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Software Engineering Institute

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## **Smart Grid Maturity Model: A Vision for the Future of Smart Grid**

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courtesy of Richard L. Kuper



## Report Documentation Page

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# Outline

## SGMM Introduction

### 2011 SGMM Milestones

- Version 1.2 release
- Building a community of SGMM Navigators
- SGMM usage highlight: the California-SAIC project
- SGMM community data as of September 2011

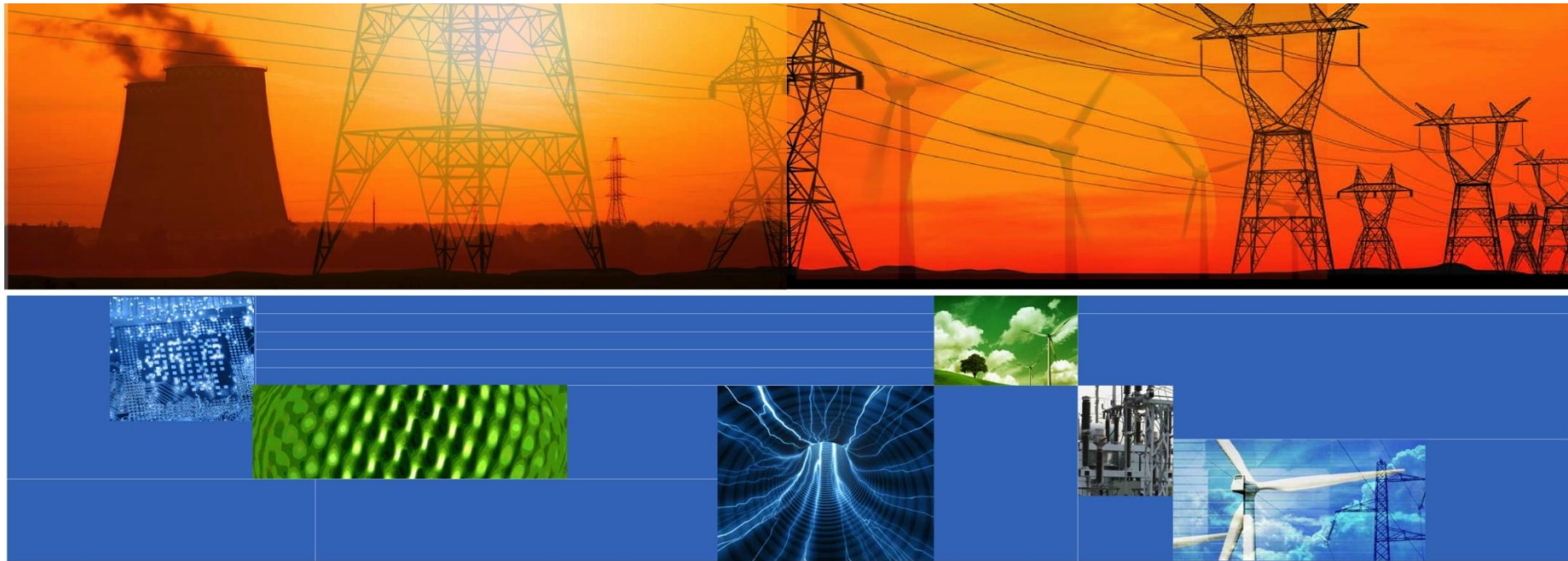
### Conclusion and discussion



# A major power grid transformation is underway

Utilities use the SGMM to:

- Develop effective roadmaps
- Track progress
- Understand their posture in comparison to peers

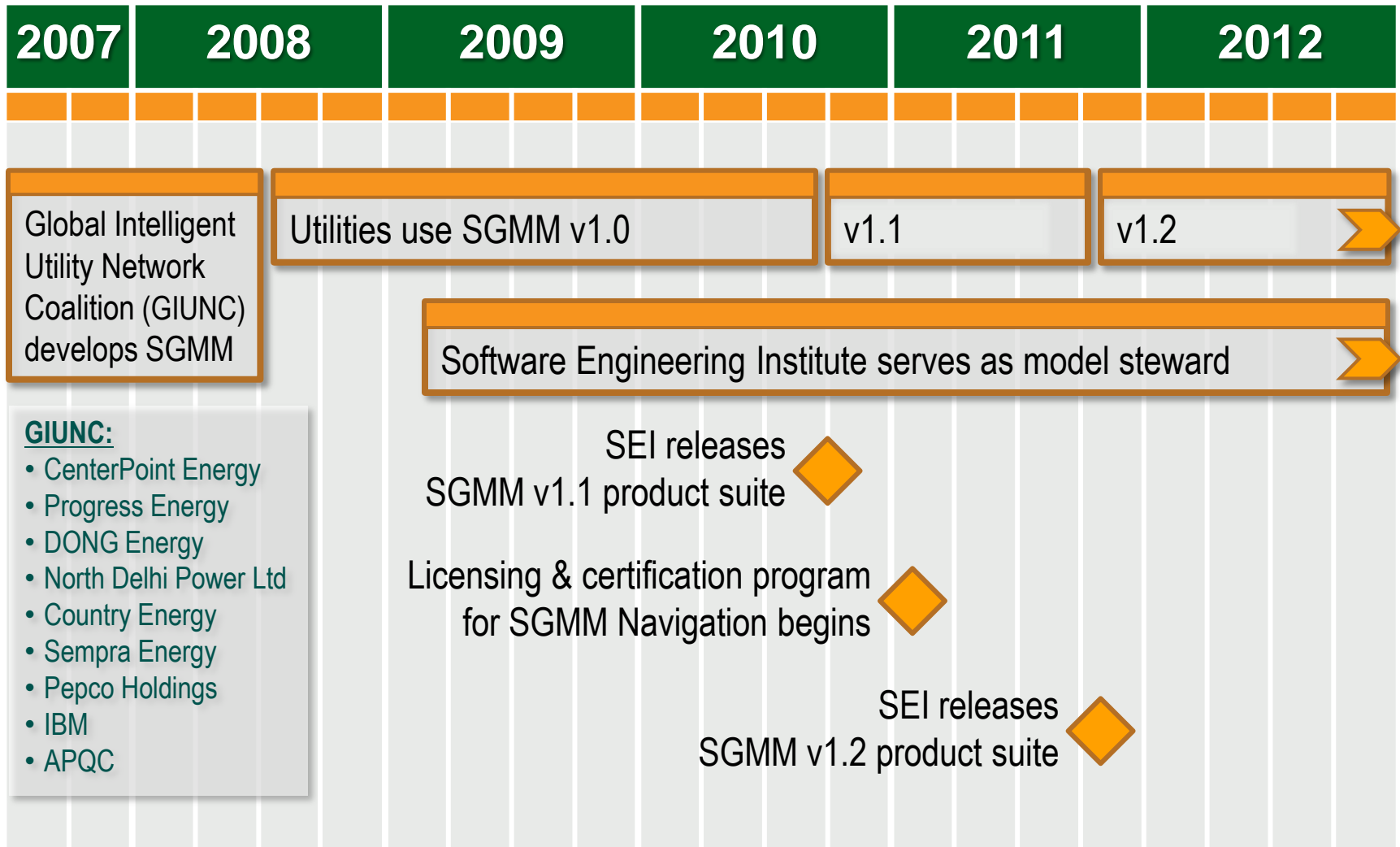


# What is the Smart Grid Maturity Model?

SGMM is a  
**MANAGEMENT TOOL**  
that provides a  
**COMMON LANGUAGE & FRAMEWORK**  
for defining key elements of  
**SMART GRID TRANSFORMATION**  
and helps utilities develop a  
**PROGRAMMATIC APPROACH**  
and track their progress.



# SGMM timeline



*Developed by utilities for utilities*



# SGMM

Smart Grid Maturity Model

V 1.2 Product Suite

## Model

- Model Definition document
- Matrix

## Compass Survey

- Compass survey yields maturity ratings and performance comparisons

## Navigation Process

- Facilitated completion and interpretation of Compass, led by a certified “SGMM Navigator”

## Training

- Overview Seminar
- SGMM Navigator Course

## Licensing

- License organizations and certify individuals to deliver Navigation process

[www.sei.cmu.edu/smartgrid](http://www.sei.cmu.edu/smartgrid)



