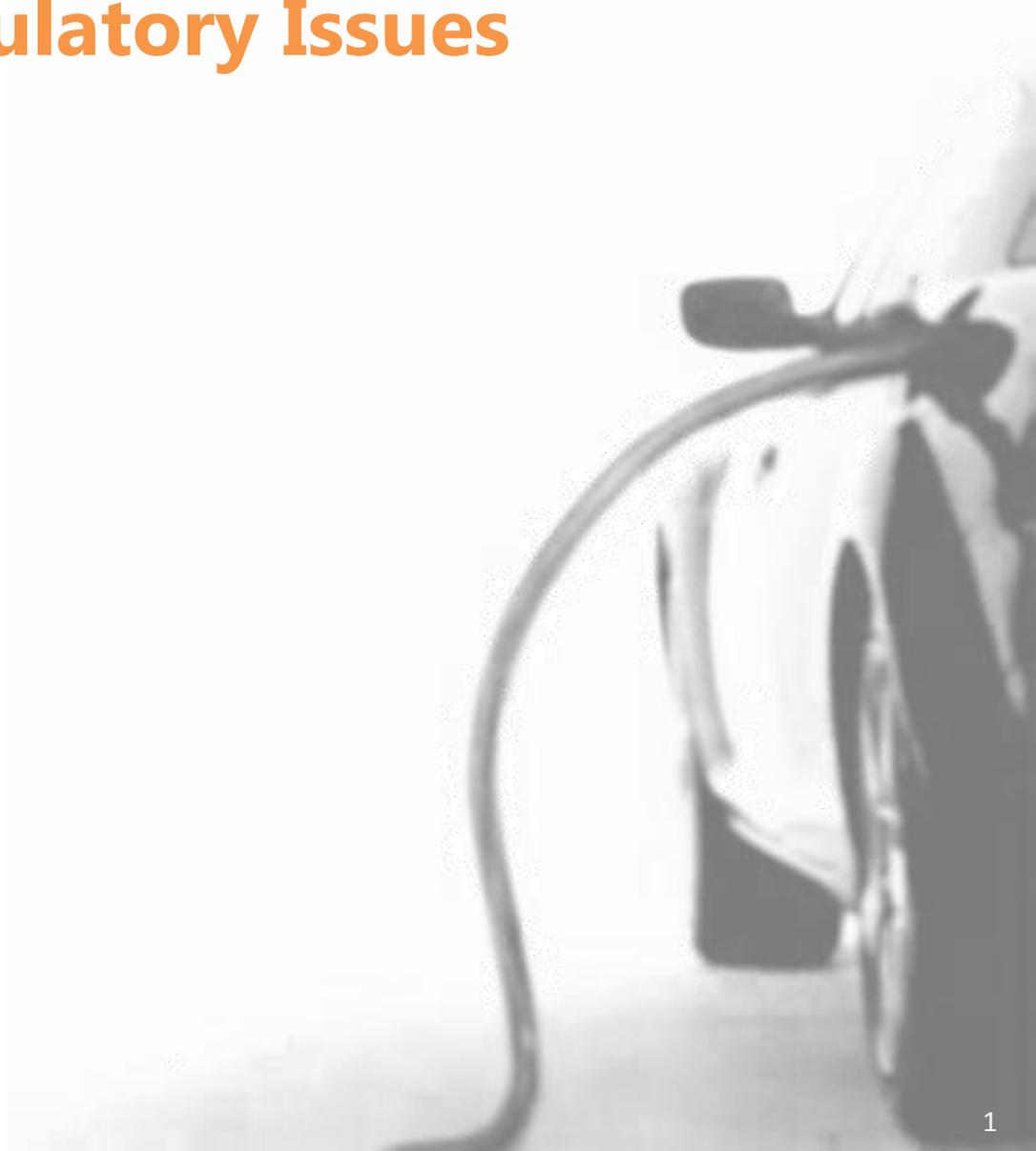


Vehicle-Grid Integration

Use Cases and Regulatory Issues

Adam Langton and Noel Crisostomo
CPUC Energy Division

CEC VGI Research Workshop
November 2014



Presentation Topics

- Draft Use Case Framework
- Valuing Grid Functionality
- Relationship to Storage Procurement
- Next Steps in CPUC alternative-fueled vehicle proceeding

Implementing VGI

Value of
Grid Functionality

```
graph TD; A([Value of Grid Functionality]) --> C([Business Case for Broad Implementation Drives Prioritization]); B([Use Cases]) --> C;
```

The diagram consists of three white-outlined ovals on a dark grey background. The top oval contains the text 'Value of Grid Functionality'. The middle-left oval contains the text 'Use Cases'. The bottom-right oval contains the text 'Business Case for Broad Implementation Drives Prioritization'. Two white arrows point from the top and middle-left ovals towards the bottom-right oval.

