High DER: Future Grid Study, Workshop Two

Gap Analysis

March 12, 2024

Agenda

- Overview of Future DSO Capabilities (SCE)
- Technology Progress by IOUs (Each IOU to present individually)
- Policy Gaps (PG&E)
- Recommendations (SDG&E)

Summary

Objective
To discuss the gaps to efficiently operate a high DER grid, unlock economic opportunities for DERs to provide grid services, limit market power, reduce ratepayer costs, increase equity, support grid resiliency, and meet State policy objectives

Status
As part of their Grid Modernization Plans, the IOUs are currently planning, developing, and deploying foundational technologies to enable future operational capabilities

Gaps & Challenges
- Key gaps include policies related to orchestration and the future grid "marketplace"
- EVs present some unique challenges and opportunities that are key to our vision, due to rapid development of technology, mobile nature of EVs, and the relative importance of individual customer behavior to their use

Recommendations
- The Commission and Stakeholders are recommended to focus initially on approaches to providing local grid services, which will establish a foundation on which more complex solutioning can later be explored
- Grid Orchestration is fundamentally required to support California's goals, including TE and decarbonization, but is imperative to do so at the lowest societal cost to our customers

Overview of Future DSO Capabilities

DSO Enablement through Technology and Policy

Unlocking DSO capabilities hinges on the development of both Technology and Policy

Technologies
Putting in place the many necessary grid enhancements to enable sophisticated services

Policies
Establishing a supportive environment for the multi-faceted activities of a modern grid

Grid Modernization Capabilities Supporting DSO

Capability	Description
DER Visibility	Real-time awareness of DER status and output. Monitor/model DER. Track DER performance and interconnection characteristics, state of charge, historical performance, aggregator data, data access, **cost of operation, real time prices**, **and manage confidentiality**
Short-term Forecasting	Highly granular forecast of DER output for next 24 hours. Ability to modify demand and utilize local resources to meet both local and system level demand will increase flexibility, strongly supporting resilience and reliability, even to the point of localized islanding
Advanced Grid Analytics	Analyze grid conditions (current and forecasted circuit loading, DER output, etc.) to identify potential issues and suggest remedies. System defense and restoration (cybersecurity, emergency load reduction, resiliency, black start)
Grid / DER Optimization	Optimize use of grid assets and DERs to provide maximum value. Unlock economic opportunities for DERs to provide grid services: SIWG, standard tariffs and contracts. Encourage investment in DERs and DER aggregation technologies. Enable DER owners to monetize the capabilities of their assets, **incentivize DER owners to support grid functioning and offset needs for grid investment.**
DER Scheduling and Dispatching Tools	Signal participating DERs to produce or consume a specific amount of power and energy at specified time (day-ahead and real time).
Advanced CAISO Coordination / Communication	Mutual sharing of DER schedules, operations, constraints. **Set appropriate rate for consumption and generation based upon cost causation to prevent market manipulation. Meet state policy objectives: meeting needs at each location, allow resources to be shared between locations, both locally and system wide, must avoid barriers to and appropriately encourage deployment of and utilization of DER**
Grid Infrastructure Orchestration	Real-time monitoring and automated grid control enabled by intelligent sensors, switches, protection, communication devices

*__Bold text:__ Capabilities dependent on policy development.

Technology Progress By IOU

Where are Utilities Now?

The Utilities are on the precipice of a transition into a new energy landscape. While exciting, we are also paving a new pathway and need to be innovative and nimble

On track per their Grid Mod Plans. While we are each facing certain challenges, none are considered Technical Gaps that will prevent the deployment of tools

In process of deploying Advanced Distribution Management System (ADMS), early release in plan

DER Management System (DERMS) will be deployed over next several years with key functional requirements largely dependent on evolving market structures and regulations

