

Facilitated Discussion on the Future of the Power Grid

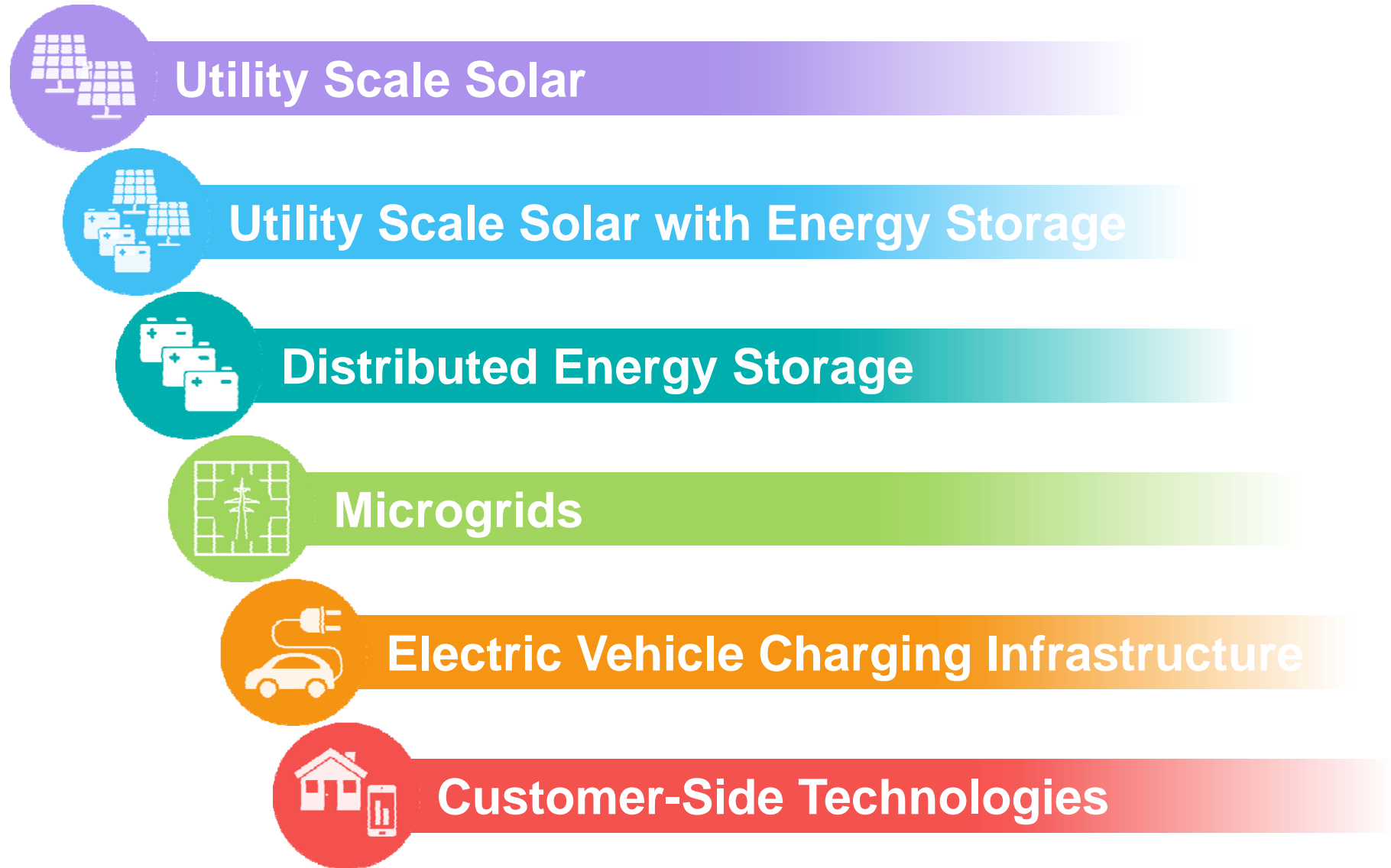
**EPRI Seminar: Integrated Grid Concept
and Technology Development**

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Matt Wakefield, Director Information,
Communication and Cyber Security (ICCS)



