GRIDWORKS

Evaluating Alternative Distribution System Operator Models for California

March 2022

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Introduction

California has a rich history with Distributed Energy Resources and has committed to continuing that tradition into the future. To prepare the electric system for that future, the California Public Utilities Commission has ordered a review of alternative approaches to distribution system planning and operations and suggested the current roles and responsibilities of California's Investor Owned Utilities could change if alternatives would better provide safe, reliable, affordable, equitable, and decarbonized service. This paper, *Evaluating Alternative Distribution System Operator Models for California,* begins a stakeholder-driven process to create and evaluate such alternatives.

In July 2021 the California Public Utilities Commission (Commission) opened Rulemaking (R) 21-06-017 "to modernize the electric grid for a high distributed energy resources future" (High DER Grid Planning proceeding). The overall objective of the Rulemaking is "to study the impacts of high penetrations of [Distributed Energy Resources] DERs on the grid and identify strategies for planning and forecasting distribution system investments necessary to support a large number of DERs on the grid in the future…"[1] Among the issues identified for investigation through the OIR, the Commission raises the issue of Distribution System Operator (DSO) roles and responsibilities. As the Ruling explains, DSO is a term used to encompass various conceptual models of operating distribution systems with high numbers of DER. These models provide alternative approaches to distribution system planning and operations that may help integrate and operate DER at least cost while maintaining system safety and reliability.

In opening the OIR the Commission provides several relevant guideposts, including:

- "as the market evolves into a high-penetration DER scenario, [Investor Owned Utility] IOU roles will also evolve and there may be a need to consider different DSO roles."
- "for an IOU-administered DSO to be successful, performance incentives not tied to capital investments may be needed, or there may be a need for a third-party DSO administrator."
- "This OIR neither seeks to set policy on the overall number of DERs nor does it seek to increase or decrease the desired level of DERs. This OIR focuses on preparing the grid to accommodate what is expected to be a high DER future and capture as much value as possible from DERs as well as mitigate any unintended negative impacts."[2]
- The OIR shall "consistently integrate equity and access considerations"[3]

[1] California Public Utilities Commission, *R.21-06-017 Scoping Ruling* (2021)
[2] California Public Utilities Commission, *Order Instituting Rulemaking 21-06-017* (2021)
[3] *ibid*

On August 16 and October 7, 2021 parties to the Commission's Rulemaking filed comments with suggestions to guide the scope, process and schedule of the Commission's consideration of this issue. Informed by party comments the Assigned Commissioner issued their November 15 Scoping Ruling. The Ruling asks the following two questions:

- How do alternative DSO models compare in their ability to plan and 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?
- Should the Utilities be incentivized to cost-effectively prepare for widespread DER deployments? If so, how?[4]

The Ruling goes on to explain,

> … included in scope will be the consideration of any federal and state jurisdictional ratemaking issues that may be relevant to the implementation of the High DER future, including Federal Energy Regulatory Commission (FERC) Order 2222 (at page 3).
>
> The issues in Track 2 will answer high-level policy issues involving distribution system operator roles and responsibilities as well as Utility and aggregator business models. … A central Track 2 activity will be the completion of a consultant technical report that provides an in-depth review of DSO models, distribution operator roles and responsibilities, and implementation feasibility (at page 10).

The Ruling also notes relevant work "to complete the analysis needed for the Commission to determine how best to improve local engagement in utility distribution planning" and "community and tribal specific outreach in addressing the community engagement issues set out in this scoping memo." Finally, the Ruling specifies the following schedule, setting expectations for the timing by which the DSO issues raised will be resolved:

Track 2: Distribution System Operator Roles and Responsibilities	
White Paper and Kickoff Workshop	April 13, 2022

[4] For example, the Hawaii Public Utilities Commission adopted a performance-based ratemaking framework that is designed to incentivize the utility to prepare for DER deployment on December 23, 2020, see https://puc.hawaii.gov/wp-content/uploads/2020/12/PBR-Phase2-DO.Page-Press-Release.Final_.12-22-2020.pdf.

Future Grid Workshop Series (Workshops #1-4)	June 8, 2022
	August 17, 2022
	January 18, 2023
	March 1, 2023
Deadline to request Evidentiary Hearing For Track 2 issues	April 30, 2023
Future Grid Study and En Banc	Third Quarter 2023
Proposed Decision	Fourth Quarter 2023

Appendix 1 shows this schedule in the context of other related activities in the rulemaking.

Regarding the scope and schedule, the Assigned Commissioner's Ruling observes:

> *This track is expected to address long-term policy issues and could result in findings that implicate potential action beyond the timeframe of this OIR…. Depending on the scope of the study and stakeholder comments, some findings might be rolled into a successor proceeding.*

Based on this guidance and time horizon expectations this paper will help inform the Commission guidance to the utilities to modernize the electric grid for a high DER future and help the Commission consider a range of distribution system operator roles and responsibilities to determine a DSO model that best enables swift evolution of grid capabilities and operations to integrate higher levels of DER to meet the State's 100 percent clean energy goals. Much of the scope of the High DER proceeding is aimed at near term changes to improve distribution planning and operations towards the goal maximizing societal and rate value from DERs. This paper compliments those near-term efforts with an investigation of longer term structural and operational changes. Some findings of the *Future Grid Study* could inform near term changes to grid planning and operations, but much of it is necessarily focused on longer term changes.

Purpose of this Paper

This paper, created by Gridworks with editorial input from Verdant, Xanthus, and the Commission's Energy Division, provides the first step in this initiative. The purpose of this paper is to begin an inclusive stakeholder engagement process addressing the two questions posed in the November 15 Scoping Ruling. The paper aims to provide an onramp for all participants in the California process, leveling the playing field and engaging parties in a process we intend to be open and creative. The paper includes:

- Background of California's Recent History with DER, Distribution Resource Planning, and DER Participation in Wholesale Markets
- An Overview of Grid Architecture and Conceptual DSO Options
- A Summary of Comparable Processes and Outcomes from other Jurisdictions
- A Proposed Process to Openly Evaluate DSO Options in California

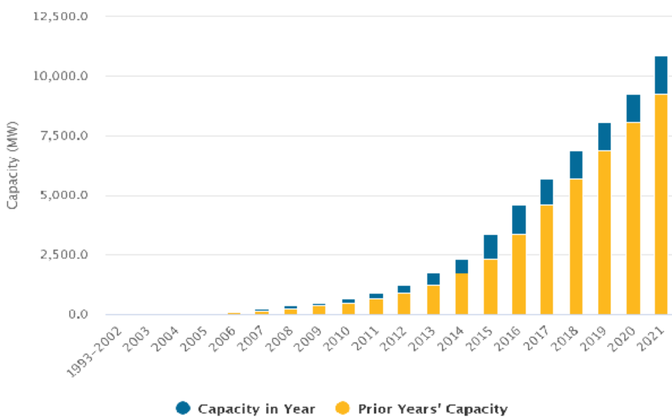
This paper benefits from many constructive suggestions made by parties in their August and October comments on the Rulemaking. References to those comments are found throughout.

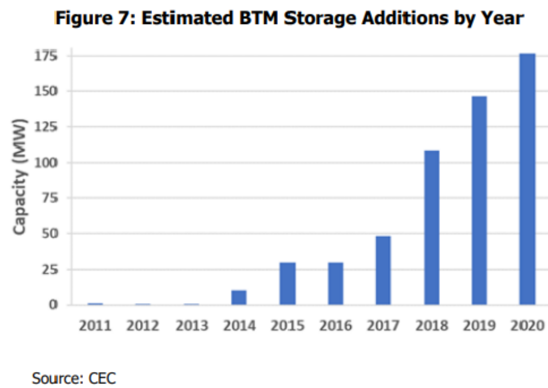
As detailed in the conclusion, this paper will be presented for feedback from parties at a workshop on April 13, 2022. To prepare for that workshop, the paper includes questions for parties to consider. Following the workshop, a summary of party comments on the paper will be completed by Gridworks and appended.

