U.S. DEPARTMENT OF ENERGY
Office of Electricity

2024 Smart Grid System Report

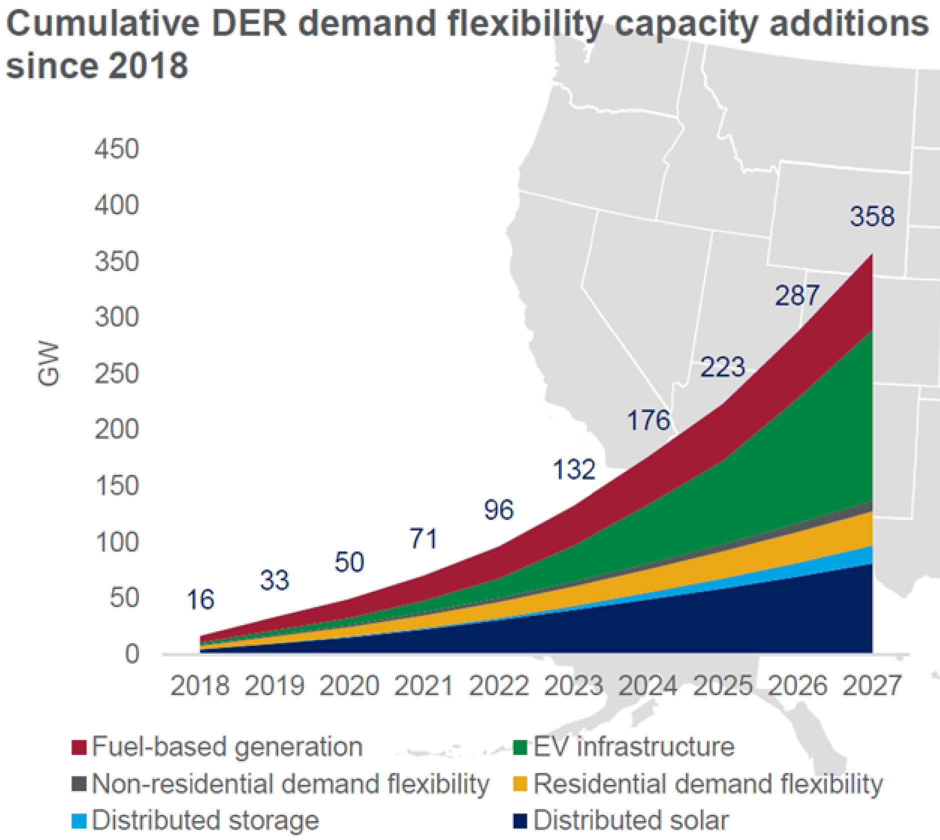
Joe Paladino
Office of Electricity

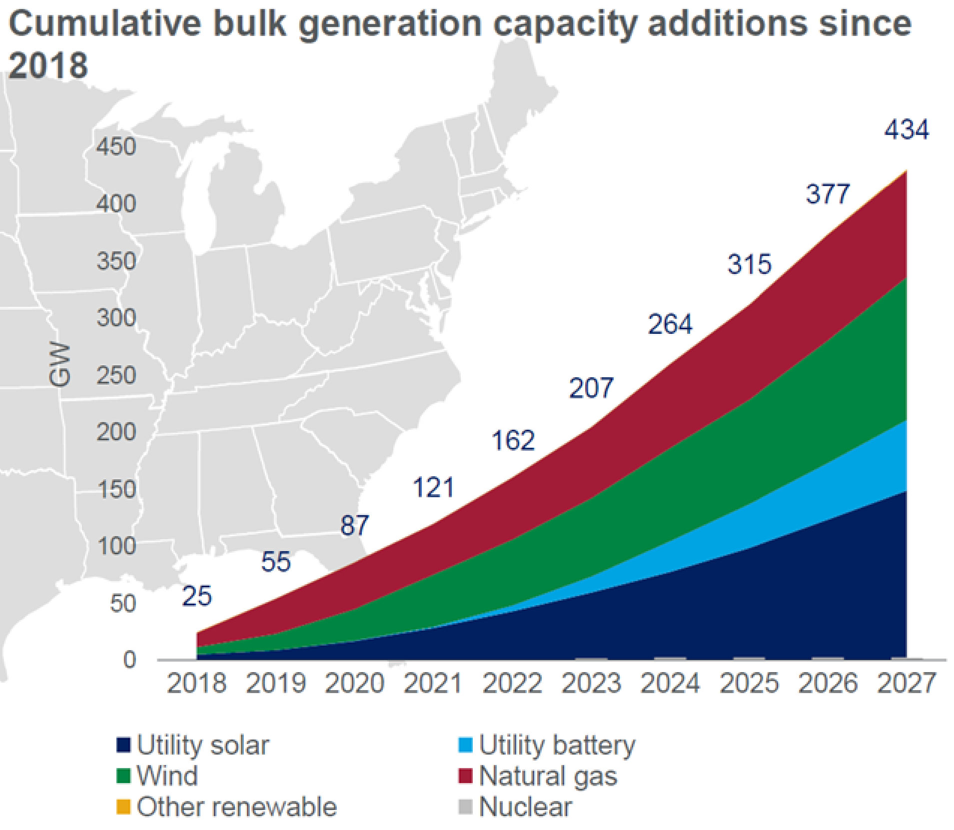
Briefing to the EAC

February 14, 2024

DER Deployment

DERs and the demand flexibility they provide are expected to grow 262 GW from 2023 to 2027, nearly matching 271 GW in bulk generation additions over that same period. For comparison purposes, as of February 2023 the U.S. had nearly 1,300 GW of generating capacity.