# SGMM at a glance

## 8 Domains: Logical groupings of smart grid related capabilities and characteristics

	SMR	OS	GO	WAM	TECH	CUST	VCI	SE
<b>5</b> PIONEERING	<ul style="list-style-type: none"> <li>1. New services and product offerings.</li> <li>2. Smart grid business activities provide sufficient financial resources to enable continued investment in smart grid sustainment and expansion.</li> <li>3. Smart grid is a core competency throughout the organization.</li> <li>4. Smart grid strategy is shared and revised collaboratively with all stakeholders.</li> </ul>	<ul style="list-style-type: none"> <li>1. Stakeholders to optimize overall grid operation and health.</li> <li>2. The organization is able to readily adapt to support new ventures, products, and services that emerge as a result of smart grid.</li> <li>3. Channels are in place to harvest ideas, develop them, and regard those who help shape future advances in process, workforce competencies, and technology.</li> </ul>	<ul style="list-style-type: none"> <li>2. System-wide, analytics-based, and automated grid decision making is in place.</li> </ul>	<ul style="list-style-type: none"> <li>1. Optimized with processes defined and executed across the supply chain.</li> <li>2. Assets are leveraged to maximize utilization, including just-in-time asset retirement, based on smart grid data and systems.</li> </ul>	<ul style="list-style-type: none"> <li>2. The enterprise information infrastructure can automatically identify, mitigate, and recover from cyber incidents.</li> </ul>	<ul style="list-style-type: none"> <li>2. There is automatic outage detection at premise or device level.</li> <li>3. Plug-and-play, customer-based generation is supported.</li> <li>4. Security and privacy for all customer data is assured.</li> <li>5. The organization plays a leadership role in industry-wide information sharing and standards development efforts for smart grid.</li> </ul>	<ul style="list-style-type: none"> <li>2. Resources are adequately dispatchable and controllable so that the organization can take advantage of granular market options.</li> <li>3. The organization's automated control and resource optimization schemes consider and support regional and/or national grid optimization.</li> </ul>	<ul style="list-style-type: none"> <li>2. Customers control their energy-based environmental footprints through automatic optimization of their end-to-end energy supply and usage level (energy source and mix).</li> <li>3. The organization is a leader in developing and promoting industry-wide resilience best practices and/or technologies for protection of the national critical infrastructure.</li> </ul>
<b>4</b> OPTIMIZING	<ul style="list-style-type: none"> <li>1. Smart grid vision and strategy drive the organization's strategy and execution.</li> <li>2. Smart grid is a core competency throughout the organization.</li> <li>3. Smart grid strategy is shared and revised collaboratively with all stakeholders.</li> </ul>	<ul style="list-style-type: none"> <li>1. Management systems and organizational structure are capable of taking advantage of the increased visibility and control provided through smart grid.</li> <li>2. There is end-to-end grid observability that can be leveraged by internal and external stakeholders.</li> <li>3. Decision making occurs at the closest point of need as a result of an efficient organizational structure and the increased availability of information due to smart grid.</li> </ul>	<ul style="list-style-type: none"> <li>1. Operational data from smart grid deployments is being used to optimize processes across the organization.</li> <li>2. Grid operational management is based on near real-time data.</li> <li>3. Operational forecasts are based on data gathered through smart grid.</li> <li>4. Grid operations information has been made available across functions and LOBs.</li> <li>5. There is an automation/machine-making within protection schemes that is based on wide-area monitoring.</li> </ul>	<ul style="list-style-type: none"> <li>1. A complete view of assets based on status, connectivity, and proximity is available to the organization.</li> <li>2. Asset models are based on real performance and monitoring data.</li> <li>3. Performance and usage of assets is optimized across the asset fleet and across asset classes.</li> <li>4. Service life for key grid components is managed through condition-based and predictive maintenance, and is based on real and current asset data.</li> </ul>	<ul style="list-style-type: none"> <li>1. Data flows end to end from customer to generation.</li> <li>2. Business processes are optimized by leveraging the enterprise IT architecture.</li> <li>3. Systems have sufficient wide-area situational awareness to enable real-time monitoring and control for complex events.</li> <li>4. Predictive modeling and near real-time simulation are used to optimize support processes.</li> <li>5. Performance is improved through sophisticated systems that are informed by smart grid data.</li> <li>6. Security strategy and tactics continually evolve based on changes in levels.</li> </ul>	<ul style="list-style-type: none"> <li>1. Support is provided to customers to help analyze and compare usage against all available pricing programs.</li> <li>2. There is outage detection and proactive notification at the circuit level.</li> <li>3. Customers have access to near real-time data on their own usage.</li> <li>4. Residential customers participate in demand response and/or utility-managed remote load control programs.</li> <li>5. Automatic response to pricing signals for devices within the customer's premises is supported.</li> <li>6. In-home net billing programs are enabled.</li> <li>7. A common customer experience has been integrated.</li> </ul>	<ul style="list-style-type: none"> <li>1. Energy resources (including Volt/VAR, DC, and DR) are dispatchable and tradable.</li> <li>2. Portfolio optimization models that encompass available resources and real-time markets are implemented.</li> <li>3. Secure two-way communications with Home Area Networks (HANs) are available.</li> <li>4. Visibility and potential control of customers' large-demand appliances to balance demand and supply is available.</li> </ul>	<ul style="list-style-type: none"> <li>1. The organization collaborates with external stakeholders to address environmental and societal issues.</li> <li>2. A public environmental and societal scorecard is maintained.</li> <li>3. Programs are in place to shape peak demand.</li> <li>4. End-user energy usage and devices are actively managed through the utility's network.</li> <li>5. The organization fulfills its critical infrastructure assurance goals for resiliency, and contributes to those of the region and the nation.</li> </ul>
<b>3</b> INTEGRATING	<ul style="list-style-type: none"> <li>1. Smart grid vision, strategy, and business case are incorporated into the vision and strategy.</li> <li>2. Smart grid governance model is established.</li> <li>3. Smart grid leaders with explicit authority across functions and lines of business are designated to ensure effective implementation of smart grid strategy.</li> <li>4. Smart grid authorizations for smart grid investments have been established.</li> </ul>	<ul style="list-style-type: none"> <li>1. The smart grid vision and strategy are driving organizational change.</li> <li>2. Smart grid measures are incorporated into the measurement system.</li> <li>3. Performance and compensation are linked to smart grid success.</li> <li>4. Leadership is consistent in communication and actions regarding smart grid.</li> <li>5. A matrix or other organizational structure is in place.</li> <li>6. Education and training is underway.</li> </ul>	<ul style="list-style-type: none"> <li>1. Smart grid information is available across systems and organizational functions.</li> <li>2. Control analytics have been implemented and are used to improve cross-LOB decision-making.</li> <li>3. Grid operations planning is now fact-based using grid data made available across organizational functions.</li> </ul>	<ul style="list-style-type: none"> <li>1. Performance, trend analysis, and event audit data are available for components of the organization's systems.</li> <li>2. CBM programs for key components are in place.</li> <li>3. Remote asset monitoring capabilities are integrated with asset management.</li> <li>4. Integration of remote asset monitoring with mobile workforce is underway.</li> </ul>	<ul style="list-style-type: none"> <li>1. Smart grid-impacted business processes are aligned with the enterprise IT architecture across LOBs.</li> <li>2. Systems adhere to an enterprise IT architectural framework for smart grid.</li> <li>3. Smart grid-specific technology has been implemented to improve cross-LOB performance.</li> </ul>	<ul style="list-style-type: none"> <li>1. The organization tailors programs to customer segments.</li> <li>2. Two-way meter communication has been deployed.</li> <li>3. A remote connect/disconnect capability is deployed.</li> <li>4. Demand response and/or remote load control is available to customers.</li> <li>5. There is automatic outage detection at the abstation level.</li> <li>6. Residential customers have an expanded access to utility usage data.</li> </ul>	<ul style="list-style-type: none"> <li>1. An integrated resource plan is in place and includes new targeted resources and technologies.</li> <li>2. Customer premise energy management solutions with market and usage information are enabled.</li> <li>3. Additional resources are available and deployed to provide substitutes for market products to support reliability or other objectives.</li> </ul>	<ul style="list-style-type: none"> <li>1. Performance of societal and environmental programs are measured and effectiveness is demonstrated.</li> <li>2. Segmented and tailored information that includes environmental and societal benefits and costs is available to customers.</li> <li>3. Programs to encourage off-peak usage by customers are in place.</li> <li>4. The organization regularly reports on the sustainability and the societal and environmental impacts of its smart grid programs and technologies.</li> </ul>
<b>2</b> ENABLING	<ul style="list-style-type: none"> <li>1. Final smart grid strategy and a business plan are approved by management.</li> <li>2. Common smart grid vision is accepted across the organization.</li> <li>3. Smart grid investment is explicitly aligned to the smart grid strategy.</li> <li>4. Smart grid programs are established specifically for funding the implementation of smart grid vision.</li> <li>5. Collaboration with regulators and other stakeholders is underway to ensure implementation of the smart grid vision and strategy.</li> <li>6. Smart grid support and funding for conducting proof-of-concept projects is established and aligned.</li> </ul>	<ul style="list-style-type: none"> <li>1. A new vision for smart grid is established in a smart grid vision process.</li> <li>2. The organization processes are established to support smart grid implementation and deployment teams include participants from all functions and LOBs that the deployment will impact.</li> <li>3. Most smart grid implementation and deployment teams include participants from all functions and LOBs that the deployment will impact.</li> <li>4. Education and training to develop smart grid competencies have been identified and are available.</li> <li>5. The linking of performance and compensation plans to achieve smart grid milestones is in progress.</li> </ul>	<ul style="list-style-type: none"> <li>1. Aside from SCADA, piloting of remote asset monitoring of key grid assets to support operational decision making is underway.</li> <li>2. Investment in and expansion of data communications networks in support of grid operations is underway.</li> </ul>	<ul style="list-style-type: none"> <li>1. Status, smart interconnectivity model has been developed.</li> <li>2. An organization-wide mobile workforce strategy is in development.</li> </ul>	<ul style="list-style-type: none"> <li>1. Standards are selected to support the smart grid strategy within the enterprise IT architecture.</li> <li>2. A common technology evaluation and selection process is applied for all smart grid activities.</li> <li>3. There is a data communications strategy for the grid.</li> <li>4. Pilots based on connectivity to distributed IECs are underway.</li> <li>5. Security is built into all smart grid initiatives from the outset.</li> </ul>	<ul style="list-style-type: none"> <li>1. The organization is modeling the reliability of grid equipment.</li> <li>2. Remote connect/disconnect is being piloted for residential customers.</li> <li>3. The impact on the customer of new services and delivery processes is being assessed.</li> <li>4. Security and privacy requirements for customer protection are specified for smart grid-related pilot projects and BPPs.</li> </ul>	<ul style="list-style-type: none"> <li>1. Pilots to support a diverse resource portfolio have been conducted.</li> <li>2. Secure interactions have been piloted with an expanded portfolio of value chain partners.</li> </ul>	<ul style="list-style-type: none"> <li>1. Smart grid strategies and work plans address societal and environmental issues.</li> <li>2. Energy efficiency programs for customers have been established.</li> <li>3. The organization considers a "triple bottom line" view when making decisions.</li> <li>4. Environmental proof-of-concept projects are underway that demonstrate smart grid benefits.</li> <li>5. Increasingly granular and more frequent consumption information is available to customers.</li> </ul>
<b>1</b> INITIATING	<ul style="list-style-type: none"> <li>1. Smart grid vision and strategy are approved by management.</li> <li>2. Smart grid investment is explicitly aligned to the smart grid strategy.</li> <li>3. Smart grid programs are established specifically for funding the implementation of smart grid vision.</li> <li>4. Collaboration with regulators and other stakeholders is underway to ensure implementation of the smart grid vision and strategy.</li> <li>5. Smart grid support and funding for conducting proof-of-concept projects is established and aligned.</li> </ul>	<ul style="list-style-type: none"> <li>1. The organization has articulated its need to build smart grid competencies in its workforce.</li> <li>2. Leadership has demonstrated a commitment to change the organization in support of achieving smart grid.</li> <li>3. Smart grid implementation and deployment teams include participants from all functions and LOBs that the deployment will impact.</li> </ul>	<ul style="list-style-type: none"> <li>1. Business cases for new equipment and systems related to smart grid are approved.</li> <li>2. New sensors, switches, and communications technologies are evaluated for grid monitoring and control.</li> <li>3. Proof-of-concept projects and component testing for grid monitoring and control are underway.</li> <li>4. Outage and distribution management systems linked to substation automation are being explored and evaluated.</li> <li>5. Safety and security (physical and cyber) requirements are being defined.</li> </ul>	<ul style="list-style-type: none"> <li>1. Enhancements to work and asset management have been built into approved business cases.</li> <li>2. Potential uses of remote asset monitoring are being evaluated.</li> <li>3. Asset and workforce management equipment and systems are being evaluated for their potential alignment to the smart grid vision.</li> </ul>	<ul style="list-style-type: none"> <li>1. An enterprise IT architecture exists or is under development.</li> <li>2. Existing or proposed IT architectures have been evaluated for quality attributes that support smart grid applications.</li> <li>3. A change control process is used for applications and IT infrastructure.</li> <li>4. Opportunities are identified to use technology to improve departmental performance.</li> <li>5. There is a process to evaluate and select technologies in alignment with smart grid vision and strategies.</li> </ul>	<ul style="list-style-type: none"> <li>1. Research is being conducted on how to use smart grid technologies to enhance the customer's experience, benefits, and productivity.</li> <li>2. Security and privacy implications of smart grid are being investigated.</li> <li>3. A vision of the future grid is being communicated to customers.</li> <li>4. The utility consults with public utility commissions and/or other government organizations concerning the impact on customers.</li> </ul>	<ul style="list-style-type: none"> <li>1. Assets and programs necessary to facilitate load management are identified.</li> <li>2. Distributed generation sources and the capabilities needed to support them are identified.</li> <li>3. Energy storage options and the capabilities needed to support them are identified.</li> <li>4. There is a strategy for creating and managing a diverse resource portfolio.</li> <li>5. Security requirements to enable interaction with an expanded portfolio of value chain partners have been identified.</li> </ul>	<ul style="list-style-type: none"> <li>1. The smart grid strategy addresses the organization's role in societal and environmental issues.</li> <li>2. The environmental benefits of the smart grid vision and strategy are publicly promoted.</li> <li>3. Environmental compliance performance records are available for public inspection.</li> <li>4. The smart grid vision or strategy specifies the organization's role in protecting the nation's critical infrastructure.</li> </ul>
<b>0</b> DEFAULT								