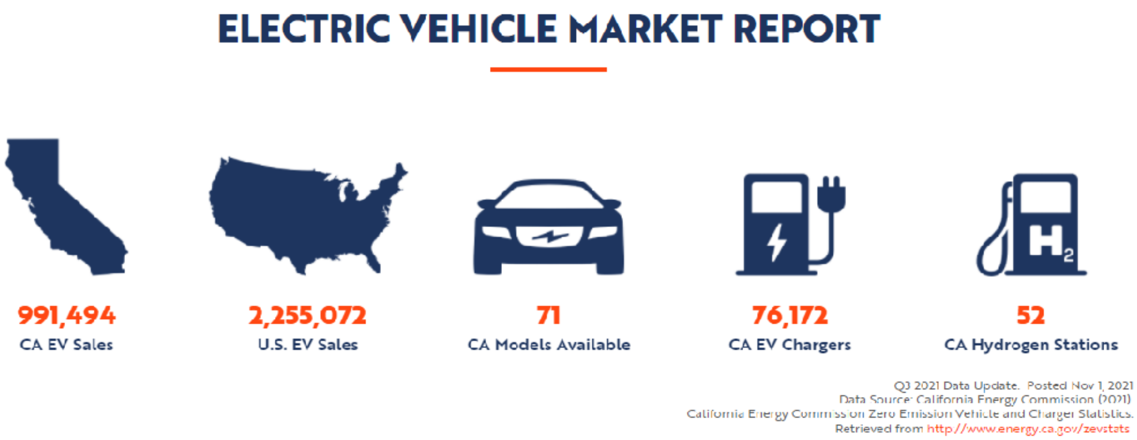
Background: DER and the Grid in California

Customer Adoption

Since its leadership using policy to promote distributed generation and energy efficiency in the 1970's California has been a leading home to DER. These technologies – which are defined as energy efficiency, demand response, distributed generation, storage, and electric vehicles interconnected to the distribution system – are a prevalent mainstay part of the California system. The following diagrams illustrate the rapid growth of different types of DER.







[5]

Looking forward, the Commission's OIR forecasts DER growth will continue to increase in California. A combination of policy mandates, technological evolution, and price declines, are expected to accelerate transportation electrification (TE) and associated DER.

- The California Energy Commission's 2021 Integrated Energy Policy Report[6] forecasts significant growth in DER by 2035 including, 67,000 GWH of behind-the-meter solar and 43GW of behind-the-meter energy storage capacity,
- Consumption of electricity by electric vehicles is expected to climb from 5,000 GWh in 2022 to nearly 35,000 in 2035.[7]

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[5] Behind the Meter Solar Capacity Installed (upper left hand corner) from www.californiadgstats.com; Estimated BTM Storage Additions by Year from 2021 IEPR, Volume IV; Electric Vehicle Market Report from www.veloz.org

[6] California Energy Commission, *Integrated Energy Policy Report: Volume IV California Energy Demand Forecast* (2021)

[7] *Ibid*

- California's TE and climate goals are expected to result in millions of EVs and electric vehicle supply equipment DER by 2030, and Executive Order N-79-20 sets a target for 100 percent of new cars and passenger trucks sold in California to be zero emission by 2035.
- In addition, California policies, programs, and incentives, such as the Self-Generation Incentive Program, continue to drive DER expansion by increasing the financial appeal of DER investment.
- Legislation aimed at reducing greenhouse gas emissions from buildings, Commission proceedings, and local reach codes are likely to further drive building electrification.
- New energy efficiency savings, however, are expected to decline in California from 24,000 GWh in 2019 to 17,800 GWh in 2030.[8]

And these DER adoptions are not expected to be islands unto themselves. CPUC Rule 21 requires specific functions that DER, including EVs, must be capable of providing, and the Smart Inverter Operationalization Working Group is expected to expand those capabilities through its work in 2022 if they are deemed beneficial. These capabilities, which require active participation in grid operations, have impacted the utility-centric model of grid management.

The treatment of these forecasts of DER adoption as assumptions by policy leaders, especially in their accounting of resources available to support reliable grid operations within Integrated Resource Planning, elevates and intensifies the goal of realizing them. As the following regulatory background shows, California remains committed to identifying strategies for planning and forecasting distribution system investments toward that end.

Technological Background

Significant technological developments have contributed to accelerating customer DER adoption. Customers looking to reduce their energy costs, carbon footprint or dependence on utility service can choose a wide range of technologies, including solar, electric vehicles, battery storage, smart inverters, communicating in-home devices (e.g., smart thermostats), and heat pumps. Most of these devices have been historically available to customers for adoption, but technological developments have increased the quality, availability, and appeal to customers.

Policy has also accelerated their use. For example, in 2014 California started the development and eventual adoption of smart inverter requirements. These requirements contributed to national momentum among inverter manufacturers and standard setting bodies to ensure customer-owned solar and storage units could respond to grid conditions, contributing to the safety, power quality, and reliability of the power system. California is continuing that momentum

[8] California Public Utilities Commission, *Order Instituting Rulemaking 21-06-017*, 2021

today through a Smart Inverter Operationalization Working Group charged with prioritizing use cases for consideration by the Commission in 2023.

Utility needs have also spurred the introduction of new grid management techniques. For instance, due to the increased threat of wildfires, they are increasing the planning for and eventual deployment of microgrids which could disconnect from the grid to provide the microgrid customers with power even if the utility has to cut power to neighboring regions.

Technological developments are also accelerating on the grid side. Partly due to encouraging grid modernization policies and partly out of necessity, utility grid operators are embracing new technologies to increase their sensing, automation and control capabilities. Highlights include:[9]

> Advanced Metering Infrastructure (AMI): the full measurement and collection system that includes meters at the customer site, communication networks between the customer and a service provider, such as an electric, gas, or water utility, and data reception and management systems that make the information available to the service provider;
>
> Advanced Distribution Management Systems (ADMS): software platforms that integrate numerous operational systems, provide automated outage restoration, and optimize distribution grid performance;
>
> Distributed Energy Resource Management System (DERMS): a software-based solution that increases an operator's real-time visibility into the status of DER, and allows for the heightened level of control and flexibility necessary to optimize DER and distribution grid operation.

So far the embrace of these grid side technologies by utilities has outpaced regulatory approval.[10] Whether and how they are used going forward will be a key question in considering distribution system operator models.

Regulatory Background

California's most recent and relevant regulatory history with DER and Distribution Resource Planning began in 2013 with the signing of Assembly Bill 327, legislation directing the integration of DER into investor-owned utility (IOU) electric distribution planning and mandating

[9] Department of Energy, *Modern Distribution Grid Report: Volume 2 v2.0 (2019)*
[10] Utility Dive, *Duke, SCE, other grid modernization proposals faced big cost questions, more regulator scrutiny in 2021* (2022)

that the Commission review, modify, and approve IOU distribution resources plans. In 2014 the Commission opened R.14-08-013 and redirected R.14-10-003 with the aim of enabling DER to provide services to the distribution grid and thereby increase the value of those resources while lowering costs and increasing service quality.[11] Considerable effort on the part of the Commission and parties yielded many accomplishments. They include:

- Creating the Distribution Investment Deferral Framework, an annual utility report detailing information about forecast grid needs, investments planned to address the needs, and opportunities for DER to defer those investments;
- Implementing a Request for Offer solicitation process and tariff mechanisms whereby DER have the opportunity to defer identified distribution grid investments;
- Developing Integration Capacity and Locational Net Benefit Analyses assessing the ability of the distribution grid to accommodate new DER and the value of that DER to the grid by location;
- Guiding DER siting decisions and accelerating interconnection by publishing the above through publicly available data portals;
- Establishing a Grid Modernization Framework to guide utility investment in technologies and grid upgrades necessary to integrate DER.

In parallel with these accomplishments focusing on DER adoption and the distribution system, the California Independent System Operator (CAISO) has made significant efforts to integrate DER into wholesale markets. Three models for DER market participation have been developed and refined: Proxy Demand Resource, Non-Generating Resources, and Distributed Energy Resource Providers.[12] These programs provide individual and aggregated DER an opportunity to compete in providing real-time and day-ahead energy, as well as select ancillary services. Following California's example, the Federal Energy Regulatory Commission (FERC) issued Order 2222, a nation-wide effort to open wholesale markets to distributed resources.[13]

Grid Challenges

Despite the continued, steady adoption of DER by California customers and considerable efforts made by policy and industry leaders, California's grid is still facing considerable challenges:

- Wildfires threaten the safety, reliability and resilience of communities across the state and some solutions to those threats reduce grid reliability;

[11] For a brief history of these efforts, consider the *DRP Retrospective* at https://gridworks.org/category/drp-retrospective/

[12] See CAISO's *PDR-DERP-NGR Summary Comparison Matrix* for an introduction

[13] FERC Order No. 2222, 86 FR 16511 (2021)

- Without mitigating action, demand for electrification of transportation and buildings has the potential to exceed the state's capacity to strategically plan and build necessary infrastructure;
- The cost of electric service relative to customers' ability to pay has reached historic highs and is forecasted to grow.
- The utility infrastructure for managing high penetrations of DER is still under development with many aspects still requiring detailed planning, new technologies, and ability to respond dynamically to changing circumstances.