Wood Mackenzie. U.*S. Distributed Energy Resource Outlook, Installed Capacity, Market Size, and Opportunities and Risks*. June 2023.

DER Capabilities Provide Benefits

Application of DERs is evolving with respect to their rate of adoption, the technological systems needed to support their converged operations with the grid, their financial viability, and the maturity of both institutional and regulatory practices needed to facilitate or incentivize their implementation. Lack of standardized practices is a major impediment to more robust application of these systems.

DER Capabilities

Energy Efficiency
Programs using technology to reduce overall demand for electricity

Demand Response
Mechanisms to reduce demand for electricity during periods of peak loads

Power Generation
The generation of electrical energy from sources such as solar PV

Energy Storage
The consumption, storage, and delivery of electrical energy from devices such as batteries

Systems Utilizing DERs

Efficient Grid-Interactive Buildings
Buildings utilizing a blend of resources to impart energy efficiency and load flexibility capabilities

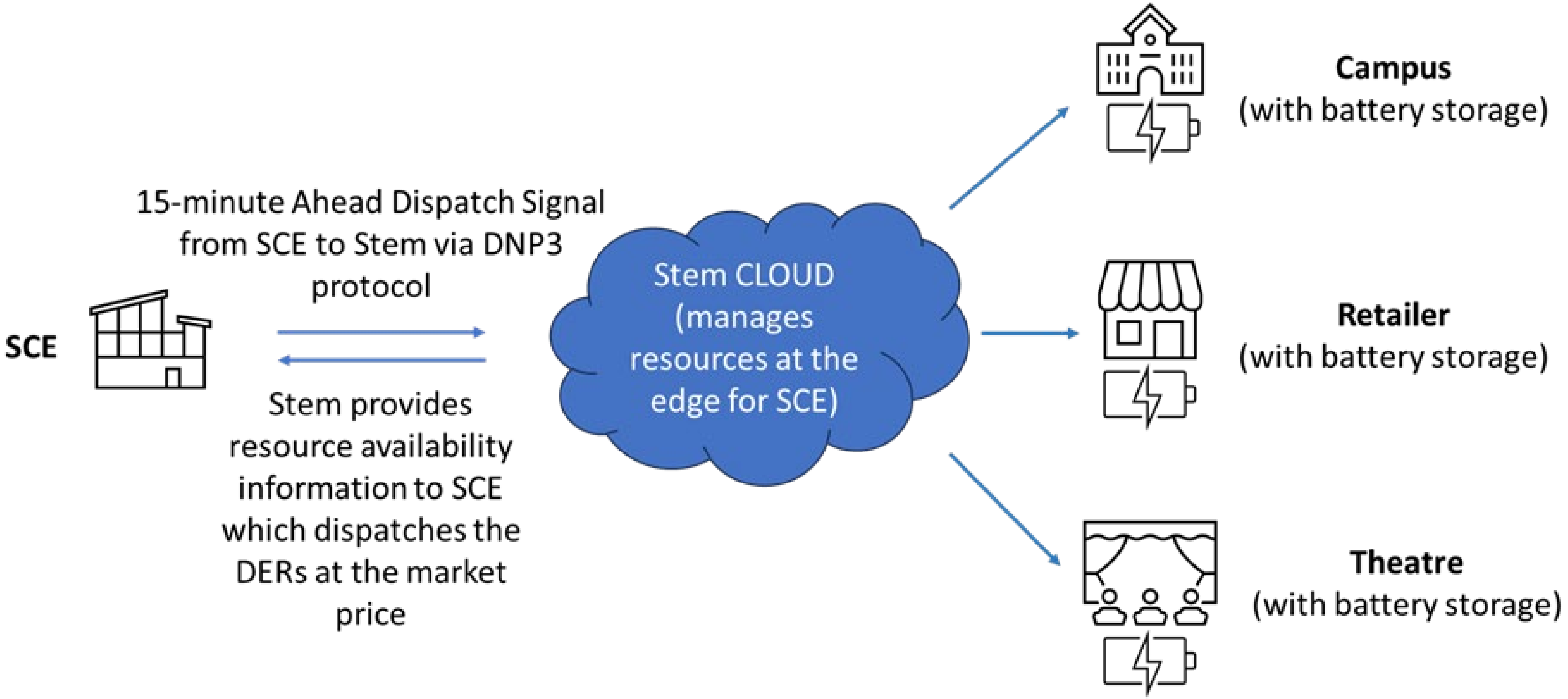
Microgrids
Campus or community grids capable of operating in grid-connected or islanded modes and served by a coordinated group of DERs

