

Committee on Electricity

Electricity and Energy Resources & the Environment Committees

**CAISO's Efforts to Integrate
Distributed Energy Resources
into its Wholesale Markets**

CAISO: Integrating Distributed Generation into Wholesale Markets

Moderator:

**Hon. Martha Guzman-Aceves,
California**

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Mark Esguerra, PG&E

Manal Yamout, Advanced
MicroGrid Solutions



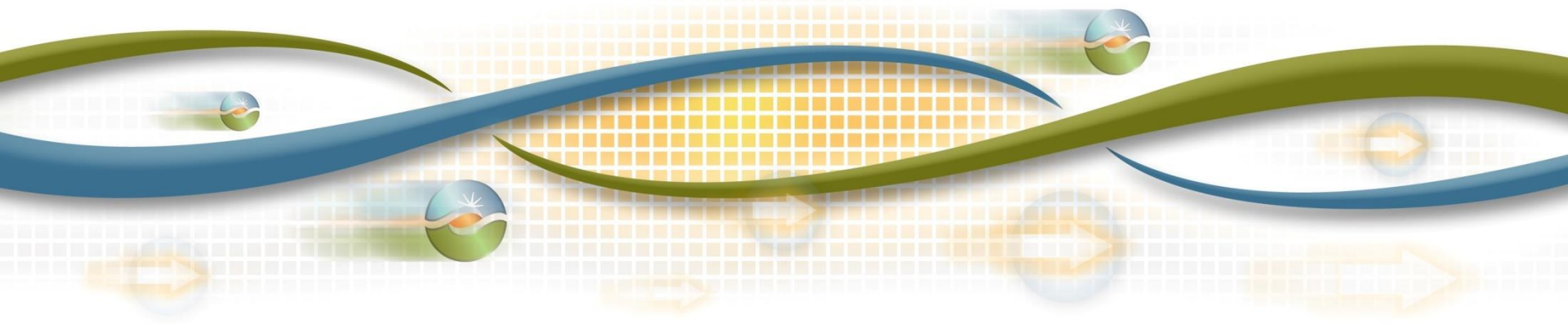
Cal ISO's Efforts to Integrate Distributed Energy Resources into its Wholesale Markets

Jill Powers

Infrastructure and Regulatory Policy Manager

NARUC Conference – San Diego, CA

July 17, 2017



Distributed Energy Resource (DER) Growth in California

- California electric power mix is transforming
 - Less reliance on traditional, large-scale fossil-fueled generation
 - More reliance on renewable distributed energy resources (DERs)
 - More than 250,000 plug in electric vehicles (EV) in CA
- Potential increased adoption of diverse DERs, including micro-grids, resulting in a more decentralized grid
- To maximize revenue opportunities, DER owners interested in providing multiple services to multiple entities (transmission operators, distribution operators, and the end use customer)

California is Targeting:

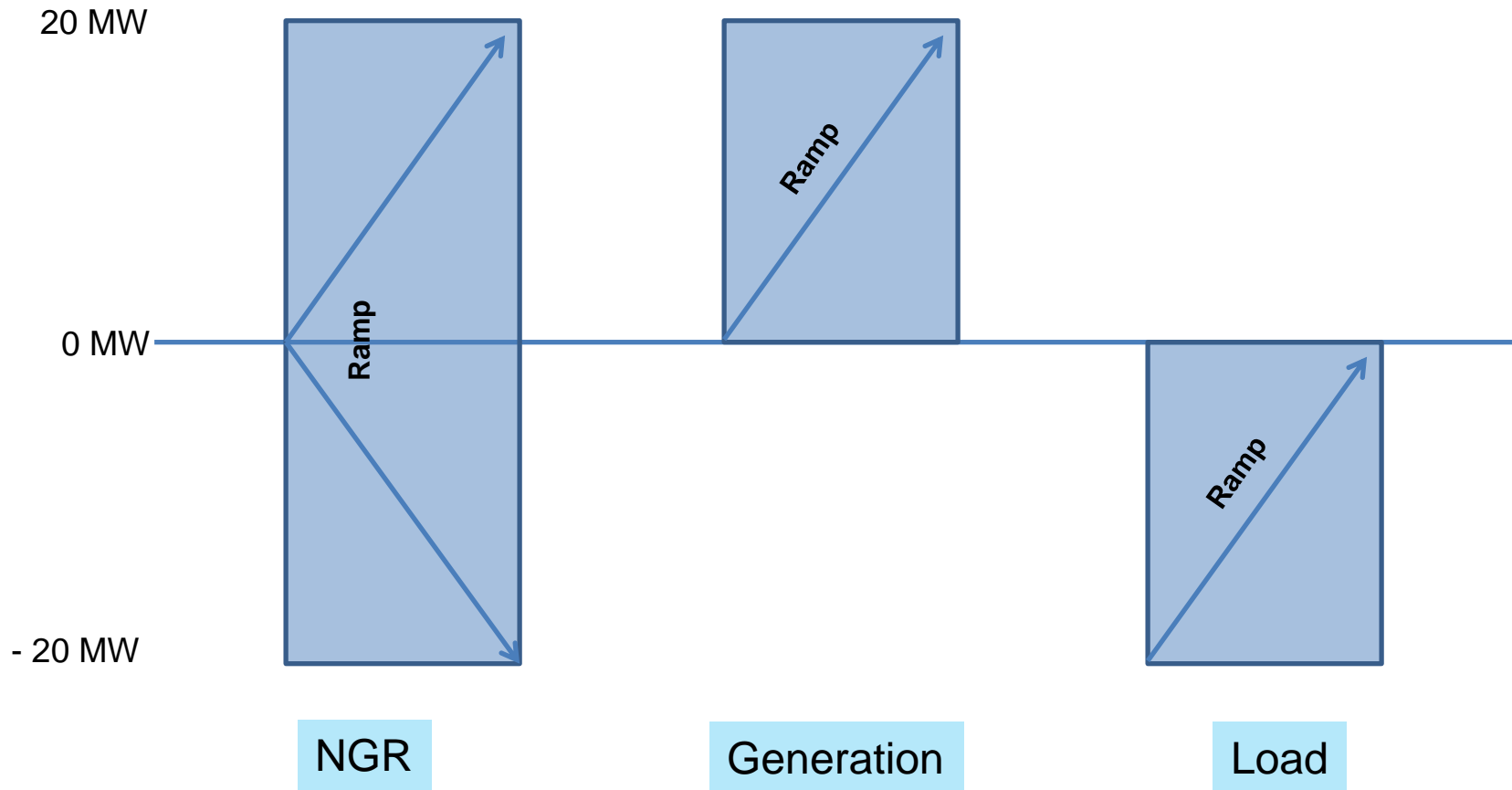


FERC NOPR (RM16-23-000) seeks to remove barriers to wholesale market participation by storage and DER aggregations

Proposes to require ISOs and RTOs to

- Establish a storage participation model that, recognizing physical and operational characteristics of electric storage resources, accommodates their participation in organized wholesale markets
- Define DER aggregators as a type of market participant than can participate in the organized wholesale electric markets under the participation model that best accommodates the physical and operational characteristics of its DER aggregation

In 2012, the ISO implemented the non-generator resource (NGR) participation model to recognize its seamless operation between generation and load



In 2016, the ISO completed the Distributed Energy Resource Provider (DERP) initiative implementation

Status

FERC approval: September 22, 2016

Technical solution development: Completed

ER16-1085 (Distributed Energy Resource)

11/30/2016 Informational report filed

http://www.caiso.com/Documents/Nov30_2016_InformationalReport_DistributedEnergyResourceProvider_ER16-1085.pdf

