Automation & Power World 2011

WPS-003-1-Smart Grid: Introduction to Demand Response

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GM & VP EPM Commercial Operations

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

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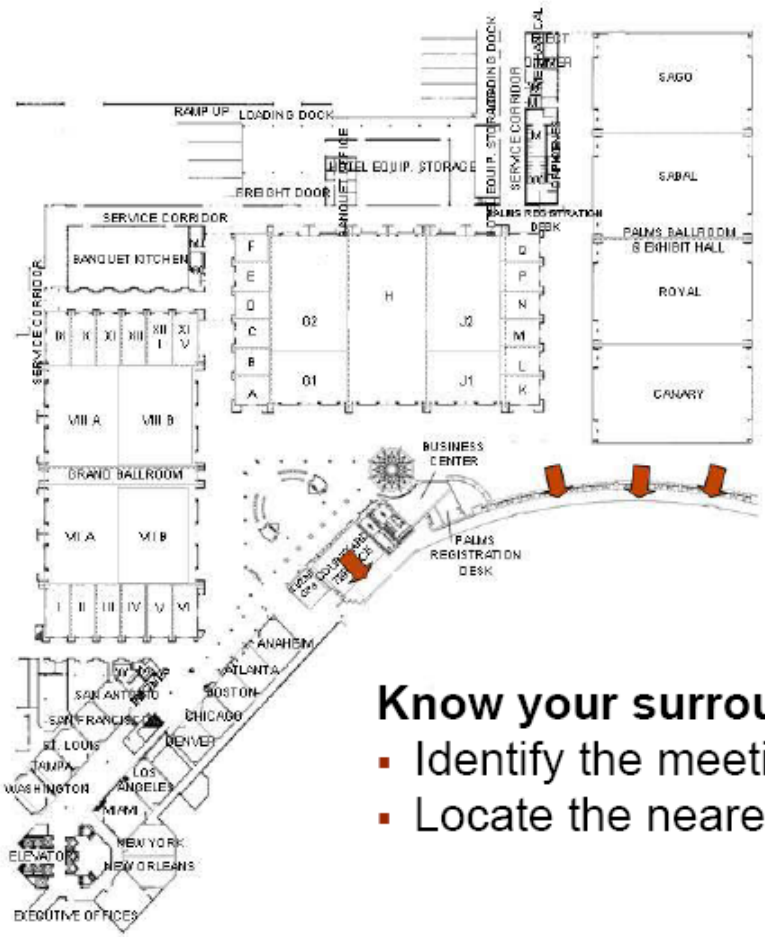

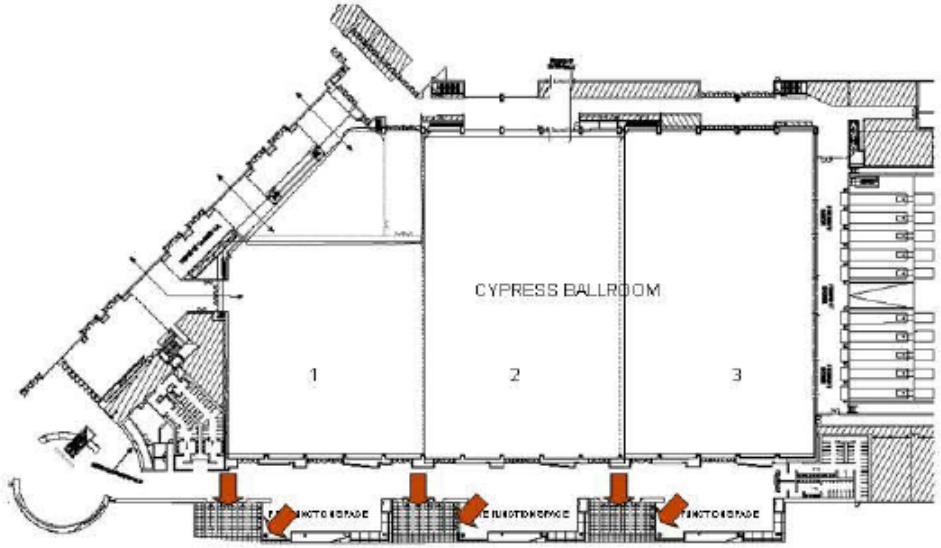

Know your surroundings:

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Agenda

- **Demand Response**
  - Definition
  - Potential DR Capacity
  - Benefits of DR
- **Virtual Power Plants**
- **Ventyx, an ABB Company Solution Map**
- **Ventyx Demand Response Management System**
- **ABB Smart Grid Landscape**

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Demand Response Definitions

- **Demand Response (FERC)- Changes in electric usage by demand-side resources from their normal consumption patterns in response to:**
  - Changes in the price of electricity over time
  - Incentive payments designed to induce lower electricity use at times of high wholesale market prices
  - System reliability issues
- **Virtual Power Plant (VPP)- Aggregation of resources including:**
  - Demand Response-based VPPs (DR)
  - Supply-side VPPs (DER)
  - Mixed Asset VPPs
- **Demand Response Program: The rules governing the operation of demand response**