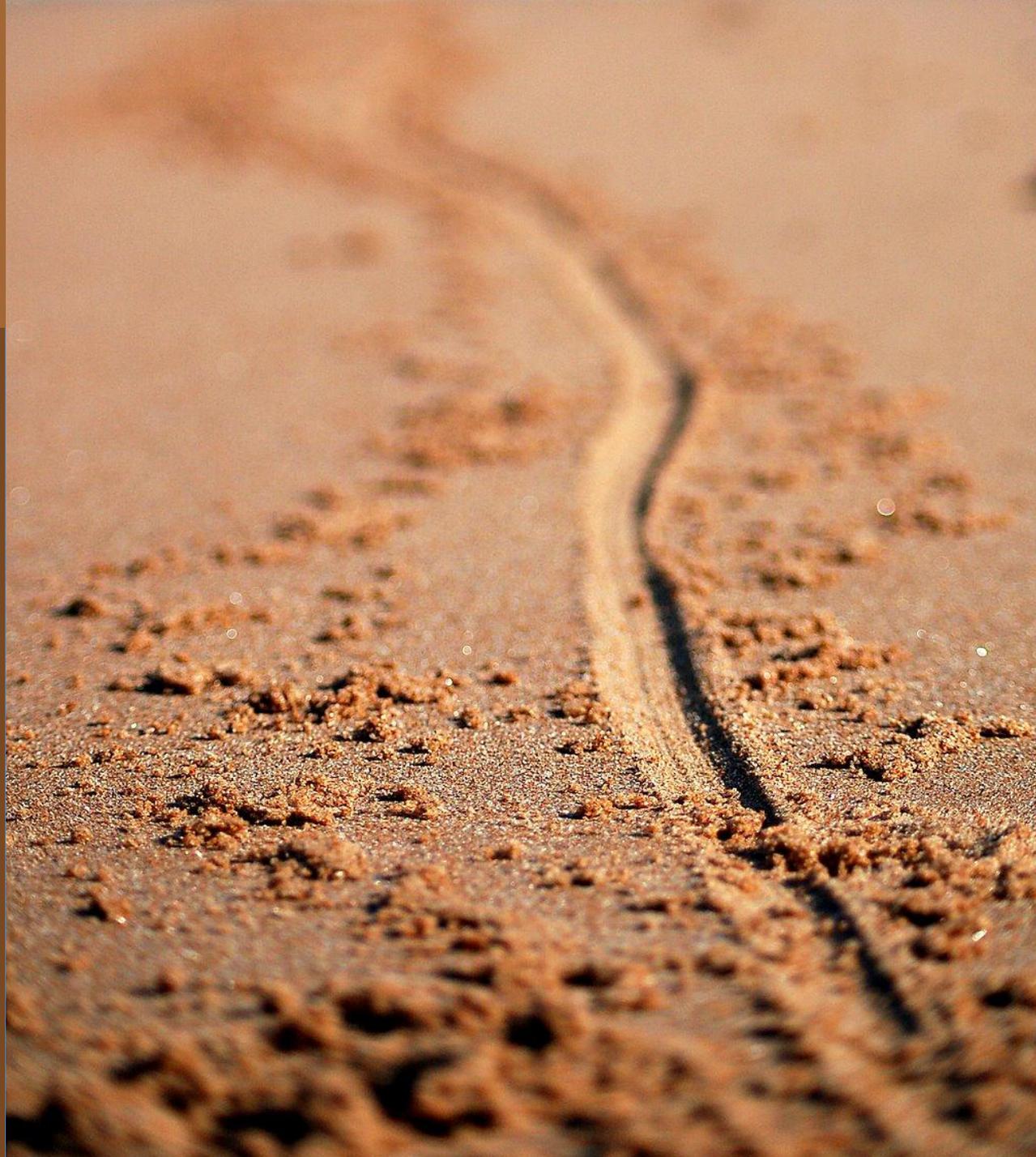
Use
Cases

Business Case
for
Broad Implementation
Drives Prioritization

VGI

Use Cases

- Identify Characteristics critical to functionality and communication
- Group into Use Case Families
- Prioritize implementation based on business case