Distributed Energy Resource Provider (DERP) initiative concepts

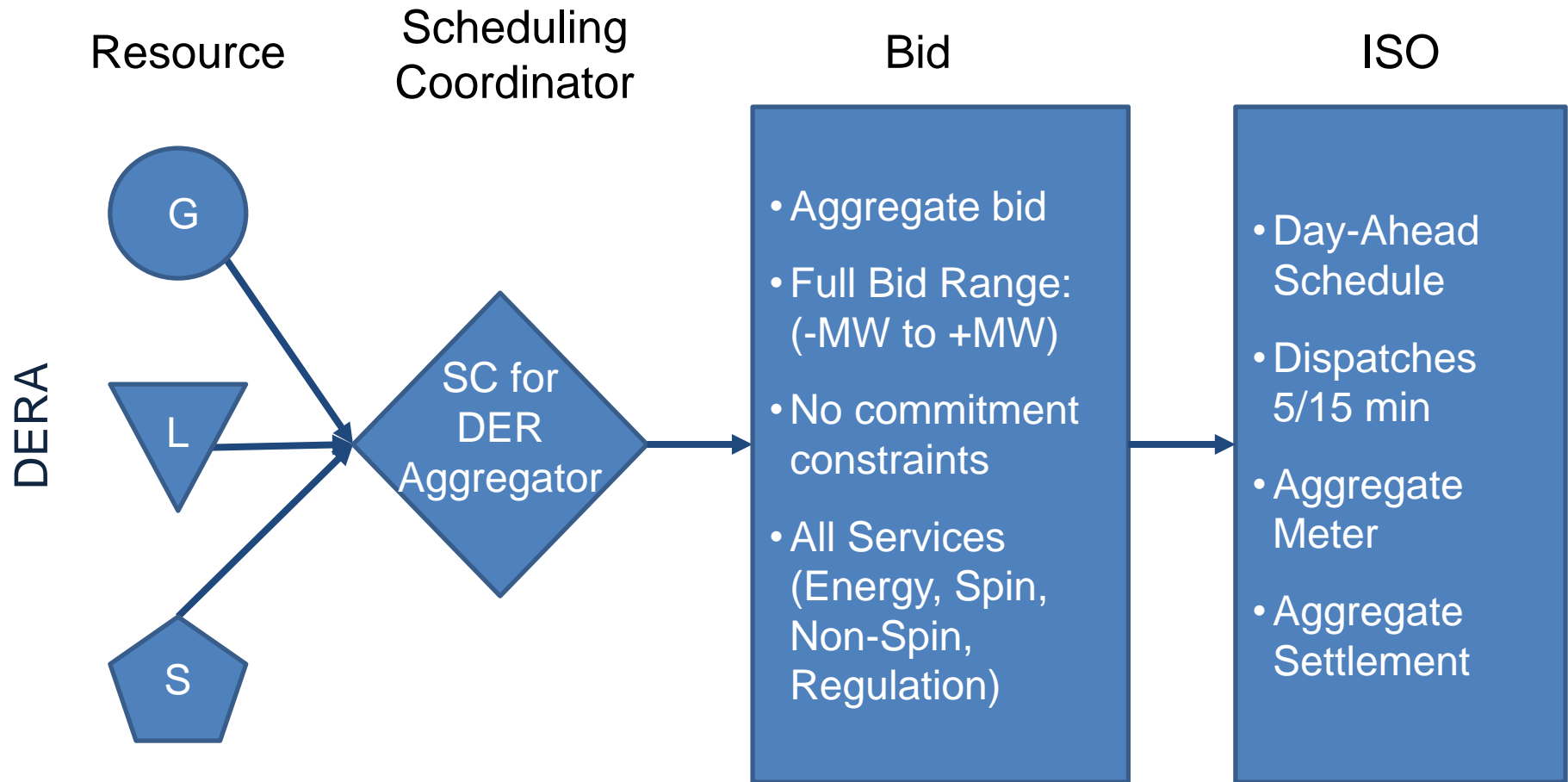
Purpose

- Create a pathway for smaller resources to be bundled by utilities or third parties and collectively meet the half-megawatt minimum requirement for participating in the energy market.

Scope:

- Establishes a new market participant identity to aggregate and represent distributed energy resources
- Allows for expanded use of non-ISO meters and avoids a direct metering relationship with the ISO
- Establishes resource aggregation rules at an ISO network level

Distributed Energy Resource Aggregation DERA participation construct



The ISO continues to work on enabling and enhancing distributed energy resource participation

- Distributed Energy Resource Provider status
 - Four parties have executed DERP agreement with ISO
 - ISO expects first DERP DERAs to begin operating in 2017
- Energy Storage and Distributed Energy Resource (ESDER) Initiatives continue in 2017 and include:
 - Enhancements to participation models used by DERAs
 - Storage
 - Demand response
 - Multiple-use applications (MUA)

High DER penetration requires enhanced operations coordination at T-D interfaces

In 2016, ISO and distribution utilities began development of an operations coordination framework for immediate DER participation.

- ISO / DSO Coordination
 - Communication
 - Technology to streamline coordination
- Resource visibility and modeling
 - Real-time aggregate metering
 - Dynamic distribution of resources
- Forecasting
 - Quantity and location of resources
 - Enhance load forecast methods

Coordination of Transmission and Distribution Operations in A High Distributed Energy Resource Electric Grid

2017 NARUC Summer Policy Summit

**Mark Esguerra
Pacific Gas and Electric Company
Grid Integration and Innovation**



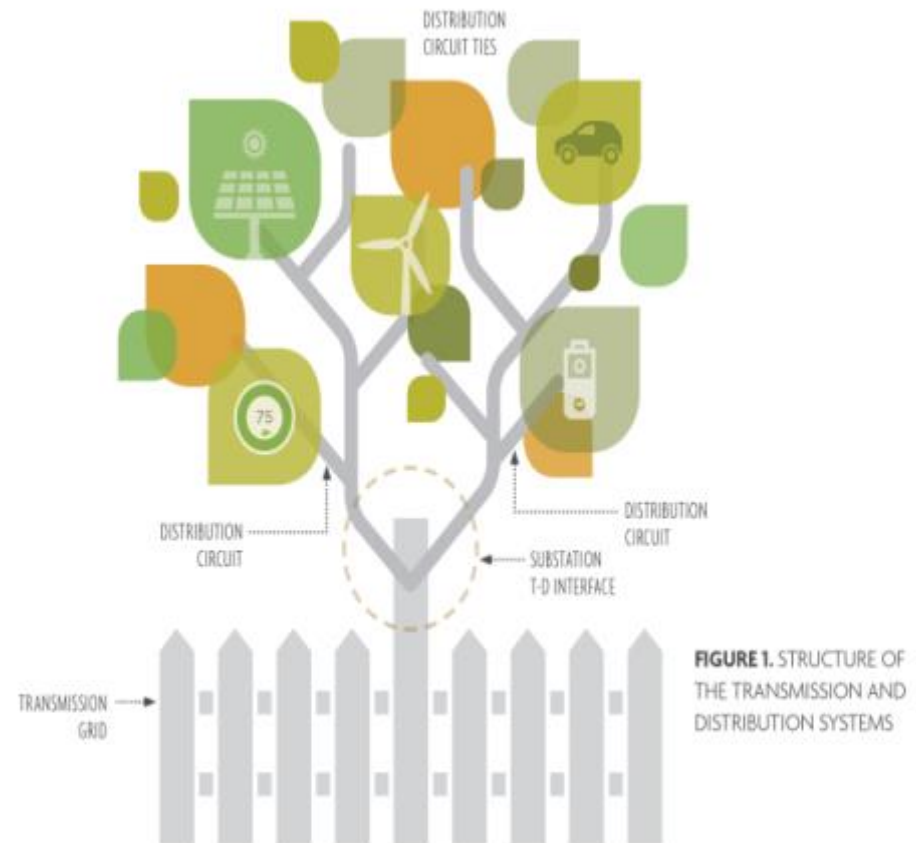
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COORDINATION OF
TRANSMISSION AND
DISTRIBUTION OPERATIONS IN
A HIGH DISTRIBUTED ENERGY
RESOURCE ELECTRIC GRID



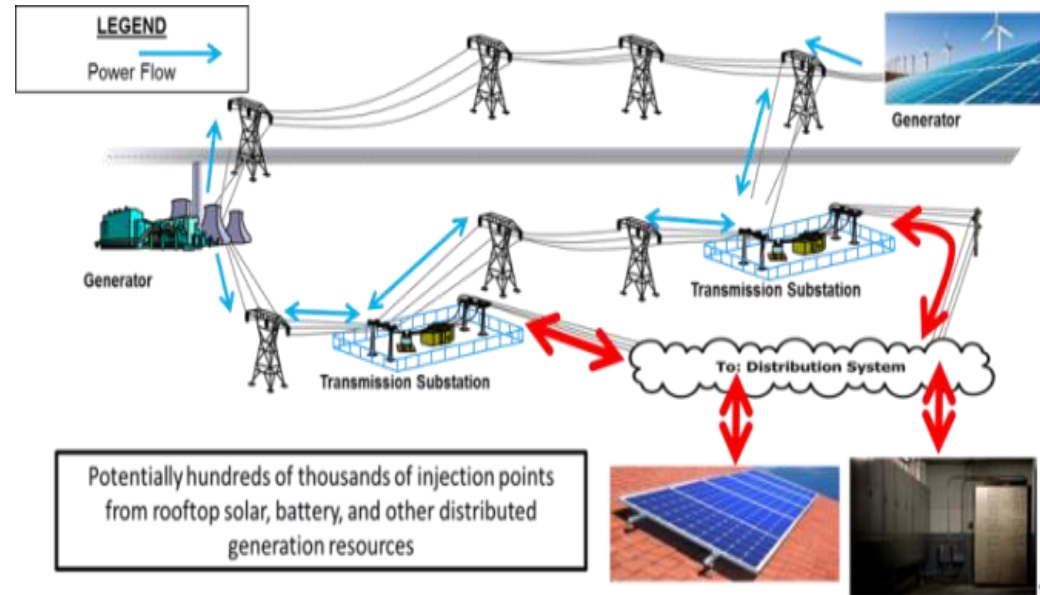
DERs use both Transmission and Distribution Systems

- DERs use both Transmission and Distribution systems when they:
 - Consume energy from the grid
 - Participate in CAISO wholesale market
 - Provide distribution services to the Distribution Operator (DO)
- Transmission and Distribution (T-D) are distinct with different structures, characteristics, functions & operating principles
- T-D “interfaces” are those substations where transmission and distribution interconnect