SCE's Technology Progress

SCE Status

Capability	Description (Implementation Timeframe)
DER Visibility	Real-time Awareness of DERs (2024), DER Optimization (real-time prices not currently in-scope pending policy) (2026-2027)
Short-term Forecasting	DER Short-Term Forecasting (2026-2027), Microgrid Management (2027-2028), Advanced Load Management (2028+)
Advanced Grid Analytics	Distribution Management (2024), DER Dispatch to Mitigate Grid Reliability Issues (2027)
Grid / DER Optimization	DER Optimization (2026-2027)
DER Scheduling and Dispatching Tools	DER Scheduling and Dispatch (2024), Microgrid Management (2027-2028)
Advanced CAISO Coordination / Communication	DER Schedules, Operations, Constraints (2026-2027)
Grid Infrastructure Orchestration	Devices operational with continued deployment 2024+, Real-Time Monitoring (2024-2025), Adaptive Protection (2026-2027)

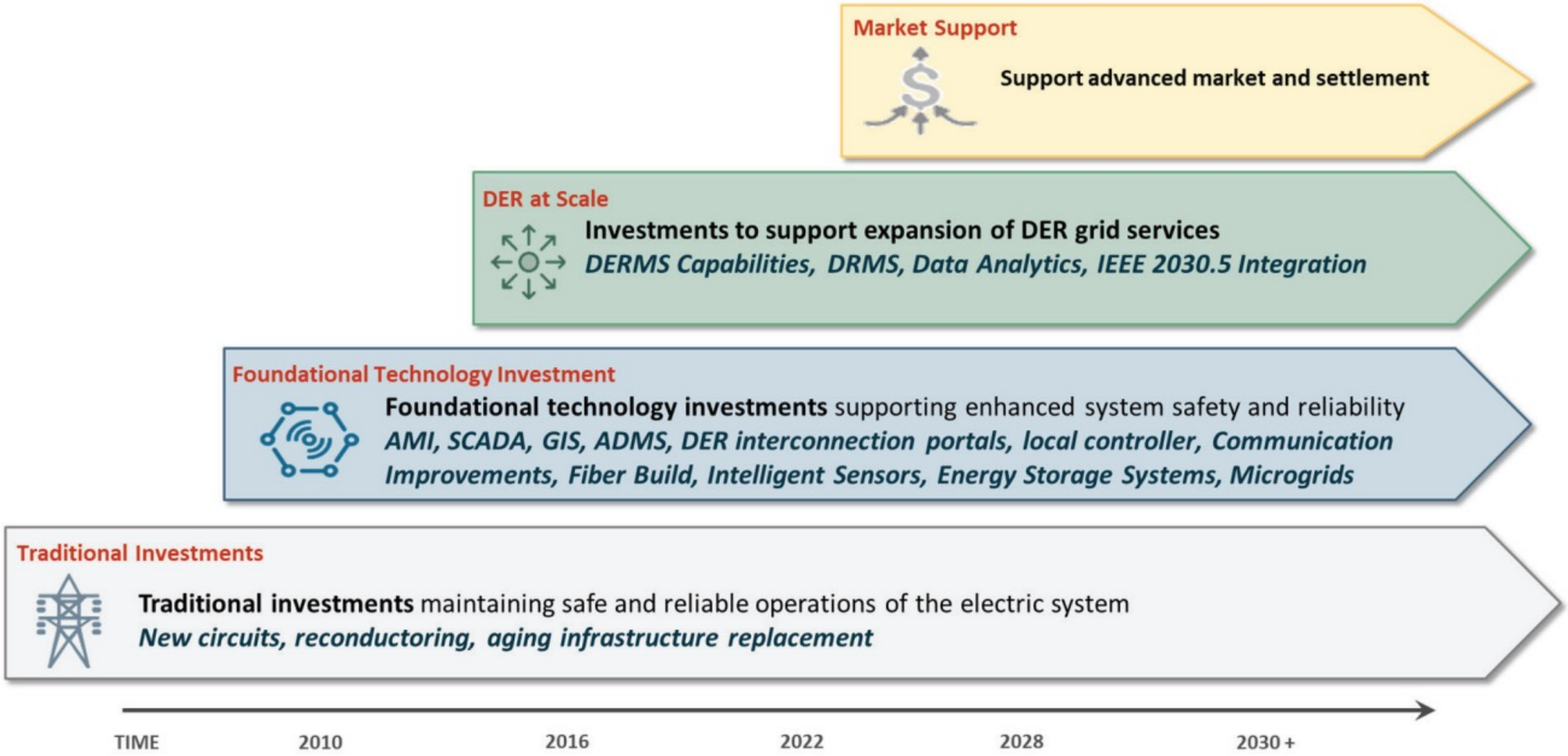
SCE's GMS Capability Roadmap & Deployment Schedule