175 Characteristics: Features you would expect to see at each stage of the smart grid journey

6 Maturity Levels: Defined sets of characteristics and outcomes

# Smart Grid Maturity Model – levels

**PIONEERING**

**5**

Breaking new ground; industry-leading innovation

**OPTIMIZING**

**4**

Optimizing smart grid to benefit entire organization; may reach beyond organization; increased automation

**INTEGRATING**

**3**

Integrating smart grid deployments across the organization, realizing measurably improved performance

**ENABLING**

**2**

Investing based on clear strategy, implementing first projects to enable smart grid (may be compartmentalized)

**INITIATING**

**1**

Taking the first steps, exploring options, conducting experiments, developing smart grid vision

**DEFAULT**

**0**

Default level (status quo)



# Smart Grid Maturity Model – domains

<b>SMR</b>	<b>Strategy, Mgmt &amp; Regulatory</b> <i>Vision, planning, governance, stakeholder collaboration</i>	<b>TECH</b>	<b>Technology</b> <i>IT architecture, standards, infrastructure, integration, tools</i>
<b>OS</b>	<b>Organization and Structure</b> <i>Culture, structure, training, communications, knowledge mgmt</i>	<b>CUST</b>	<b>Customer</b> <i>Pricing, customer participation &amp; experience, advanced services</i>
<b>GO</b>	<b>Grid Operations</b> <i>Reliability, efficiency, security, safety, observability, control</i>	<b>VCI</b>	<b>Value Chain Integration</b> <i>Demand &amp; supply management, leveraging market opportunities</i>
<b>WAM</b>	<b>Work &amp; Asset Management</b> <i>Asset monitoring, tracking &amp; maintenance, mobile workforce</i>	<b>SE</b>	<b>Societal &amp; Environmental</b> <i>Responsibility, sustainability, critical infrastructure, efficiency</i>



# SGMM Compass Survey

## Contains

- One question for each expected characteristic in the model and
- Attribute and performance questions

## Example questions:

WAM-3.2 Condition-based maintenance programs for key components are in place.

**WAM-3.2** For what percentage of key components have you implemented condition-based maintenance?

- A. 0%
- B. 1 - 25%
- C. 26 - 50%
- D. 51 - 75%
- E. 76 - 100%

WAM-2.1 An approach for using smart grid capabilities to create inventories, maintain event histories, and track assets is in development.

**WAM-2.1** Have you established an approach to track, inventory, and maintain event histories of assets using smart grid capabilities?

- A. No
- B. In documented plan including committed schedule and budget
- C. In development
- D. Being piloted
- E. Completed

### Smart Grid Maturity Model: Matrix

#### Work and Asset Management (WAM)

asset monitoring, tracking and maintenance, mobile workforce

- 5 PIONEERING**
- 1 The use of assets between and across supply chain participants is optimized with processes defined and executed across the supply chain.
  - 2 Assets are leveraged to maximize utilization, including just-in-time asset retirement, based on smart grid data and systems.
- 4 OPTIMIZING**
- 1 A complete view of assets based on status, connectivity, and proximity is available to the organization.
  - 2 Asset models are based on real performance and monitoring data.
  - 3 Performance and usage of assets is optimized across the asset fleet and across asset classes.
  - 4 Service life for key grid components is managed through condition-based and predictive maintenance, and is based on real and current asset data.

- 3 INTEGRATING**
- 1 Performance, trend analysis, and event audit data are available for
  - 2
  - 3
  - 4
  - 5 An integrated view of grid and asset monitoring is in place.
  - 6 Asset inventory is being tracked using automation.
  - 7 Modeling of asset investments for key components is underway.

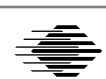
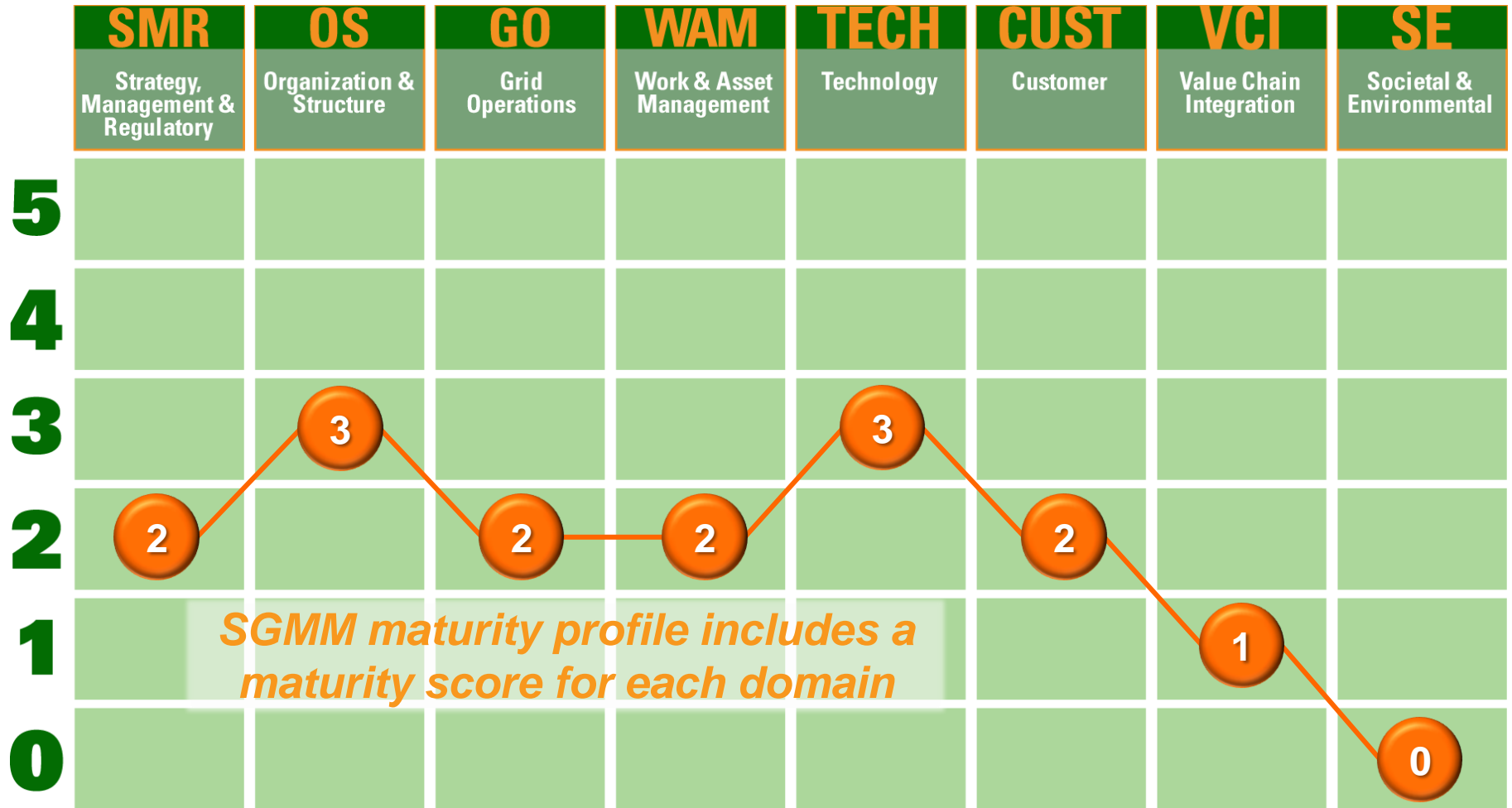
- 2 ENABLING**
- 1 An approach to track, inventory, and maintain event histories of assets is in development.
  - 2
  - 3

- 1 INITIATING**
- 1
  - 2
  - 3 Assets are being evaluated for their potential alignment to the smart grid vision.

