Engineering Assessment of Distribution System Capabilities and Limitations

Hilal Katmale
President, Microgrid Energy Solutions LLC

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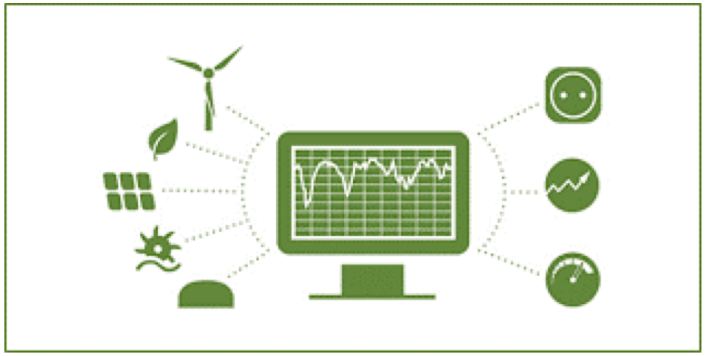
Topics for Today

- Aggregation of DER
- DER Coordination
- Advanced inverter functions
- Communication standards and protocols
- Key technology areas for bi-directional power flow

DER Aggregation

- Enables energy services from Distribution → Transmission
- Opposite to traditional one-way flow down from T → D
- Driven by DER penetration in the distribution system