Phase 1 ADMS		Phase 2 DERMS	Phase 3 Adv. ADMS & DERMS	Phase 4 Grid Platform
Release 0.5 (Complete)	**Release 1 (Testing)**	**Development**	**Plan**	**Plan**
D-SCADA upgrade	***Adv. DMS, OMS, & DERMS***			
May 2021	**2023-2025**	**2026-2027**	**2027-2028**	**2028+**
Back-office platform that is virtualized, scalable and highly resilient to support ADMS and DERMS	Advanced grid mgmt. functions, including automated fault location, isolation, and service restoration (FLISR), electronic switching, base DER mgmt., and mobile grid operations	PSPS automation, adaptive protection, DER short-term forecasting and optimization, secure field devices, and energized wire down event detection	Expand mobile grid operations, outage metrics, operator training systems, microgrid mgmt., and storm analytics capabilities	Expand load management, power quality management and substation device management capabilities
D-SCADA Functionality Infrastructure upgrade to support: • D-SCADA Operations • Red Flag / Load Shed • Distribution Volt Var Control • Tie Device Restoration Logic	**OMS Functionality** • Replace and Enhance OMS Functions • Fully Integrated Electronic Switching Management • Deploy Mobile ADMS field functions	**DERMS Functions** • Short-term Forecasting (Load & Generation) • Optimization Engine • Constraint Management	**Advanced ADMS Functions** • Storm Analytics • Mobile Grid Operations expansion • Outage metrics expansion • Microgrid Management	**Grid Platform Functions** • Adv. Load management • Substation device management • Power Quality platform
	DMS Functionality • Deploy Advance Distribution Network Analysis Functions • Deploy Assisted Switching (Fault Location Isolation & Service Restoration, Protection Validation) • Enhanced Volt Var Control • Base DER Management Functions (IEEE2030.5 aggregator dispatch)	**ADMS Functions** • Next generation integrated ADMS and DERMS • Wildfire/PSPS- GMS Integration • Automatic wire down detection & isolation • Adaptive Protection • Device Management	**Advanced DERMS Functions** • Operator Training expansion (high DER) • DER response to weather modeling and islanding	

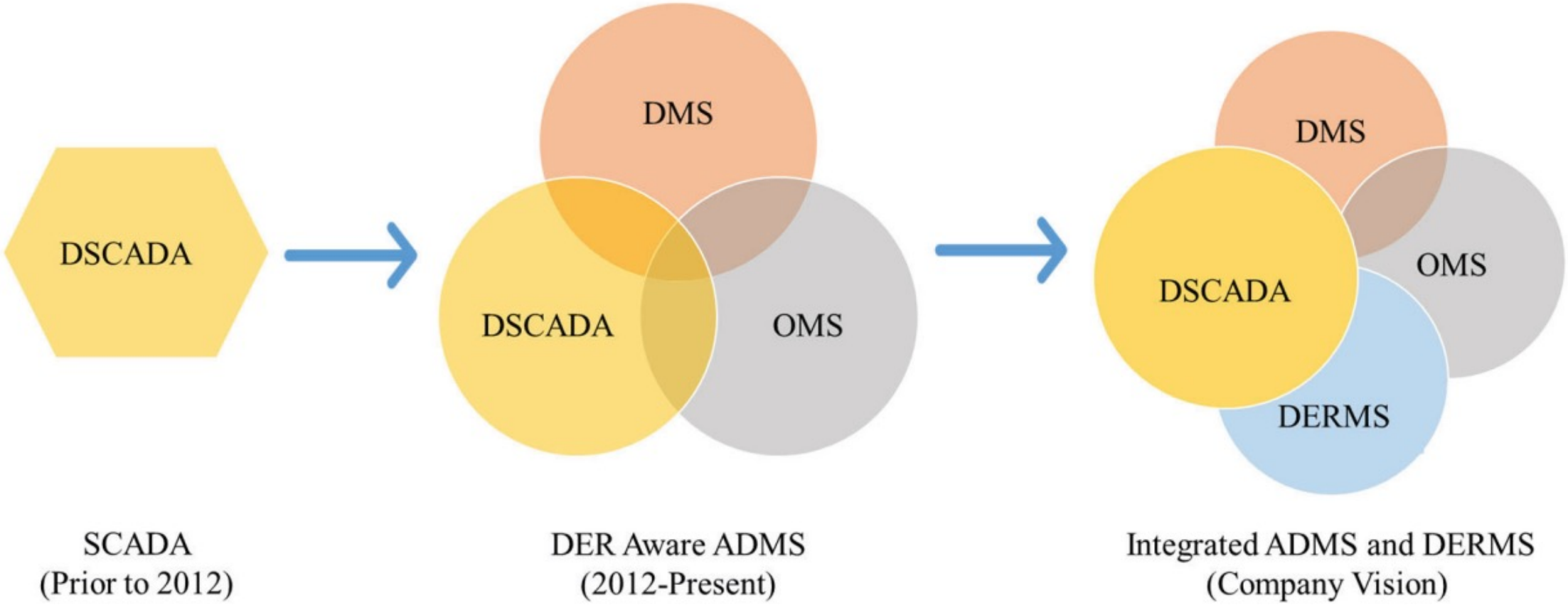
Acronym Definitions:
ADMS: Advanced Distribution Management System
D-SCADA: Distribution Supervisory Control and Data Acquisition
DERMS: Distributed Energy Resource Management System
DMS: Distribution Management System
OMS: Outage Management System
PSPS: Public Safety Power Shutoff