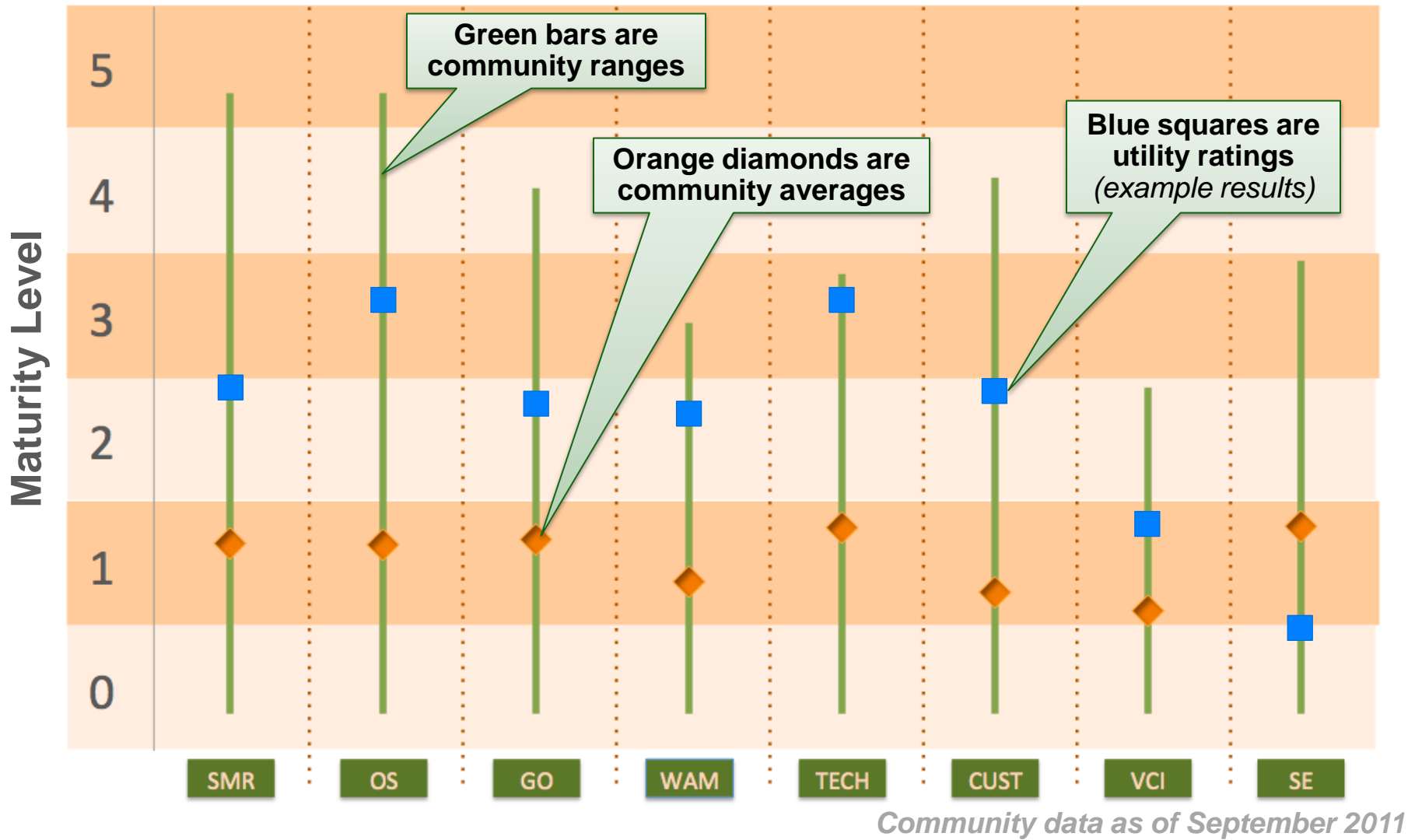
**0 DEFAULT**

Example results  
Fictitious organization

# Compass results: maturity profile



# Compass results: summary community data provided for comparison



# SGMM Navigation: five-step, expert led process



## Stakeholders complete SGMM Compass survey

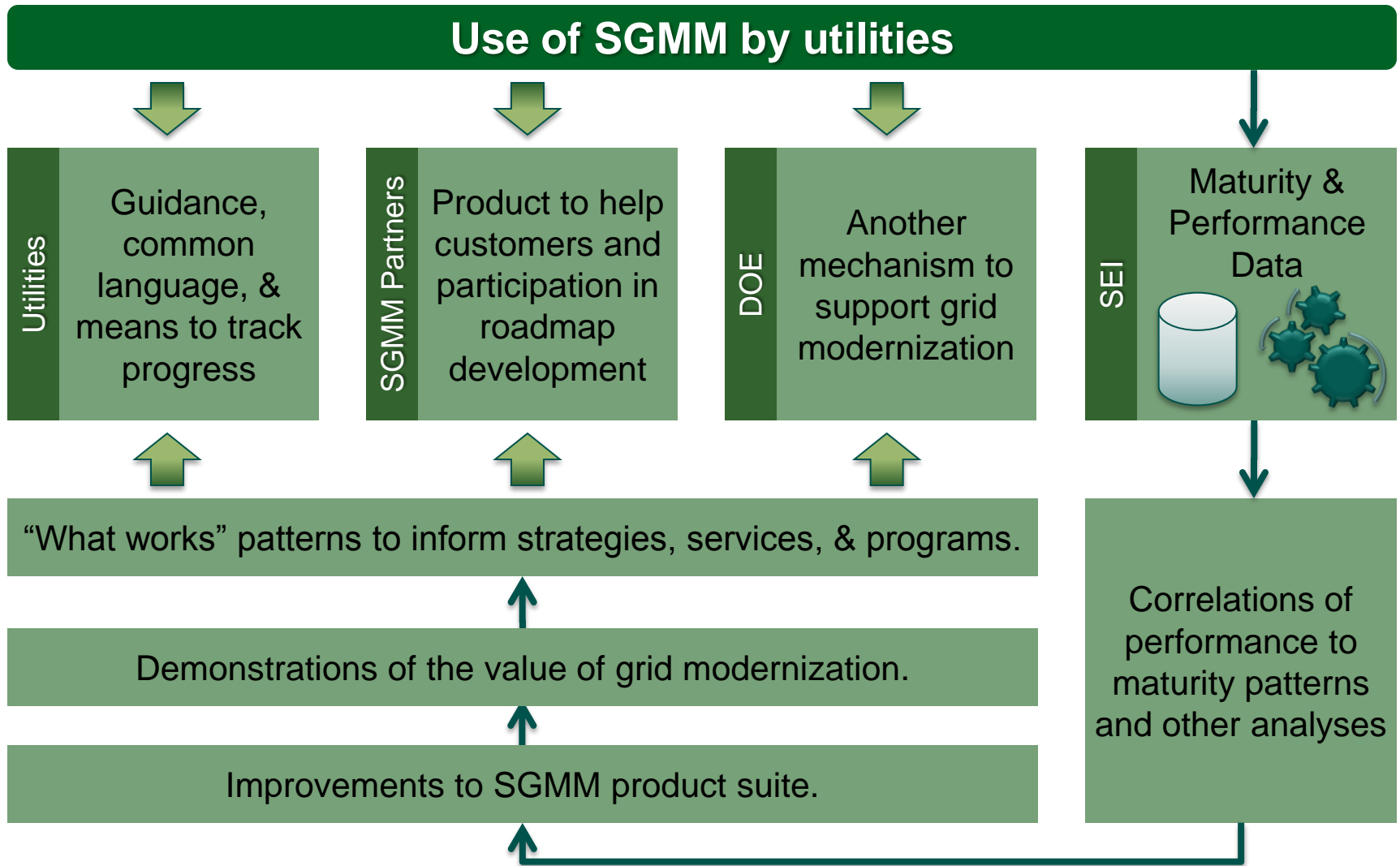
Discussion and consensus answers lead to internal alignment on current state

## Stakeholders review survey findings & set aspirational profile

Consensus on aspirational state and identification of motivations, actions, and obstacles to achieve it



# SGMM benefits – a community view



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Conclusion and discussion



# SGMM Version 1.2

Released in September 2011

Changes:


- New and revised SGMM Compass questions about utility attributes and performance
  - Enable better segmentation
  - Inform Aspirations workshop
- End of pilot licensing period — licensing now open to all qualified applicants
- Updates to all product elements based on community feedback



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# SGMM licensing & certification