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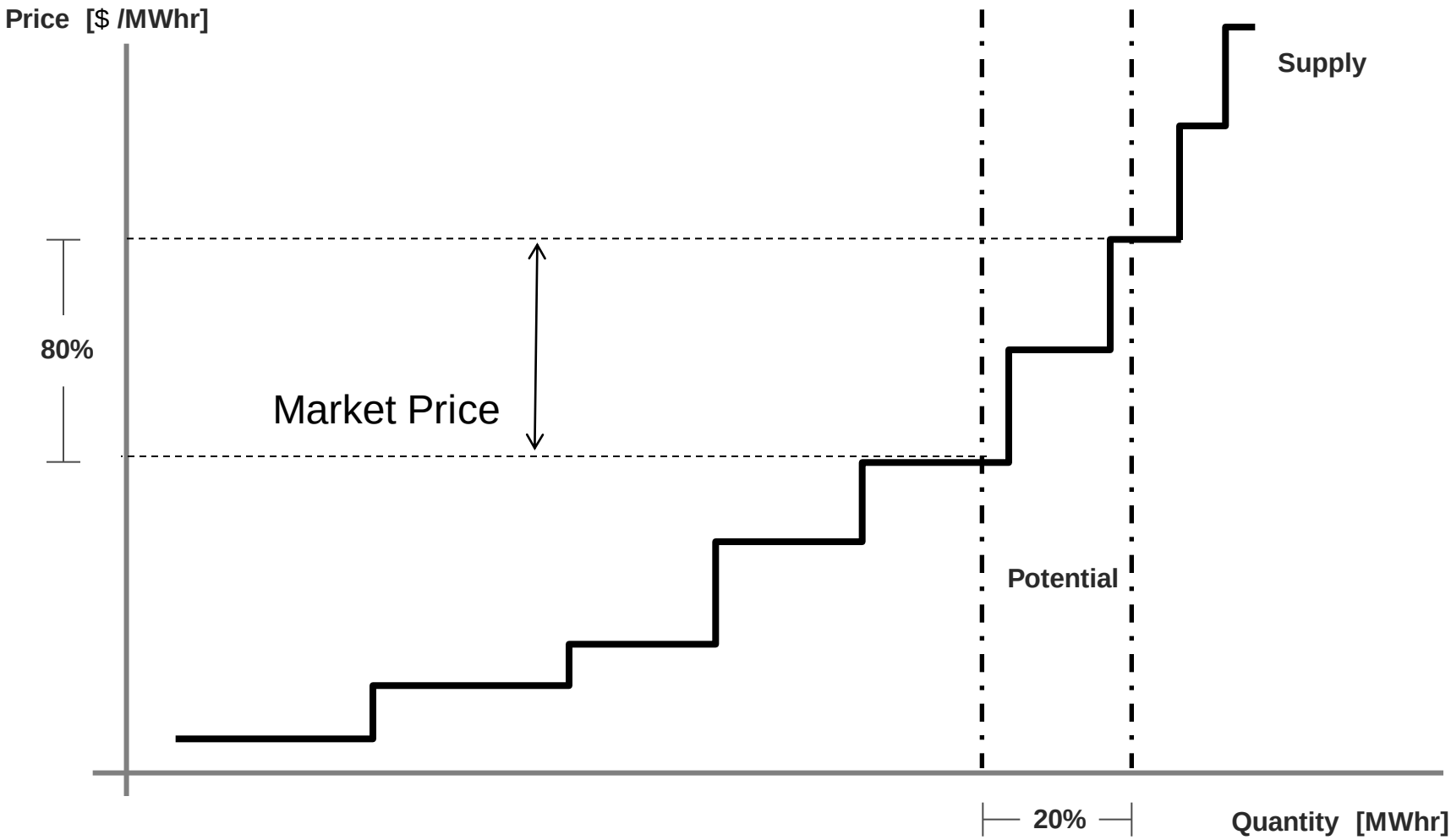
Impact of Demand Response