New Operational Challenges

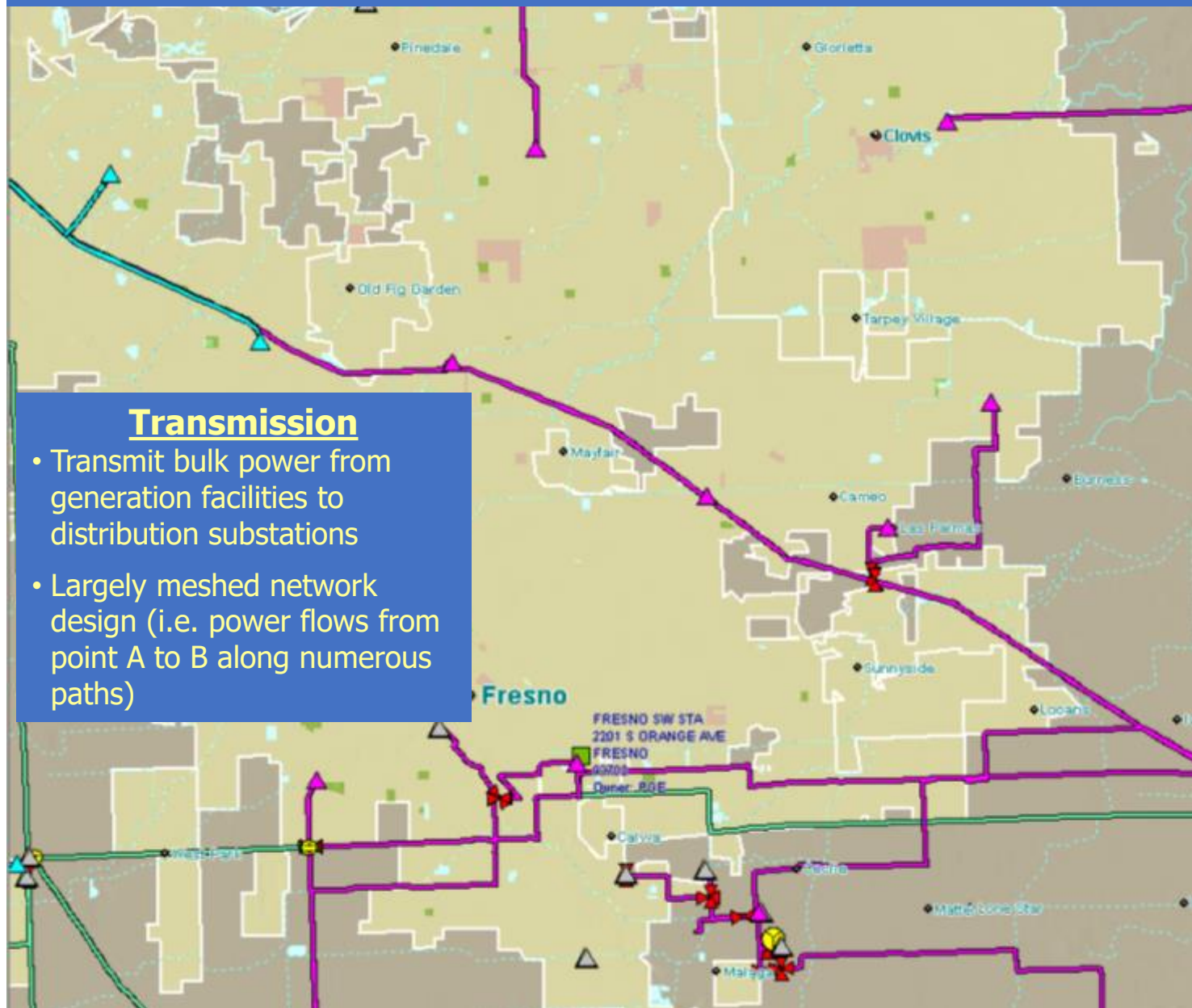
1. ISO dispatches DERS without knowing impact of those dispatches on the distribution system
2. Understanding how DER aggregations' dispatch impacts distribution system is difficult because distribution grid is re-configured more frequently than transmission system
3. No adequate methods exists to forecast how DER participation affects net load and other characteristics at the T-D interface
4. Distribution Operator does not have same level of visibility, control and situational awareness of DERs as ISO does with transmission resources
5. Challenges will only increase with increasing DER penetration



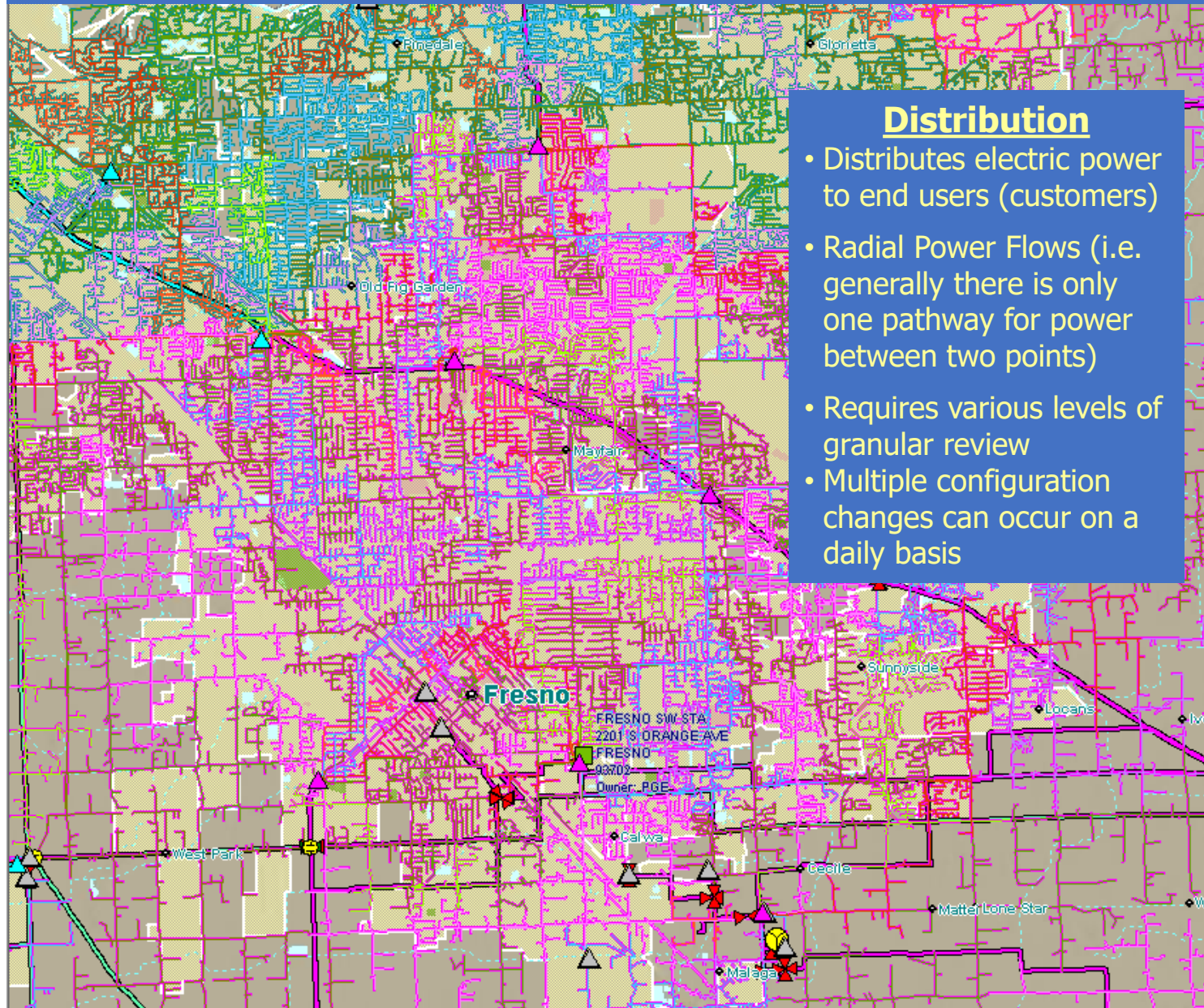
Local Area Transmission

Transmission

- Transmit bulk power from generation facilities to distribution substations
- Largely meshed network design (i.e. power flows from point A to B along numerous paths)