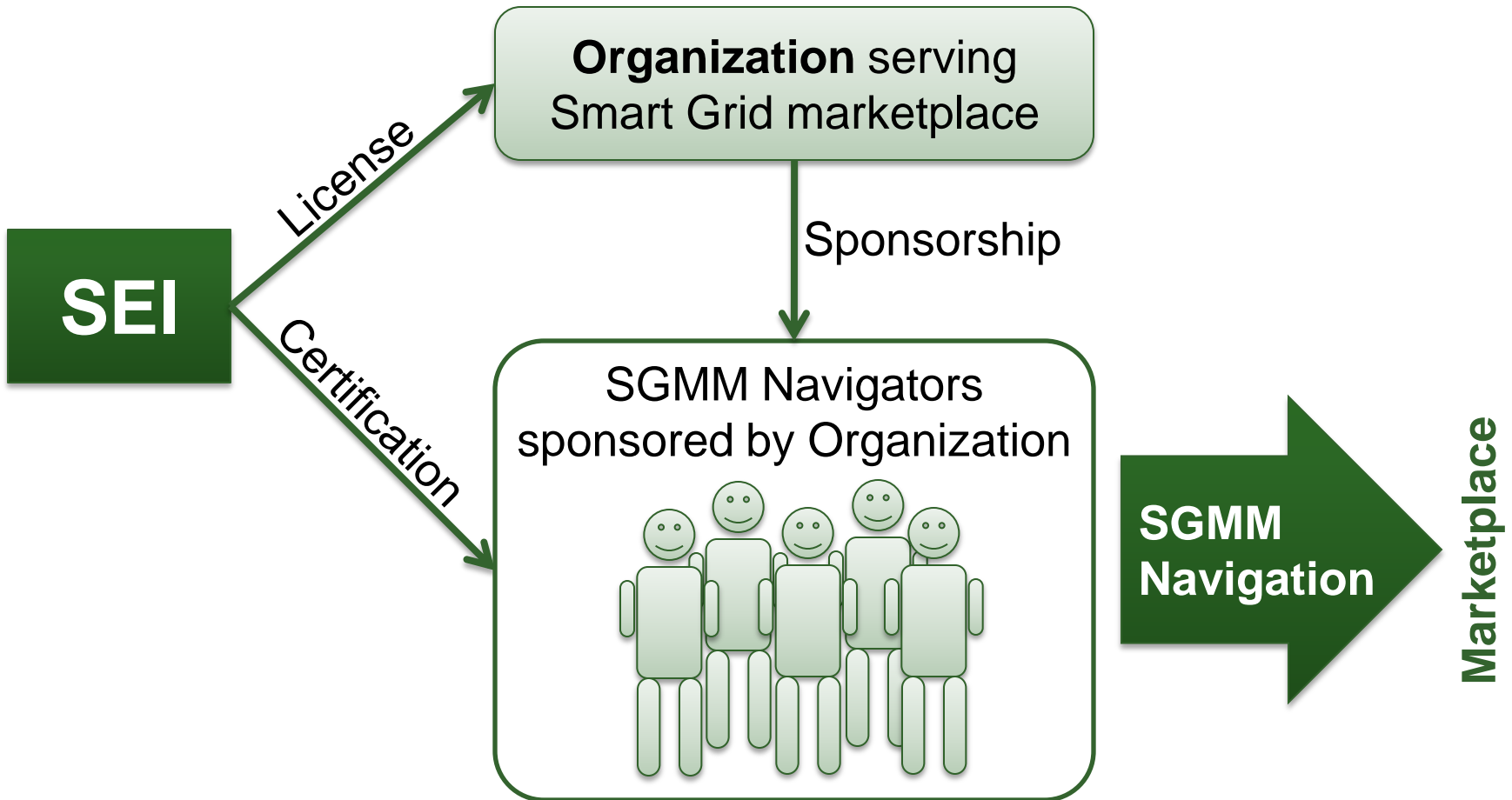
Licensing and certification are core elements of our strategy to promote and enable broad adoption and use of the SGMM.

Licensed organizations (SGMM Partners) are able to

- Offer SGMM Navigation as a service, which must be delivered by SEI-Certified SGMM Navigators
- Sponsor individuals to become SEI-Certified SGMM Navigators
- Participate in the ongoing evolution of the SGMM product suite



# Licensing & certification program structure



# Current SGMM Partners: seven total



[www.sei.cmu.edu/partners/sgmm](http://www.sei.cmu.edu/partners/sgmm)



# SGMM Navigator population



## SGMM Navigator Certification Statistics

- 41 Navigator trainees** *(completed course)*
- 34 Candidate Navigators** *(passed exam)*
- 7 Certified Navigators** *(completed all requirements)*



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# CA public utilities 2020 roadmap project

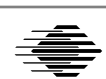
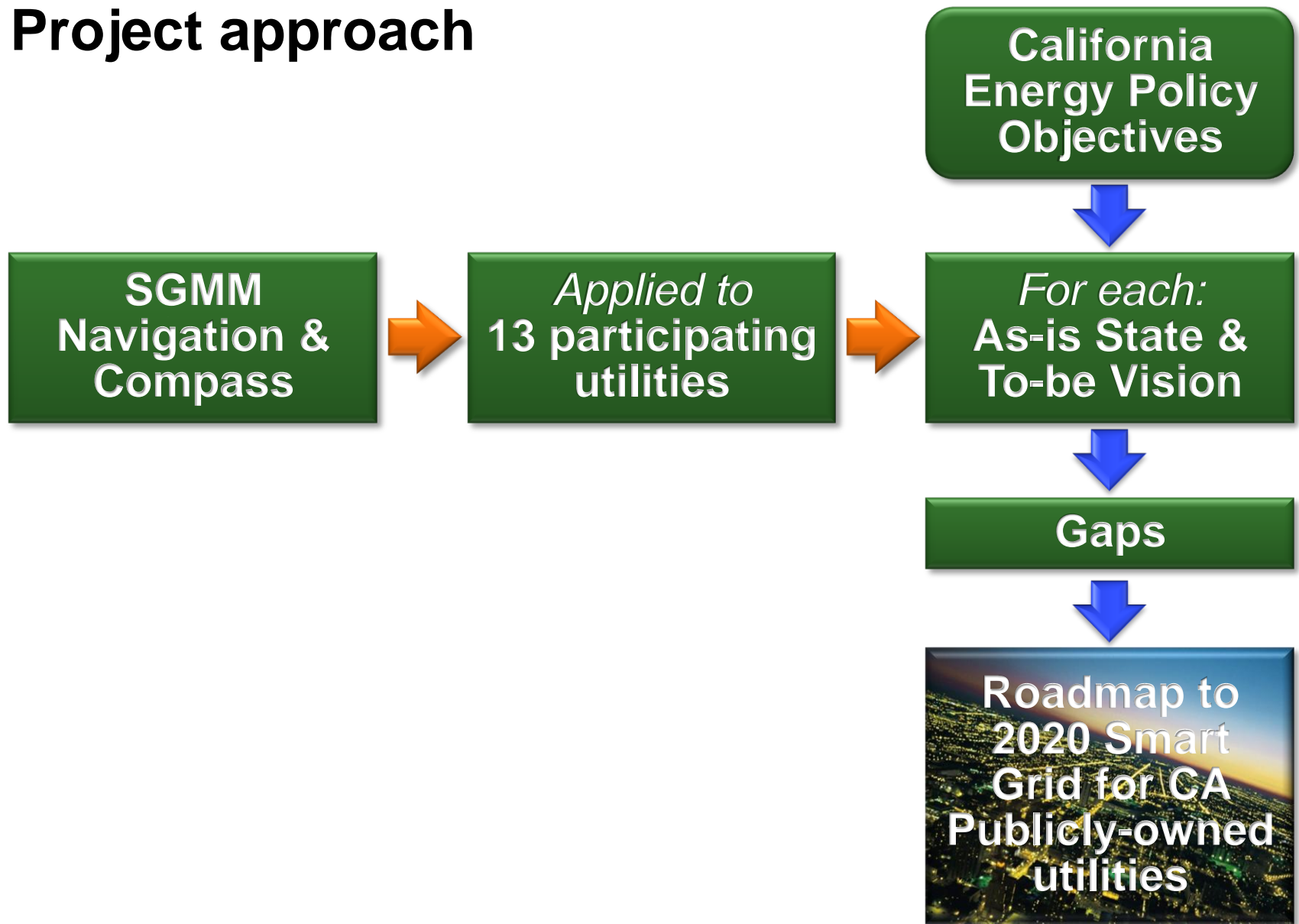
**Project objective:** develop a roadmap to smart grid implementation in 2020 for California's publicly-owned utilities (POUs) that helps to achieve state energy policy objectives

## Project details:

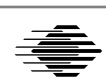
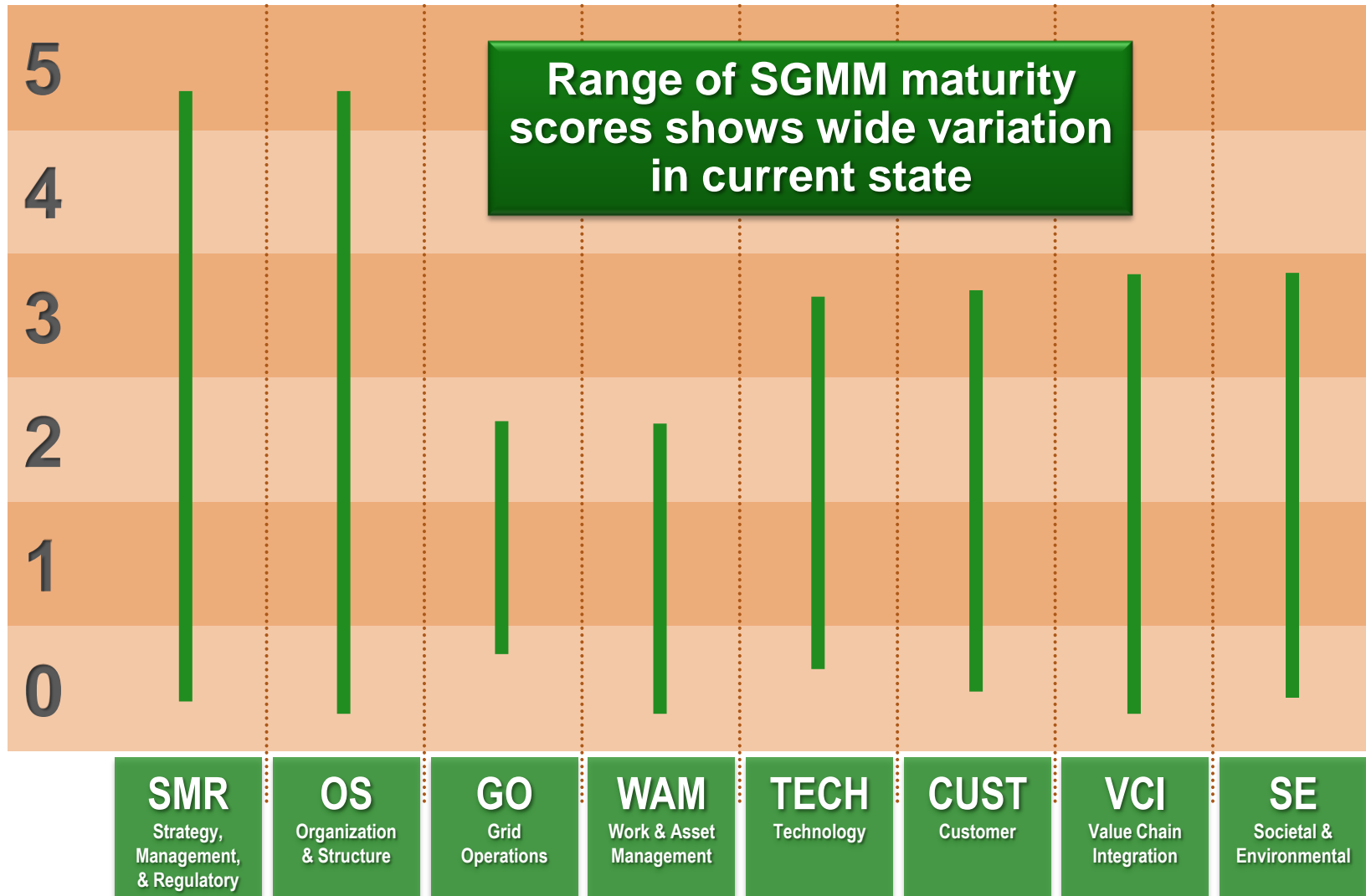
- Commissioned by California Energy Commission
- Performed by SAIC, an SGMM Partner
- Led by Steven Rupp, an SGMM Navigator
- Focused on 13 publicly-owned utilities
- Using SGMM to support roadmap development