These problems are compounded for many low-income customers and historically disadvantaged communities. Perspectives on how California should address these grid challenges are nearly as diverse as its customers. But most agree: California has not achieved its full potential.

These challenges are playing out amidst a major industry transition in which the following legacy principles[14] are being challenged.

Past	**Present**
Generation is firm dispatchable	Generation is variable
Generation follows load; always kept in power balance	Controllable loads can and must be capable of following generation to achieve power balance
Distribution can be treated as a passive load attached to transmission	Distribution is active and may serve resources to transmission
Real power flows in one direction only at the distribution level	Two-way power flows in distribution feeders and substations, and event into the transmission system
Generation source selection performed on cost and reliability requirements	Renewable energy and climate-change-related policies affect the selection of generation sources
Designed for reliability, not economy	System increasingly economically driven and competitive

[14] Adapted from "*Grid Architecture: An Overview,*" a presentation by J. Taft, R. Melton and D. Hardin to SEPA's Grid Evolution Summit

Defining DER and DSO

In California, DER has been defined by statute as “distributed renewable generation resources, energy efficiency, energy storage, electric vehicles, and demand response technologies.”[15] Meanwhile the FERC defines DER as “any resource located on the distribution system, any subsystem thereof or behind a customer meter.” Technologies included in FERC’s definition include electric storage resources, intermittent generation, distributed generation, demand response, energy efficiency, thermal storage, and electric vehicles and their supply equipment.[16] Although not directly included in these definitions of DER, controllable loads are often considered part of DER even if they are not formally part of a demand response program. For instance, storage and electric vehicles while they are charging can still be viewed as part of the DER ecosystem and can be managed as such.

The definition of DSO has less official backing. In their seminal 2015 paper on the subject, *Distribution System in a High Distributed Energy Resource Future*, Paul De Martini and Lorenzo Kristov define a DSO as “the entity responsible for planning and operational functions associated with a distribution system that is modernized for high levels of DERs.” The authors stress the term need not imply an entity different from the existing utility.[17]

After wrestling with defining a DSO for nearly three years, participants in the United Kingdom’s Open Energy Network initiative arrived at the following:[18]

> *A Distribution System Operator (DSO) securely operates and develops an active distribution system comprising networks, demand, generation and other flexible DER. As a neutral facilitator of an open and accessible market, it will enable competitive access to markets and the optimal use of DER on distribution networks to deliver security, sustainability and affordability in the support of whole system optimisation. A DSO enables Customers to be both producers and consumers; enabling Customer access to networks and accessible markets, Customer choice and great Customer service.*

In “An Overview of Distribution System Operator Models,” a 2020 white paper appended to the Commission’s OIR, DNV surmises a DSO as “a market-based system for distributed energy resources (DER) services” calling out a distribution services market as a distinct function. In their comments on the OIR, SDG&E draws out a similar distinction,

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[15] California Public Utilities Code, Section 769(a)
[16] FERC Order No. 2222, 86 FR 16511 (2021)
[17] De Martini & Kristov, *Distribution Systems in a High Distributed Energy Resource Future* (2015)
[18] UK Energy Networks Association, *Open Networks: Future Worlds* (2018)

separating out market operation from the role of a DSO.[19] This tendency to distinguish between market-based responsibilities also surfaced in Australia's Open Energy Network. The distinction led to two separate functions and definitions.[20]

> *DMO – Distribution market operator; this term refers to the function of the distribution level market operator, as distinct to the wholesale market operator.*
>
> *DSO – Distribution system operator; this term refers to an expanded technical capability of a current distribution network services provider to identify and communicate network constraints.*

These examples suggest the definition of DSO depends on the objectives being served and the corresponding functions expected by its users. Conceptual DSO models are further discussed below, including an Independent DSO (IDSO) model.

Questions for Party Consideration:

- ★ How well does California's statutory definition of DER serve the purposes of this initiative?
- ★ What about the DSO definitions provided above is most relevant for California?

Grid Architecture

The concept of a Grid Architecture can be used to provide tools to help define a DSO based on the objectives the entity should fulfill. According to PNNL, a Grid Architecture is the application of system architecture, network theory, and control theory to the electric power grid. A grid architecture is the highest level description of the complete grid, and is a key tool to help understand and define the many complex interactions that exist in present and future grids.[21] These methods begin with a four-step logic: first, define high-level objectives for the power system; second, determine the necessary requirements to achieve those objectives; third, translate these requirements to functions required to meet the requirements, and; fourth, assign those functions to key players.

[19] SDG&E, Opening Comments, 2021

[20] AEMO and Energy Networks Australia, *Interim Report: Required Capabilities and Recommended Actions* (2019)

[21] https://gridarchitecture.pnnl.gov/

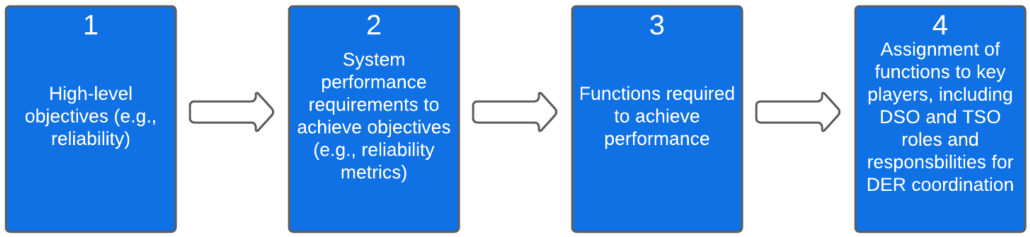

Figure from "Development of a Transmission-Distribution Interoperability Framework", ICF (May 2020)

The ultimate outcome of developing a Grid Architecture is a system structure that intentionally and systematically assigns roles and responsibilities to key players. In the past, these key players in grid operation are the Transmission System Operator (TSO), Transmission Owner (TO), and Distribution Operator (DO), while in the future they will need to include DER Owners, DER Operators (including Aggregators), and Customers. To illustrate this allocation and further the orientation of all parties to the work at hand in California, the following table[22] shows how select functions have been allocated to transmission and distribution operators in California today.

Function	**Transmission System Operator and Transmission Owner**	**Distribution Operator (DO)**
Balance supply and demand	Balances for its area, include net load of all distribution areas and interchange with adjacent balancing areas	No current balancing responsibility; DO delivers energy to and from the transmission system to customers and maintains safety and reliability.
Maintain frequency	Supports frequency for its system or at regional interconnections, along with other balancing authorities	Distribution operator is not responsible for maintaining frequency.
Maintain voltage	Ensures voltage regulation of transmission system	Ensures voltage regulation of distribution system, including DER generation serving local load
Grid scheduling	TSO responsible for the	Coordinate with CAISO

[22] De Martini & Kristov, *Distribution Systems in a High Distributed Energy Resource Future,* (2015) with adaptations by Gridworks

and coordination	scheduling and coordination of transactions across its area	
Open-access transmission service	All TSOs provide open-access pursuant to federal law	See “interconnection” below
Operate energy markets	CAISO clears wholesale day-ahead and real-time markets for residual energy	No current responsibilities
Infrastructure planning	CAISO plans for participating transmission owners (TO); TOs own, maintain, and physically operate assets	Distribution operator plans distribution asset replacement and system upgrades with regulatory oversight through Distribution Resource Planning, General Rate Cases, Wildfire Mitigation Plan
Interconnection	CAISO manages generator interconnection for DER that will inject energy into the grid and participate in the wholesale market	Distribution operators have open-access FERC-jurisdictional interconnection procedures for DER that will inject energy into the bulk power system (Wholesale Distribution Access Tariff). Also have distinct state-interconnection processes for loads and DER located behind the customer meter (Rule 21)

The architecture of new DSO models is the work of re-shaping these roles and responsibilities, including whether and how a DSO, DER Owner, DER Operator (Aggregator), and Customer may take on new roles in grid operations. Therefore, this table could be expanded to include these additional roles.

Alternatively, a Grid Architecture can be seen as the equivalent to Use Case architectures that include Business Cases for the high level objectives and performance criteria, and utilize System Use Cases for expressing the functional requirements for the various actors or roles. Such an approach is under active consideration in the Smart Inverter Operationalization Working Group.