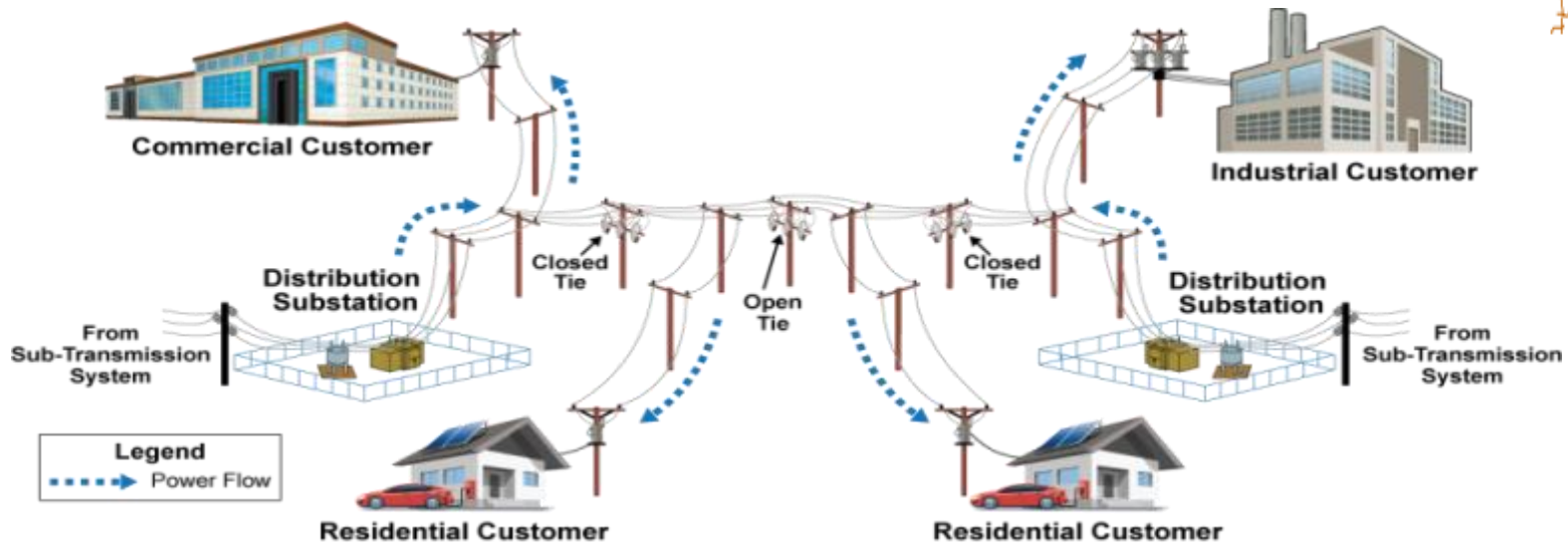


Local Area Transmission and Distribution Systems



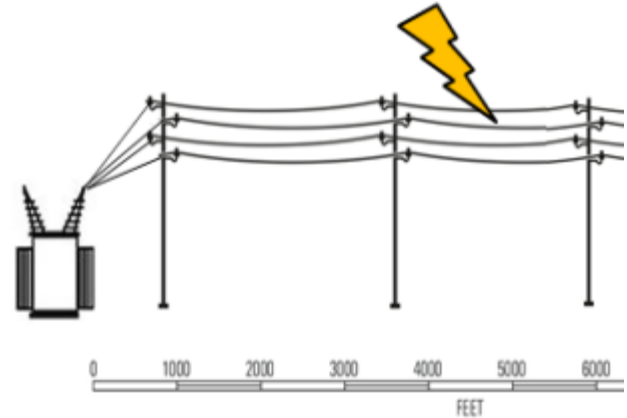
Frequency of Distribution Outages and Use of Switching Configurations

- Radial distribution design is reconfigurable via connections between feeders
- Many possible configurations adding operational complexity
- Outages and abnormal circuit configurations can create capacity constraints, which can affect DERs' ability to participate in wholesale markets



DER Effects on Distribution System Phase Balancing and Voltage Regulation

- Balancing Loads between three phases on distribution grid becomes challenging with higher DER penetration
- Must consider effects of DERs' output, location and characteristics on distribution grid to mitigate phase imbalance and voltage regulation problems
- More sophisticated interconnection, planning, and construction methods will be required to maximize efficient use of distribution grid

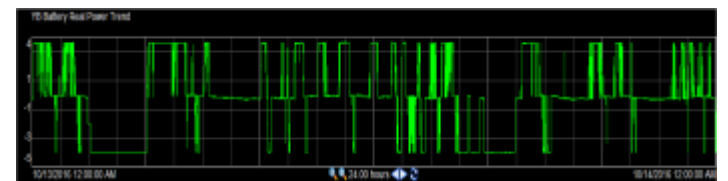
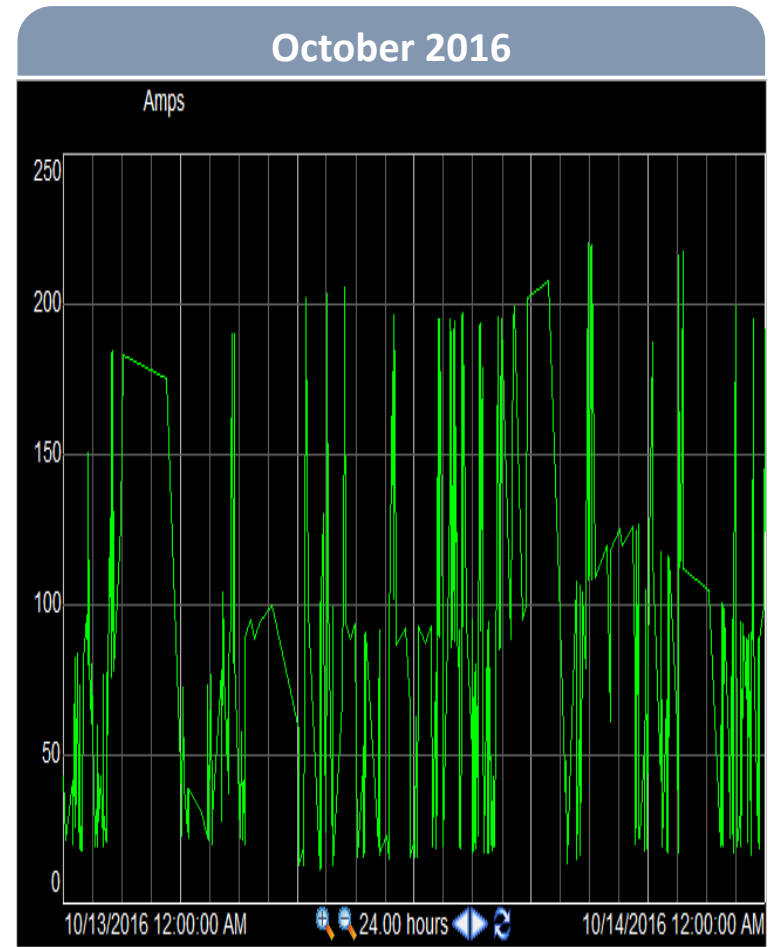
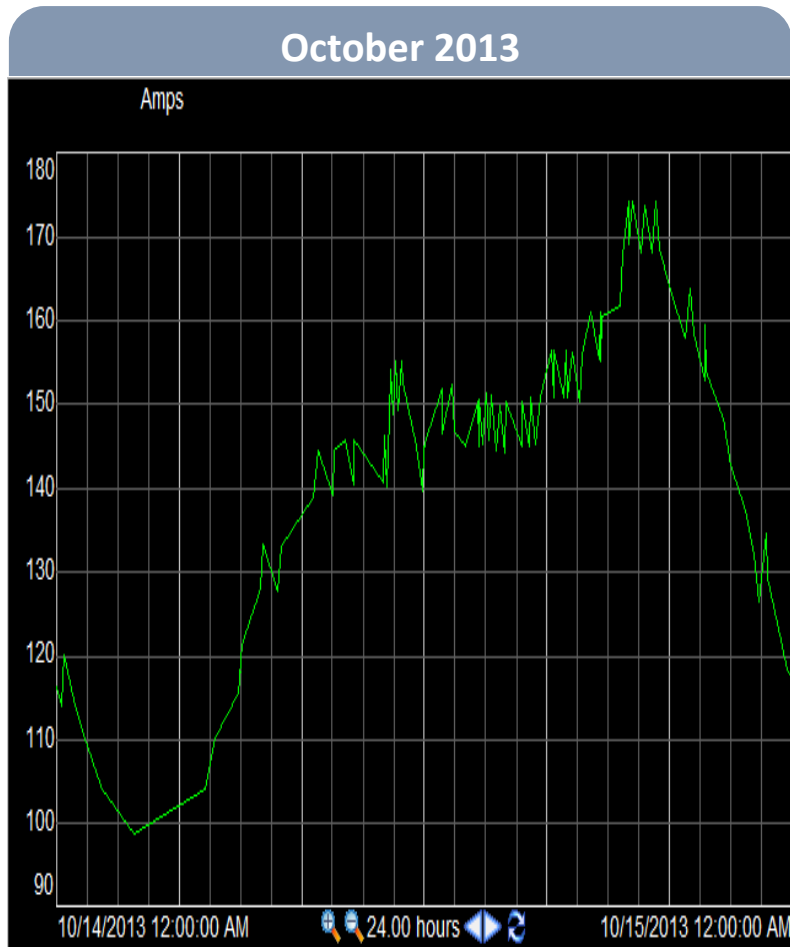


Lack of Visibility, Situational Awareness and Management

- DO and the ISO do not have visibility and situational awareness about status and output of DERs
- DER Provider does not have visibility into distribution system to ensure export via TD Interface is feasible
- DO needs additional granular visibility into distribution system, including tools for:
 - Predicting DER behavior
 - Viewing real time DER response
 - Forecasting DERs' impact on grid