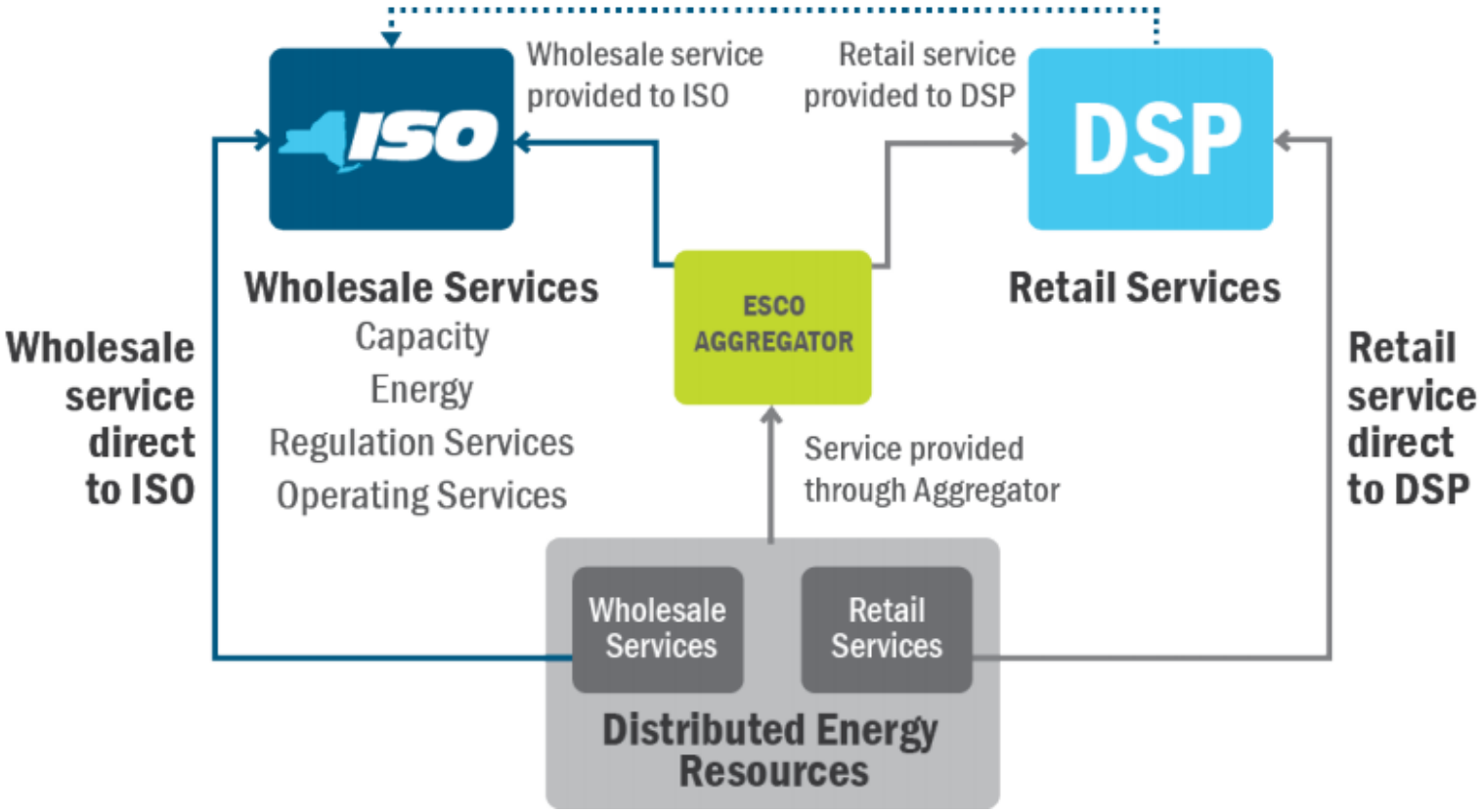
DER Aggregator Value Proposition

- Eases integration of renewable energy
- Customer resiliency
- Enhances reliability
- Improves grid efficiency (at scale)

DER Aggregation Market - California

- Proxy Demand Response (PDR)
  - No injection of power back into the grid
- Distributed Energy Resource Provider (DERP)
  - Injection of power back into the grid (through storage)