This brief introduction to the concepts of a Grid Architecture necessarily omits critical details. For further information, readers are encouraged to explore https://gridarchitecture.pnnl.gov/. For the purpose of this paper, we conclude by highlighting the following takeaways of relevance to the California initiative:

- Stakeholder Engagement is critical: from defining objectives, to inferring requirements, functions, roles and responsibilities, the context provided by stakeholders is indispensable;
- Taxonomy: investing time in shared taxonomy offers users a tool to ease communication, especially valuable when discussing complex systems;
- Diagrams: structural diagrams are visual maps showing the key actors in a system and their key interactions and relationships, especially valuable when envisioning complex systems and changes thereto.[23] Examples of these diagrams can be found below in the introduction to Conceptual DSO Models.

Questions for Party Consideration:

★ How would the four-step Grid Architecture process summarized here serve California's evaluation of DSO options? Are there alternative approaches to consider?
  - What challenges should be anticipated?
  - What shortcomings should be considered?

★ How long should organizers anticipate that implementing the summarized process might take, assuming input from a diverse group of stakeholders?

★ Should the Grid Architecture methodology be prioritized for use in California?

Conceptual DSO Models

Four primary conceptual models have emerged through consideration of DSOs. They are the Total TSO, Total DSO, IDSO and Hybrids consisting of variations on the three other models.[24] Following the logic of Grid Architecture, models are differentiated by their distinct assignment of functions to entities.

In theory the recipe for a DSO model could be a unique combination of any of the functions listed in the table above or imagined for the future.[25] For the purposes of this paper, three features are most prominent in distinguishing among the models:

[23] Climate Center, *Opening Comments,* 2021
[24] The DSO models introduced here were informed by numerous papers listed in the Works Cited.
[25] For more complete and forward-looking menus of potential Distribution Functions see Figure 6 in *Distribution Systems in a High Distributed Energy Resource Future* or Appendix 1 of *Open Networks: Future Worlds*

- How is the value of DER to the distribution grid exchanged between system operators and DER owners? Are markets for DER to provide distribution services revised or unrevised?
- Are markets for wholesale and distribution services layered, consolidated, or coordinated?
- Are the profit-making opportunities of distribution system ownership separated from distribution service market operations or left consolidated?

For the purposes of this paper, key terms within these questions are defined as follows:

Unrevised Distribution Services Market[26]: Implies the current Distribution Investment Deferral Framework, whereby DER have some opportunity to be procured to meet anticipated distribution system needs, continues as is.

Revised Distribution Services Market: Implies some change to the opportunity available to DER to meet distribution system needs.

Layered: Implies the market for services from DER settles at the interface of the Transmission and Distribution System without DER participating directly in wholesale markets. The transmission and distribution system are optimized in layers rather than jointly.

Consolidated: Implies the wholesale markets currently serving the bulk power system are expanded to include the distribution system; DER do not participate in a separate distribution services market.

Coordinated: Implies DER participate in both distribution and wholesale markets; operators of the distribution and transmission systems coordinate those services.

The following summary highlights distinguishing features of each conceptual model.

Total TSO

The Total TSO model revises the markets for DER to provide distribution services by extending the centralized, open-access markets of a Regional Transmission Operator/Independent System Operator to the distribution system and thereby consolidates the market for wholesale and distribution grid services.[27]

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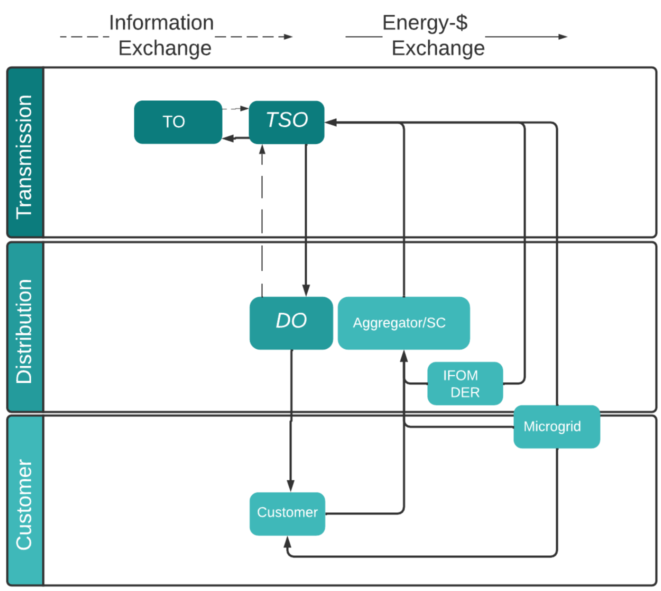
[26] The term "market" here refers to the heretofore limited exchange of value between Investor Owned Utilities and DER providers under the Distribution Investment Deferral Framework.
[27] Kristov, De Martini & Taft, *Two Visions of a Transactive Electric System* (January 2016)

In California, application of this model would extend wholesale markets operated by the California Independent System Operator beyond the high-voltage transmission system and past the current transmission-distribution interface into lower-voltage distribution systems. The CAISO's network model would necessarily include the distribution circuits, including modeling of DER at their actual locations on those circuits.[28]

Total TSO Diagram



The Total TSO model separates the profit-making opportunities of distribution system ownership from distribution system market operations by tasking the wholesale market operator with distribution system market operations. In California this model implies reduced role for California's Investor-Owned Utilities relative to DER. Potential examples include:

- determination of a DER's locational net benefits may be determined by the ISO, instead of the IOU;
- solicitations for non-wire alternatives from DER currently performed by IOUs for distribution capacity may be replaced with a distribution capacity market; and
- identification of distribution infrastructure needs as well as integration of DER into infrastructure planning and operations by the ISO.

These examples would imply a business model change for California's IOUs as well as CAISO's wholesale market products.

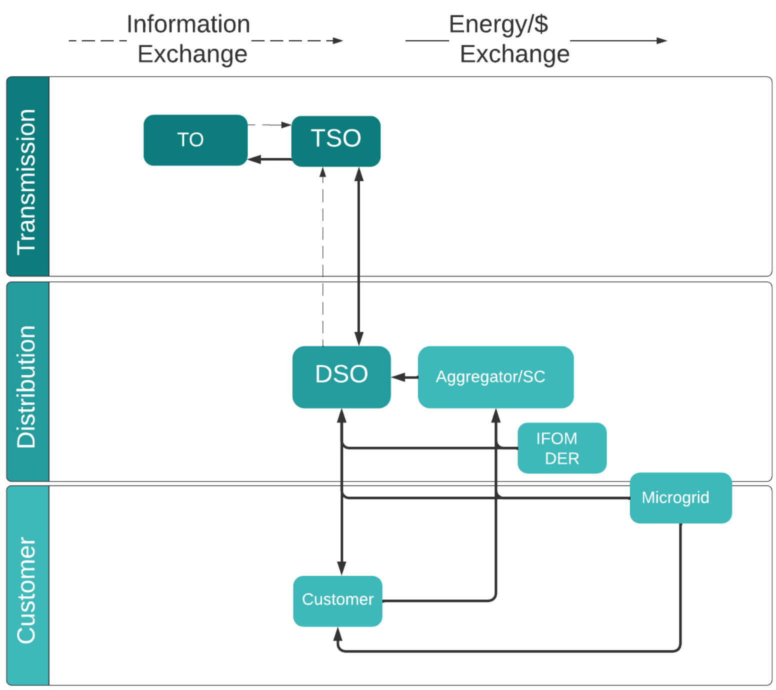
[28] *ibid*

Total DSO

The Total DSO would task the DO with revising markets for distribution services. Those markets would be separate from the wholesale market. The model implies DER would not participate directly in the wholesale market, but rather be balanced by the Total DSO. In turn the DSO represents all DER within its footprint as a single net load/supply bid in wholesale markets. The distribution and transmission systems are therefore optimized in layers.

In California, application of this model would revise the current structure through which investor-owned utilities source DER to establish a new, market-based system for optimization. While the exact shape and character of that market would need significant work to determine, the characteristics of the CAISO's wholesale market offer a model of the outcome.

Total DSO Diagram



The Total DSO does not separate the profit-making opportunities of distribution system ownership from distribution system market operations. In California, this model implies the investor-owned utilities would remain responsible for overseeing the valuation, sourcing and dispatch of DER providing distribution system services.

Independent DSO

With regard to revising distribution services and the layering of wholesale and distribution service markets, the Independent DSO model would be the same as the Total DSO. However, the IDSO separates the profit-making opportunities of distribution system ownership from distribution system market operations by tasking an independent organization with distribution system market operations.