SDG&E's Technology Progress

SDG&E Grid Modernization Investment Phased Roadmap



Control System Evolution at SDG&E



SCADA
(Prior to 2012)

DER Aware ADMS
(2012-Present)

Integrated ADMS and DERMS
(Company Vision)

SDG&E Current Capabilities for DER Orchestration (2024)

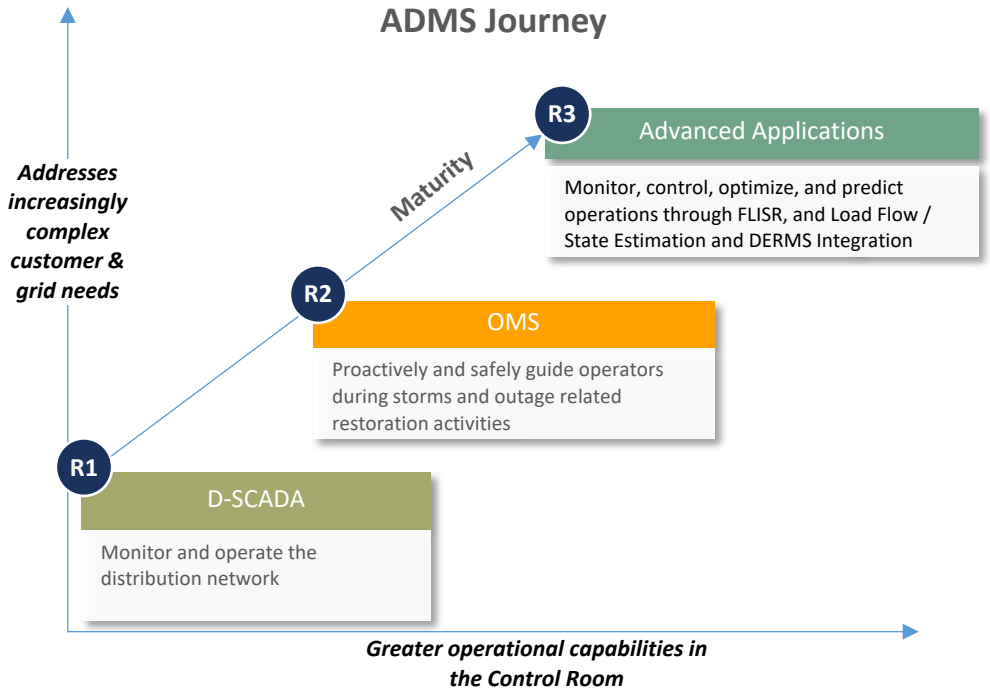
Capability	Description
DER Visibility	• Telemetry requirement for DERs >1MW, allowing for control center visibility. Situational awareness includes topographical visibility in Network Management System (NMS). Ability to isolate CAISO DER via SCADA switch if operational emergency calls for it. • In-flight project, PIVA: Photovoltaic Integration over Virtual Airgap, to quantify "True Load"
Short-term Forecasting	• Short-term forecasting is available and being evaluated with distribution system model. Additional efforts to integrate with other functional modules and operational processes.
Advanced Grid Analytics	• Building out ADMS capabilities to prepare for DERMS, including power flow and day-ahead forecasting. Additional future capabilities included in the roadmap are fault location, VVO, and FLISR.
Grid / DER Optimization	• DER-Aware NMS today and future plans for DER-Aware ADMS. • Local Area Distribution Controllers (LADC) deployed at our internally owned DER locations to optimize DER assets within an electric microgrid environment.
DER Scheduling and Dispatching Tools	• For DERs >1MW there is control center visibility of static charge limits.
Advanced CAISO Coordination / Communication	• Requests to attach and permission to operate per an interconnection agreement which includes safety and reliability requirements (SCADA Isolation Switch, Telemetry, Anti-Islanding, Charging/Discharging Parameters, Ramp Rates)