DER Aggregation Market – New York

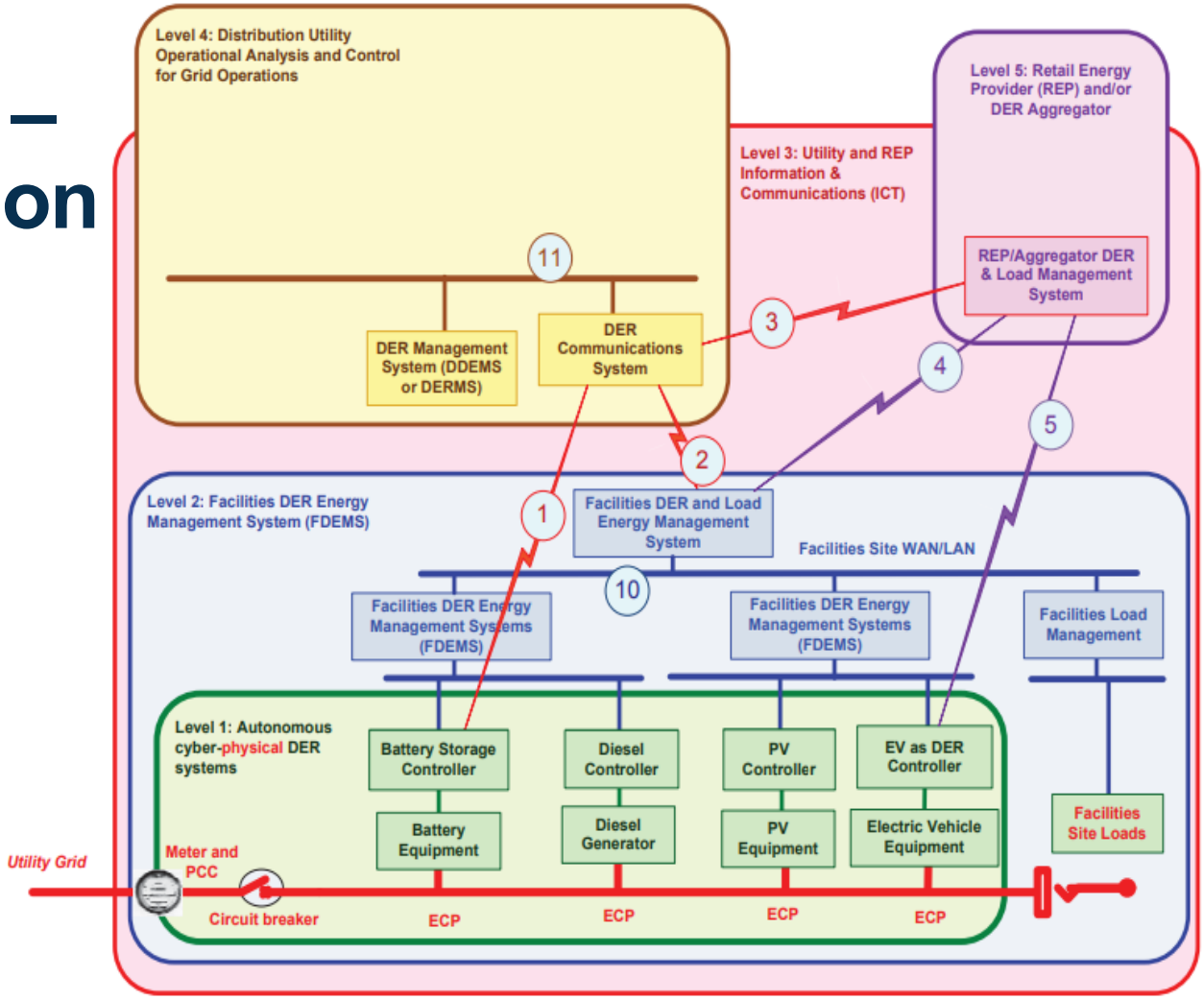


http://www.nyiso.com/public/webdocs/markets_operations/market_data/demand_response/DER_Roadmap/DER_Roadmap/Distributed-Energy-Resources-2017-Market-Design-Concept-Proposal.pdf

Barriers for DER Aggregation

- Settlement Requirement
- Interconnection Requirement
- Metering Requirement
- Wholesale/Retail Market Boundary
- Low Net Revenues
- Alternative Revenue Streams
- Technical Challenges

DER Coordination – Communication Landscape



http://www.energy.ca.gov/electricity_analysis/rule21/documents/SIWG_Phase_2_Communications_Recommendations_for_CPUC.pdf

California Smart Inverter Working Group

- Phase 1 – Autonomous Functions
  - Adopted in September 2017
- Phase 2 – Communication Protocols
  - Slated in 2018
- Phase 3 – Advanced Functions
  - Recommendations are being finalized

Advanced Inverter Functions

- Monitor key DER data
- DER cease to energize and DER return to service
- Limit maximum active power mode
- Frequency – Watt mode
- Volt – Watt mode
- Dynamic reactive current support mode
- Scheduling power values and modes

Communication Standards and Protocols

Protocol	Protocol	Protocol
OpenADR 2.0	OCHP (EV)	Open SG Protocol
IEEE 2030.5 (1547)	OCPI (EV)	TeMIX
IEC 61850-8-2	OCPP (EV)	CTA 2045
DNP3 (1547)	OICP (EV)	ETSI TS 104.001
SunSpec (1547)	OSCP (EV)	FAN USEF
MESA	Green Button	ASHRAE 201/2030.5
IEC 61850-90-8	Orange Button	PowerMatcher
ISO/IEC 15118	OpenFMB	
eMIP (EV)	IEC 61850-4-720	

DER Standards

Messaging Protocol	DER Data Model
IEC 61850-8-2	IEC 61850-7-420 and -90-7
IEEE 2030.5 (SEP 2)*	IEC 61850-7-420
OpenADR 2.0	Energy Interop/61968 (CIM)
SunSpec*	IEC 61850-7-420 and -90-7
IEEE 1815 (DNP3)*	IEC 61850-7-420 and -90-7 (in process)

Common Transport and Data Models

http://www.pointview.com/data/2017/06/1904/pdf/James-Mater-30645.pdf
http://www.pointview.com/data/2017/06/1904/pdf/James-Mater-30645.pdf