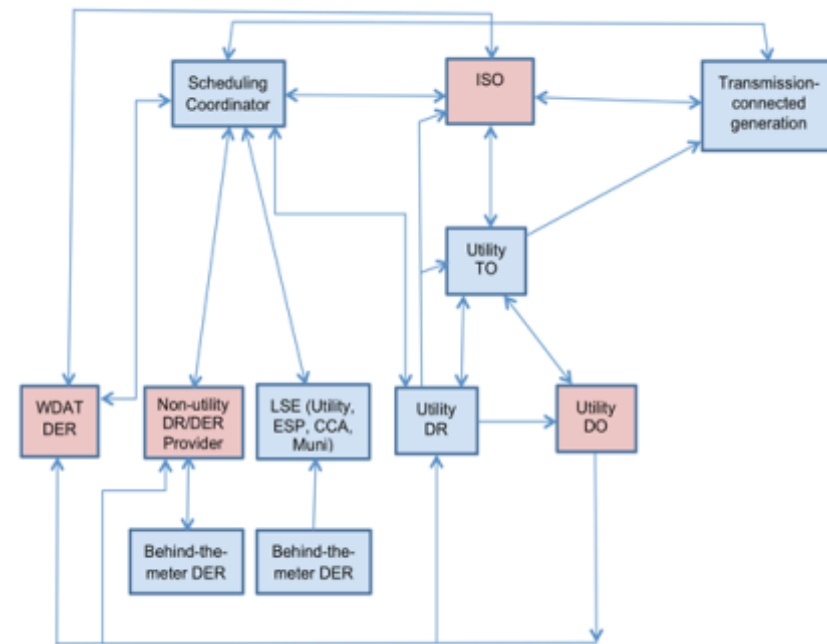


DER Wholesale Market Participation Before and After Impacts on Distribution Grid



Entity's Objectives and Responsibilities Drive Needed Tools, Information Flows & Procedures

- DER provider/aggregator is concerned with business viability
 - Ability to participate, in a non-discriminatory manner, in all markets for which it has required performance capabilities
 - Ability to optimize its choice of market opportunities and manage its risks curtailment for reasons beyond its control
- ISO's primary DER concern is at the T-D interface
 - Predictability/confidence re DER responses to ISO dispatch
 - Short-term forecasts of net interchange at each T-D interface
 - Long-term DER growth scenarios for transmission planning
- DO's concern starts with reliable distribution system operation
 - Visibility/predictability to current behavior of DER
 - Ability to modify behavior of DER via instructions or controls as needed to maintain reliable operation
 - Long-term DER growth scenarios for distribution planning



Near-Term Recommendations

Recommendations may be implemented as pilots or manual procedures for near term, and then considered for automation as DER volumes increase.

1. DO should communicate advisory info on current system conditions to DER providers, so that DER providers can modify their ISO market bids accordingly and if necessary submit outage or derate notifications to the ISO
2. ISO should provide day-ahead DER schedules to DO, for DO to pilot a feasibility assessment to identify schedules that may create distribution system reliability problems.
3. DER provider should communicate constraints on its resources' performance to the ISO, in the form of updated market bids or outage notifications, if needed
4. DO should pursue a pro forma DER Provider (DERP) "integration agreement" with the DER provider with regard to DER aggregations.

Case Study | Distributed Energy Storage in California

Manal Yamout, Vice President of Policy & Co-Founder



Advanced Microgrid Solutions

July 17, 2017

Advanced Microgrid Solutions

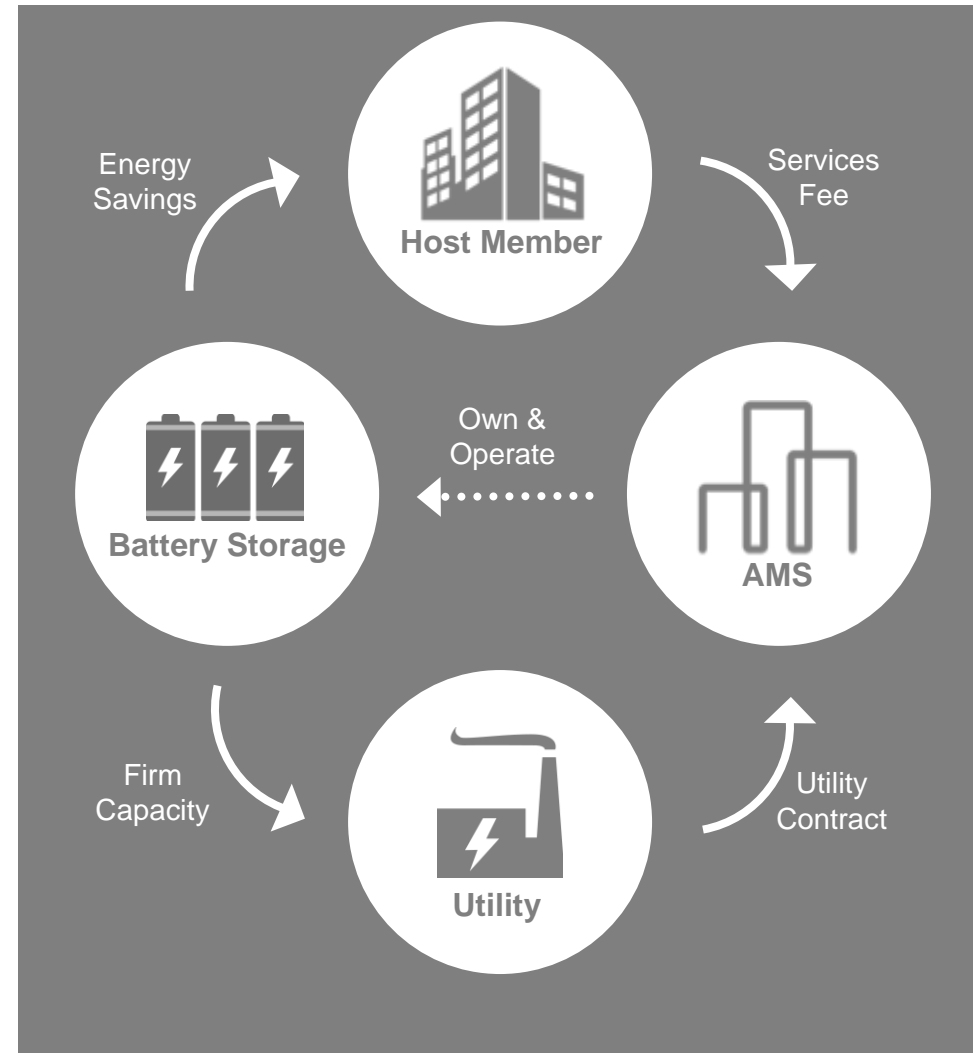
AMS IS THE **NEXT GENERATION BUILDING-TO-GRID** ENERGY MANAGEMENT PLATFORM THAT **DESIGNS, OPTIMIZES, AGGREGATES AND MANAGES** BEHIND-THE-METER DISTRIBUTED ENERGY RESOURCES

THE ARMADA PLATFORM PROVIDES **MAXIMUM COST SAVINGS** TO RETAIL END USERS AND CLEAN, COST EFFECTIVE **GRID SERVICES** TO ELECTRIC UTILITIES

- Scalable and bankable **Storage-as-a-Service** business model
- Proprietary technology platform **optimizes revenue generation** from aggregated DERs
- **Groundbreaking** 90 MW / 360 MWh utility grid services contracts with SoCal Edison
- **Largest industry project financing** of \$200M with Macquarie Capital
- **First non-recourse debt financing** of energy storage assets with CIT
- Projects **deployed and operating**

Energy Storage as a Service

- Host customers receive cost savings, operational efficiencies and market revenues with no capital outlay and no technology risk
- Utilities receive clean, flexible fully energy products that are fully dispatchable and competitively priced – with cost reductions for customers
- AMS recruits host customers, negotiates utility and service agreements, designs, builds and manages assets
- AMS finances projects with a combination of fixed services fees from hosts, utility revenues, available incentives and/or grants



BUSINESS MODEL

Integrated System Design with Energy Storage

Economic Optimization of Distributed Energy Resources

Demand Management

- Peak Demand Reduction
- TOU Load Shifting
- EV/Solar Integration
- Load Balancing
- Microgrid Controls
- Back-Up Generation