# Project approach



# SGMM results for participating CA POU



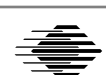
# Visions for 2020

Three distinct visions emerged for the participating utilities:

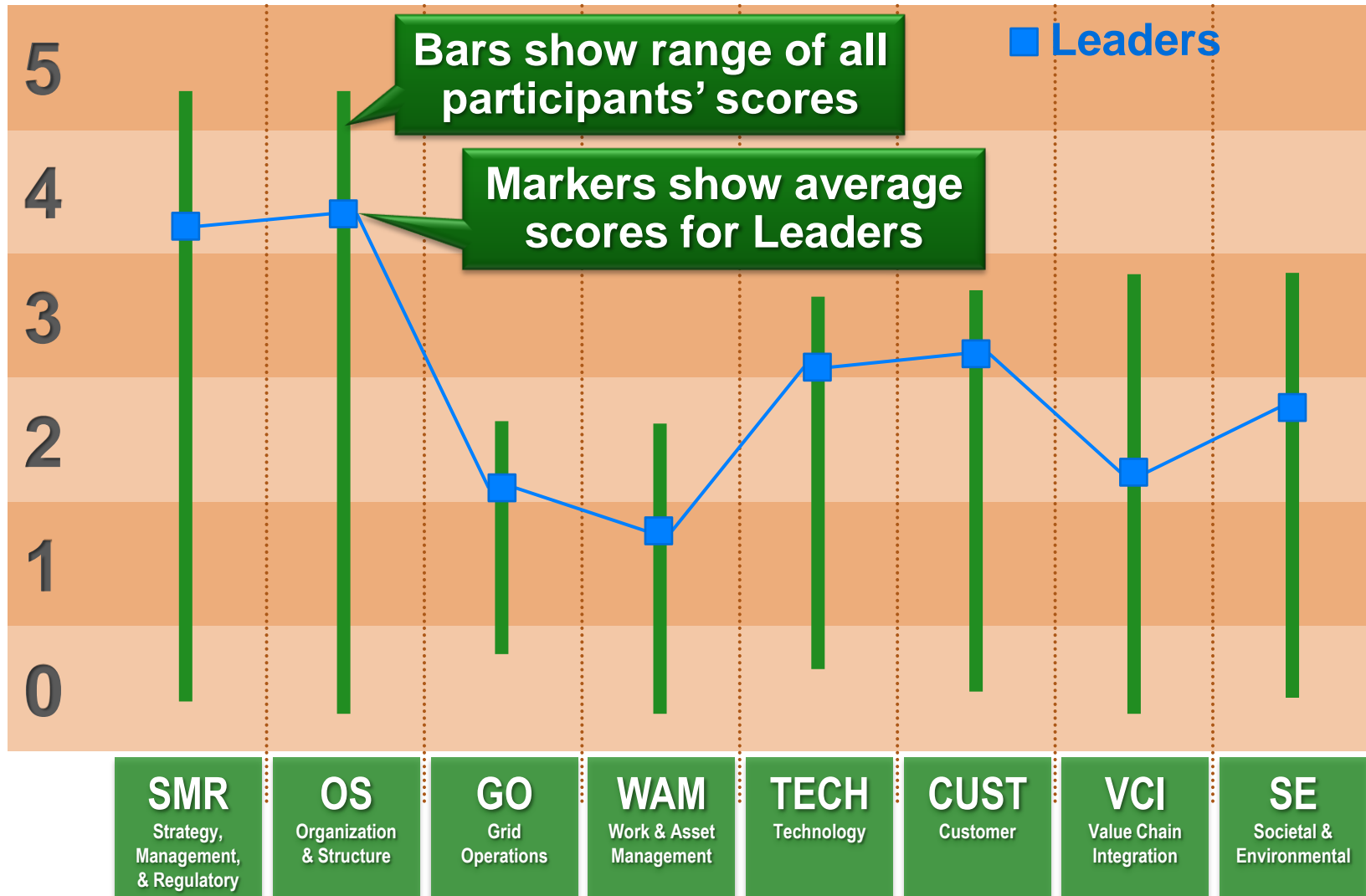
- **Leaders**
- **Fast Followers**
- **Followers**

The visions are characterized by

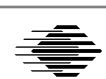
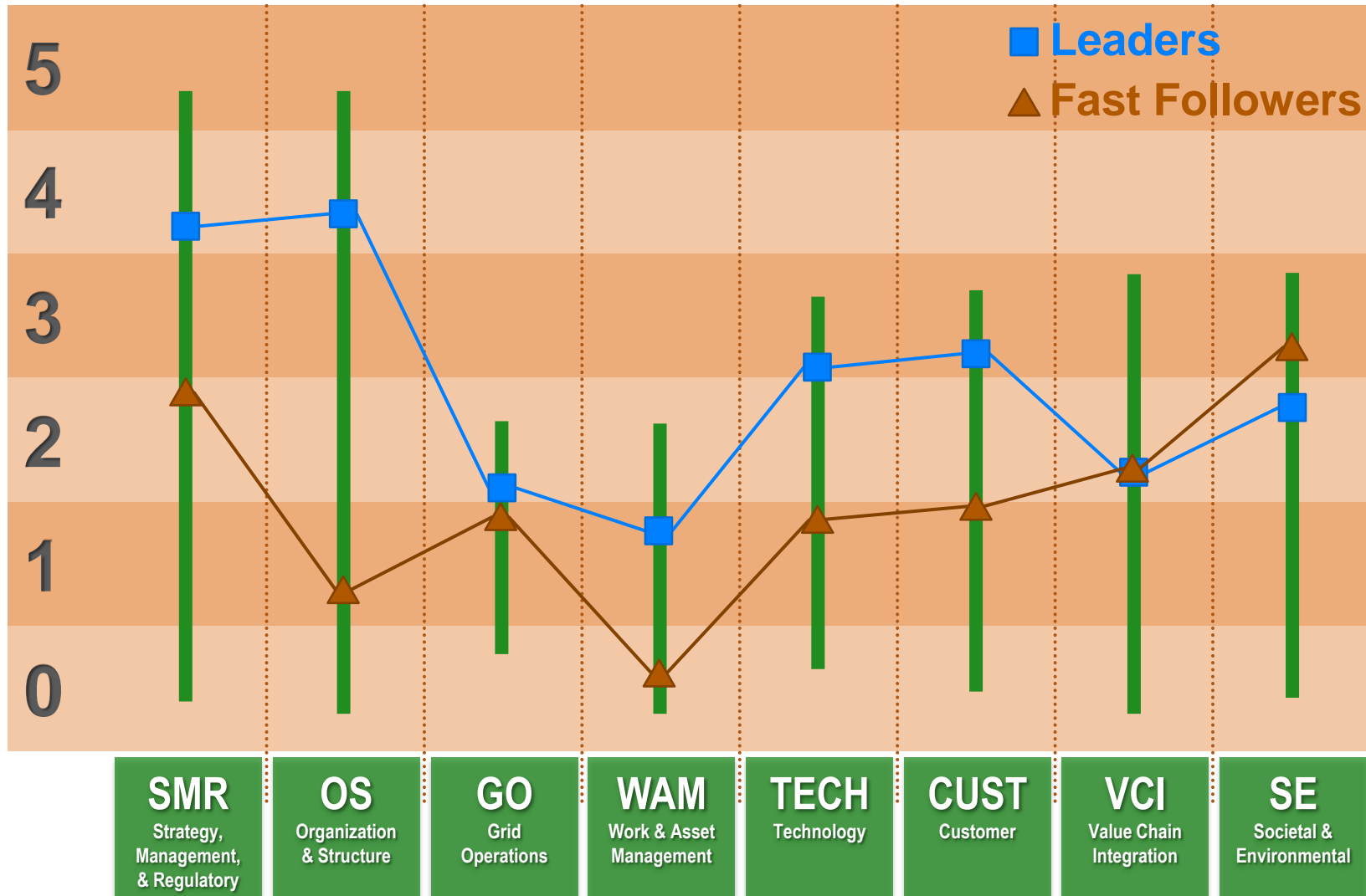
- Differences in planned pace and scope of smart grid deployment
- Varying financial, environmental and social priorities of the communities that govern and are served by local POUs