Use Case Characteristics

Performance Signal

Service Destination

Power Flow Characteristics

Aggregation

...Sub use-cases incorporate actor complexity and communication richness

Performance Signal

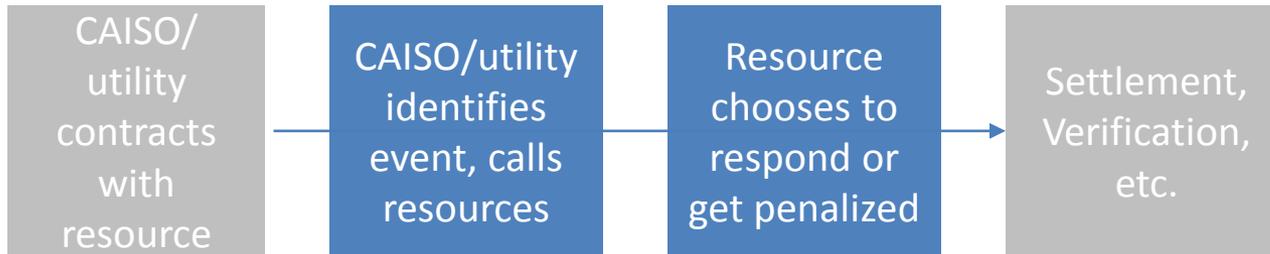
Event-Based

Automatic Communication

Reservation-Based

Performance Signal

Event-Based



Performance is triggered by a message from the grid in real-time as an event is occurring

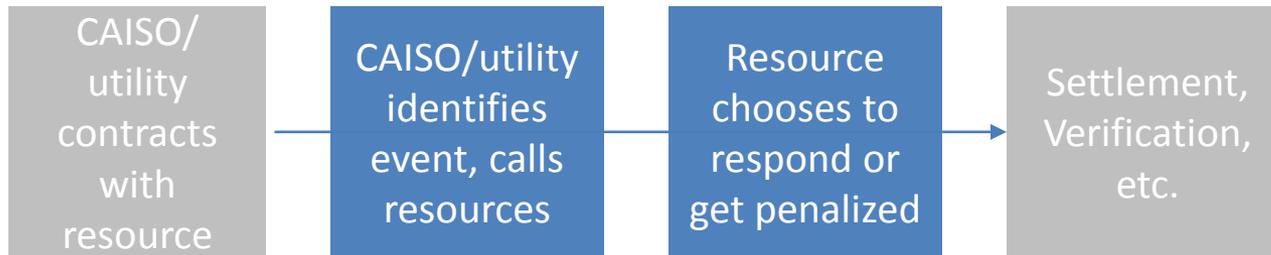
Utility/CAISO indicates magnitude and duration

Automatic Communication

Reservation-Based

Performance Signal

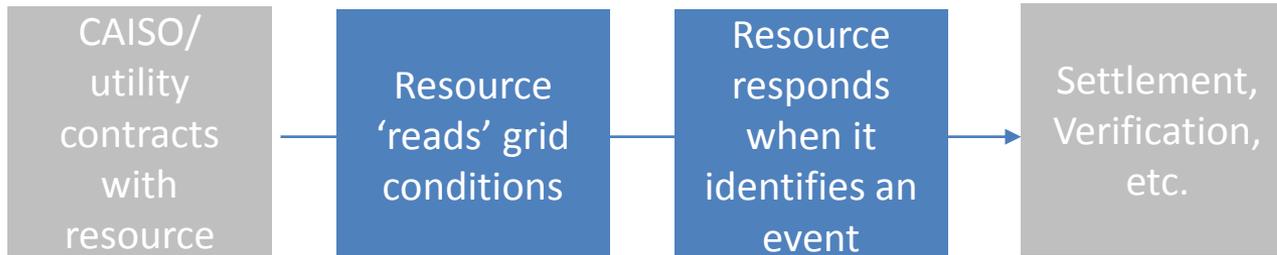
Event-Based



Performance is triggered by a message from the grid in real-time as an event is occurring