Energy Efficiency

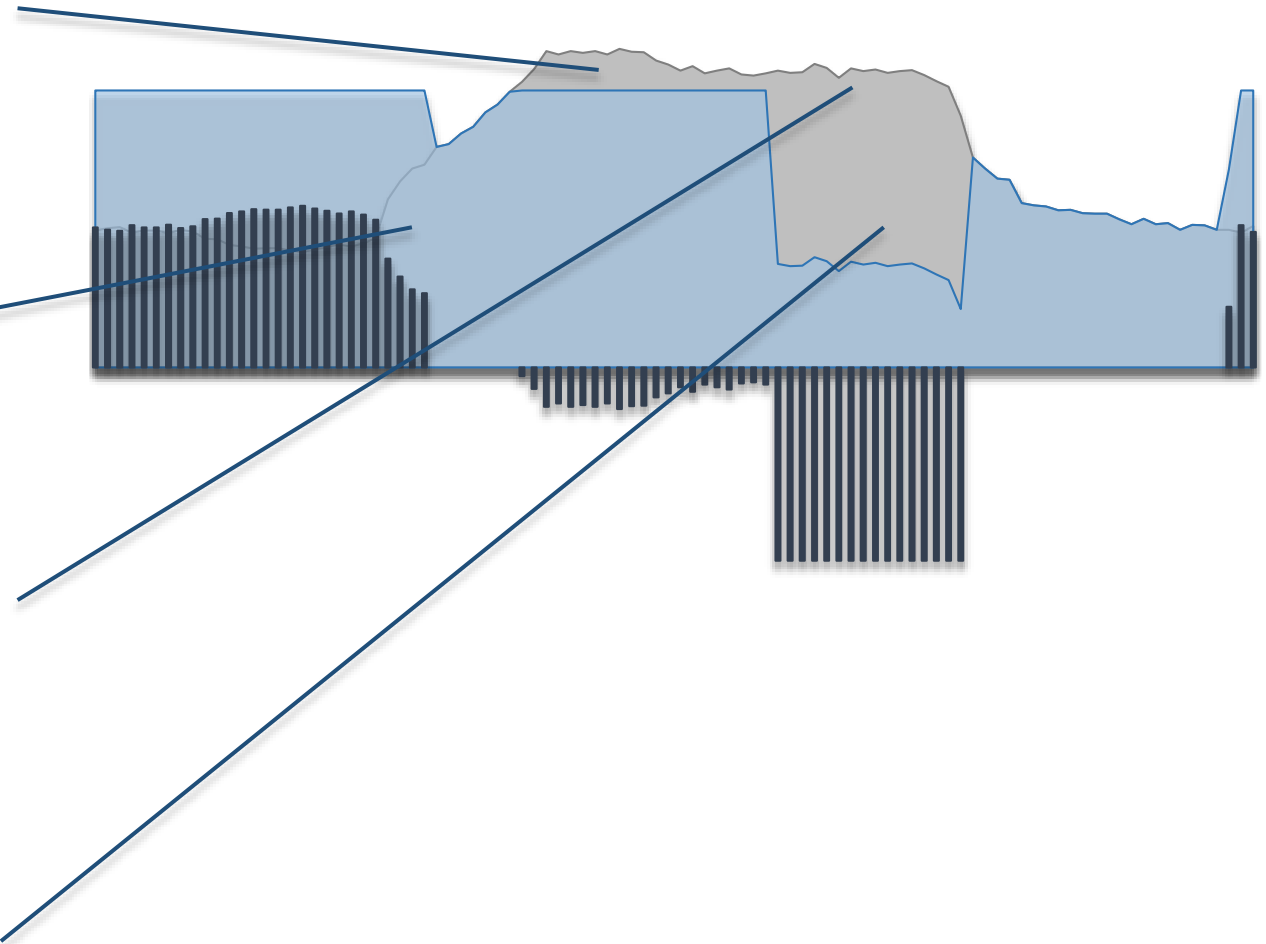
- Monitor-Based Commissioning
- Strategic Energy Management
- Solar PV Optimization
- Power Quality

Market Products

- Flexible Capacity
- Energy Imbalance
- Ancillary Services

Utility Products

- Resource Adequacy
- Reactive Power
- Volt/VAR Optimization
- Conservation Voltage



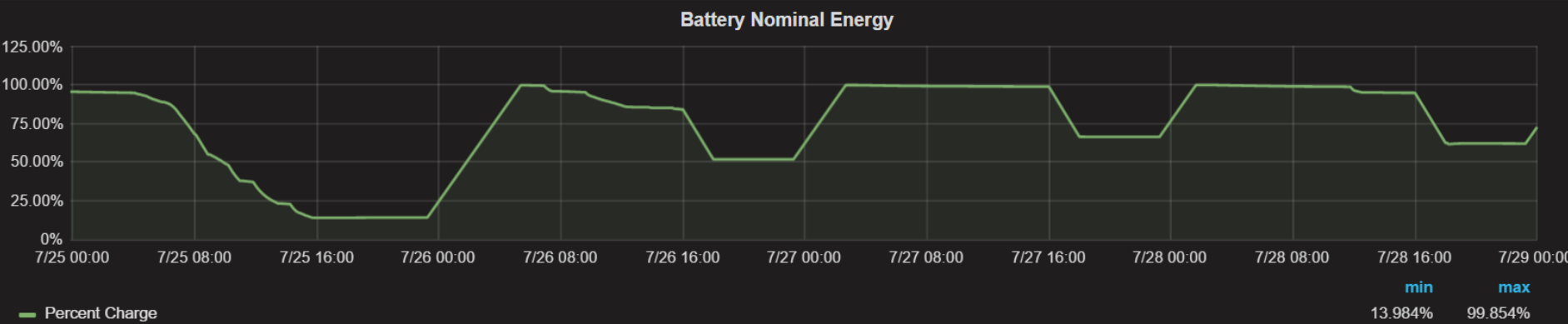
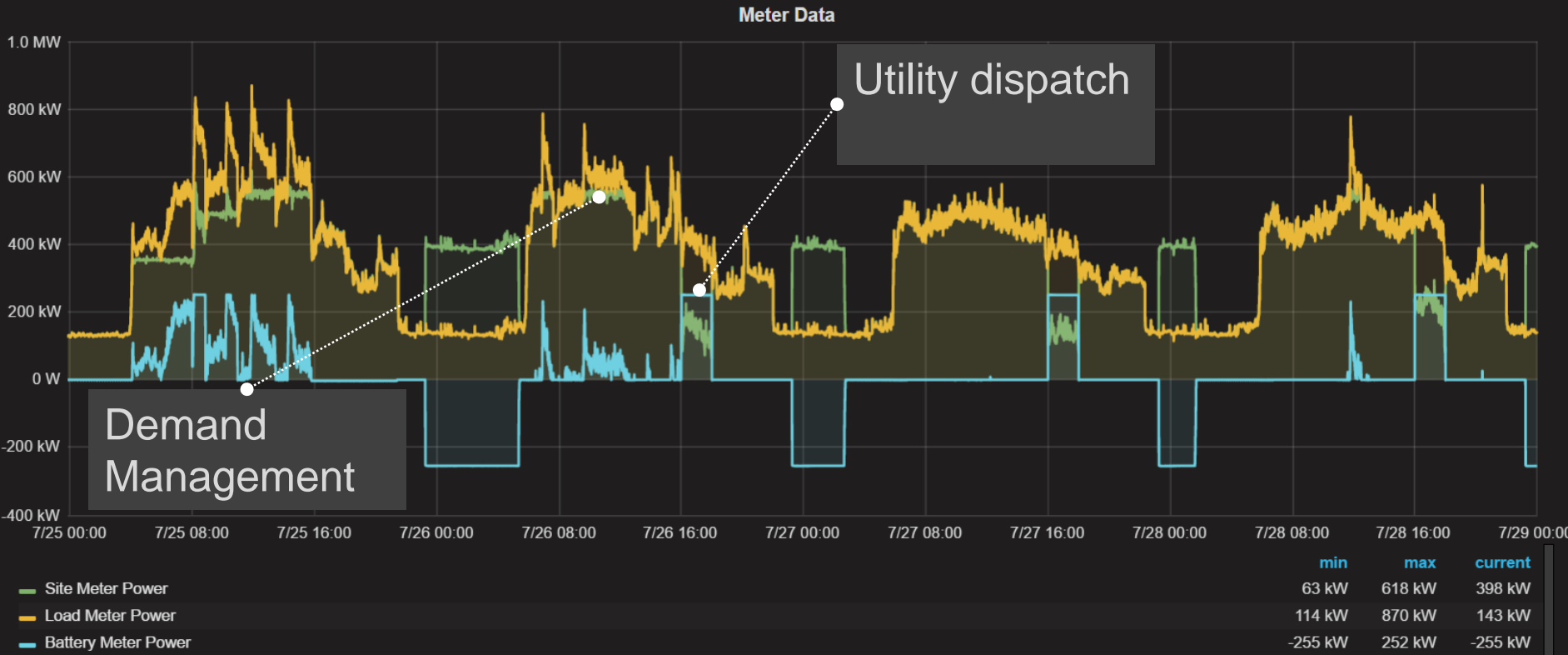
FIRST FLEET OF HYBRID ELECTRIC BUILDINGS®



- Portfolio of 24 commercial buildings
- 250 kW - 750 kW/ 6 hour storage systems
- 25% peak demand reduction
- 10 MW dispatchable capacity to local electric utility
- Zero emissions
- No distribution upgrade



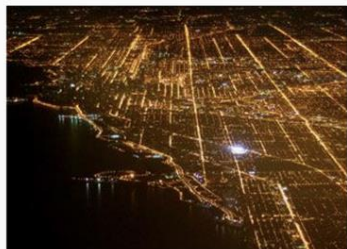
Providing Multiple Services





greentechmedia:

Inside SoCal Edison's Groundbreaking 2.2GW Grid Modernization Plan

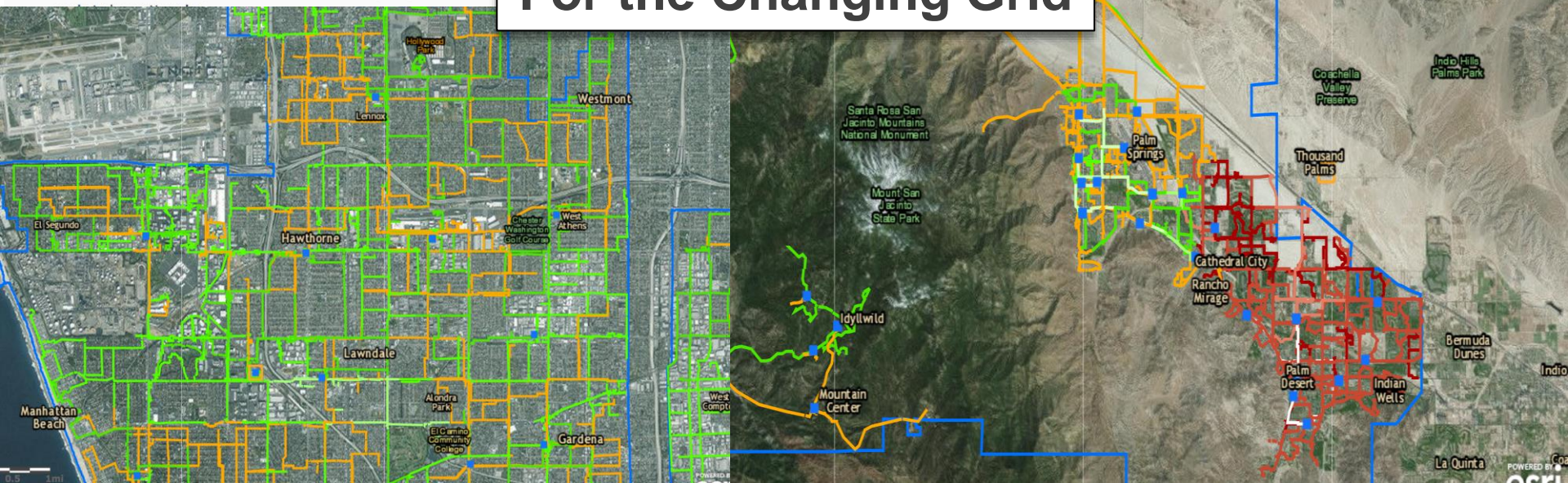
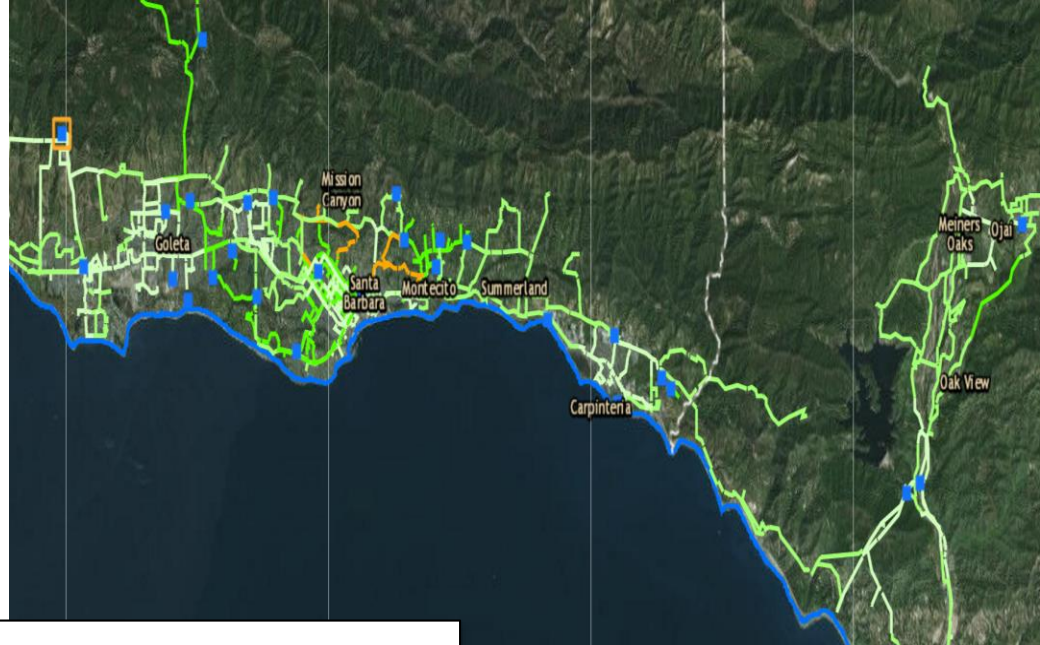


A new model lets distributed solar, energy storage and efficiency stand with power plants and resources.

Jeff St. John
November 21, 2014

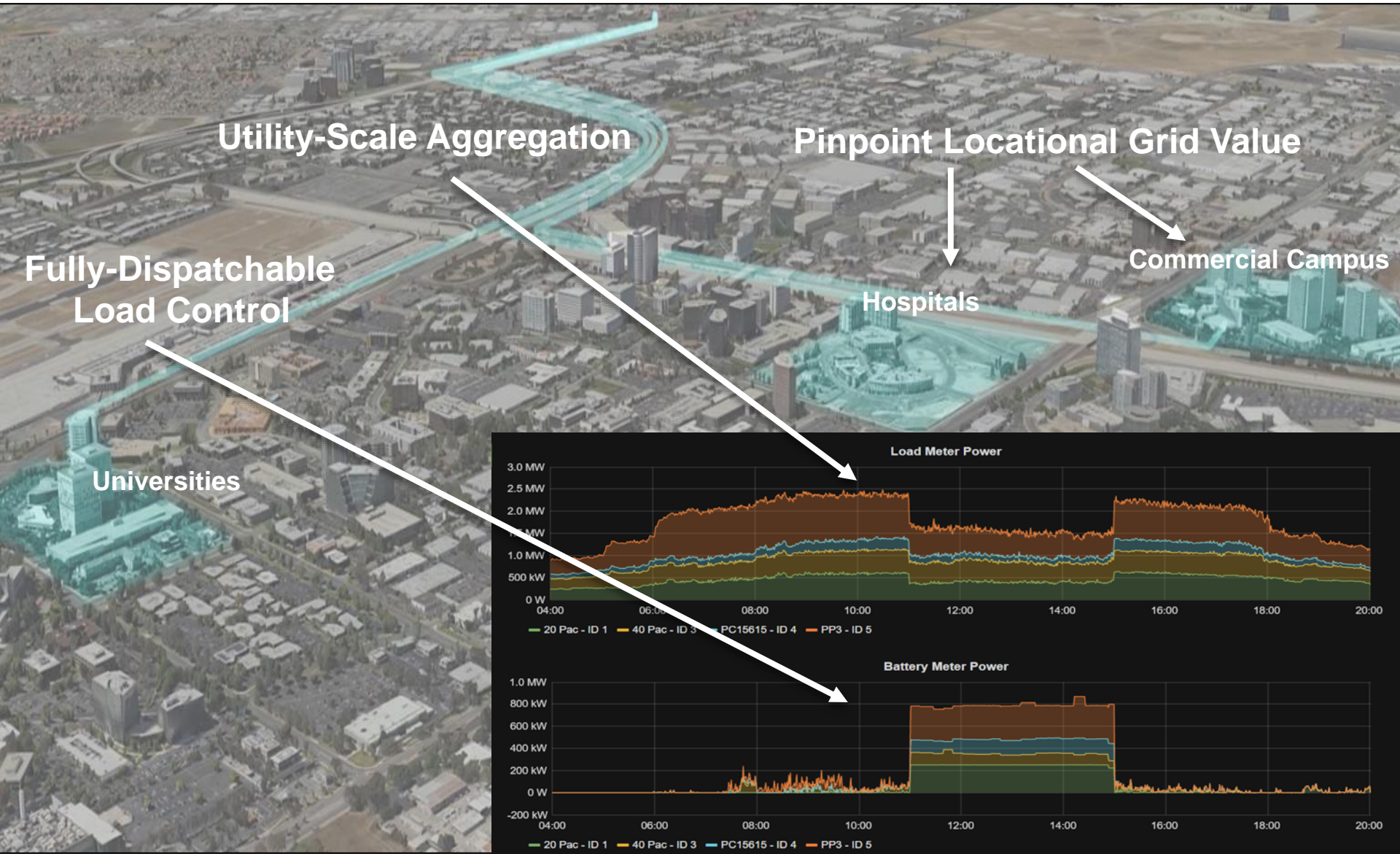
Two weeks ago, utility Southern California Edison launched a real experiment in grid-edge economics, one that's going to unfold in

