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Automation & Power World 2011

WPS-156-1: A smart grid vision from source to socket

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WPS-156-1: A smart grid vision from source to socket

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- **Speaker Title: GM and VP EPM Commercial Operations**
- **Company Name: Ventyx, an ABB Company**
- **Location: Orlando, FL**

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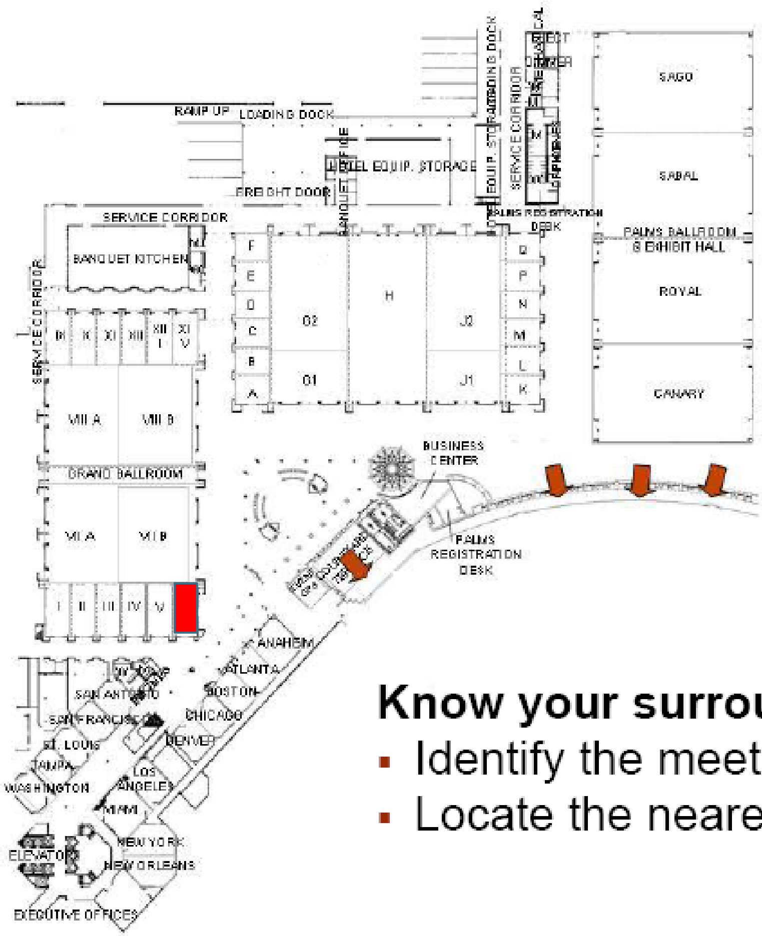

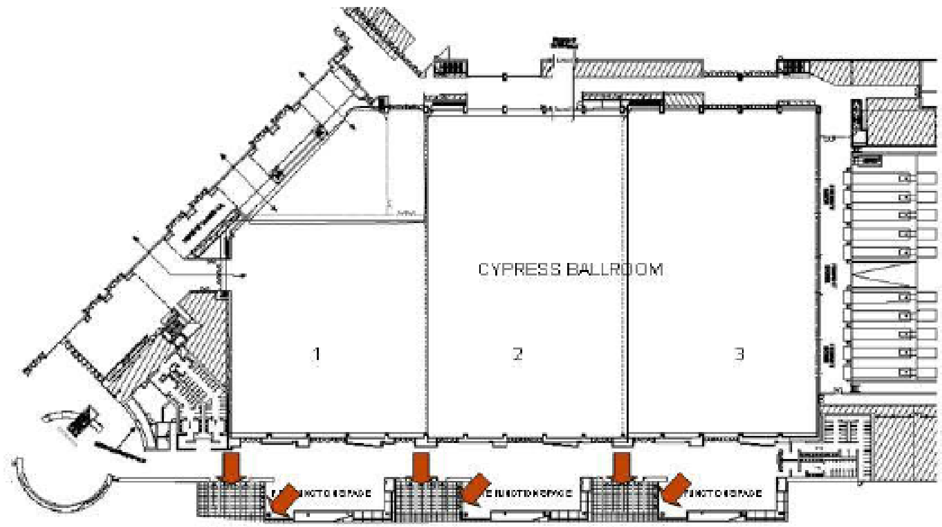

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Agenda

- Smart Grid Defined
- Smart Grid from Source to Socket
- Integrating Operations Technology with IT
- Where are we on the path to Smart Grid?
- Recent examples of progression towards Smart Grid

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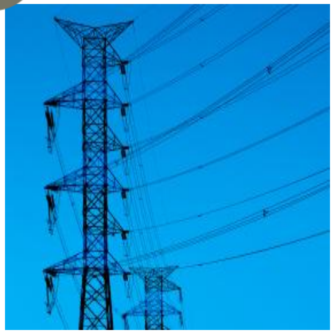
What is Smart Grid?