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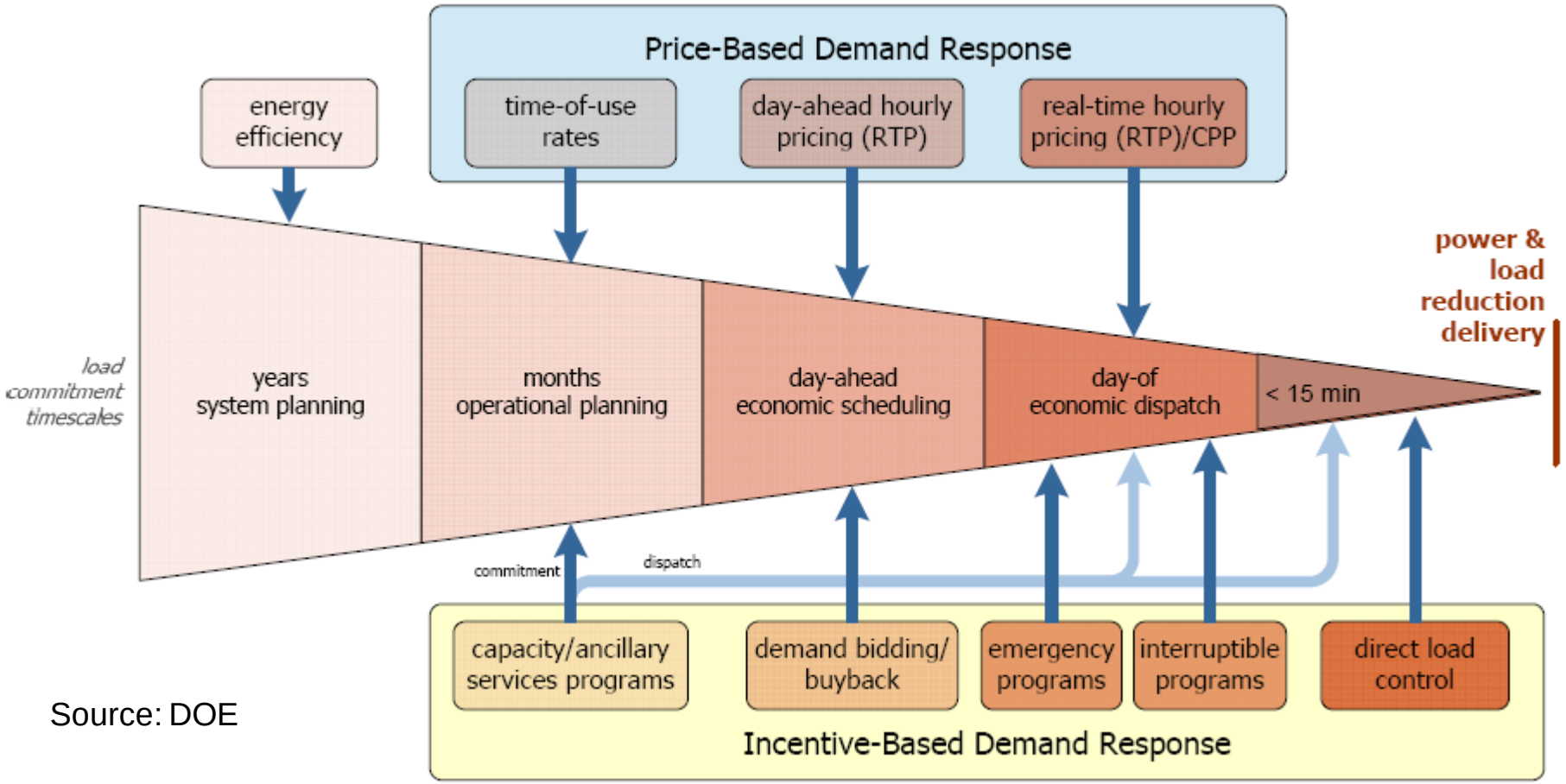
Demand Response Applications