Non-Wires Alternatives
A portfolio of DERs used primarily to meet load growth requirements at specific locations within a distribution system

Virtual Power Plants
Aggregations of DERs for the purposes of providing energy and/or demand-side options for load reduction

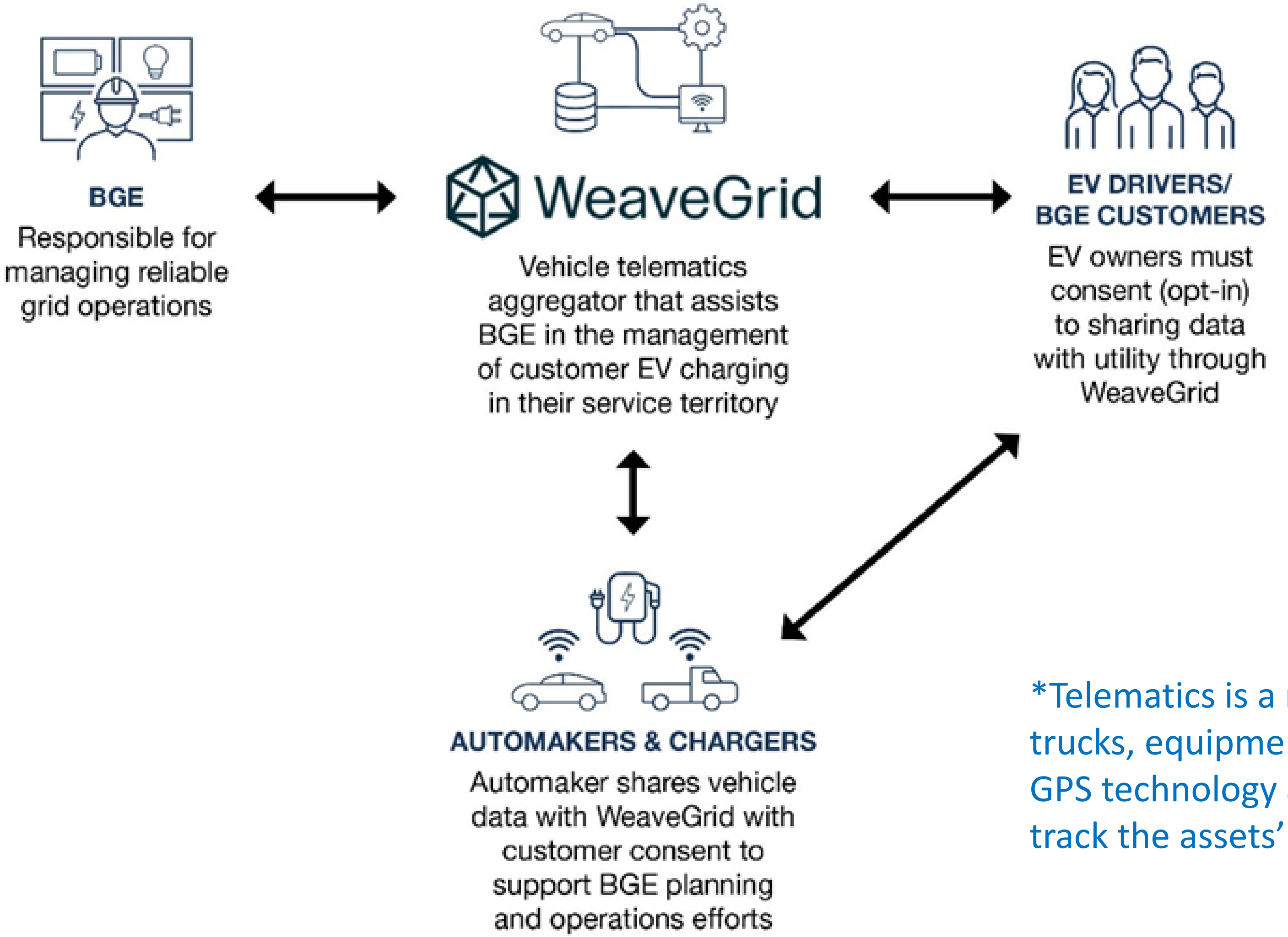
SCE-Stem VPP

SCE-Stem VPP delivers potentially 50MW/340MWh Based on Market Signal from CAISO



Baltimore Gas & Electric Managed Charging Pilot Framework

BGE is working with WeaveGrid to provide EV telematics*

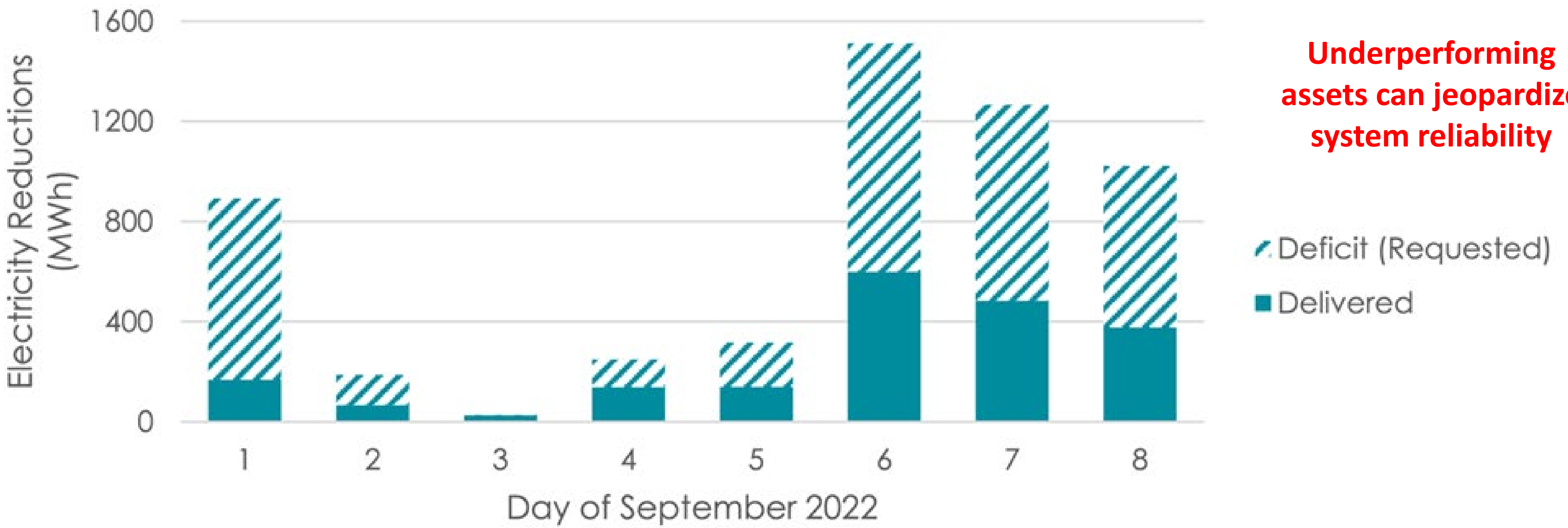


*Telematics is a method of monitoring cars, trucks, equipment, and other assets by using GPS technology and on-board diagnostics to track the assets' movements.

Demand Response Potential

In 2021, FERC reported 32,421 MW of demand response resource participation in ISO/RTO markets representing 6.6% of peak load. The level of participation grows annually (~6%).

The below figure shows the performance of demand response aggregators during a critical 8-day stretch in September 2022 when text alerts were sent out from the California Office of Emergency Services