Key Technology Areas For Two-Way Power Flow

- Sensing and Measurement
- Advanced Power Grid Components
- Advanced Control Methods
- Integrated Communications
- Improved Interfaces and Decision Support bi-directional power flow

Customer Technologies

Key Technology Area	Technology
Advanced Components	Photovoltaics
	Microturbines
	Reciprocating Engines
	Fuel Cells
	Plug-In Hybrid Electric Vehicles (PHEVs)
	Electric Vehicles (EVs)
	Smart Appliances
	Thermal Energy Storage
	Distributed Storage (Batteries, Ultra-Capacitors)
	Inverters
	Wind Systems
Advanced Control	Demand Response (DR)
	Price Driven Load Management (PDLM)
	Home Energy Management System (HEMS)
	Electric Load as Reliability Resource
	Advanced Metering Infrastructure (AMI)
Sensing and Measurement	Radio Frequency Identification (RFID)
Integrated Communications	Home Area Networks (HAN)
	Internet 2 (IP6)
	Fiber-to-Home (FTH)
	WiMax (4G)
	Cellular (3G)
	WiFi
	Zigbee
Improved Interfaces and Decision Support	In-Home Displays
	Advanced Consumer Portal

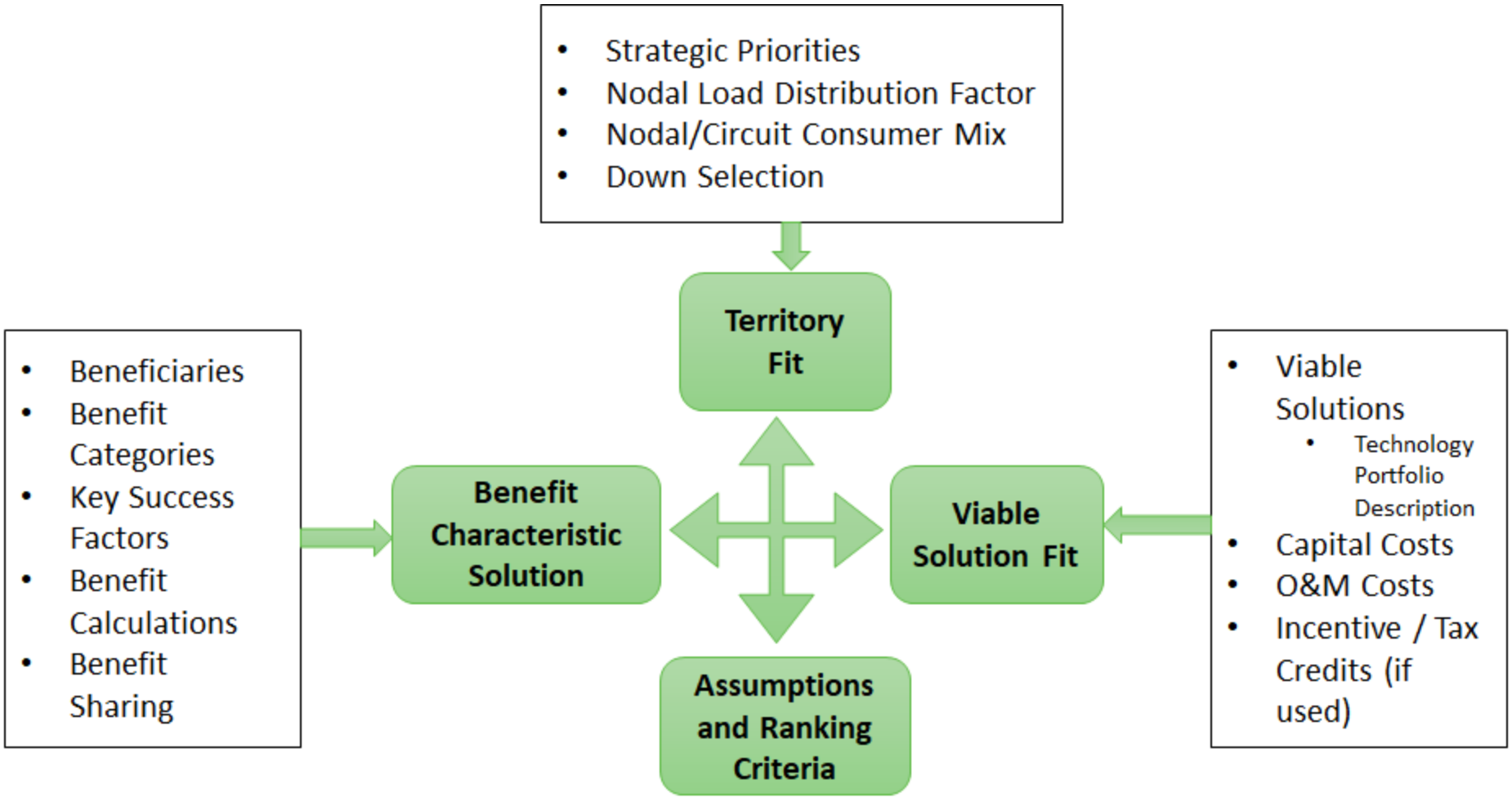
Advanced Distribution Technologies (Substation to the Customer)