Source: DOE

- **Includes both price-based and incentive-based DR programs**

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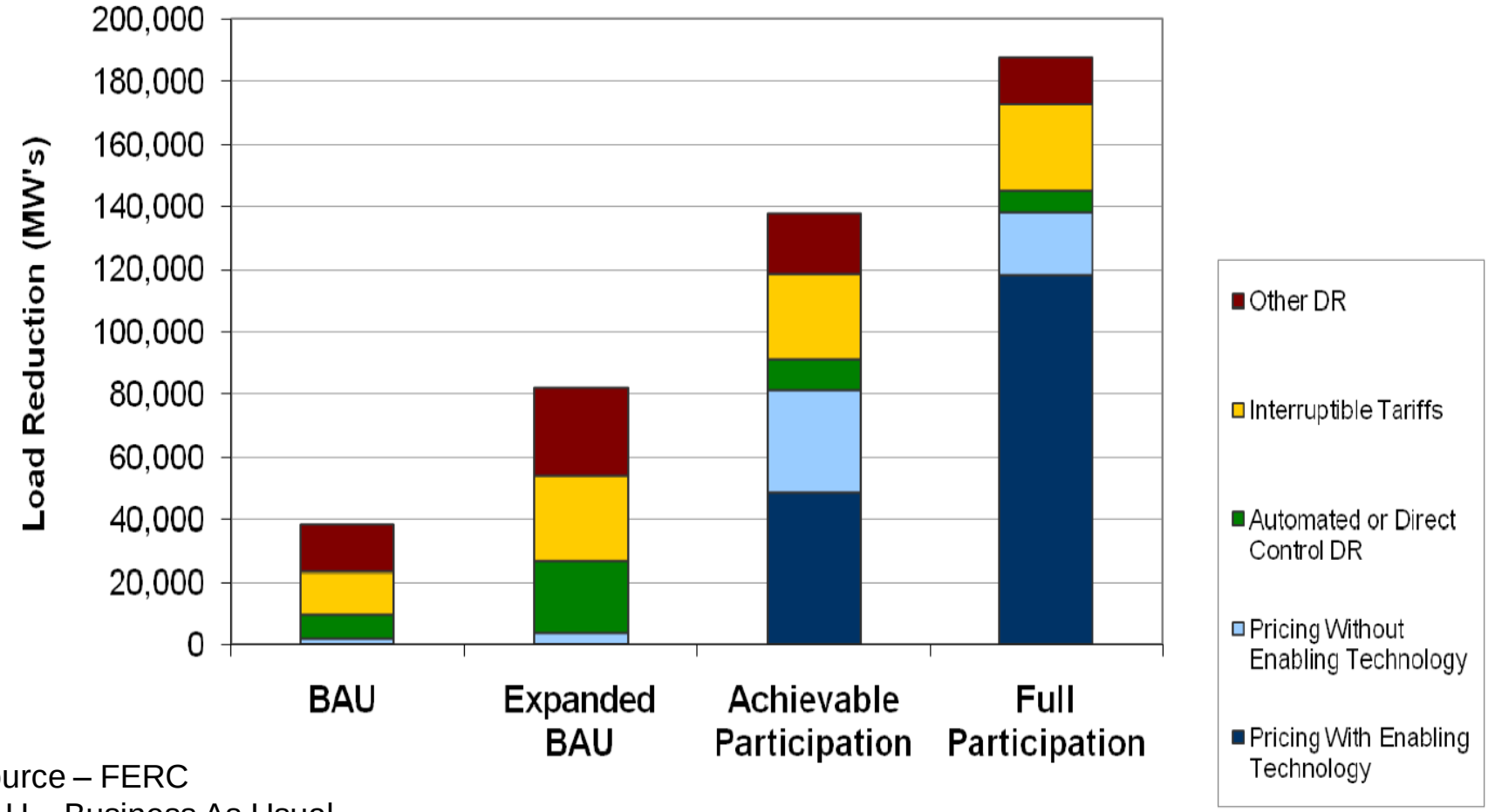
Potential US DR Participation



Source – FERC
BAU – Business As Usual

Benefits of Implementing DR in the Demand and Supply Curve

- **Economic**
  - Connect end customers to wholesale markets
  - More efficient energy costs
  - Better use of existing infrastructure
  - Deferment of new infrastructure (fuels, transmission, distribution, transformation, generation)
- **Environmental**
  - Reduction on emissions
  - More efficient use of fuel
  - Reduced impact on new construction
- **Other**
  - Customer satisfaction
  - New product and services

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Benefits from DR/DER- Based on Utility Interviews

- **Shape Demand to Match Supply – to avoid unit start up and operating costs**
- **Provide Ancillary Services (Spin and Non Spin Reserves)**
- **Provide load relief on Distribution Networks**
- **Avoid or Delay Power Plant Investment Costs**
- **Facilitate customer choice, energy efficiency and demand response**
- **Improving system performance and reliability (Reduce losses, Load relief)**
- **Seamless integration of distributed generation and renewable resources**
- **Improve customer service**
- **Reduce emissions- Carbon**

From "Smart Grid Strategy of Leading Global Utilities" prepared by the McDonnell Group Inc. based on a Survey of over 25 utilities

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From DR/DER to Virtual Power Plants

DIRECT LOAD CONTROL	PRICING PROGRAMS	DISTRIBUTED RESOURCES
• PROGRAMMABLE THERMOSTATS • HVAC CONTROL • WATER HEATERS • POOL PUMPS • HOME ENERGY MANAGEMENT SYSTEMS	• PEAK TIME REBATES • TIME OF USE • REAL TIME • CRITICAL PEAK PRICING • VARIABLE PEAK PRICING	• DIESEL GENERATION • WIND & SOLAR • ELECTRIC CARS • HOME BATTERIES • LARGE BATTERY STORAGE

DEMAND SIDE PROGRAMS ARE THE FOUNDATION OF VIRTUAL POWER PLANTS

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VPP Characteristics

VIRTUAL POWER PLANT	TRADITIONAL GENERATION ASSET
DR Capacity Forecast	Operating Limits
Number of Executions	Start Constraints
Event Durations	Total Energy Constraints
Time Between Event	Chronological Constraints
Customer Payments	Fuel and O&M Costs
Opt-Outs	Maintenance