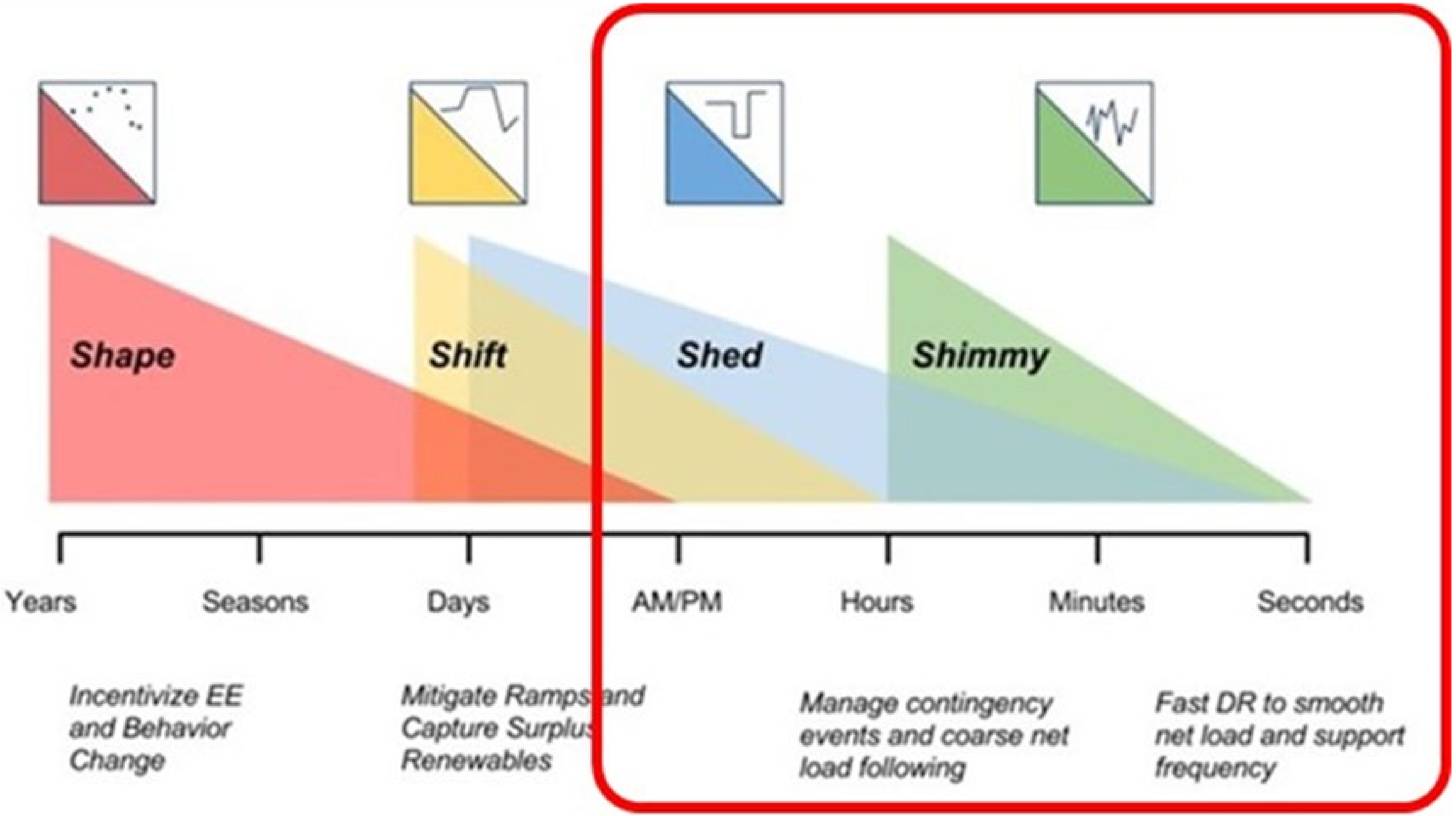


Underperforming assets can jeopardize system reliability

California Public Advocates Office. *Without critical reforms, demand response programs are not ready to scale*. July 10, 2023. Available online at: https://www.publicadvocates.cpuc.ca.gov/-/media/cal-advocates-website/files/press-room/reports-and-analyses/230710-caladvocates-without-critical-reforms-demand-response-not-ready-to-scale.pdf.

Modifying the Load Curve with DERs

The ability to provide flexible services on a continuous basis implies that DERs become operational assets. As many of these DER are owned by utility customers, it will become necessary to determine their willingness to participate and how participation might be best achieved.

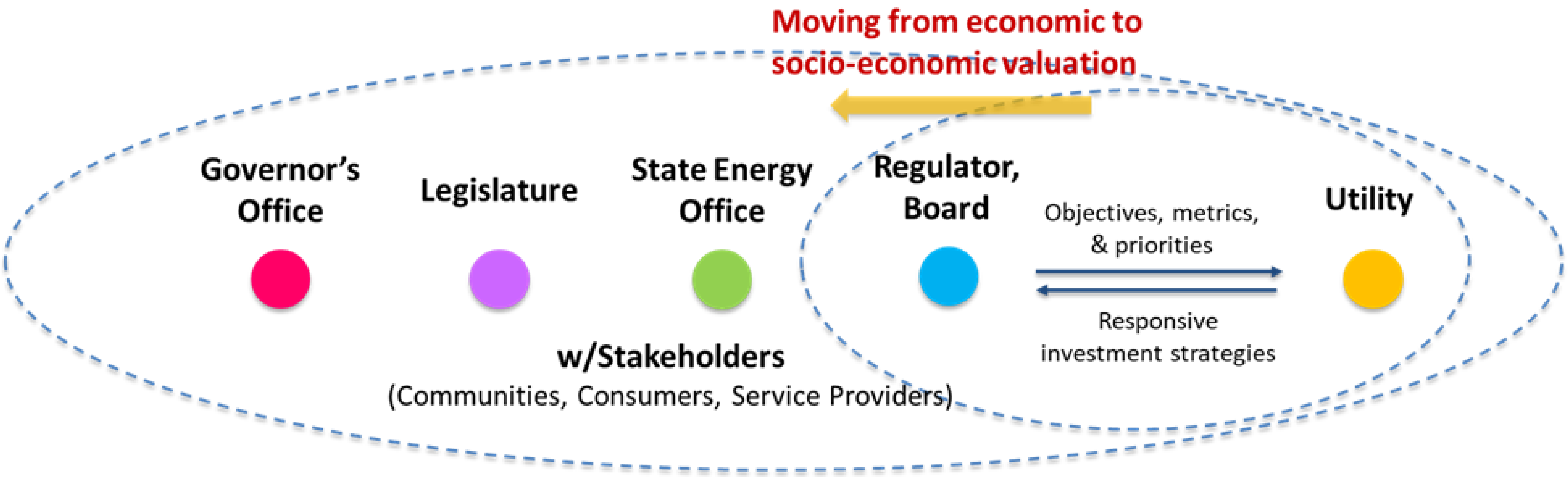


Such a partnership model embodies a "co-production" relationship involving actively engaging consumers and/or communities that own resources in the design, commissioning, and operation of flexibility service.