Integrated Grid Demonstration Pilots



Utility Scale PV



Technology Options

- Single site or multiple site array installations
- Smart inverters as grid interface
- Monitoring and controls infrastructure

Architecture and Integration

- Monitoring, communications and control of PV plant
- Assessment of inverter functionality with utility system controls
- Integration of PV plant with central resources and dispatch

Research Options

- Test the need for and benefits of integrated PV deployment
- Assess resultant impacts to distribution system (operational, protection/coordination, work practices, system planning)
- Evaluate impact on and support to bulk system voltage and frequency
- Evaluate plant performance relative to local feeder integration and wider balancing operations
- Assess impacts of advanced solar forecasting upon asset utilization and planning
- Evaluate communications/cyber standards to optimize system operability and security

Business Models

- Benefit cost analysis to value integration of the PV plant and the grid
- Understand optionality for RPS requirements through an owned/operated and potentially rate based asset
- Judge locational benefits of PV plant vs. other potential system investments

Validate operability of a key intermittent generating resource along with system impacts

Utility Scale PV with Energy Storage



Technology Options

- Single site or multiple site array installations
- Smart inverters as grid interface
- Storage medium/technology
- Monitoring and controls infrastructure

Architecture and Integration

- Monitoring, communications and control of PV-storage plant
- Assessment of inverter functionality with utility system controls
- Integration of plant with central resources & dispatch

Research Options

- Test the need for and benefits of integrated PV-storage deployment
- Assess the inverter and grid interface functionalities of the PV and storage systems
- Assess resultant impacts to distribution system (operational, protection/coordination, work practices, system planning)
- Determine resource adequacy/capacity value contribution of PV-storage system as well as support to bulk system voltage and frequency
- Assess battery and PV participation in ancillary services markets
- Evaluate plant performance relative to local feeder integration & wider balancing operations
- Assess impacts of advanced solar forecasting upon asset utilization and planning

Business Models

- Benefit cost analysis to value integration of the PV-storage plant and the grid
- Understand optionality for RPS requirements through an owned/operated & potentially rate based asset
- Value PV-storage participation in ancillary markets
- Judge locational benefits of PV-storage plant vs. other potential system investments

Validate PV operability with a variety of storage system support and arbitrage options

Distributed Storage



Technology Options

- Customer scale assets (1-100kW)
- Utility scale assets (kW to MW range)
- Monitoring and control infrastructure

Architecture and Integration

- Monitoring, communications and control of storage assets
- Assessment of inverter functionality with utility system controls
- Integration of storage with central resources & dispatch

Research Options

- Test the need for and benefits of integrated storage
- Determine optimal locations for storage based on feeder configurations as well as storage system attributes
- Evaluate storage operating strategies coordinated with other DER assets in the area through the use of advanced distribution automation
- Evaluate impact on and support to system voltage and frequency

Innovative Rate Structures

- Develop & implement experimental rate riders for customer scale installations

Business Models

- Benefit cost analysis to value integration of storage and the grid
- Understanding how the use of storage can provide multiple value streams when managed in grid operations

Balance intermittent resources while improving asset utilization at the distribution level

Microgrids



Technology Options

- Distributed energy resources
- Combined heat & power systems
- Microgrid controllers

Architecture and Integration

- Monitoring, communications and control of microgrid assets
- Use/control of microgrid infrastructure as an integrated asset

Research Options

- Assess various microgrid configurations, interconnection & operational issues
- Evaluate microgrids as dispatchable resources for grid support-voltage/frequency support, peak load reductions and community power support
- Evaluate grid-tied and islanded modes of operation
- Assess locational factors for community vs. facility microgrids

Innovative Rate Structures

- Develop & implement experimental rate riders
- Test pricing models relative to grid support, load management & reliability

Business Models

- Develop a microgrid technical & cost/benefit analysis framework for resiliency related investments and advanced customer offerings

Evaluate reliability & resiliency impacts of microgrids on the utility grid as well as isolated and critical customers