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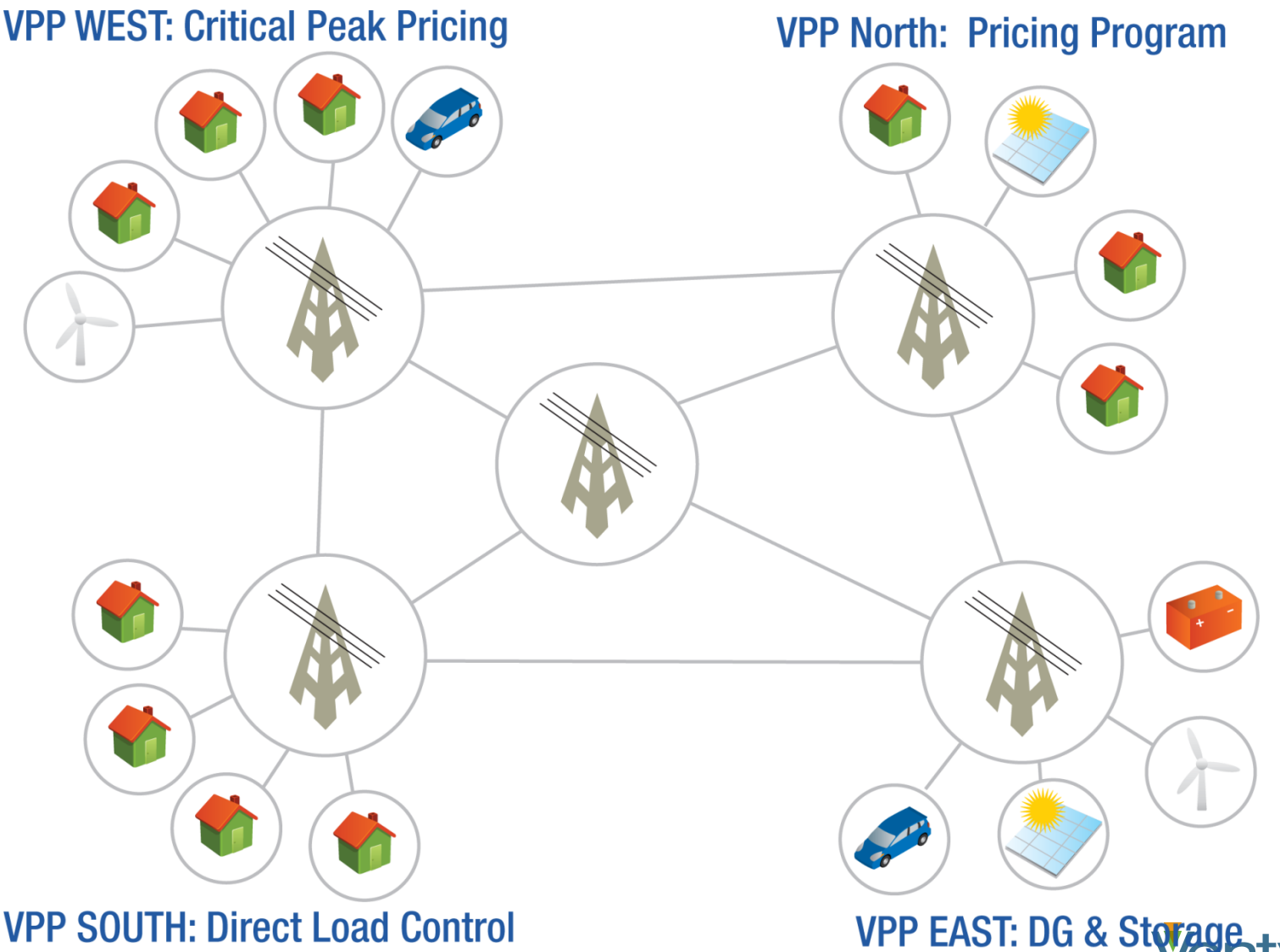
VPPs Aggregate Resources for Optimization