Utility/CAISO indicates magnitude and duration

Automatic Communication



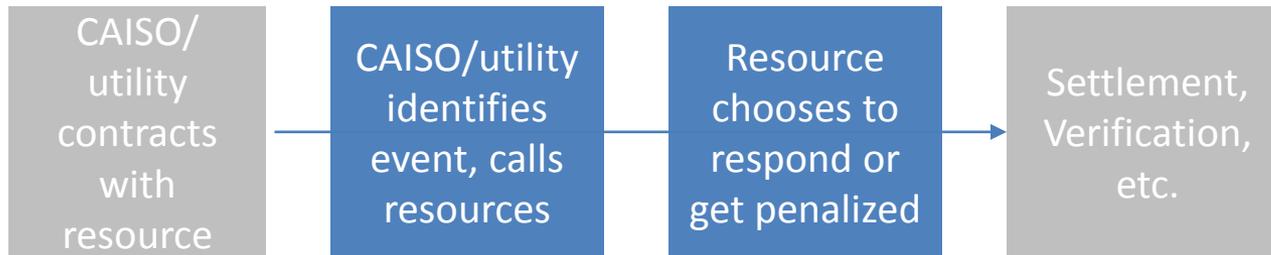
Performance is triggered by conditions read from the grid

Performance occurs in real-time, following pre-determined rules

Reservation-Based

Performance Signal

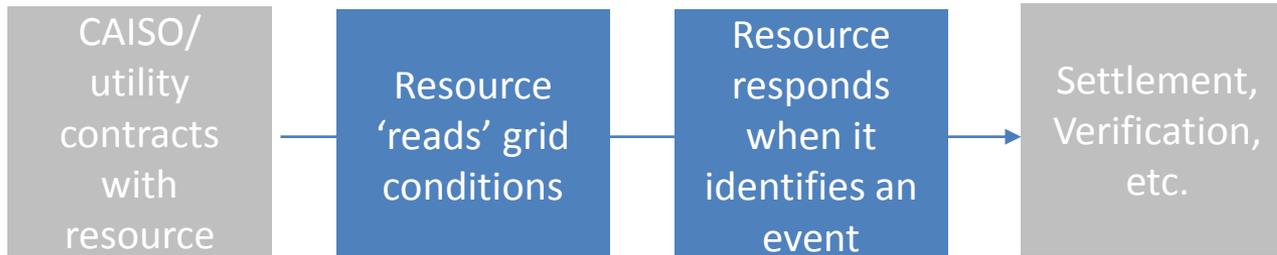
Event-Based



Performance is triggered by a message from the grid in real-time as an event is occurring