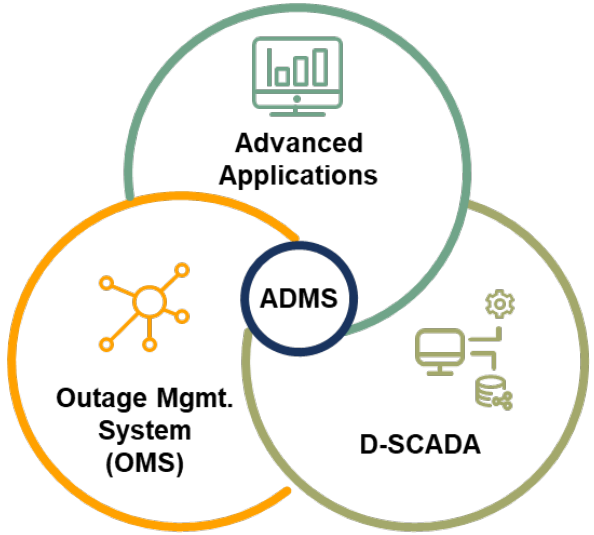
Grid Infrastructure Orchestration	• In-flight projects and demonstrations:
	  ○ Vehicle2Grid Partnerships
	  ○ EPIC projects focused on evaluating communications
	  ○ Two Virtual Power Plant (VPP) Projects
	• Need to integrate with future grid management tools (DERMS)

PG&E's Technology Progress

PG&E Advanced Distribution Management System (ADMS)

ADMS replaces legacy control center software used to operate the electric distribution system with an integrated technology platform, **enabling step-level improvements** in PG&E's ability to monitor, manage, and control our distribution network.





ADMS consolidates the Distribution Supervisory Control and Data Acquisition (D-SCADA), Outage Management System (OMS), and other Advanced Applications into an integrated, modern platform

***D-SCADA**: Distribution Supervisory Control & Data Acquisition*
***OMS**: Outage Management System*
***FLISR**: Fault Location, Isolation, and Service*
***DERMS**: Distributed Energy Resources Management System*

PG&E's ADMS Progress

We will finish upgrading Distribution SCADA and in a good path to deploy ADMS. DERMS platform setup to enable EV goals

2023	2024	2025	2026 - 2030	Future State

ADMS as a foundation for grid management

DERMS platform to support future grid orchestration

What we Achieved

ADMS Release 1 (SCADA)
- Pilot Go-Live for 5 divisions
- End-state Go-Live for 1 of 14 remaining divisions (Humboldt)

ADMS Release 2 (Outage Mgmt Consolidation)
- Design & Build kickoff

ADMS Release 3 (Adv. Apps)
- Design & Build kickoff
- Supported Microgrid enablement in SCADA