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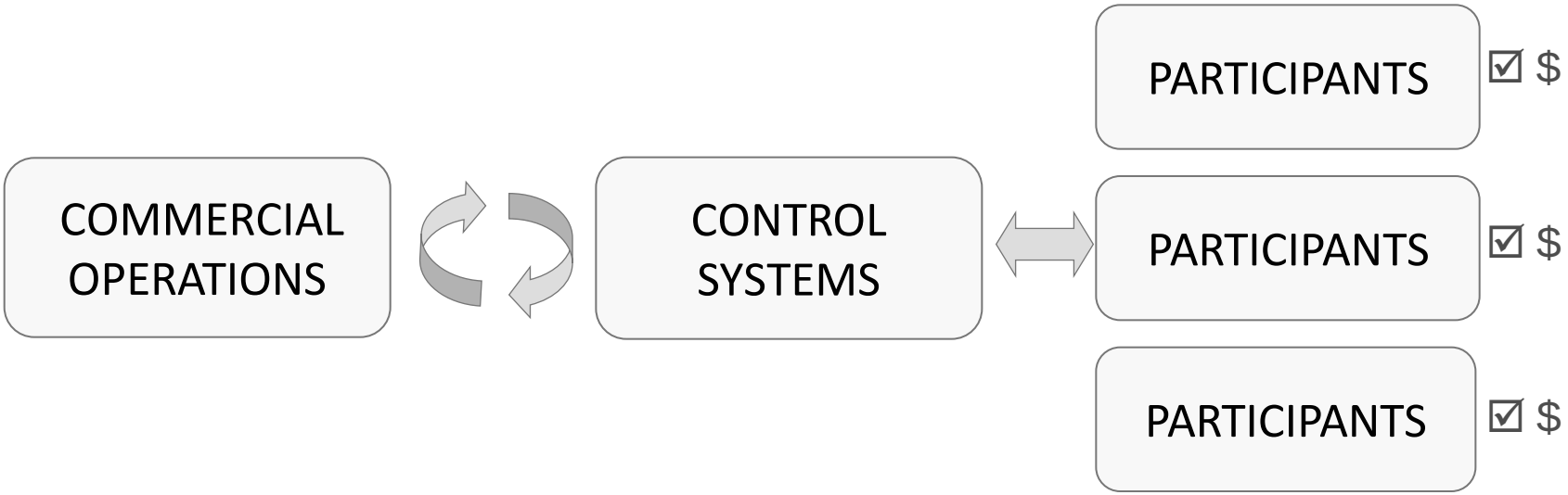
VPPs Aggregate Resources for Optimization

- **Optimization of Distributed Energy Resources**
- **Communication of Real Time Information**
- **Measure and React to Changing Conditions**
- **Provides Economic and Environmental Analysis**
- **Connects Commercial Operations to the Customer**



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Ventyx's Optimization Capabilities

- **Latest generation unit commitment algorithm with simultaneous co-optimization**
  - Electricity, Ancillary Services, Hydro, Fuels, Emissions, etc.
- **Interactive Trade Pricing Support**
- **Competitive differentiators**
  - Complex Modeling
  - Complex Cascaded Hydro Systems
  - Complex Combined Cycle Plants
  - Renewables Integration
  - Latest Mathematical Advances – Mixed Integer Linear Programming (MILP)
  - Proven DR optimization capabilities along with traditional units
- **Flexible / Extendable for changing / growing business needs**

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Ventyx Software Solution Map

FocalPoint Advanced Business Intelligence

-ETL and Enterprise BI Model
-Data Warehousing
- BI & Performance Mgmt Applications
-Ad Hoc Reporting
-Reporting
-Dashboards & Scorecards

Physical Asset & Work Mgmt.

-Asset Mgmt.
-Supply Chain
-Work Mgmt.
-Performance Monitoring
-Maintenance Optimization
-Operations Mgmt.
-Safety & Compliance
-System Health
-Equipment Reliability

Mobile Workforce Mgmt.

-Forecasting & Planning
-Scheduling & Dispatch
-Mobile Work Execution

Customer Mgmt.

-Customer Information
-Billing Management
-Call Center Management

Network Management Systems

-Generation Coordination & Control
-Automated Generation Control
-Real Time Market Communications
-Control Area Function
-Security Control & Assessment
-Switching Control
-Transmission Coordination
-Reliability Management
-System Monitoring
-Switching Orders
-Reliability Control
-Volt/VAR Optimization

SCADA – Supervisory Control & Data Acquisition

EPM Commercial Operations

-Load & Rev Forecasting
-DR/DER Management (VPP)
-Trading & Risk Mgmt
-Unit Optimization & Bidding
-Physical Scheduling
-Market Comms & Settlement

EPM Planning & Analytics

-Forecasting & Analysis
-Market Price Formation
-Portfolio Analysis and Planning
-Market Data Intelligence
-Advisory Energy Consulting

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Demand Response Management System

- **Customer Enrollment and Display**
  - Customer Enrollment to allow for customers or CSR to establish customer participation in programs
- **Demand Response (DR)/ Distributed Energy Resources (DER) Program Management**
  - Manage definition, rules and customer relationships for DR, DER, Pricing and Environmental Programs
- **Virtual Power Plants**
  - Aggregation of DR, DER, Pricing and Environmental programs into transmission areas and forecast their capability / availability
- **Aggregation / Disaggregation**
  - Ability to disaggregate a VPP schedule by communications protocol, by feeder sections, and apply topology information such as priority

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Demand Response Management System