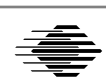
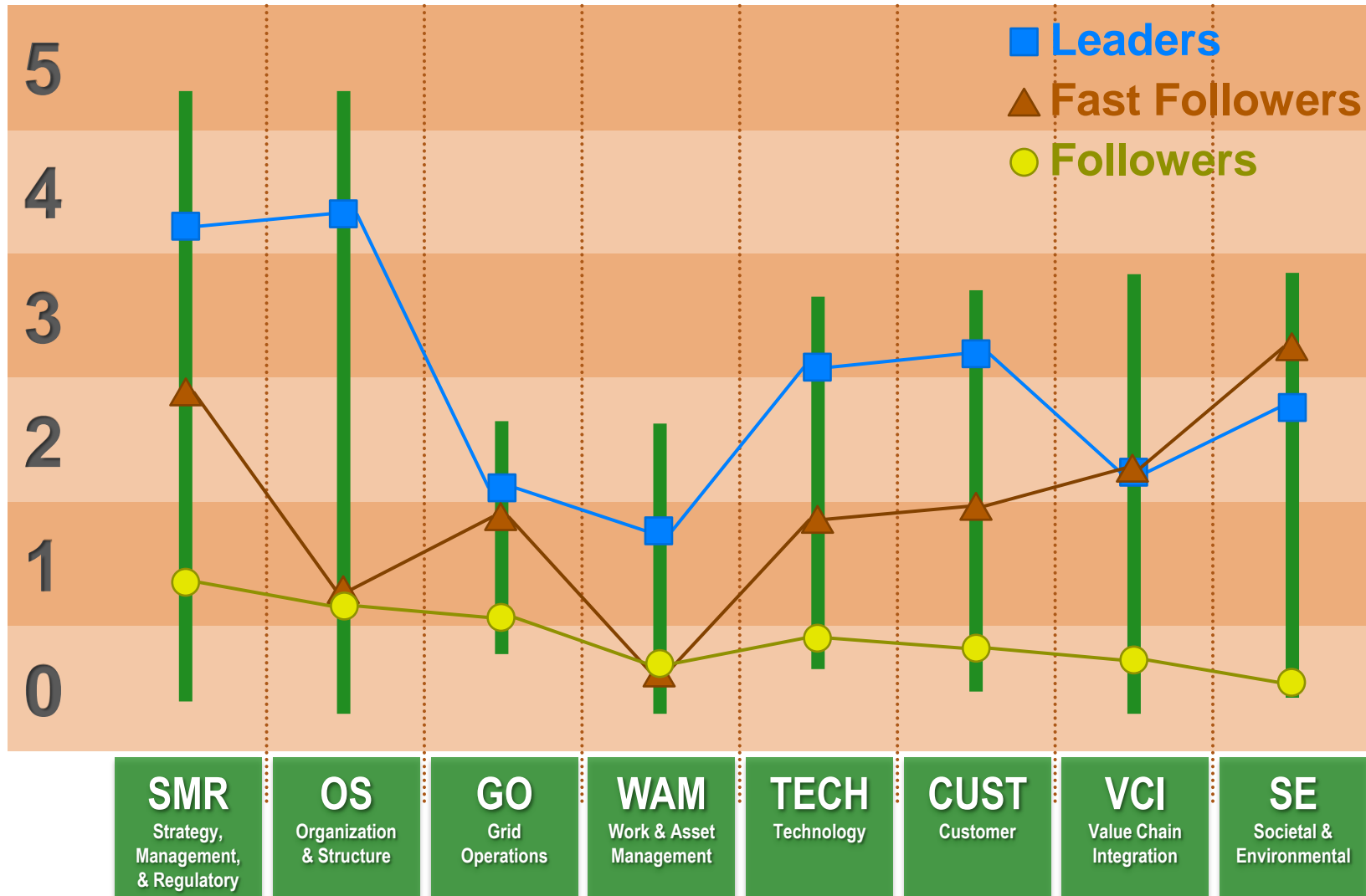
# Leaders



# Leaders, Fast Followers



# Leaders, Fast Followers, Followers



# Reported benefits

## Planning

- In several instances, SGMM Navigation provided the first opportunity for utilities to have a comprehensive discussion about smart grid among regulators, managers and staff.
- Utilities are aligning smart grid initiatives into their strategic plans using SGMM language.

## Executing

- Utilities are using SGMM to evaluate progress and success of current initiatives.

## Publicizing

- Utilities are using results to broadcast impact of smart grid programs.
- Project is garnering national interest and attention by public power.



# Outline

SGMM Introduction

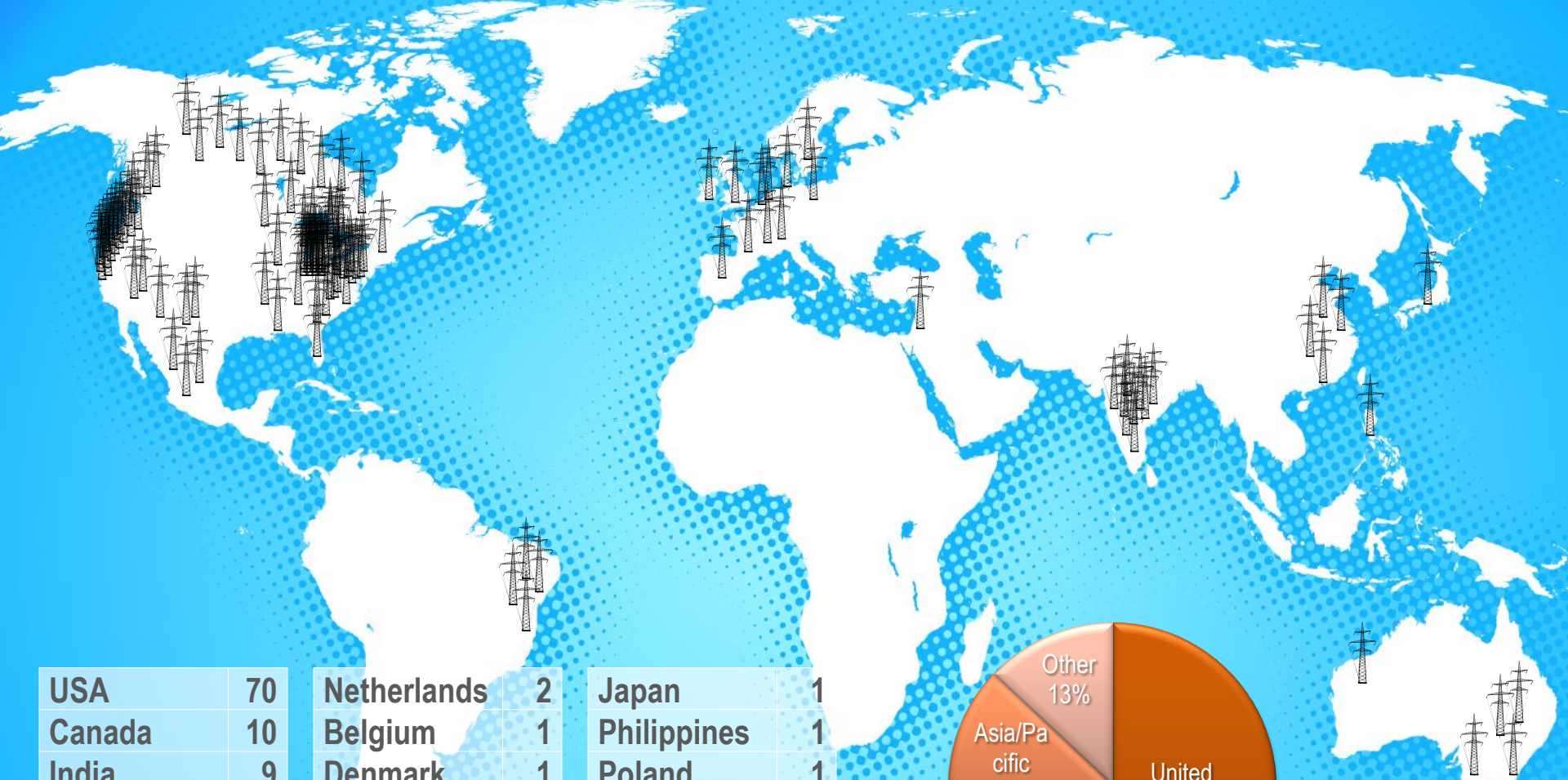
2011 SGMM Milestones

- Version 1.2 release
- Building a community of SGMM Navigators
- SGMM usage highlight: the California-SAIC project
- ▶ • SGMM community data as of September 2011

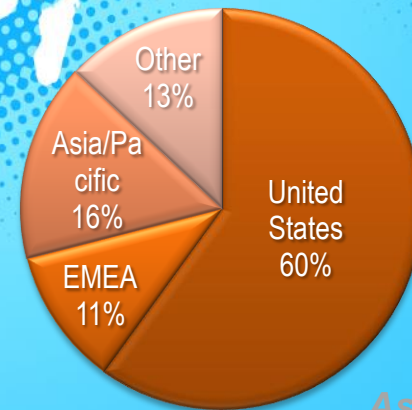
Conclusion and discussion



# SGMM community: 119 utilities in 21 countries



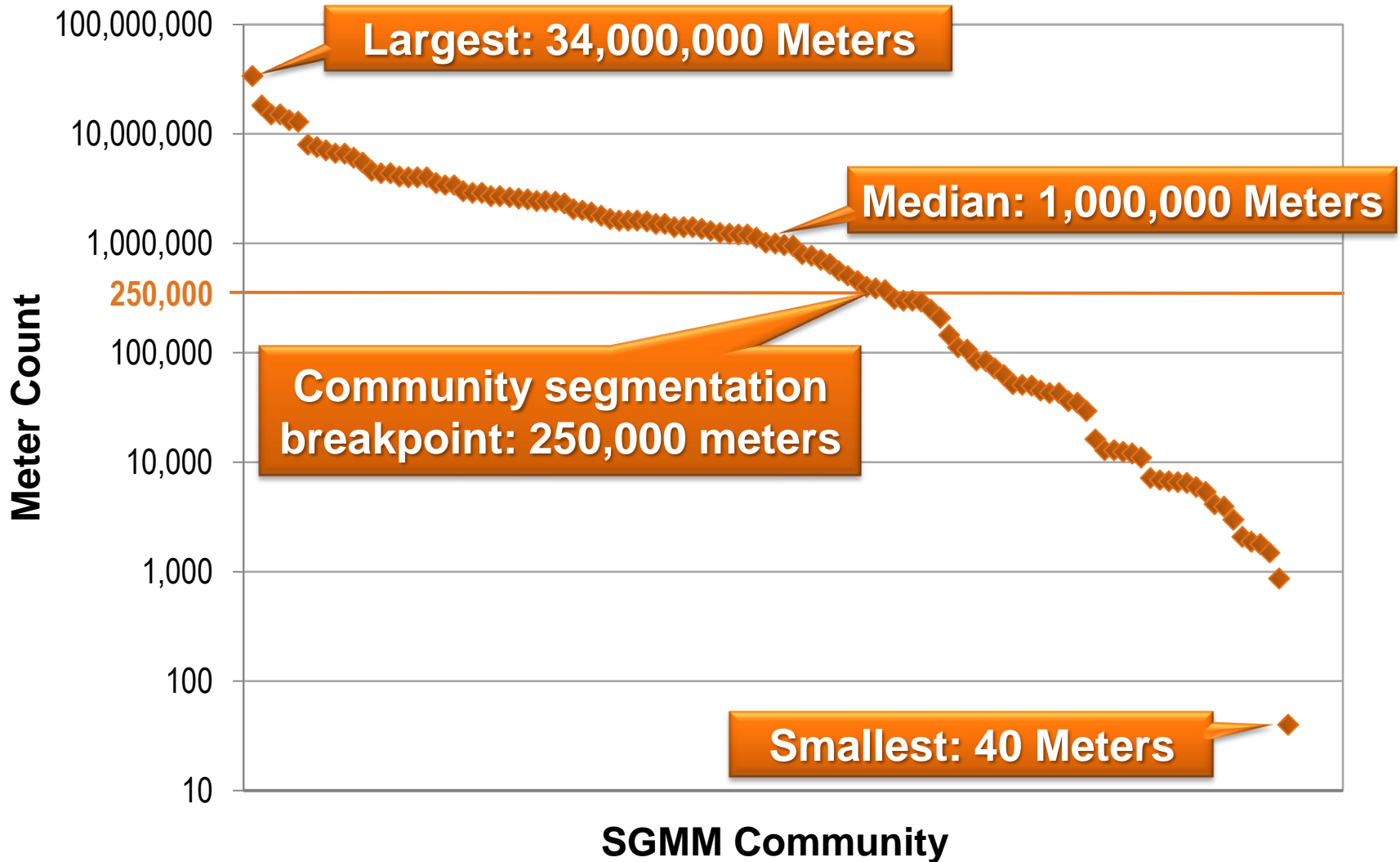
USA	70	Netherlands	2	Japan	1
Canada	10	Belgium	1	Philippines	1
India	9	Denmark	1	Poland	1
Australia	5	France	1	Spain	1
Brazil	4	Hong Kong	1	Sweden	1
China	3	Ireland	1	Switzerland	1
Mexico	3	Israel	1	UK	1