What's in Progress

ADMS Release 1 (SCADA)
- End-state Go-Live for remaining 13 divisions; close out the Release

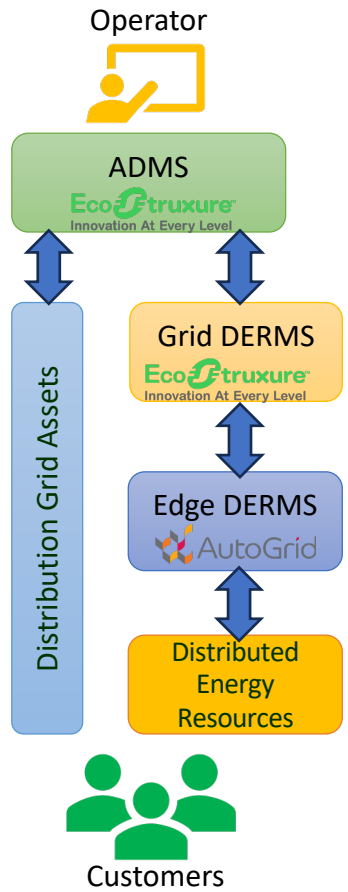
ADMS Release 2 (Outage Mgmt)
- Complete the Design Phase

ADMS Release 3 (Adv. Apps)
- Deploy Enhanced Powerline Safety Settings (EPSS) functionality in ADMS

What's Planned

ADMS Release 2 (Outage Mgmt)
- 2025 – Complete Build & Test activities
- 2026 – Deploy Outage Management System, including PSPS module

ADMS Release 3 (Adv. Apps)
- 2025 – Complete foundational Line Sensor and Load Flow/State Estimation functionality deployment on limited feeders; Deploy EPSS additional enhancements and functions
- 2026+ - Complete enablement of additional advanced ADMS features such as power flow and state estimation



Key Outcomes

PG&E SDGE SOUTHERN CALIFORNIA EDISON

PG&E DER Orchestration Roadmap and Evolution

DERMS aims to create near-term value while building toward DER Orchestration Vision while leveraging ADMS capabilities as they become available

Present focus is on uses cases and capabilities to enhance situational awareness and manage distribution grid capacity constraints. Over time focus will expand to orchestrating DERs across multiple value streams.

Now (2023/2024)	Mid-Term (2024-2027)	Longer-Term (2028-2030)
Deployed foundational DERMS platform including 2030.5 DER headend for low-cost telemetry	**Scale DERMS capabilities to the entire system rather than spot locations**	**Simplify customer experience via a single interface and engagement platform**
Implement initial use cases to enable Flexible Service Connections for bridge capacity on constrained circuits	**Transition demand response and load management programs to Enterprise DERMS**	**Optimize customer value of DERs for participation in distribution and transmission grid services and energy markets**
Dispatch contracted DERs as "non-wires alternatives" to capacity projects (DIDF)	**Orchestrate DERs and LM across multiple value streams**	**Evolve DERMS into a grid edge computing platform to automatically optimize at the hyper local level**
	Enable electric vehicles as flexible loads via managed charging and V2X	
	Integrate real-time pricing pilots and initiatives to utilize DERs as a system resource	

PG&E Current Capabilities for DER Orchestration (2024)

Capability	Description/Current Status
DER Visibility	Real-time Awareness of DERs for 1MW+ and DERs participating in capacity use cases via IEEE 2030.5, Visibility and control of initial Microgrid Locations via SCADA.
Short-term Forecasting	Short-Term Forecasting at targeted constrained grid locations where SCADA is available (~100 circuits of 3200 modeled)
Advanced Grid Analytics	Measurement-based FLISR deployed, EPSS functionality targeted for 2024 ADMS Advanced Applications such load flow state estimation in the design phase for initial pilot deployment in 2025
Grid / DER Orchestration	Ability to mitigate distribution capacity constraints by managing a single participating DER or aggregation (H2 2024)
DER Scheduling and Dispatching Tools	DER Dispatch and communications of limits to participating DERs (~10 sites in 2024)
Advanced CAISO Coordination / Communication	Market participants notify CAISO in the event of local dispatch via modification of bids

Policy Gaps

Policy Gaps for DER Orchestration: What needs to be true to unlock the local DER orchestration opportunity?