- **US DOE characteristics or performance features of a smart grid:**
  - Self-healing from power disturbance events
  - Enabling active participation by consumers in demand response
  - Operating resiliently against physical and cyber attack
  - Providing power quality for 21st century needs
  - Accommodating all generation and storage options
  - Enabling new products, services, and markets
  - Optimizing assets and operating efficiently

5 ways Smart Grid technologies improve the grid from Source to Socket

1 CAPACITY

2 RELIABILITY



3 EFFICIENCY

4 SUSTAINABILITY

5 CUSTOMER ENABLEMENT

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Capacity: New opportunities present new challenges

- In 2020 the fleet of electric cars could reach 40 million world wide, around 2 percent of the cars then on the road[1]
- The infrastructure for charging the vehicles has to be built
- Fast charging options cannot be provided by the current grid infrastructure

[1] Sources: CS Investment Bank, Boston Consulting, Renault-Nissan, Roland Berger

Transmission Grid Management
Connecting renewables to the grid

- **Renewable sources need to be connected to the grid, but they are often located remotely and in challenging locations.**
- **HVDC – High Voltage Direct Current lines decrease line loss and connect remote sources**
- **FACTS - Flexible AC transmission systems (FACTS) for improved power transfer**

Distribution Grid Management
Optimizing the grid to increase capacity

- Grid operators get limited feedback from the traditional grid making it difficult to detect incipient problems and take corrective action. When the system has a problem handling peak load their response is reactive.

- Volt/VAr Optimization – Reduction in feeder losses and peak demand create additional distribution capacity. VVO can reduce feeder losses by 4-5%

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Reliability
Brownouts and Blackouts Cost Billions Annually

- In U.S. the annual cost of system disturbances is an estimated $79 billion*
- Commercial ($57 billion), industrial ($20 billion) and residential ($2 billion) sectors affected
- Most cost ($52 billion) due to short momentary interruptions

* Berkley National Laboratory

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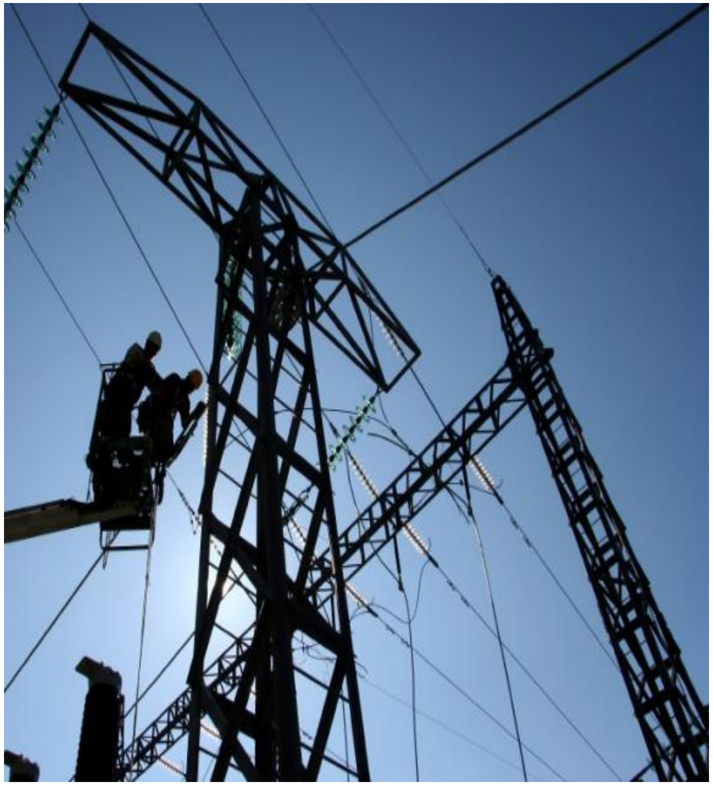
Distribution Grid Management

