Engineering Assessment of Distribution System Capabilities and Limitations

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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 $T \rightarrow D$
- 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

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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 bidirectional power flow



Customer Technologies

Key Technology Area	Technology
	Photovoltaics
	Microturbines
	Reciprocating Engines
	Fuel Cells
Advanced Components	Plug-In Hybrid Electric Vehicles (PHEVs)
	Electric Vehicles (EVs)
	Smart Appliances
	Thermal Energy Storage
	Distributed Storage (Batteries, Ultra-Capacitors)
	Inverters
	Wind Systems
	Demand Response (DR)
	Price Driven Load Management (PDLM)
Advanced Control	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

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Advanced Distribution Technologies (Substation to the Customer)

Advanced Components Combustion Turbines Advanced Components Fuel Cells Solar Photovoltaic Systems IntelliRupter Pulsecloser 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) Distribution Management System Geographic Information System Advanced Outage Management System Advanced Control Conservation Voltage Reduction Advanced Network Applications Intelligent Electronic Devices Sensing and Measurement Broadband over Power Lines (BPL) WiFi WiMax (4G) Cellular 3G Microwave Fiber Optic Power Line Carrier (PLC) Zwave Engineering Information Systems (EIS) Improved Interfaces and Decision Support Asset Optimization Tools Integrated Communications Fiber Optic Power Line Carrier (PLC) Zwave Engineering Information Systems (EIS) Workforce Management System (WMS)	Key Technology Area	Technology
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Transient and Dynamic Modeling Load Flow Modeling		Asset Optimization Tools
Load Flow Modeling		Transient and Dynamic Modeling
		Load Flow Modeling



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

Key Technology Area	Technology
	Advanced Transformers
	Capacitor Banks
	Static VAr Compensator (SVC)
	Compressed Air Storage
	Pumped Hydro Systems
Advanced Components	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
	Distribution System Modeling Software
	Demand Dispatch
	Substation Automation
	Advanced Feeder Automation
Advanced Control	Advanced Supervisory Control and Data
	Acquisition System (SCADA)
	Advanced Outage Managent System (OMS)
	Advanced Energy Management System (EMS)
	Condition Based Maintenance (CBM)
	Phasor Measurement Units (PMUs)
	Wireless Intelligent Sensors
Sonsing and Moasurement	Advanced Instrument Transformers
Sensing and Measurement	Advanced Protection System
	Distributed Weather Data System
	Asset Health Monitors (IEDs)
Integrated Communications	Security Management Portal (SMP) Gateway
	Microwave
	Fiber Optic
	WiMax (4G)
mproved Interfaces and Decision Support	Engineering Information System (EIS)
	Capacity Planning Tools
	Workforce Management



Technology Selection – Cost Benefit Analysis Model





Questions?

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