Key Technology Area	Technology
Advanced Components	Combustion Turbines
	Microturbines
	Fuel Cells
	Solar Photovoltaic Systems
	Wind Systems
	IntelliRupter Pulsecloser
	Inverters (4 quadrant capable)
	FAST Switches
	D-VAR / DSTATCOM
	SCADA enabled circuit switches
	Advanced Energy Storage (Electric)
	Thermal Energy Storage
	Flywheels
	Capacitors (Fixed or Switched)
Advanced Control	Distribution Management System
	Geographic Information System
	Advanced Outage Management System
	Customer Information System
	Distribution Automation
	Conservation Voltage Reduction
	Advanced Network Applications
Sensing and Measurement	Intelligent Electronic Devices
	Advanced Digital Protective Relays
	Smart Transformers
Integrated Communications	Broadband over Power Lines (BPL)
	WiFi
	WiMax (4G)
	Cellular 3G
	Microwave
	Fiber Optic
	Power Line Carrier (PLC)
	Z-Wave
Improved Interfaces and Decision Support	Engineering Information Systems (EIS)
	Workforce Management System (WMS)
	Asset Optimization Tools
	Transient and Dynamic Modeling
	Load Flow Modeling

Advanced Distribution Operation (ADO) Technologies (Transmission System to the Substation)

Key Technology Area	Technology
Advanced Components	Advanced Transformers
	Capacitor Banks
	Static VAr Compensator (SVC)
	Compressed Air Storage
	Pumped Hydro Systems
	Advanced Energy Storage (Electric)
	Utility Scale Solar Systems [Concentrating Solar Power (CSP Tower & CSP Trough System), Concentrating Photovoltaic System (CPV), Dish Sterling]
	Utility Scale Wind Systems
Advanced Control	Distribution System Modeling Software
	Demand Dispatch
	Substation Automation
	Advanced Feeder Automation
	Advanced Supervisory Control and Data Acquisition System (SCADA)
	Advanced Outage Managent System (OMS)
	Advanced Energy Management System (EMS)
	Condition Based Maintenance (CBM)
Sensing and Measurement	Phasor Measurement Units (PMUs)
	Wireless Intelligent Sensors
	Advanced Instrument Transformers
	Advanced Protection System
	Distributed Weather Data System
	Asset Health Monitors (IEDs)
Integrated Communications	Security Management Portal (SMP) Gateway
	Microwave
	Fiber Optic
	WiMax (4G)
Improved Interfaces and Decision Support	Engineering Information System (EIS)
	Capacity Planning Tools
	Workforce Management

Technology Selection – Cost Benefit Analysis Model



Questions?

Hilal Katmale

hkatmale@microgridenergysolutions.net