In California an independent organization would need to be hired or created to be responsible for operating the market for distribution services. Where the responsibilities of the IDSO and the IOUs as distribution owners begin and end would require detailed delineation. Coordination between the entities akin to the CAISO's coordination with IOU transmission operators would be necessary.

Hybrids

Many variations to the Total TSO, Total DSO, and IDSO model could emerge. We highlight three Hybrid models.

> Hybrid A: Markets for distribution services and wholesale services from DER remain unchanged. DER opportunities to serve and their use in each market must be coordinated by distribution and transmission system operators. Hybrid A represents California status quo, although DER participation in both markets and implied coordination is nascent.[29]
>
> Hybrid B: Hybrid A, except the current market for distribution services is improved upon. For example, new Smart Inverter Use Cases are developed and implemented. Hybrid B is the status quo with continuous improvement to the distribution market; no layering of wholesale and distribution markets or Independent DSO.
>
> Hybrid C: Hybrid B, except distribution service market revisions include tasking an independent organization with responsibility for operating the market for distribution services. Hybrid C is an IDSO without layering of wholesale and distribution markets.

[29] Gridworks, CAISO, PG&E, et al., *Coordination of Transmission and Distribution Operations in a High Distributed Energy Resource Electric Grid*, 2017

Comparing Conceptual DSO Models

The following matrix illustrates these models relative to the three distinguishing criteria in focus here.

Model	**Distribution Market Design (Revised or Not Revised)**	**Wholesale and Distribution Market Relationship (consolidated, layered, or coordinated)**	**Owning and/or Operating (consolidated or separate)**
Total TSO	Revised	Consolidated	Separated
Total DSO	Revised	Layered	Consolidated
IDSO	Revised	Layered	Separated
Hybrid A (status quo)	Not Revised	Coordinated	Consolidated
Hybrid B	Revised	Coordinated, with distribution service market revisions	Consolidated
Hybrid C	Revised	Coordinated, with distribution service market revisions	Separated

The DSO models presented here are shaped by a focus on these key questions.

- Should markets for DER to provide distribution services be revised or remain as is?
- Should markets for wholesale and distribution services be consolidated, layered or coordinated?
- Should profit-making opportunities of distribution system ownership be separated from distribution service market operations or left consolidated?

Gridworks does not suggest these models represent the full or best range of options. Instead, this presentation aims to illustrate what may be three key choices facing California. Whether to frame the questions facing California this way and, if so, how to go about resolving the questions may be informed by considering comparable processes and their outcomes from other jurisdictions.

Questions for Party Consideration:

★ What additional information do parties need to define, understand and evaluate DSO models?

★ What are the advantages and disadvantages of distinguishing between DSO models using the three criteria identified here?

A Summary of Comparable Processes and Outcomes from other Jurisdictions

Industry leaders have been considering DSO models in Australia, the United Kingdom and New York. The following summarizes their respective processes and outcomes.

Australia Open Network Initiative

Rapid adoption of solar and storage technologies by customers began to challenge Australia's grid operations model in 2017.

In response Australia's Energy Market Operator (AEMO) and Energy Network Australia (ENA)[30] launched the 3-year Open Networks Project, an initiative to "identify how best to transition to a two-way electricity grid and associated marketplace that effectively integrates and actively manages DER within Australia's energy system."[31] The Open Energy Networks project explored various frameworks for the coordination and optimization of DER, including some of the conceptual models summarized above.

The Australia Open Networks Project included the following milestones and accomplishments, listed sequentially from beginning to end:

- Electricity Network Transformation Roadmap (2015 - 2017): Anticipating a future where up to 45% of all electricity is generated by customers, the Roadmap provides detailed goals, milestones and actions to guide efficient and timely network transformation between 2017 and 2027.[32]
- Initial Consultation Interim Report (June 2019): The Report explores frameworks required to integrate DER, including a more active Distribution System Operator (DSO) and distribution markets.[33]

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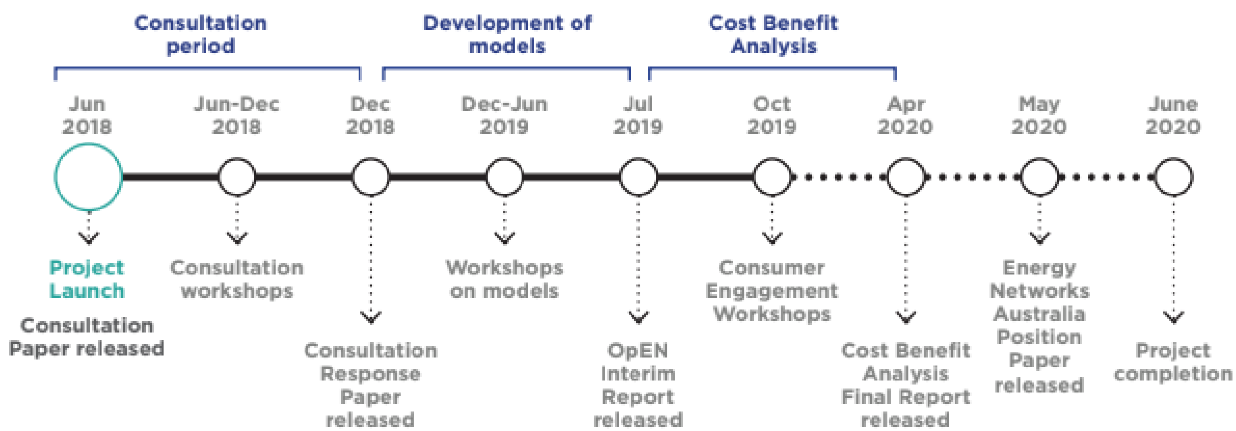
[30] AEMO's mission is comparable to the CAISO; ENA is an association of transmission and distribution network owners

[31] https://aemo.com.au/initiatives/major-programs/nem-distributed-energy-resources-der-program/markets-and-framework/open-energy-networks-project, accessed January 2022

[32] Energy Networks Australia and CSIRO, *Electricity Network Transformation Roadmap: Final Report* (2017)

[33] AEMO and Energy Networks Australia, *Open Energy Networks, Consultation Paper*, (2018)

- Smart Grid Architecture Models (July 2019): Detailed Smart Grid Architecture Models (SGAMs) illustrate each of the proposed energy market models.[34]
- International Review (July 2019): This review focuses on progress made internationally (i.e., UK, EU, California, New York, Japan, and PJM Market Area) and the steps taken to develop DER coordination frameworks between Distribution and Transmission networks.[35]
- The Required Capabilities and Recommended Actions, Interim Report (2019): This report summarizes key outcomes from the detailed research and engagement phases of the project and outlines the required capabilities and recommended actions to effectively integrate high levels of DER into the future energy grid.[36]
- Baringa Assessment of Open Energy Networks (May 2020): This report includes a cost-benefit analysis of the evaluated DSO options.[37]
- Energy Networks Australia Position Paper (May 2020):[38] This paper summarizes the network industry's position on the Open Energy Networks Project.



Australia Open Network Outcomes

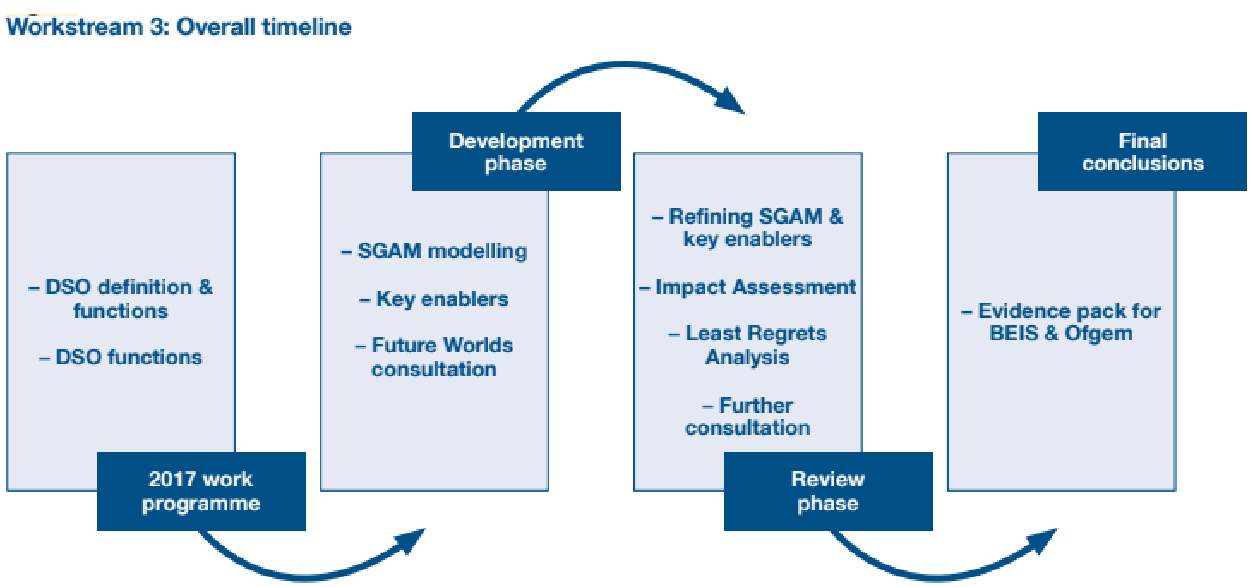
At the conclusion of its process the Energy Network Australia opted for a hybrid DSO model, prioritizing real-time DER coordination and dispatch with DER providers, as well as grid