*As of September 2011*



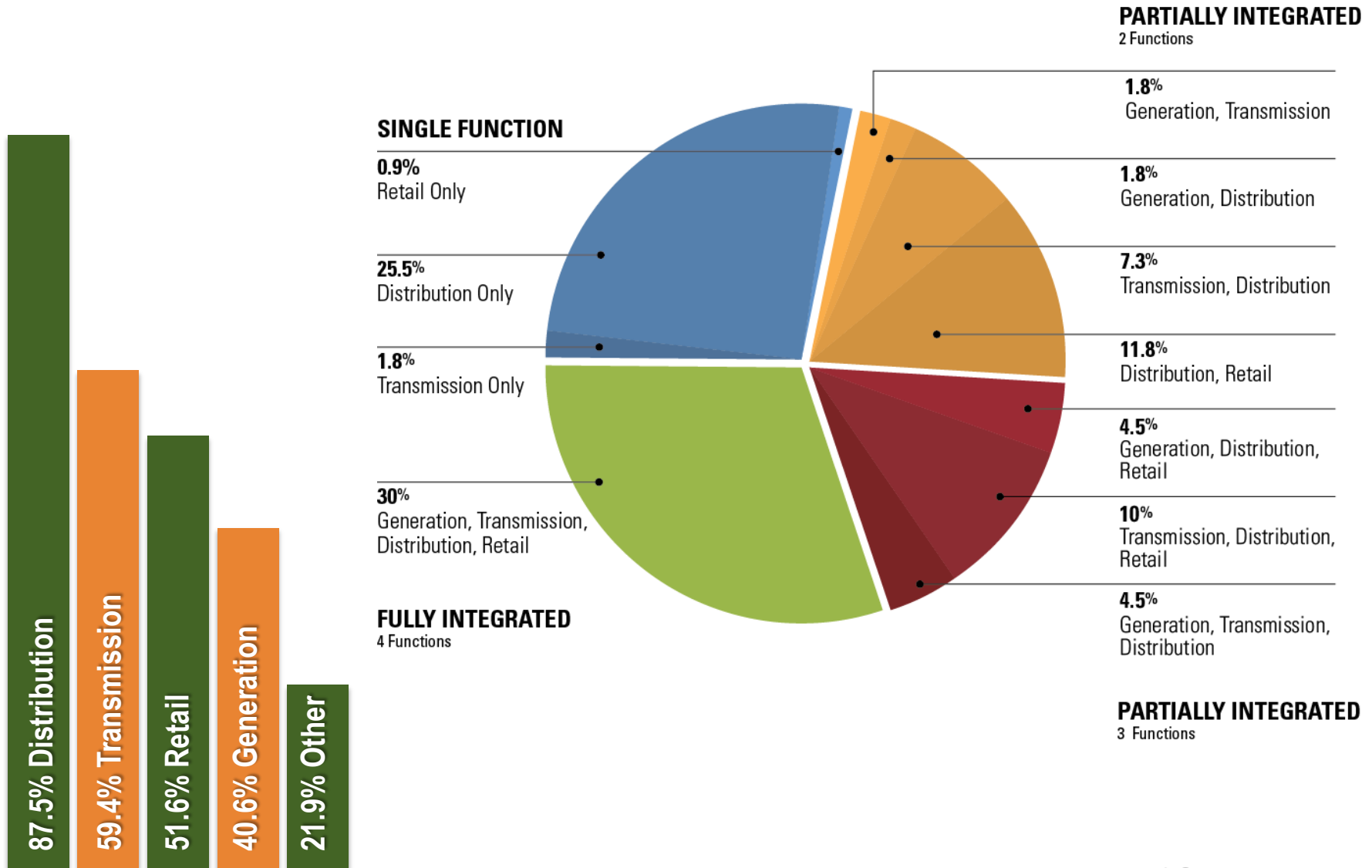
# SGMM community – meter count diversity



*As of September 2011*



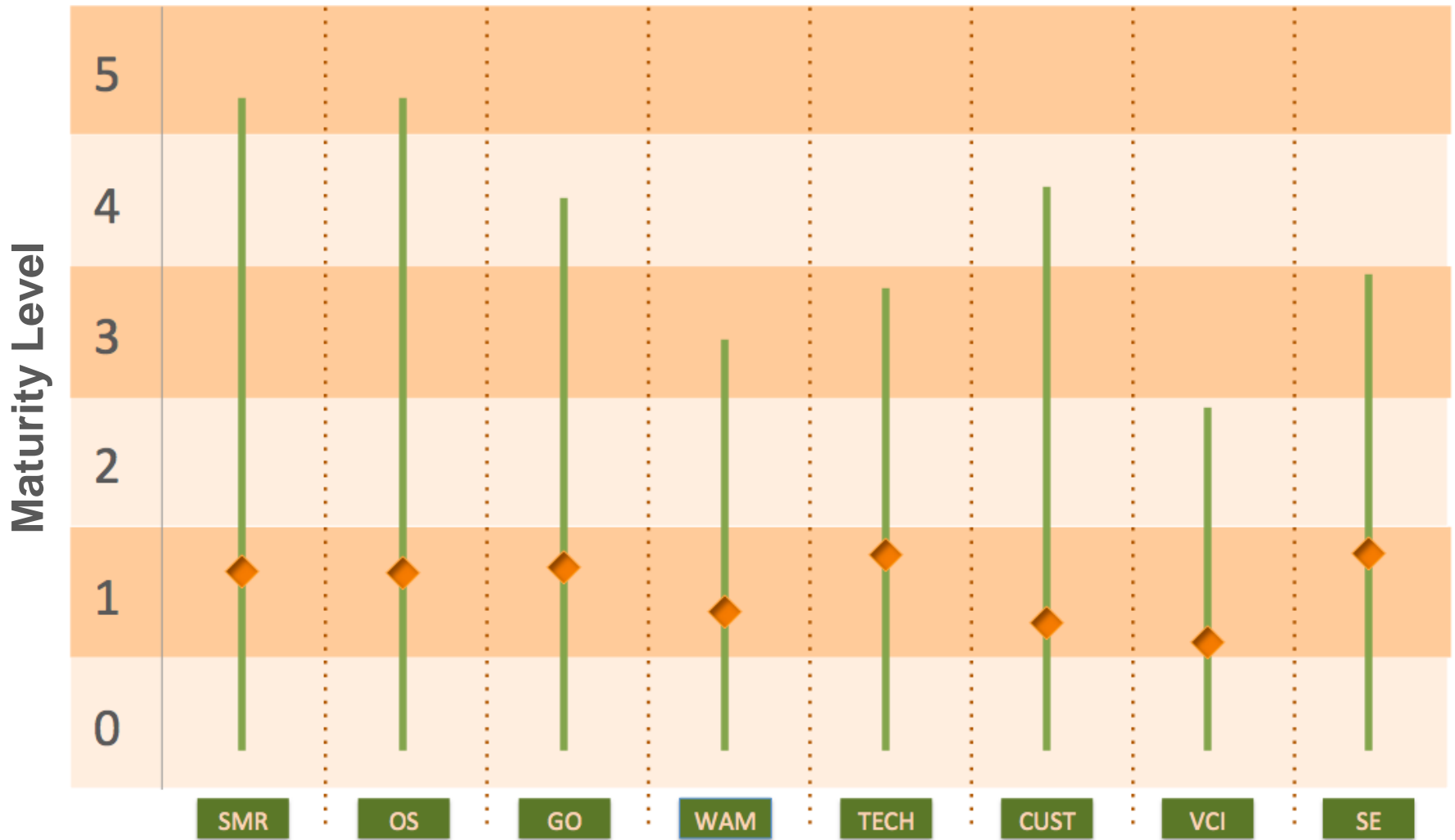
# SGMM community – utility type



As of September 2011



# SGMM community – maturity average & range



As of September 2011



# Outline

SGMM Introduction

2011 SGMM Milestones

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 Conclusion and discussion



# Conclusion & questions

SGMM has proven to be a useful tool for utilities of all descriptions in support of planning their smart grid program and tracking progress.

The community of users and practitioners of the model is global and growing. As the community grows, the model becomes increasingly useful as a repository of industry experience.

As demonstrated in the California project, SGMM can be effectively deployed to better understand a group of utilities, and align their efforts with broader policy goals.

Data collected by SEI on the use of the model and the performance of utilities using the model will continue to provide insights and a basis for informative comparison by model users.



**For more information**

## **SEI Customer Relations**

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Q&A



**Plug in and Get Connected  
to the SGMM**



**@SGMM\_Navigator**



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**SGMM User Forum**

