>Work and Asset Management</th>
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- George Potts - Pepco Holdings
- Caroline Winn - Sempra
- Don Cortez - Centerpoint Energy
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