[34] EA Technologies, *Open Energy Networks Project, (2019)*
[35] Newport Consortium, *Coordination of Distributed Energy Resources; International System Architecture Insights for Future Market Design, (2018)*
[36] AEMO and Energy Networks Australia, *Interim Report: Required Capabilities and Recommended Actions, (2019)*
[37] Baringa, *Assessment of Open Energy Networks Frameworks* (2020)
[38] Energy Networks Australia, *Open Energy Networks Project: Energy Networks Australia Position paper* (2020)

modernization investments needed toward that end. No new markets were created, a conclusion which may have been driven by the expectation among some parties that the costs of standing up a distribution market would exceed the benefits in all but the highest DER adoption scenarios. Looking forward, and anticipating potential changes to DSO structures in the future, a selection of "least regrets" investments were identified which would be suitable across the full range of future scenarios.[39]

United Kingdom Open Network Initiative

Driven by ambitious carbon reduction targets, export constraints in high-DER areas, and strong regulatory support for increasing flexibility, the United Kingdom initiated a 5-year Open Networks initiative in 2017.[40]



This figure depicts the UK workstream, beginning with defining DSO as a set of desired functions, identifying potential DSO structural models, evaluating those models and providing policy leaders evidence on which to draw conclusions.

The milestones and accomplishments of the process mirror in many key respects the arc of the Australia Open Network process. Similarities include:

- Beginning with an effort to determine objectives, requirements, and functions;

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[39] *ibid*
[40] UK Energy Networks Association, *Open Networks Future Worlds*, (2018)

- The use of Smart Grid Architecture Models to depict DSO model components and the structure of their relationships and interactions;
- Extensive stakeholder engagement;
- Performing cost-benefit analysis to assess the various DSO models;

However there are some key differences, including:

- Distinct focus on “neutral market facilitation,” the question of whether to separate the profit-making opportunities of distribution system ownership and distribution service market operations;
- Workstreams are re-scoped annually with rolling product development, allowing for active adaption of focus and effort;
- Process governed by a Steering Group, which includes regulators and stakeholders;
- Like California, the UK’s weighing of DSOs is a distinct workstream embedded in a larger set of grid modernization initiatives.

United Kingdom Open Network Outcomes To Date

In 2019, after 3-years of cooperation between stakeholders, a Hybrid model was selected. In the UK this model is referred to as “Future World B.” It consists of increased distribution operator functionality, direct DER participation in wholesale markets, and increased coordination between the two. As of January 2022, the UK Open Network initiative has recently launched a DSO Implementation Plan.[41] The Plan’s roadmap identifies eight core DSO functions with the majority being implemented prior to 2030 but “services and market facilitation” being implemented though January 2040.

New York Reforming Energy Vision

In 2015, the New York Public Service Commission (NYPSC) launched its Reforming the Energy Vision (REV) proceeding, articulating a transformation to a future electric industry in New York State that incorporates and makes optimal use of distributed resources and dynamic load management. REV envisioned a DSO model, which they called a Distributed System Platform (DSP), enabling third-party providers of distributed energy resources (DER) to deliver value to both customers and the electric system. Those DSP services were expected to combine planning, operations, and market functions.[42]

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41 https://www.energynetworks.org/creating-tomorrows-networks/open-networks/distribution-system-operation-transition and for the full report: https://www.energynetworks.org/industry-hub/resource-library/open-networks-2021-ws3-p1-dso-implementation-plan-report-(31-mar-2021).pdf

42 NYPSC, *Department of Public Service Staff Whitepaper Guidance for 2018 DSIP Updates,* (2018)

In the ensuing months stakeholders collaborated on an accelerated basis to assess how the policy objectives outlined in the REV vision inform required platform functions, capabilities and investments. Like the processes in Australia and the UK, REV considered how the role of various market participants and their interactions might change as markets evolve. In their 2015 report, stakeholders concluded:

- "A core function of the DSP is to develop and implement vibrant markets for distribution system products and services;"[43]
- "...DSP market structure, products, and basic market sourcing methods should complement and not replicate existing NYISO wholesale markets. Thus, DERs may continue to be able to provide wholesale market services to the NYISO… An important implication, which is described above within market staging and further expounded upon within the implementation sections below, is the recommended need for coordination between the NYISO and the DSP across the planning and operations of the T&D systems, especially as DER penetration increases."[44]

These conclusions were supported by detailed recommendations setting expectations for utilities to meet through an interactive Distribution System Implementation Planning process.[45]

In 2018 NYPSC staff re-energized guidance to utilities toward distribution markets.[46] Guidance included requirements for the utility to "detail the roles and responsibilities of the utilities, the NYISO, and other parties involved in planning and executing integrated market functions which accommodate and productively employ DERs." In March 2019 NYPSC staff launched a "DSP Market Design & Integration Working Group" to continue consideration of the design and implementation of the DSP market functions needed to enable and optimize operation of DERs in the utilities' electric distribution systems. This working group sought to follow the trajectory recommended above in the Grid Architecture section, envisioning implementation of this process over 15 months, moving sequentially through the following tasks:

1. Convene Working Group and File Work Plan
2. Workshop Addressing Design Concepts and Development Practices
3. Establish Definitions, Objectives and Qualities
4. Define Necessary Capabilities, Properties, and Functionality
5. Establish Industry Structure (roles, responsibilities, interactions)

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[43] *Market Design and Platform Technology Working Group Final Report,* (2015)
[44] *Ibid*
[45] See section 5.1.3 in *MDPT Working Group Final Report* for detailed recommendations on Distribution Market Operations capabilities
[46] NYPSC, *Department of Public Service Staff Whitepaper Guidance for 2018 DSIP Updates,* (2018)

6. Define Functional and Performance Requirements and Constraints
7. Identify and Characterize Suitable Technology and Process Architecture
8. Identify and Specify Essential Technical and Process Design Standards
9. Develop Priorities and Generic Roadmap for DSP Market Implementation

As of January 2022, nearly 24 months after its launch, the Working Group has completed tasks 1-4 and is moving with purpose into the remaining tasks.

New York REV Outcomes

As noted above, REV remains a work in progress. To date, REV has concluded a DSO model should be pursued, including an open market for distribution services from DER. While the initial efforts in 2015 concluded distribution and wholesale markets should be coordinated, rather than layered, the ongoing working group has been reassessing that question. Considerable thought has gone into the question of whether and how to separate distribution system ownership and market operations. No final conclusions have been drawn.

Synthesizing the Process and Outcomes from Australia, United Kingdom, and New York

Our review of the initiatives in Australia, the UK, and New York concludes that they used similar processes. Where conclusions have been reached, they have also been similar, although the New York initiative is not complete.

Similarities in process include:

- Each began with a detailed review of objectives, inferring from these objectives the desired requirements and DSO functions through the application of Grid Architecture methods;
- Each focused on review of similar conceptual DSO models; and
- Each included significant stakeholder engagement led by consultants with significant levels of participation by grid operators and thought-leaders.

The following table shows the outcomes of each process to date.

Jurisdiction	**Selected DSO Model**	**Distribution Market (Revised or Unrevised)**	**Wholesale and Distribution Market (consolidated, layered, or**	**Owning and Operating (consolidated or separate)**

			coordinated)	
Australia	Hybrid A	Unrevised	Coordinated	Consolidated
United Kingdom	Hybrid A	Unrevised	Coordinated	Consolidated
New York	TBD	Revised	TBD	TBD

Questions for Party Consideration:

★ What best practices for DSO definition and evaluation may be inferred from these comparable initiatives?