Reducing outage duration with quick response

- **In order to reduce outage time and increase power quality utilities need technologies that give them remote access to grid status and the tools they need to respond to problems.**
- **Distribution Management Systems (DMS) – allows the grid operator to monitor status of the grid and manage grid disturbances and can drive a substantial reduction in outage duration.**
- **Outage Management Systems (OMS) – Automates and integrates outage management response for more timely outage location and repair.**
- **Fault Detection Isolation and Restoration (FDIR) – “Self Healing” reduces duration of outages by isolating problems on the grid.**

Asset Health Management

Managing assets to minimize disruptions



- **Utilities must effectively manage aging and capacity constrained assets to minimize disruptions.**
- **Data Collection – collects condition data of assets in the field.**
- **Asset Health Decision Support – analyzes the data to determine the health of the asset and recommended actions.**
- **Workforce and Asset Management – manages the execution of preventative and predictive maintenance.**

Distribution Grid Management

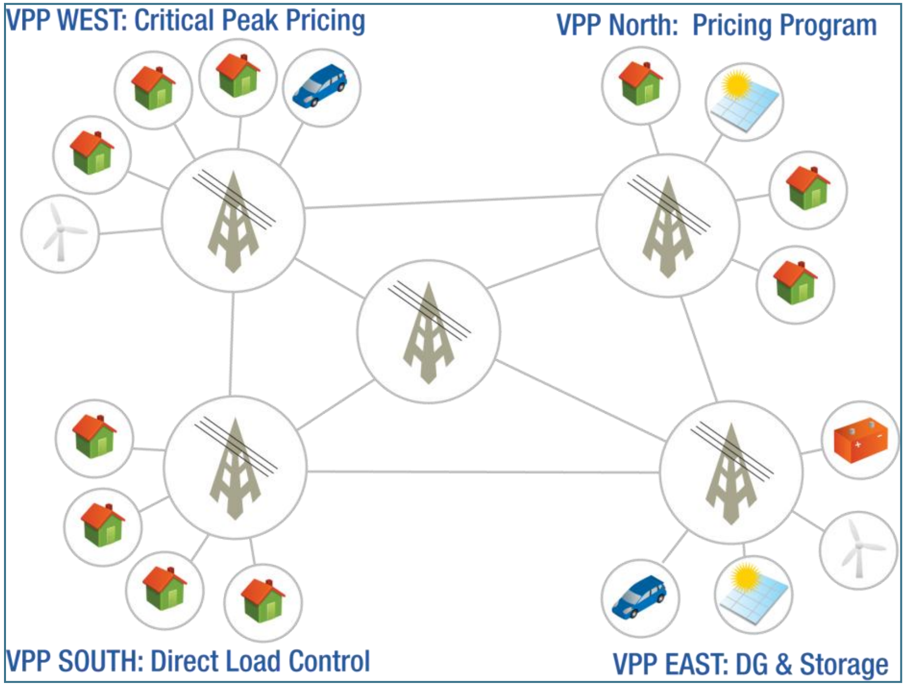
Optimizing power for maximum efficiency

- **Reactive power can account for a significant portion of distribution losses. Utilities need to manage the amount of reactive on the grid to ensure maximum efficiency. A 1% improvement in efficiency is estimated to eliminate 100 million tons of CO_2.**

- **Volt/VAr Optimization – Optimizing the balance between active and reactive power can allow for reduction energy losses on the distribution feeders of 4-5%**