In order for DERs to effectively contribute to future grid operations, DERs will need to reliably and cost effectively perform key functions at targeted locations over time. Policy to play a key role in ensuring that certainty via the rules, compensation mechanisms, performance requirements etc.

- **Establishment of standard rules of engagement for participation in orchestration schemes or programs *that can evolve over time***
  - Valuation of distribution services and determination of cost effectiveness. (noting that the value is location and time specific)
  - Rules for how to allocate scarce capacity to electrification loads (Who gets dispatched? Who gets curtailed?)
  - Mechanisms to engage with multiple flexible service providers (multi-vendor, multi-technology)
    - Participation models for heterogenous (mixed) aggregations of distributed generation, storage, and demand response to participate in grid services and wholesale markets
    - Mode of engagement: bilateral agreements, price signals, retail rate design, flexibility markets, dispatchable programs, allocation rules (e.g. FIFO)
  - Compelling value proposition for customers to participate
  - Determination roles, responsibilities and allocation of risks in the more dynamic and decentralized ecosystem codified in rules, tariffs and/or agreements
    - Performance requirements, monitoring, cybersecurity, fail-safes, measurement and verification
    - Contingencies in the event of business failure (e.g. provider of last resort or other provisions)
  - Establishment of customer programs targeted toward distribution grid needs

Policy Gaps for DER Orchestration (continued)

- **Ability to connect and coordinate localized transmission grid needs w/ DER participation and engagement**
  - Cross jurisdictional challenge across FERC and CPUC to align planning processes and participation models for DER
  - Alignment across transmission and distribution planning on forecasting assumptions and requirements for infrastructure planning

- **Resolution of key equity and fairness issues raised by local capacity markets or local pricing**
  - Example: Higher capacity prices at capacity constrained locations
  - Consideration of impacts of DER policies on customers without DERs or load flexibility
  - Potential market power for single DERs on radial circuits

Policy Gaps for coordination and orchestration between grid needs and energy system

Coordination and communication between market participants is required to scale DER participation while maintaining safety and reliability.

Orchestration across value streams has the potential to unlock value by optimally deploying and operating DERs across multiple value streams (customer, grid, system)

- **Common framework(s) for wholesale market participation:** today's patchwork includes direct participation of DERs, Participation via LSE, Participation via DSO, price signals via real-time pricing other retail rates
- **Information sharing across market actors (T&D Grid Operators, ISO, Market Participants)**
  - Grid impact of DER market participation and other dynamic participation methods (e.g. real time prices, load modifying programs) are unknown to grid operators today
  - Planned and emergent local grid conditions are unknown to market actors (e.g. outages, abnormal configurations)
- **Prioritization between the needs of Distribution Grid and the Energy System** and the mechanisms to coordinate participation across different impacted entities.
  - E.g. What is the sequence of committing resources across various services? What are the procedures for out of sequence dispatch to address emergent conditions?

Proposed Next Steps

Recommendations

- **Resolving Policy Gaps and Developing a Framework**
  - Working group/task force(s) to map out jurisdictional responsibilities, needs, and opportunities to collaborate on a framework for cooperation that enables advanced orchestration.
  - Leverage this work to develop a regulatory framework that is adaptable to future technological advancements in orchestration of DERs. This framework should support scalability, interoperability, and seamless integration of new DERs.
  - Clearly delineate the roles of various parties in removing barriers for the deployment of a pilot.

- **Develop Intersecting Pilots to Determine What a Framework Will Look Like**
  - Focus on targeted pilot programs which will allow us to identify successful paths towards a more robust solution(s).

Recommendations (continued)

- **Iterative Approach for Future Solutions**
  - Initially focus on creating a stable and reliable operational framework. Advanced orchestration can be gradually introduced based on learned experiences and technological maturity.

- **Coordination with CAISO**
  - Strengthen coordination mechanisms between IOUs and with the California Independent System Operator (CAISO) to ensure that the operational needs of both the distribution and transmission levels are met.

- **Equity**
  - Defining and assigning responsibility to ensure equity in customer market participation

Q&A