Utility/CAISO indicates magnitude and duration

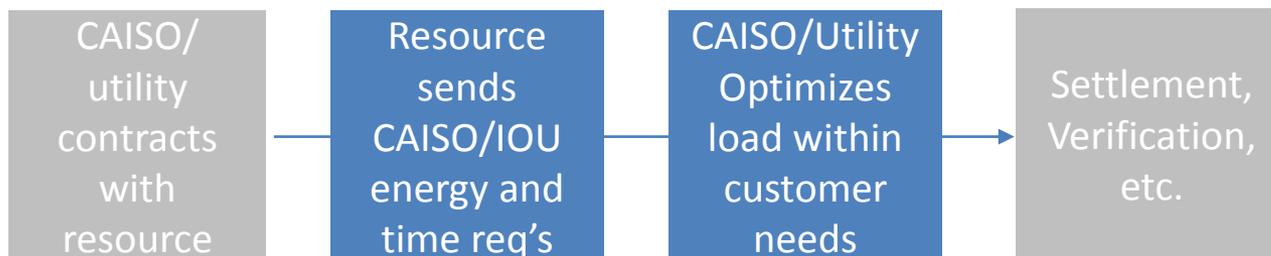
Automatic Communication



Performance is triggered by conditions read from the grid

Performance occurs in real-time, following pre-determined rules

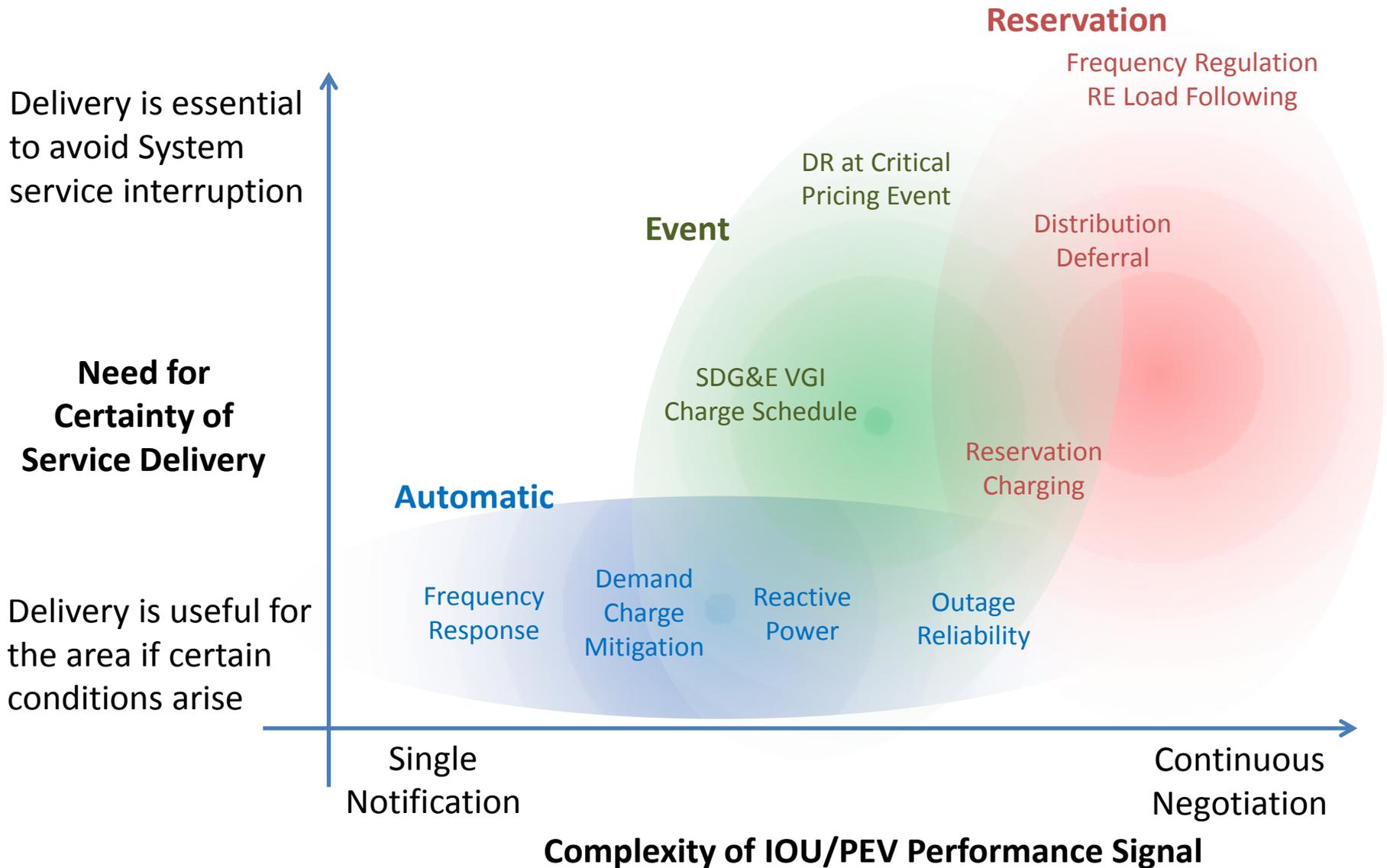
Reservation-Based



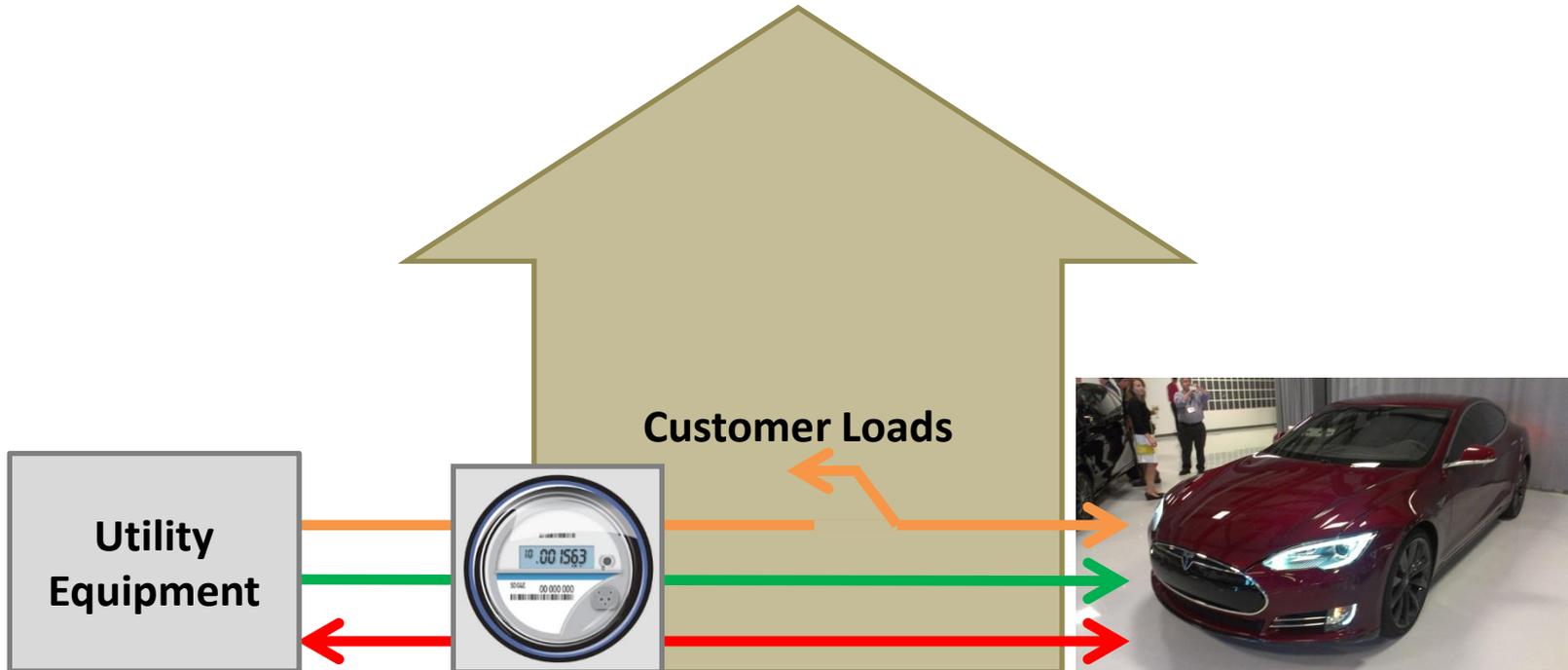
Customer gives utility control over its resource under specified terms

CAISO/utility determines performance based on expected and real-time grid conditions

Performance Signal type may implicate the development of grid services and affect their value.



Vehicle Power Flow



V1G: Unidirectional power into PEV charging
Load-Modifying V1G: service behind the meter
V2G: Bi-directional power in front of the meter

Aggregation Type

Single Site

- Can be multiple vehicles, but must be at one grid location
- Capable of delivering local distribution benefits

Geographic Site Aggregation

- Multiple vehicles at multiple grid locations
- Maybe Capable of delivering local distribution benefits