Distributed Energy Resources and Electric Vehicles

The power to optimize energy production choices

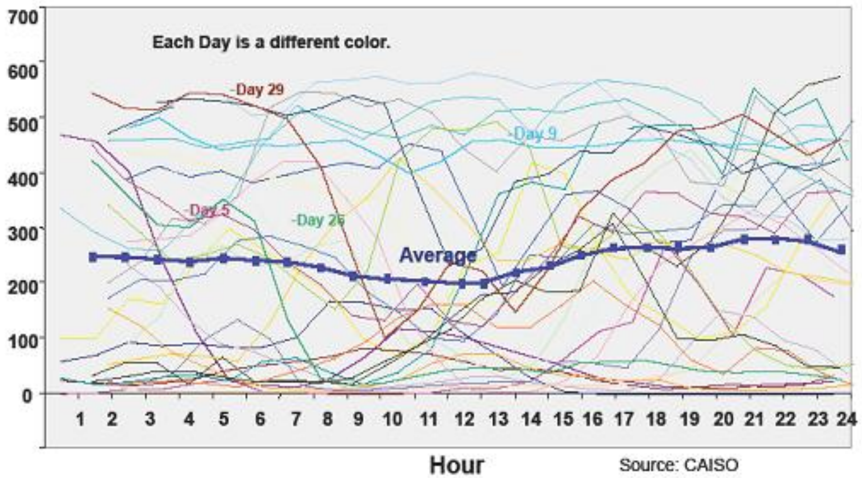


- **With distributed energy resources, utility operators need visibility into demand and the ability to quickly assess the most efficient power sources to address requirements.**
- **Virtual Power Plants– Provides operator information on grid requirements as well as information on sources including costs, emissions, and availability.**

Asset Health Management
Extending the life of critical assets

- **Many utilities and companies have aging transformers situated in strategic locations.**
- **The failure and replacement rate is expected to increase 5X in the next 15 years. The cost of failure is high so these critical assets need to be performing at peak condition in order to ensure the grid efficiency.**
- **Condition Based Maintenance - Provides operators with information on actual operating condition of the equipment instead of relying on past experience to ensure peak performance.**

Sustainability
Connecting renewable sources to the grid



- Renewables will be the primary source of new energy production in the future
- By their very nature, renewables are variable. Solutions will be needed to store energy for peak demand or to supplement when renewable production is low.
- Renewable sources of energy are often located in remote regions and are variable in nature. Energy storage can help meet requirements during peak times.
- Utility Scale Energy Storage – Allows energy to be stored to address variability of renewable sources.

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Distributed Energy Resources and Electric Vehicles
Enabling edge of grid technologies

- **Renewable sources of energy, especially solar, are often highly distributed. These sources need to be connected to the grid.**
- **Community Energy Storage – stores energy locally at the feeder level of the power grid.**
- **Electric Car Charging– DC Fast Charging Stations can help eliminate “range anxiety” for electric car owners**
- **Distributed Generation – ABB power electronics and generation resource management software support solar PV renewable generation.**

Customer Enablement
Demand Response Management

- 67% of Americans say they would reduce their usage if they had visibility
- 68% of Americans polled never heard of "smart grid"
- 24% of international consumers would give utilities control over appliances when offered a price discount of 10%
- 29% of international consumers trust utilities to advise them on actions they can take to optimize their electricity consumption
- Trust and education are critical for the future of the Smart Grid

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Customer Enablement
Distribution Grid Management

- **Customers want choices, but they don't always have the same preferences - saving money, environmental impact, convenience**
- **Demand Response Management System – gives customers the power to set their own preferences such as:**
  - To cycle my air conditioning automatically during peak times
  - To shut off my pool pump when energy goes above a certain price
  - To delay energy use until it is available from my preferred source e.g. wind energy

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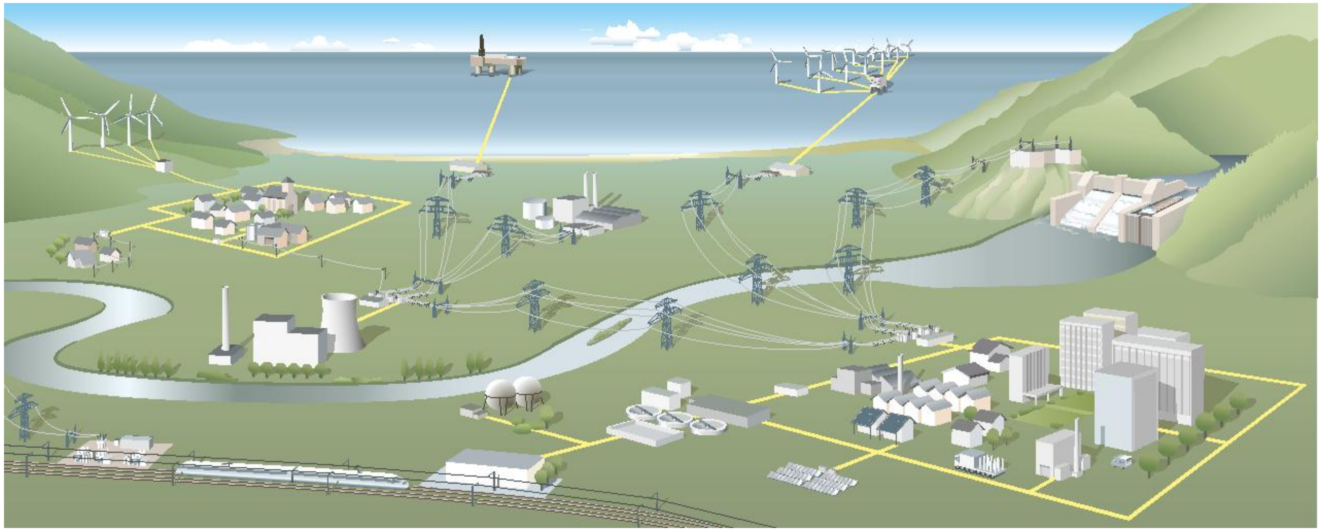
Smart Grid from Source to Socket