Integrated Planning

The practice of Integrated Distribution System Planning is evolving and not universally applied across the country, nor is robust consideration of DERs in Integrated Resource Plans and regional planning processes. Key challenges:

- **Processes that result in a shared understanding of grid investment requirements between regulators and utilities**
- **Translating state/community policies and priorities into planning objectives**
- **Analytical capabilities that enable the analysis, including economics assessment, of policy and technology options**



Operational Coordination

The advent of a mixed set of DERs owned and operated by entities other than utilities, such as aggregators, has shifted the engineering challenge from one of *control* to both *control and coordination* requiring disparate organizations to function in a highly organized manner. Key challenges:

- **Standard rules (e.g., grid codes) governing the roles and responsibilities, and information exchange requirements, of all participants involved in the delivery, management, and oversight of services from DERs**

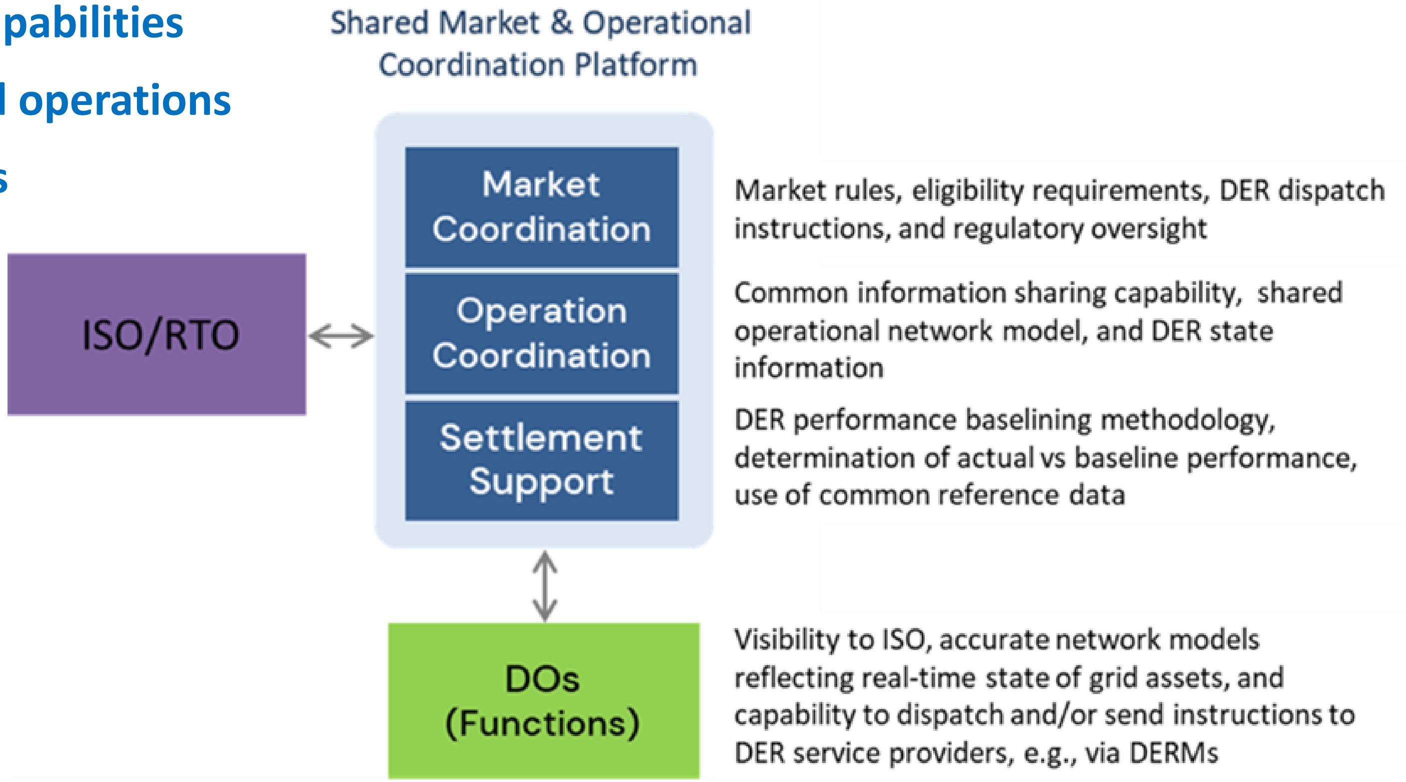
Coordination Frameworks Are Required

Code Families	Code Elements
Grid Engineering	Hosting Capacity Analysis Short and Long – Term DER Forecasting Locational Value Analysis Electrification
DER & Microgrid Integration	Inverter Based Resources Microgrids Monitoring and Control of DERs DER Interconnection Procedures Community Based Renewable Energy Microgrid Interconnection Procedures
Virtual Power Plants and Microgrid Services	Retail Energy and Distribution Grid Services Distribution Resilience Service DER Aggregation DER Aggregator Wholesale Market Services
DER & Microgrid Operations	Monitoring and Control of DERs Distributed Resource Management - Utility Distributed Resource Management – Aggregator Operating Agreements Common Information Sharing Model/ Framework/ Capability between System Operators, Utilities, Market Participants Utility Operational Technology (ADMS/ DERMS/ SCADA) Registration of DERs and DER Aggregations for Market Services Market Participation Rules Validation for DER Aggregations Net Load Baselining and Performance Analytics for DERs and DER Aggregations
Information Sharing and Security	Customer Data Access and Privacy Distribution System Data Information Sharing – Aggregators Cybersecurity
Governance and Oversight	Distribution Open Access DER Aggregator Oversight DER/ Microgrid Value Determination and Cost Allocation Governance and Oversight of Wholesale Market Participating DER (for e.g., through FERC Order 2222)