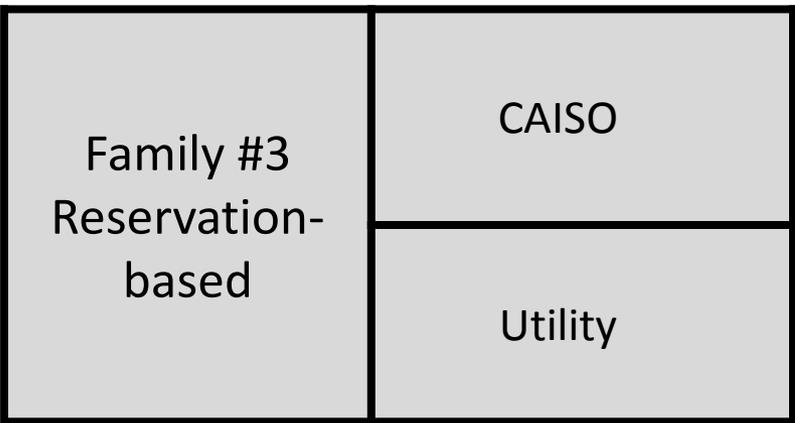
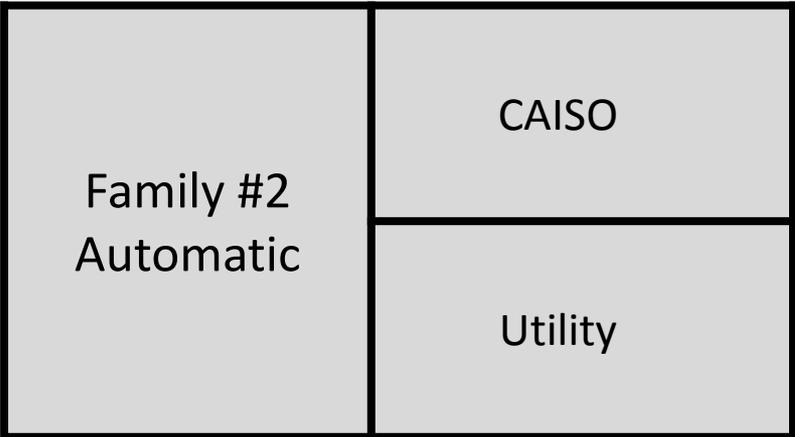
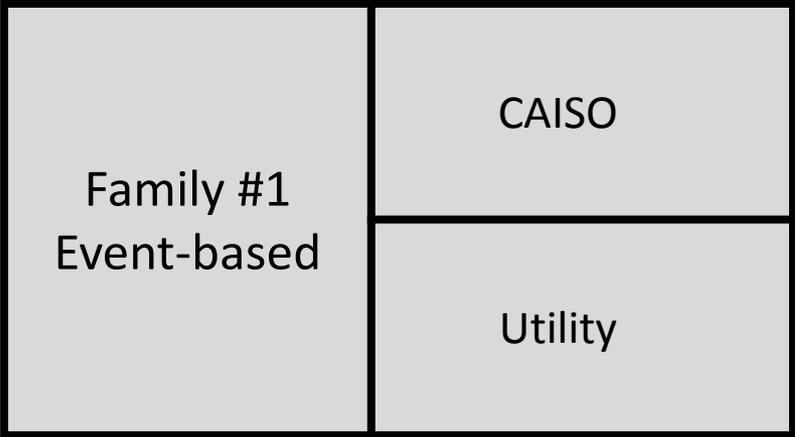
Research can help us understand how tariffs and rules that govern reliability might be modernized to open customer value unlocked by new technology.

Commercial Stage & Objective		Project Subject, Program Administrator & Investment Plan #, Affected Segment(s) of Electricity Value Chain			
Technology Demonstration & Deployment	Cross-Cutting (*)			*Utility Dispatch of CAISO DR, SCE 2	
				*Regional Grid Optimization, SCE 2	
				*Mobile Metering, PG&E 2	
				*Automated Open Architecture Devices, PG&E 2	
Customer Products & Services Enablement				Load Scanning to Identify EV, SCE 1	
				Transformer Load Management, SCE 1	
				Advanced V2G Applications, CEC 1	
				Submetering & Subtractive Billing, PG&E 1	
				Submetering & Subtractive Billing, SCE 1	
				DCFC Mapping Tool, PG&E 1	
				DCFC Installation, SCE 2	
				L1 Make-Readies, SCE 2	
				Off-Road Electrification, SCE 2	
				A/S & Streetlight EVSE, CEC 2	
Renewable & Distributed Energy Resource Integration				Intelligent Universal Transformer, PG&E 2	
				DER Management System, PG&E 2	
Grid Optimization & Modernization			EVs for P Quality & Outages, PG&E 1		
				VAPS Retrofits, SCE 2	
Applied Research & Development		Charging to Integrate Renewable Energy, CEC 2			
		V2G Communications Interfaces, CEC 1,2			
				Battery Recycling, CEC 2	
				Smart & Efficient EVSE, CEC 1	
			Customer EMS, CEC 2		
Electric Program Investment Charge Projects with Plug-In Electric Vehicles		Generation	Transmission	Distribution	Demand-Side Management
		<i>Grid Operations and Market Design (italicized Project Subject)</i>			