- **Optimization & Dispatch**
  - Optimize the entire Resource Portfolio including VPP's for least cost , least emissions, best market position and dispatch the schedule
- **Complex Billing**
  - Compute interval level billing with time varying volumes and price/ special pricing rules; integrate with CIS systems
- **Reporting**
  - Ability to report and perform analytics on Program results, Customer results / participation, Program Cost / Benefits and VPP's

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Demand Response Management System

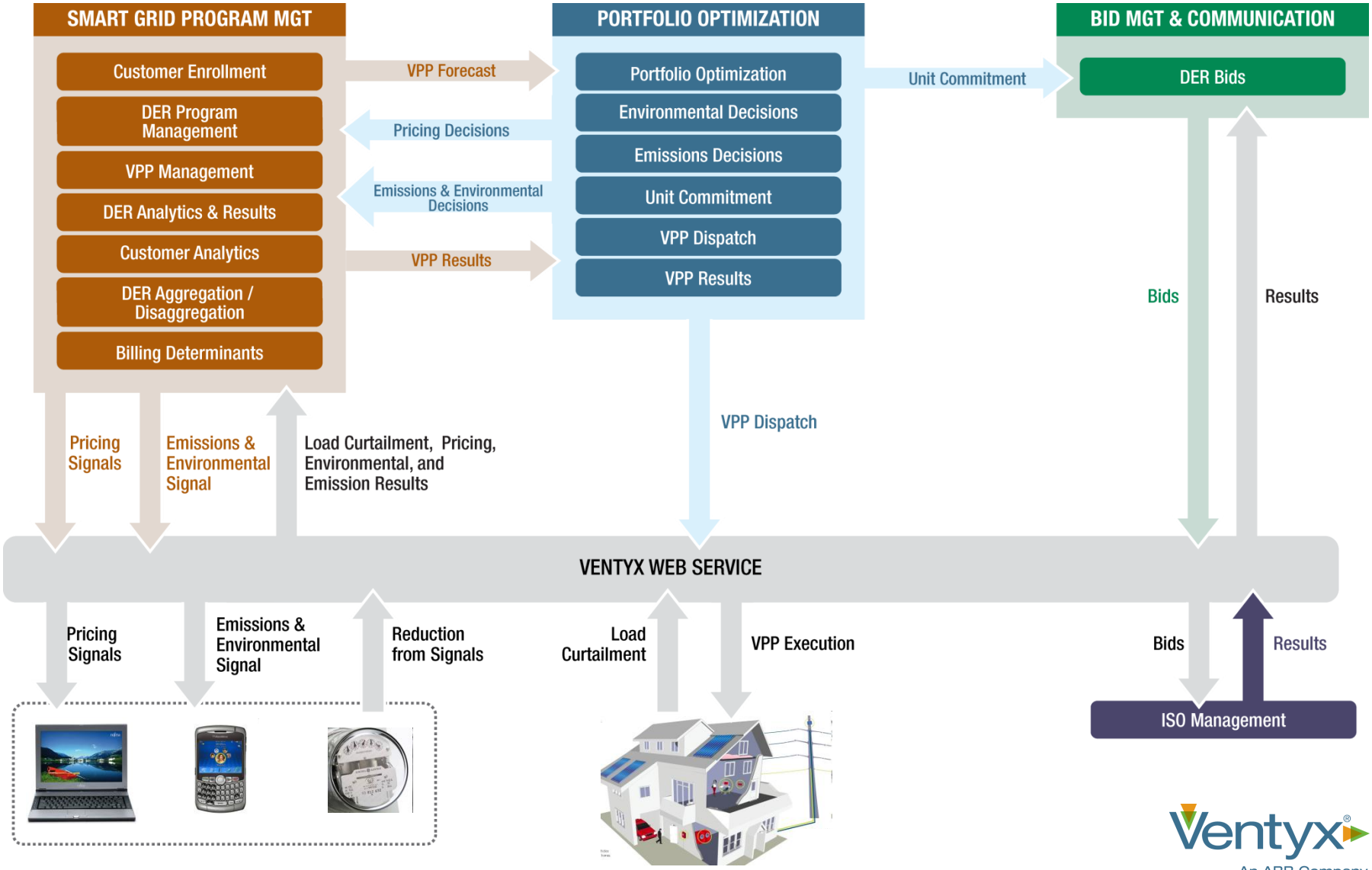

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ABB Smart Grid Landscape

Information Technology	Integration of Operations Technology and Information Technology	Distribution Edge of Grid Technologies

Information Technology

-  **CIS** — Ventyx
-  **Comms** — PS, Trilliant
-  **GIS**
-  **Asset Mngmnt** — Ventyx
-  **Work Mngmnt** — Ventyx
-  **Mobile Data** — Ventyx
-  **Security** — Industrial Defender

Integration of Operations Technology and Information Technology

Advanced Metering Infrastructure (AMI)

Smart Meters — Network Management

Meter Data Management — Communications

Trilliant, Freewave, MDS

Distribution Grid Management (DGM)