- **Capacity – expand the capacity of the grid to handle future requirements**
- **Reliability – reduce and shorten the duration of outages customers with the tools and information they need to make wise energy choices**
- **Efficiency – increase the efficiency of energy transmission and distribution.**
- **Sustainability – improve the viability of renewable sources of energy**
- **Customer Enablement – provide customers with the tools and information they need to make wise energy choices**



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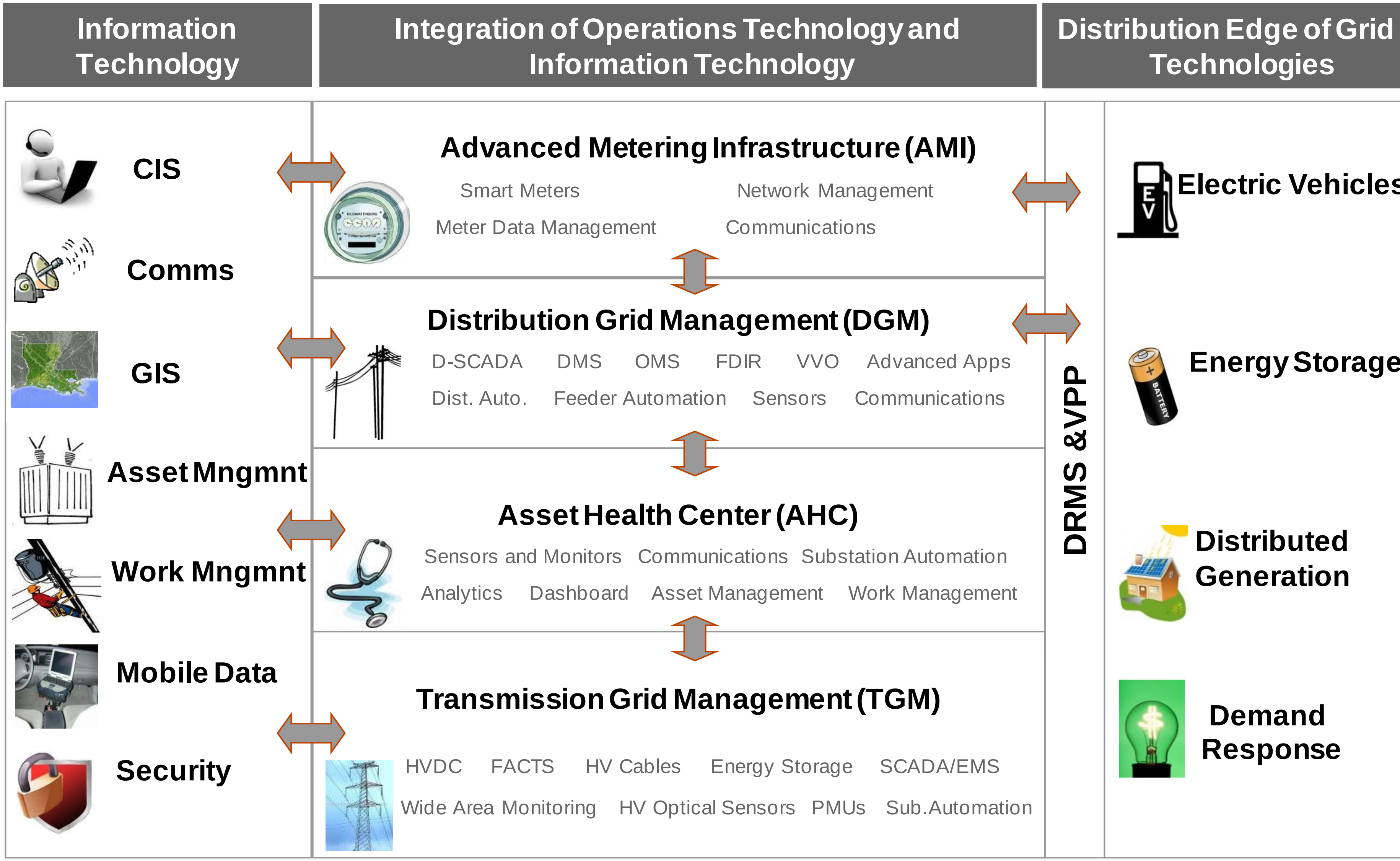
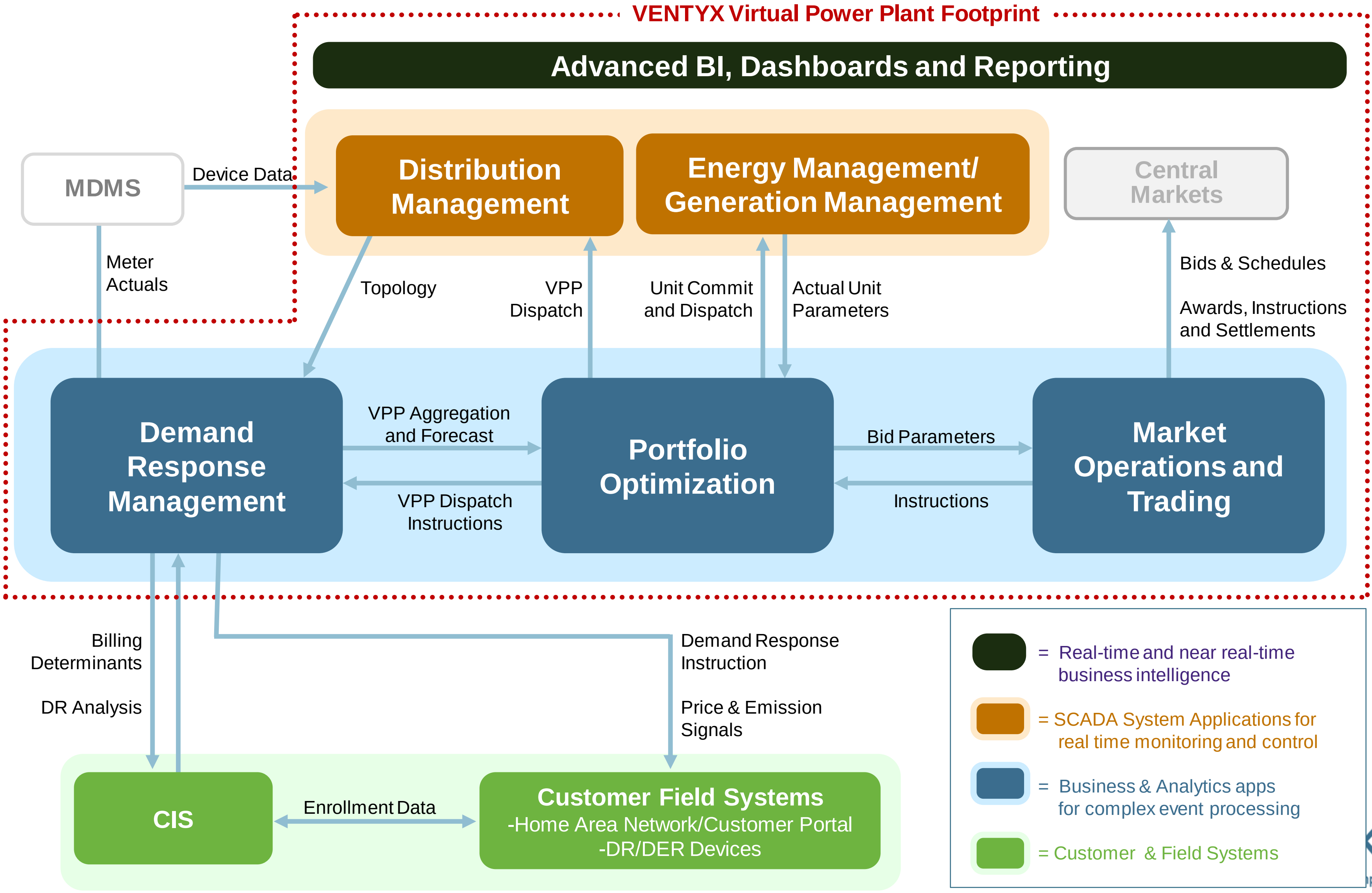
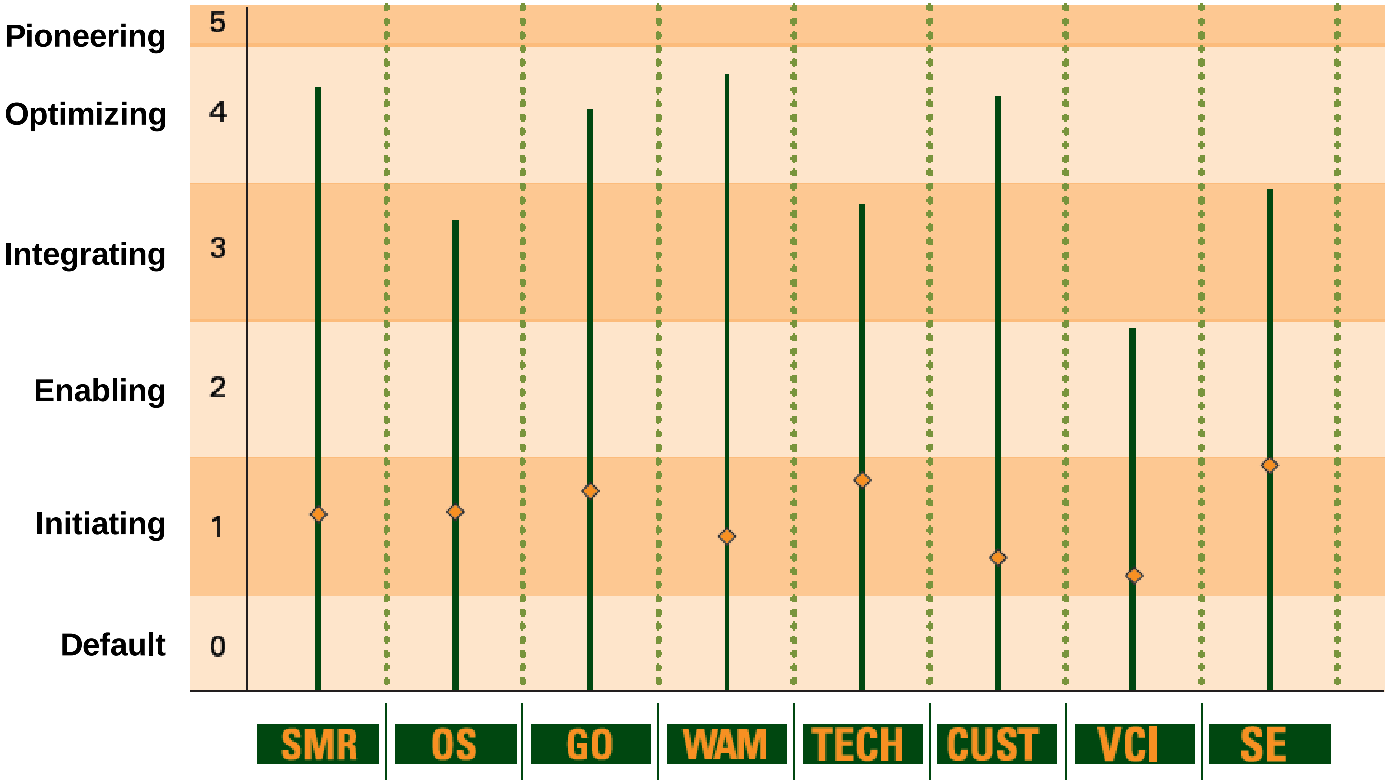
Integrating Operations Technology with IT