EV Charging Infrastructure



Technology Options

- Level 1 and 2 home EV charging stations
- Public charging infrastructure (3rd party & utility owned)
- Monitoring and control infrastructure

Architecture and Integration

- Monitoring, communications and control of charging sessions
- Use/control of charging infrastructure as an integrated asset

Research Options

- Test the need for and benefits of integrated deployment
- Test hardware, software, and grid integration
- Analyze customer behavior
- Evaluate impact on greater adoption/use of EV's

Innovative Rate Structures

- Develop & implement experimental rate riders
- Evaluate time of use rates for charging behavior impacts
- Test pricing influence on use of Level 1 vs. Level 2 charging options

Business Models

- Enhanced understanding of technology, integration, customer behavior and societal benefits
- Increased adoption and usage of electric transportation

Understand emerging options for managing EV charging to benefit all customers

Customer Side Technologies



Technology Options

- Distributed generation, energy storage
- Smart thermostats & appliances
- EV's, home energy management systems

Architecture and Integration

- Integration of multiple customer technologies with a diversity of communications approaches/protocols
- Security, privacy, interoperability and open standards options

Research Options

- Assess customer behavior/acceptance around technology & pricing options
- Evaluate technology performance & life cycle economics
- Understand how customer technologies can be aggregated & integrated into a grid resource

Innovative Rate Structures

- Develop & implement experimental rate riders
- Test dynamic pricing models to shape customer usage

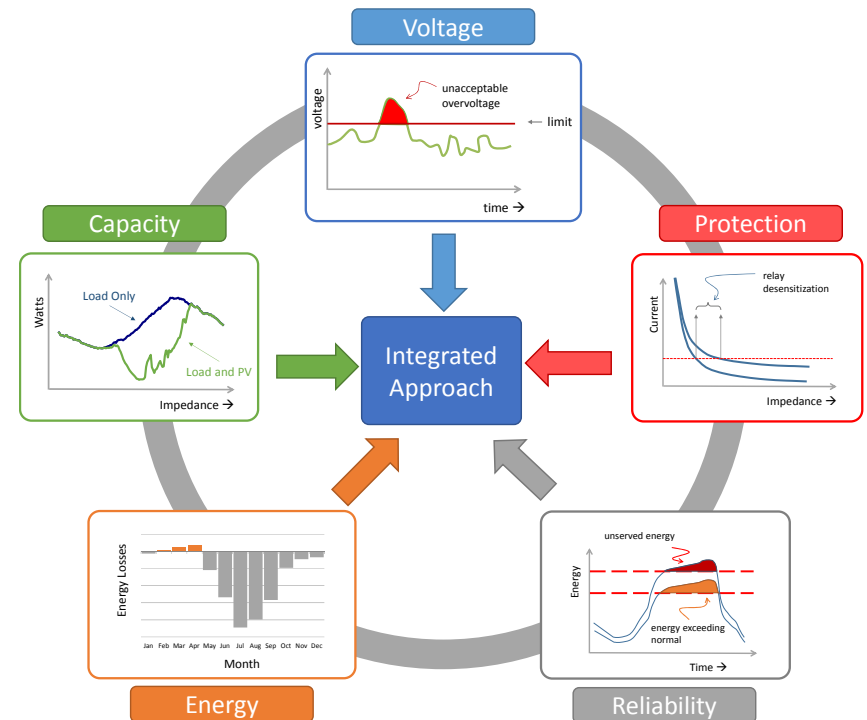
Business Models

- Develop new programs for customers that provide greater customer efficiency & related benefits
- Increase adoption rates of electrically powered customer loads

Performance & cost evaluations for behind the meter technologies to drive new business opportunities & support the grid

Discussion on Existing Projects and Necessary R&D for Integration of Distributed Energy Resources (DER)

- **What Research Projects are you doing in Japan related to an Integrated Grid?**
 - Utilities, NEDO, CRIEPI, Others?
- **Short-term (6-12 months) research needs for Integration of DER?**
- **Long-Term (3-5 years) research needs for Integration of DER?**
- **EPRI's Integrated Grid Approach**
 - Is it useful to you?
 - How could it be improved?





Together...Shaping the Future of Electricity