★ In what ways should California recreate the processes defined above?

A Proposed Process to Openly Evaluate DSO Options in California

As with the initiatives in Australia, the UK and New York, California faces the challenge of evaluating DSO models and concluding whether changes to the current roles and responsibilities of market actors would speed progress toward the state's goals. The intermediate goal of this initiative is to publish a *Future Grid Study* which enables Commission resolution of the questions identified in the Scoping Memo. Implied objectives for this initiative include determining what DSO model and utility incentive structure best:

- unlocks economic opportunities for DERs to provide grid services,
- limits market power,
- reduces ratepayer costs,
- increases equity,
- supports grid resiliency,
- meets state policy objectives, and
- maintains safe and reliable service

The task before parties is to support the Commission in making its determination, and to do so through an inclusive stakeholder engagement process. Gridworks will convene, facilitate and report on the process and outcomes. Gridworks' role is to raise questions and create a space for parties to consider and address them; content and conclusions will be drawn by parties.

Recognizing Party Input

In their comments to the OIR, parties offer the following perspectives and suggestions to inform how DSO models could be assessed:

- "A facilitator-led working group process that generates a report with consensus and non-consensus proposals is the prudent approach to tackling these issues."[47]
- "How can the various Commission-mandated pilots inform the Commission in making decisions regarding whether distribution-level markets and programs are prudent and align with consumers' interests and preferences?"[48]
- "…the first objective should be to identify those capabilities that will be necessary for the grid of the future and are incremental to the functions that IOUs perform today."[49]
- "The Commission should take an implementation-focused approach (i.e.: what is needed to implement DSO models that can meet California's goals, and what is the customer impact) … a guiding principle should be that scoping questions are framed to produce findings of fact and conclusions of law on which the Commission can make its policy decisions that inform future ratesetting proceedings."[50]
- "...present an affirmative question on "what" are the electric distribution roles that will exist in a high DER future, how are these defined, how do these roles interact, are these roles universally relevant, and how can these roles be organized to best provide customers with safe, reliable, affordable, and clean electric service."[51]
- "...it is important for California decisionmakers to outline clearly their expectations regarding distribution grid operations and optimization, not merely for planning investments, but also to send signals regarding levels of visibility to planners, operators and distribution-level markets (if they come into being). California decisionmakers should also send clear directions as to their expectations regarding interoperability, coordination with integrated resource planning, and reliability (including providing capacity and ancillary services). Early clarity of these expectations will help inform technology deployments that will enable the safe, reliable and affordable operation of a high-DER grid" [52]
- "...the Commission should get input from industry players that are already implementing the types of solutions called for in this proceeding in other states and RTOs. To that end, … call for stakeholder presentations and paper proposals first, permit the consultant scope of work to include a review and evaluation of all stakeholder proposals and

[47] SDG&E Opening Comments, 2021
[48] SDG&E Opening Comments, 2021
[49] SCE Opening Comments, 2021
[50] PG&E Opening Comments, 2021
[51] PG&E Opening Comments, 2021
[52] Utilidata, Opening Comments, 2021

technical presentations, and allow the consultant to incorporate them into the final report of recommendations."[53]
- "….expand stakeholder participation beyond the usual participants to include the communities most in need of the decarbonization, resilience, economic and health benefits the High DER Future can offer, as well as the local and tribal governments and agencies who will be developing and implementing DER-related projects for their jurisdiction"
- "…consider, in its investigation, reforming the distribution IOU structure to separate a regulated open access monopoly wires company (DSO) and a competitive affiliate that could play various roles including LSE and provider of DERs and other customer services in level competition with other companies."[54]
- "The crucial dilemma facing the Commission in this proceeding is whether to pursue a course of incremental changes that expand the for-profit monopoly scope into evolving technologies where competition and innovation might otherwise flourish, or to pursue a more fundamental reconsideration and redefinition of the role of the IOU distribution monopolies to better serve the needs of all California communities in the face of a volatile, dangerously disrupted climate and potentially even more inequitable energy future."[55]

The Scoping Memo anticipates a Future Grid Workshop Series to raise and discuss the issue. Parties offered the following suggestions for that series.

A. Proposal A:[56]
    - Workshop 1: Proposals for DSO models to meet needs of High DER future in California (IOU and other stakeholder proposals)
    - Workshop 2: Aggregator roles in DSO models; Aggregator Services (pdf p. 23)
    - Workshop 3: Equity, cost effectiveness, and cost allocation
    - Workshop 4: Miscellaneous/revisit WG topics; WG stakeholder comments

B. Proposal B:[57]
    - Workshop 1: Articulate the greater societal goals the high-DER electricity system must support
    - Workshop 2: Specify the ways the High DER future will contribute to the goals
    - Workshop 3: Describe the requirements on the electric distribution system to deliver the outcomes specified in step two

[53] Microgrid Resource Coalition, Opening Comments, 2021
[54] The Climate Center, Opening Comments, 2021
[55] The Climate Center, Reply Comments, 2021
[56] PG&E, Opening Comments, 2021
[57] The Climate Center, Opening Comments, 2021

- Workshop 4: Specify the functional roles and responsibilities of the electric distribution utility that are required to fulfill what was laid out in the first three steps

c. Proposal C:[58]
  - Workshop 1: Define high-level public policy objectives
  - Workshop 2: Identify desired outcomes and system performance characteristics
  - Workshop 3: Specify operational and functional requirements and interdependencies
  - Workshop 4: Determine the organizational structure and roles of market participants, IOUs and other stakeholders within the DSO model

Gridworks Proposed Track 2 Process

Gridworks appreciates these proposals and draws much from the parties' input. Guided by the Commission's direction, party proposals, and our review of the Australia, UK and New York process and outcomes, we propose the following goals and process to complete this initiative. His proposal is offered for party feedback and may adapted, overhauled or replaced.

Our proposal adapts Proposal C above. In doing so, we recognize California policy-leaders and parties have already invested considerable time and resources defining their objectives for a high-DER grid and developed many of the components of an effective DSO model. Still, as outlined above in the Grid Challenges section, California has not achieved its potential. This initiative affords the opportunity to determine whether its existing allocation of roles and responsibility – its existing DSO model – helps or hinders integrating DER onto the grid while maximizing DER value to the grid and what, if anything, could be improved.

Proposed Initiative Goals

1. Ensure the initiatives provides solutions to problems
2. Center equity and increase the diversity of participating stakeholders
3. Leverage the insights gained from Australia, the UK and New York, while creating the process and new ideas California needs
4. Inspire stakeholders to do good work
5. Be timely

[58] UCAN, Opening Comments, 2021

Proposed Initiative Objectives and Supporting Activities

Gridworks' proposed 5-step process would set targets ("Essential 2030 Operations[59]"), Assess Gaps, Propose Solutions, Assess Barriers to those solutions, and Determine Potential Actions. Each step is detailed as follows.

1. **Initiative Kick-off:** Initiate stakeholder engagement in support of Track 2.
    a. Activity:
        i. Publish this DSO paper
        ii. Kick-off workshop to review this proposal, consider alternatives, and receive party input on the questions posed in this paper, especially on how best to organize Track 2 process (Parties, with Facilitator guidance)
        iii. Summarize party input from the workshop as an addendum to this paper and issue to stakeholders (Facilitator)
        iv. Determine Track 2 stakeholder engagement process based on party input (Facilitator, Energy Division)
2. **Essential 2030 Operations:** Identify the operations essential to the distribution grid in 2030 in line with the proceeding's High-DER future grid vision, including the required planning, investment and market functions needed to enable those operations.
    a. Activity:
        i. Collect and organize relevant, existing goals to anchor the aims of the initiative (Facilitator, Energy Division)
        ii. Workshop 1: Identify the operations essential to the distribution grid in 2030 (Parties, with Facilitator guidance)
        iii. Request and incorporate feedback (Facilitator)
        iv. Document the outcome and issue to stakeholders (Facilitator)
    b. Guidance:
        i. Objectives for the grid go beyond technical and economic challenges to include social (e.g., equity) and environmental (e.g., wildfire risk mitigation) challenges
        ii. A manageable scope may necessarily require abstractions for now
        iii. Do not re-litigate existing policy

[59] Taxonomy Note: Many DSO research and stakeholder initiatives have used the term "function" to refer to the intended activity or purpose of an actor within the power system. In the context of the Smart Inverter Operationalization Working Group, the term "function" is used to refer to something more specific (e.g., the ability of a smart inverter to ride through frequency fluctuations). To avoid potential confusion, this DSO initiative will use the term "operations" to refer to the intended activity or purpose of an actor and "function" to refer to specific smart inverter activity.