Southern California Ground Zero For the Changing Grid

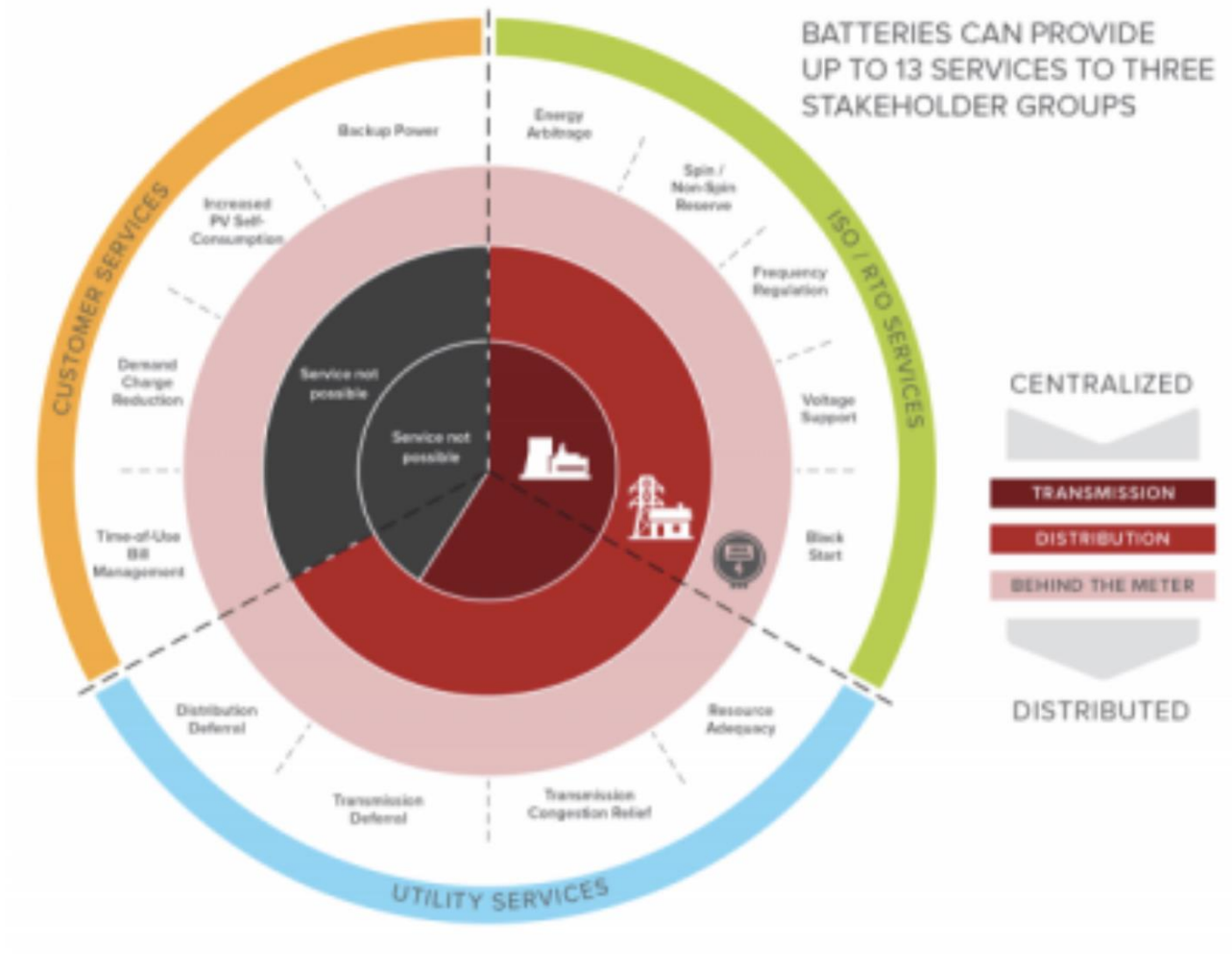


Real Time Portfolio Optimization

Aggregated load centers continuously optimized to deliver full contracted capacity to utilities, services to host customers and participate in market events



Energy Storage Economics



Maturing Markets for Multiple Integrated Services Will Have Implications to Current Utility Business Models

Stakeholders	Services Provided	Applicable Energy Storage Location			Service Value Range (\$/kW) ⁽¹⁾
		Transmission	Distribution	Behind-the-Meter	
ISO / RTOs	Energy Arbitrage	✓	✓	✓	\$5 - \$100
	Frequency Regulation	✓	✓	✓	\$20 - \$220
	Spin / Non-Spin Reserves	✓	✓	✓	\$5 - \$80
	Voltage Support	✓	✓	✓	\$60
	Black Start	✓	✓	✓	\$10
Utilities	Resource Adequacy		✓	✓	\$60 - \$160
	Distribution Deferral		✓	✓	\$60 - \$900
	Transmission Congestion Relief		✓	✓	\$20
	Transmission Deferral		✓	✓	\$80 - \$500
Customers	Time-of-Use Bill Management			✓	\$180 - \$240
	Increased PV Self-Consumption			✓	\$20
	Demand Charge Reduction			✓	\$40 - \$210

Source: Rocky Mountain Institute ("RMI").

(1) Based on RMI's "The Economics of Battery Energy Storage" report.

Future California Market Products

Retail Customer Services	Distribution Grid Services	Wholesale Market Services
<ul style="list-style-type: none">• Solar self-consumption• Backup power with low-voltage ride-through	<ul style="list-style-type: none">• Distribution Upgrade Deferral• Voltage support/optimization• Islanding or maintenance support• Low-voltage ride-through	<ul style="list-style-type: none">• Frequency regulation• Frequency response• Spinning/non-spinning reserve• Reactive power supply

Specific Issues to Address

- **Compensation Model:** Accurately value the market and reliability services provided by energy storage
- **Wholesale Market Variations & Overall Complexity:** Common foundation for the resource in all markets
- **Interconnection Issues:** Often overly complex, prohibitively costly, and unnecessarily lengthy for the size of the resource under consideration

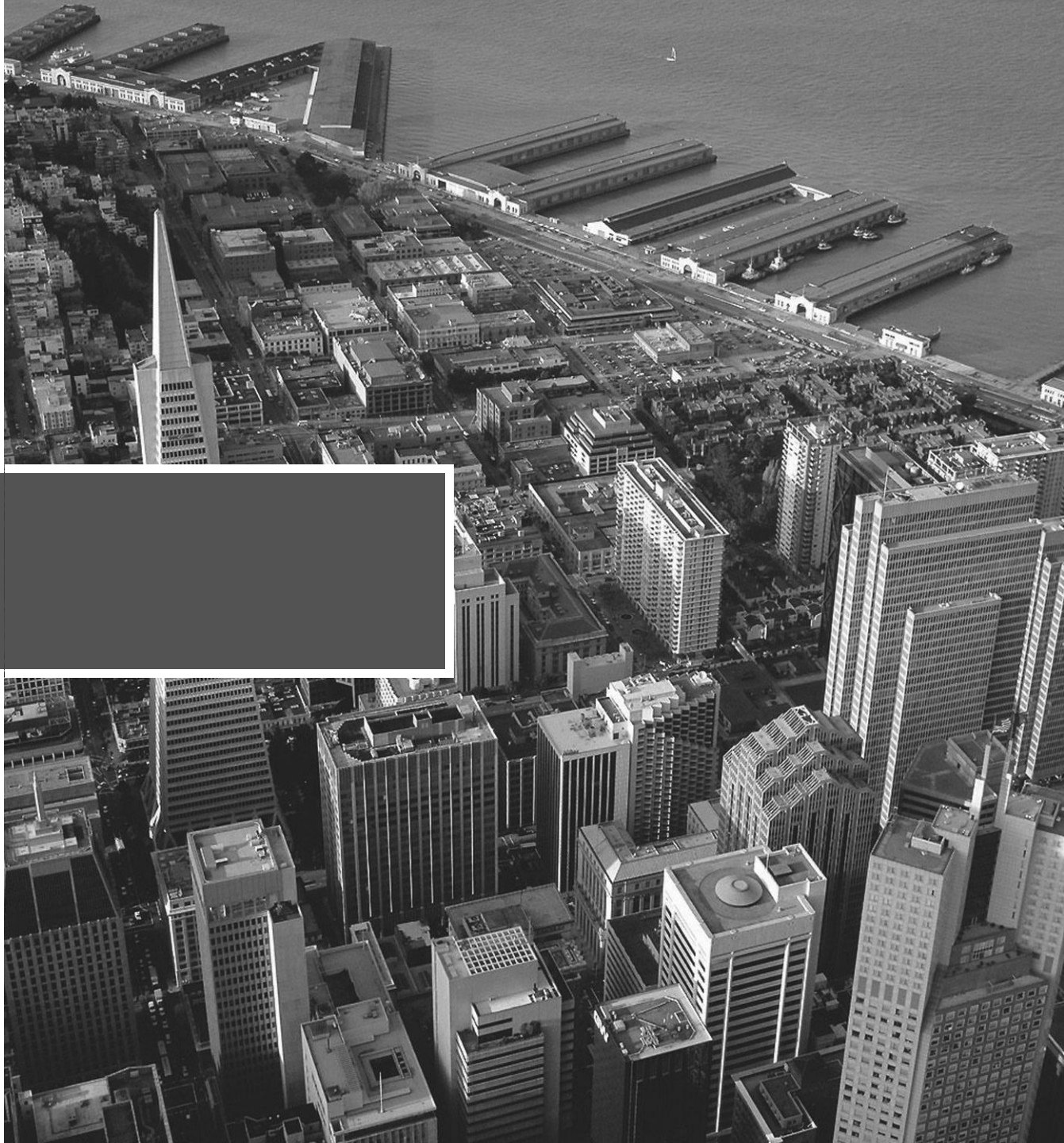
Guiding Principles

- **Clarity & Consistency:** Interconnection, metering, telemetry and general market rules
- **Urgency:** These projects are online now
- **Err on the side of innovation:**
 - Participation in multiple programs
 - Keep things simple

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www.advmicrogrid.com



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