OpenADR and DER Operations April 24, 2018



Stem Overview



Stem operates the world's smartest and largest digital energy storage network

Founded: 2009 Headquarters: Millbrae, CA Employees: 140+ Operations In: CA, HI, NY, TX, MA, Japan, ONT Pipeline & Installed: 800+ sites, 200+ MWh Installed: 350 sites, 5M device hours 8 utility contracts: 350 MWh **Project Finance:** \$500 MM

High Caliber Global Investors



Distinguished Honors & Awards



Value to Customers and Grids

HOW IT WORKS - CUSTOMER BENEFITS

- <u>Predicts</u> customer energy usage 30 days in advance
- <u>Anticipates</u> costly peak events and releases stored energy for demand management
- <u>Customer friendly</u> charging battery with PV and/or at cheaper TOU times



DUAL VALUE: Customer & Grid

HOW IT WORKS - GRID BENEFITS

- 24/7 on-demand access to storagebased virtual power plant to smooth loads and mitigate PV variability
- Lower cost aggregator model offering agility, scalability & utility control
- Building value through scale and proven results



VPP Operating Lifecycle Forecast, Status, Schedule/Dispatch, Settle



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Hierarchy of Networks, Controls and Markets

REP Trading and Ops Center



Hierarchy of Networks, Controls and Markets



Hierarchy of Networks, Controls and Markets



OpenADR and VPP/DER Topology



- Adaptable to individual parties' integration needs
- Built on common interactions provided by Stem's control, telemetry and forecasting services
- Support for business process integrations (e.g. enrollment, VPP/DER capacities, characteristics)

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Example VPP Reports with OpenADR

- VPP Nameplate Info
 - VPP Asset Power & Energy Capacity
 - Charge & Discharge Curves
- Status
 - One minute updates
 - Signals include
 - x-REAL_POWER
 - x-REACTIVE_POWER
 - x-AVAILABLE_CHARGE_POWER
 - x-AVAILABLE_DISCHARGE_POWER
 - x-AVAILABLE_CHARGE_ENERGY
 - x-AVAILABLE_DISCHARGE_ENERGY

Forecast

- 15 minute intervals
- 24 hr forecast 96 intervals (daily)
- 4 hr forecast 16 intervals (rolling hourly)
- Signals include
 - x-REAL_POWER
 - x-REACTIVE_POWER
 - x-AVAILABLE_CHARGE_POWER
 - x-AVAILABLE_DISCHARGE_POWER
 - x-AVAILABLE_CHARGE_ENERGY
 - x-AVAILABLE_DISCHARGE_ENERGY

Example VPP Events with OpenADR

Events

- Forward-Schedule VPP operation for up to several days with 288 5 min intervals per day
- Charge or Discharge and Values for each interval
- "0" means no charge or discharge
- "None" indicates VPP idle (normal Demand Charge Management operation at sites)
- Create new event scheduling new intervals
- Modify update the scheduled intervals remaining in an event (one minute minimum advance notice)
- Cancel all remaining scheduled intervals in an event are cancelled

Closing thoughts

ADMS / DERMS / DRMS

- Grid topology and connectivity models
- Load flow and constraint analysis
- DER group forecasting and scheduling
- CA Rule 21 and DSO Ancillary services operation
- Focus on a single (DSO) grid control area
- Future DSO nodal pricing and market operations

Aggregator

- Customer economics-aware
- Flexible customer-sited resource coordination and bidding - value stacking
- Islanding as a grid service?
- Asset management & optimization
- Services across multiple ISO/DSO grid control areas
- Participation in both ISO wholesale and DSO

Thank you