Integrating Operations Technology with IT with VPPs



Where are we on the path to Smart Grid?



SMR Strategy, Management, and Regulatory

OS Organization and Structure

GO Grid Operations

WAM Work and Asset Management

TECH Technology

CUST Customer

VCI Value Chain Integration

SE Societal and Environmental

Source: the Smart Grid Maturity Model (SGMM) from the Software Engineering Institute at Carnegie Mellon University

Where are we on the path to Smart Grid?
Technology

Initiating

- An enterprise IT architecture exists or is under development.
- Existing or proposed IT architectures have been evaluated for quality attributes that support smart grid applications.
- A change control process is used for applications and IT infrastructure.
- Opportunities are identified to use technology to improve departmental performance.
- There is a process to evaluate and select technologies in alignment with smart grid vision and strategies

Optimizing

- Data flows end to end from customer to generation.
- Business processes are optimized by leveraging the enterprise IT architecture.
- Systems have sufficient wide-area situational awareness to enable real-time monitoring and control for complex events.
- Predictive modeling and near real-time simulation are used to optimize support processes.
- Security strategy and tactics continually evolve based on changes in the operational environment and lessons learned.

Source: the Smart Grid Maturity Model (SGMM) from the Software Engineering Institute at Carnegie Mellon University

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Where are we on the path to Smart Grid?
Customer

Initiating

- Research is being conducted on how to use smart grid technologies to enhance the customer's experience, benefits, and participation.
- Security and privacy implications of smart grid are being investigated.
- A vision of the future grid is being communicated to customers.
- The utility consults with public utility commissions and/or other government organizations concerning the impact on customers.

Optimizing

- Support is provided to customers to help analyze and compare usage against all available pricing programs.
- There is outage detection and proactive notification at the circuit level.
- Customers have access to near real-time data on their own usage.
- Residential customers participate in demand response and/or utility-managed remote load control programs.
- Automatic response to pricing signals for devices within the customer's premise is supported.
- In-home net billing programs are enabled.
- A common customer experience has been integrated.

Source: the Smart Grid Maturity Model (SGMM) from the Software Engineering Institute at Carnegie Mellon University

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Where are we on the path to Smart Grid?
Grid Operations

Initiating

- Business cases for new equipment and systems related to smart grid are approved.
- New sensors, switches, and communications technologies are evaluated for grid monitoring and control.
- Proof-of-concept projects and component testing for grid monitoring and control are underway.
- Outage and distribution management systems linked to substation automation are being explored and evaluated.
- Safety and security (physical and cyber) requirements are considered.

Optimizing

- Operational data from smart grid deployments is being used to optimize processes across the organization.
- Grid operational management is based on near real-time data.
- Operational forecasts are based on data gathered through smart grid.
- Grid operations information has been made available across functions and LOBs.
- There is automated decision-making within protection schemes that is based on wide-area monitoring.

Source: the Smart Grid Maturity Model (SGMM) from the Software Engineering Institute at Carnegie Mellon University

Where are we on the path to Smart Grid?
Work and Asset Management

Initiating

- Enhancements to work and asset management have been built into approved business cases.
- Potential uses of remote asset monitoring are being evaluated.
- Asset and workforce management equipment and systems are being evaluated for their potential alignment to the smart grid vision.

Optimizing

- A complete view of assets based on status, connectivity, and proximity is available to the organization.
- Asset models are based on real performance and monitoring data.
- Performance and usage of assets is optimized across the asset fleet and across asset classes.
- Service life for key grid components is managed through condition-based and predictive maintenance, and is based on real and current asset data.

Source: the Smart Grid Maturity Model (SGMM) from the Software Engineering Institute at Carnegie Mellon University

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Recent Examples of progression towards Smart Grid

- **Managing Electric Vehicles**
  - Source to Socket Optimization
    - Capture and forecast charging demand
    - Optimize supply/demand/storage
    - Maintain reliability
- **Combining Workforce Management with Distribution Management**
  - Integrating Operations Technology with IT
    - Reduce outage restoration time
    - Increase workforce utilization and efficiency
    - Integrate operations and eliminate organizational silos
    - Accurately predict staffing for outages
- **Incorporating DER/DR into the Market**
  - Providing Customer Choice
    - Capture and forecast demand
    - Forecast DER/Renewables
    - Offer capabilities to market
    - Support settlement and billing

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