Family #1
Event-based

Family #2
Automatic

Family #3
Reservation-
based



Family #1 Event-based	CAISO	Controlled Charging	Load Modification	Bi-directional Power Flow
		No Aggregation	No Aggregation	No Aggregation
		Controlled Charging	Load Modification	Bi-directional Power
		Geographic Aggregation	Geographic Aggregation	Geographic Aggregation
	Utility	Controlled Charging	Load Modification	Bi-directional Power Flow
		No Aggregation	No Aggregation	No Aggregation
Controlled Charging		Load Modification	Bi-directional Power	
		Geographic Aggregation	Geographic Aggregation	Geographic Aggregation

Family #2 Automatic	CAISO	Controlled Charging	Load Modification	Bi-directional Power Flow
		No Aggregation	No Aggregation	No Aggregation
		Controlled Charging	Load Modification	Bi-directional Power
		Geographic Aggregation	Geographic Aggregation	Geographic Aggregation
	Utility	Controlled Charging	Load Modification	Bi-directional Power Flow
		No Aggregation	No Aggregation	No Aggregation
Controlled Charging		Load Modification	Bi-directional Power	
		Geographic Aggregation	Geographic Aggregation	Geographic Aggregation

Family #3 Reservation- based	CAISO	Controlled Charging	Load Modification	Bi-directional Power Flow
		No Aggregation	No Aggregation	No Aggregation
		Controlled Charging	Load Modification	Bi-directional Power
		Geographic Aggregation	Geographic Aggregation	Geographic Aggregation
	Utility	Controlled Charging	Load Modification	Bi-directional Power
		Geographic Aggregation	Geographic Aggregation	Geographic Aggregation
Controlled Charging		Load Modification	Bi-directional Power	
		Geographic Aggregation	Geographic Aggregation	Geographic Aggregation

VGI Services

Wholesale Market Services	Distribution Infrastructure Services	Customer-Facing Services
Frequency Regulation	Upgrade Deferral	Power Quality
Spin/Non-Spinning Reserves	Voltage Support	Power Reliability
Load Following/Ramping		Retail Energy Time-Shift
		Demand Charge Mitigation

Stakeholders need to understand:

- the value of each service (\$/kW/yr)
- the frequency that it is called
- the duration of a given service
- whether or not aggregation can be used
- which performance signal is needed for each

VGI and Storage Procurement

Bi-Directional Power Flow and Load Modification VGI resources are eligible technologies for utility storage procurement.

At this time, Controlled Charging is not considered a storage resource

Controlled Charging will be revisited for inclusion in the 2016 procurement cycle

Solicitations issued or pending release:

[SDG&E](#) 9/5/14

[SCE](#) and [PG&E](#) 12/1/14

CPUC VGI Process Updates

July 16: R.13-11-007 AFV OIR Scoping Memo

- Phase 1: Guiding Principles, Infrastructure Questions, Demand Charges, Education and Outreach
- Phase 2: VGI Implementation

September 29: Consolidation of AFV OIR and SDG&E's VGI Pilot proceedings

Questions? Thank You

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CPUC Alternative Fuel Vehicles Page

<http://www.cpuc.ca.gov/PUC/energy/altvehicles/>

Recent Activities in AFVs

July 16: R.13-11-007 AFV OIR Scoping Memo

- Phase 1: Guiding Principles, Infrastructure Questions, Demand Charges, Education and Outreach
- Phase 2: VGI Implementation

September 1: PEV Submetering Pilot open for customer enrollment, until 2/28/2015

September 29: Consolidation of AFV OIR and SDG&E's VGI Pilot proceedings

October 30: SCE files application for Charge Ready and Market Education Programs

November 14: Proposed Decision addressing utilities' role in development of electric vehicle infrastructure

November 18: Proposed Decision adopting Low Carbon Fuel Standard Revenue Allocation Methodology for the IOUs