D-SCADA DMS OMS FDIR VVO Advanced Apps

Dist. Auto. Feeder Automation Sensors Communications

Ventyx Power Systems COE PPMV, PPHV

Asset Health Center (AHC)

Sensors and Monitors Communications Substation Automation

Analytics Dashboard Asset Management Work Management

Ventyx Power Systems PPHV, PPTR

Transmission Grid Management (TGM)

HVDC FACTS HV Cables Energy Storage SCADA/EMS

Wide Area Monitoring HV Optical Sensors PMUs Sub.Automation

Power Systems Ventyx PPHV

DERMS &VPP Ventyx

Distribution Edge of Grid Technologies

-  **Electric Vehicles** — DA&M, ECOtality
-  **Energy Storage** — PS, DA&M, PPMV
-  **Distributed Generation** — DA&M, LV, PP
-  **Demand Response** — PA, LV

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Smart Grid Software Offerings

- **Demand Response Management**
  - Enrollment
  - Forecasting and VPP Aggregation
  - VPP Disaggregation and Integration to Legacy Systems
  - Reporting
  - Billing determination
- **Demand Response Management Commercial Optimization**
  - Optimize all assets (DR/DER/Traditional)
  - Resource Optimization
  - Price and Emission Signals
- **Demand Response Management – With Analytics**
  - System Optimizer to determine best programs/ program designs
  - Planning and Risk to analyze expected long term benefits and assess risk
- **Demand Response Management – With DMS**
  - DMS/ SCADA solution and integration
  - Volt/ VAR Optimization

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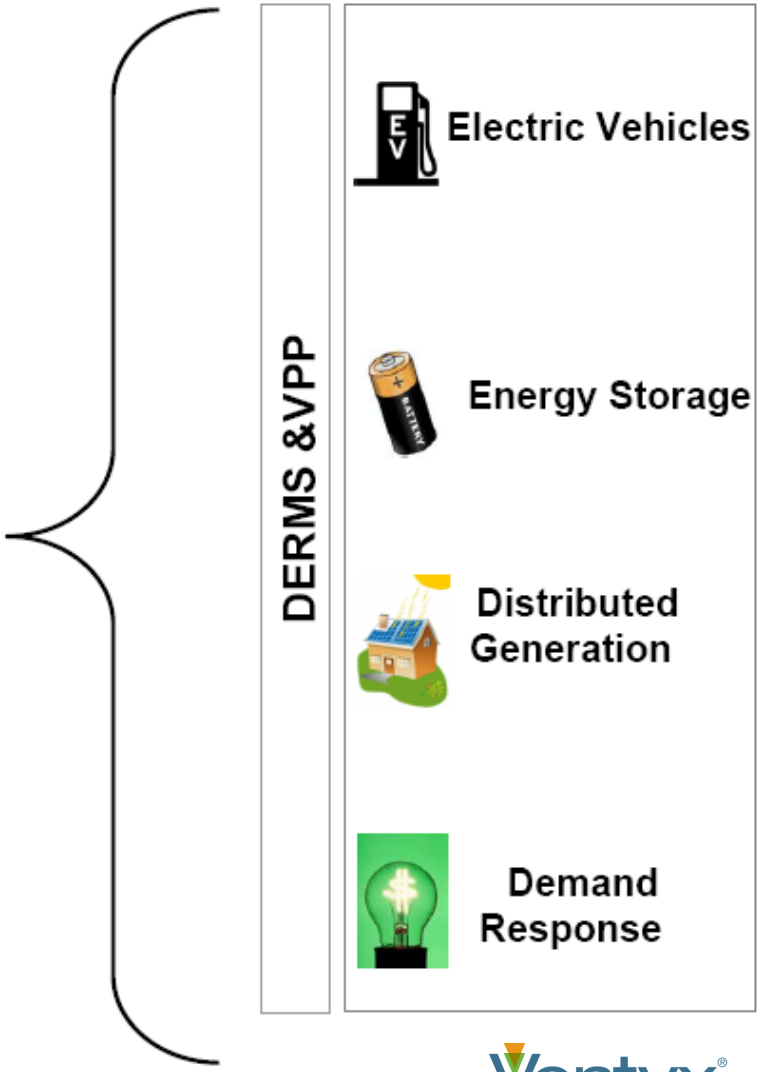
ABB Smart Grid Landscape

1. **Distributed Energy Resource Management System**
   - Forecasts and aggregates resources
   - Models distributed energy resources as a Virtual Power Plant
   - Manages customer registration and billing determinants
   - Integrates to Operations
   - Manages commercial process of participating in demand response energy market
2. **ABB is a supplier for distributed energy resources**
   - Power electronics for EV charging
   - Modular power conditioning systems for battery energy storage
   - Packaged community energy storage systems
   - Inverters for solar PV systems



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