System Technology Requirements

A highly complex and dynamic operating environment is envisioned due to the scale and scope of DER interactions with the grid requiring system engineering approaches. Key challenges:

- **Orchestration of DER operations and dynamic modeling**
- **Observability and situational awareness**
- **Enhanced computational and data processing capabilities**
- **Secure communications that support distributed operations**
- **Grid components that enable flexible operations**
- **Platforms for coordinated operations**



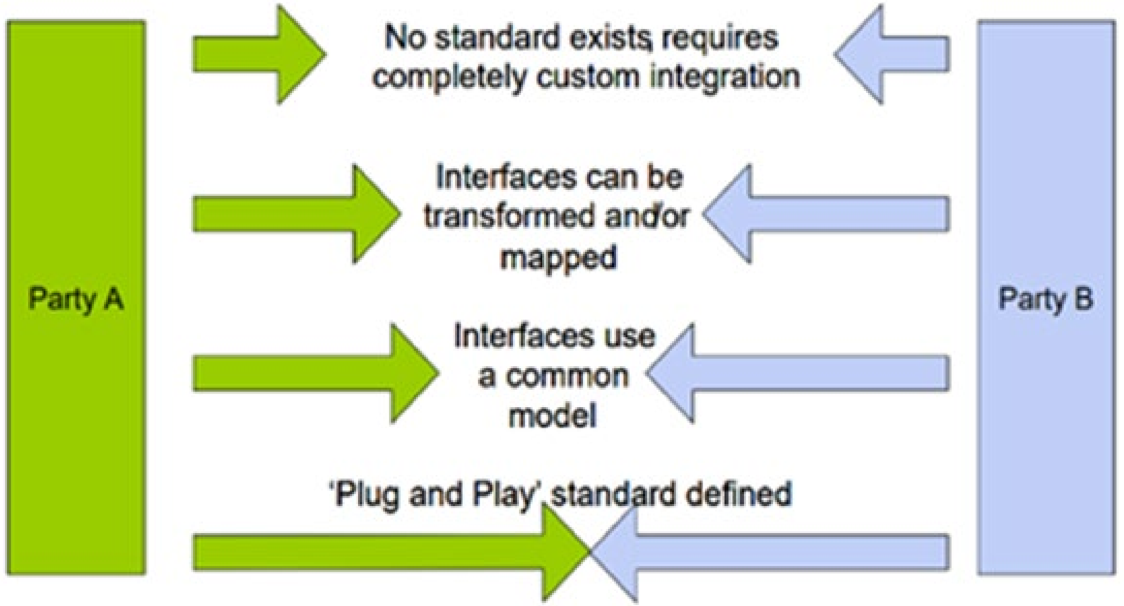
A shared market and operational coordination platform includes providing visibility to the operational state of assets, a common information sharing capability, and eligibility and dispatching requirements

Interoperability & Cybersecurity

The increasing the number of devices at the grid-edge is driving exponential growth in the amount of data that needs to be exchanged and integrated creating an urgent need to improve interoperability between devices and systems, particularly between 3rd-party service providers, DER owners, and utilities. Key challenges:

- **Standard approaches for sharing data. Universal adoption of the Common Information Model (CIM) may provide an approach to standardizing the exchange of data across the system among a variety of entities.**
- **Common practices for addressing cybersecurity at the distribution system level. CESER/NARUC are issuing guidelines on baseline cybersecurity practices at the grid edge.**