3. **Gap Assessment:** Assess the current status of the identified 2030 Essential Operations and deduce any gaps, real or perceived. The results of Objective A and B yield a shared problem/opportunity statement.
    a. Activity:
        i. Collect and organize relevant, existing official documents which speak to gaps (Facilitator, Energy Division)
        ii. Workshop 2: Provide additional information to inform gaps (Parties, with facilitator guidance)
        iii. Request and organize feedback (Facilitator)
        iv. Document the outcome and issue to stakeholders (Facilitator)
    b. Guidance:
        i. Use official documents where possible to avoid subjective, debated conclusions
        ii. Work together to supplement as needed
4. **Propose Solutions:** Create DSO model proposals to address identified gaps.
    a. Activities:
        i. Create DSO models which address identified gaps (Parties)
        ii. Workshop 3: Present proposals and receive feedback (Proposing Parties)
        iii. Document the outcome and issue to stakeholders (Facilitator)
    b. Guidance:
        i. Invest time and effort to build mutual understanding of proposals
        ii. Proposals may include incentive mechanisms to encourage operator performance consistent with Essential 2030 Operations.
        iii. Proposals may include outcomes of the CPUC's Smart Inverter Operationalization Working Group initiative to prioritize use cases (Final Report due Q1 2023).
5. **Barrier Assessment and Action Recommendations:** Identify what barriers (i.e., legal, regulatory, procedural, technical and financial) challenge the closing of those gaps by proposed DSO models. Then show what findings, conclusions, or actions the Commission or other policy makers could take to overcome barriers
    a. Activities:
        i. Workshop 4:
            1. Identify barriers to various DSO model implementation (Parties, with facilitator guidance)
            2. Identify actions to overcome various barriers (Parties, with facilitator guidance)
            3. Identify tradeoffs, pros and cons (Parties, with facilitator guidance)
        ii. Document the outcome and issue to stakeholders (Facilitator)
        iii. Request and organize feedback (Facilitator)
    b. Guidance:

i. Invest time and effort to build mutual understanding of barriers
ii. Where possible, provide potential actions in the form of Findings of Fact, Conclusions of Law, or Ordering Paragraphs.
iii. Recognize trade-offs openly
iv. Include incentive mechanisms worthy of further investigation
v. Include outcomes of the CPUC's Smart Inverter Operationalization Working Group initiative to prioritize use cases (Final Report due Q1 2023).

A gantt chart illustrating these activities and their timing can be found in Appendix B. The gantt chart shows three important timing features.

- First, parties work together for nearly 6 months to define the problem (steps 2 and 3 above);
- Second, parties have nearly 5 months to work independently to develop proposed DSO models as potential solutions to the problem as defined;
- Third, proposed solutions and evaluation of those solutions comes to a head in 2023 after relevant contributing work being completed in the SIOWG concludes.

Workshop materials and files associated with the study will be hosted on Gridworks' public website for ease of access throughout the process. Progress Reports will be issued to the Service List periodically either formally or informally to inform the High DER proceeding.

The following example is offered to illustrate a potential outcome of this 5 step process. The contents of this example are intended to be illustrative; they are not intended to be accurate or real.

Goal: Utilities integrate the anticipated impacts of electrification into distribution planning (Draft DER Action Plan Vision Element 2D)		
Essential 2030 Operations	Distributed Load Forecasting	8760 Time Series Analysis
Gap(s)	Granularity currently limited to circuit-level (primary distribution system). Secondary distribution system by 2025. Premise-level needed by 2030	Granularity currently limited to 576 hours/year; 8760 needed by 2025, full 8760 (all DER and grid components) by 2030
Proposed DSO Model	Total DSO: Layered approach to distribution system planning enables and motivates balancing at distribution-level, maximizing attention to	

	electrification integration into distribution planning	
Barrier(s)	Total DSO reliant on uncertain EV adoption forecast	Computationally intensive
Action(s)	Use a stochastic analytical approach to account for risk in uncertain forecasts	EPIC program investments in machine learning methods to isolate most relevant computations from noise

If successful, the process proposed by Gridworks will result in a collection of Essential 2030 Operations (each associated with an existing or proposed goal), identified gaps relative to current capabilities, proposed DSO Model(s) which addresses the gap, barriers to implementing the proposed DSO model and actions that can be taken to address those barriers.

Conclusion

To conclude this initiative, the facilitator will compile the created material to form a draft *Future Grid Study*. The Commission will then take two steps to receive party input. First, parties will file comments on the draft study. Second, the Commission will host an *en banc* to discuss the study findings and party positions. The *en banc* will be followed by a Proposed Decision, the requisite comment cycle, and final decision of the Commission. The Commission's decision may include the adoption of a proposed DSO model, relevant policy statements, near-term, concrete action items, longer-term intentions, and recommendations for legislative change. The final *Future Grid Study* would be republished as needed based on additions or modification pursuant to the adopting Decision.

Questions for Party Consideration?

★ What are the key features of Gridworks' proposed process?
★ What about Gridworks' proposal motivates you? What concerns you?
★ What changes or alternatives would better meet California's needs?

Next Steps

On April 13, 2022 the Commission's Energy Division and Gridworks will host a kickoff workshop to begin this initiative. In preparation for that workshop, parties are encouraged to:

- Review this paper and prepare:
    - Thoughts on the starred questions herein;

    - Any corrections necessary to promote understanding of the staff, facilitator and participants.
- Parties wishing to present alternative proposals for how the questions posed by the Commission should be addressed through this process should inform Gridworks by email to info@gridworks.org by April 7. Alternative proposals are welcome and encouraged. Please limit proposed work processes to the timeline afforded by the Commission's Scoping Memo.
- Meet with one another to discuss the questions posed by the Commission, the content of this paper, and the initiative ahead. Invest in mutual understanding.

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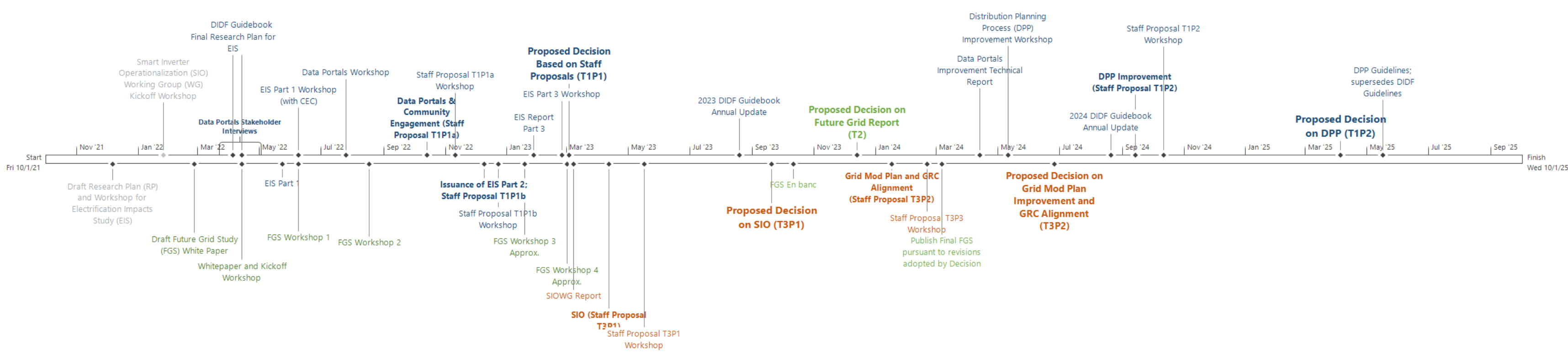
Appendix A: High DER Proceeding Timeline

The below timeline represents the best estimate of work in support of the High DER proceeding. It is expected that some of these dates will shift as the proceeding evolves and new data and insights are revealed.



Grayed out items have been completed

Blue is Track 1; Distribution Planning Process (DPP)

EIS is Electrification Impact Study

Green is Track 2; Future Grid Study (FGS)

Orange is Track 3; Smart Inverter Operationalization (SIO)

WG is Working Group

GRC is General Rate Case

T is for Track

P is for Phase

So T1P1 is Track One Phase One

GRIDWORKS

Appendix B: Process Diagram