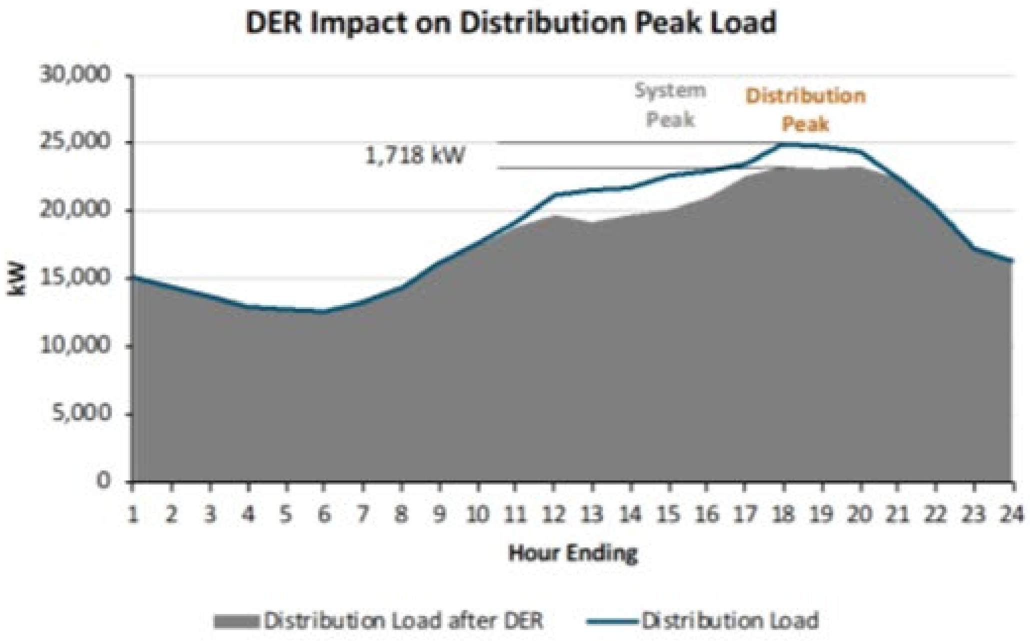
Integration Complexity Can Be Reduced through Common Interfaces and Common Data Models

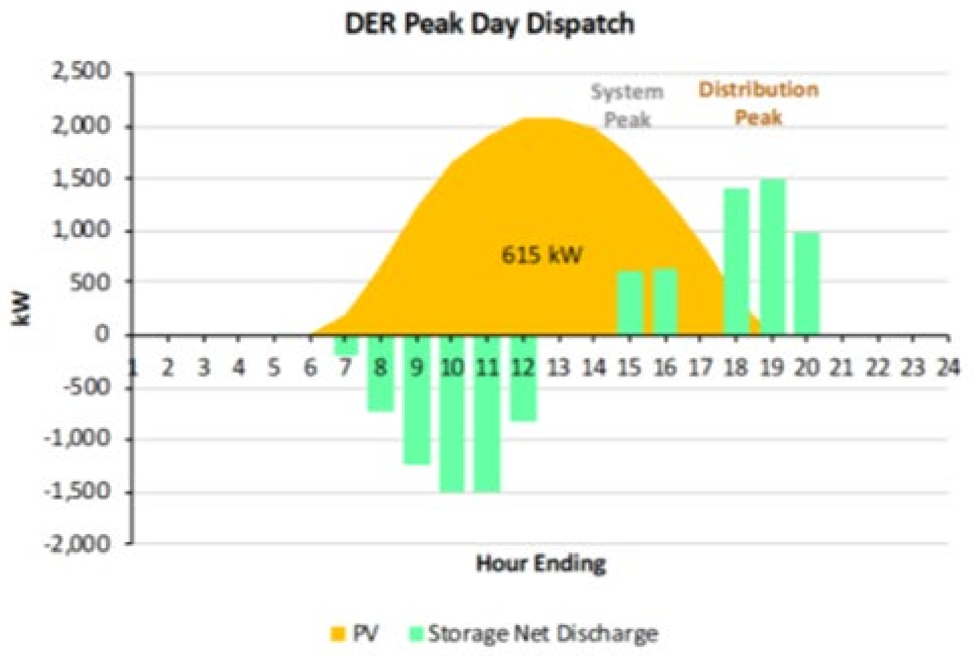


DER Valuation and Compensation

Methods for determining the value of DER services and for providing compensation to entities providing them are evolving. Some tariffs (e.g., NEM) result in unstructured DER growth; others are considering power system and societal benefits (NYS VDER). Key challenges:

- **Standard practices, e.g., DERA services agreements, and partnering to reduce the upfront costs of DER aggregators**
- **Revenue certainty for DER service providers**
- **A DER valuation and compensation framework that serves local system and community needs**
- **Determining the balance of regulated and competitive services with consideration of consumer protections and financing**





Frick, Natalie Mims, Snuller Price, Lisa C. Schwartz, Nichole L Hanus, Ben Shapiro. Lawrence Berkeley National Laboratory. *Locational Value of Distributed Energy Resources*. 2021. https://emp.lbl.gov/publications/locational-value-distributed-energy.

An Observation

"Currently, individual states, such as California and New York, are developing their own distribution-level solutions to DER integration. While these efforts are reflective of the actions of individual, forward-looking states, this approach is insufficient, as each state has to essentially reinvent the wheel. This situation will lead to a proliferation of disparate standards, terminology and approaches around DER integration across the United States, which in turn will generate confusion and increase costs among manufacturers, developers, and other DER service providers. It will ultimately result in less access to distribution systems for DER providers, higher DER costs, and lower benefits to customers."

Excerpt from *The Transition to a High-DER Electricity System – Creating a National Initiative on DER Integration for the United States*, Energy Systems Integration Group (ESIG), August 2022; The Transition to a High-DER Electricity System: Creating a National Initiative on DER Integration for the United States - ESIG

Thank You