High DER: Future Grid Study, Workshop One

Operational Needs

February 8, 2024

Agenda

What Does Success Look Like?
Expected Future Customer and Their Grid Needs
Future Operational Needs to Meet Customer Expectations
Questions

What Does Success Look Like?

Where Are We Now and Where Are We Going?

In the face of significant change, the utility role is evolving and expanding, but the core objectives remain consistent:

- ➢ Maintain a grid that is ***safe, reliable, clean, and affordable*** to all in support of achieving state decarbonization goals at lowest cost

From Grid-Centric to *Customer-Centric*

- ➢ Until now, utilities have primarily used grid-centric operational tools
- ➢ The future DSO will enable more customer-centric operations

From traditional DERs* to focus on *Transportation Electrification*

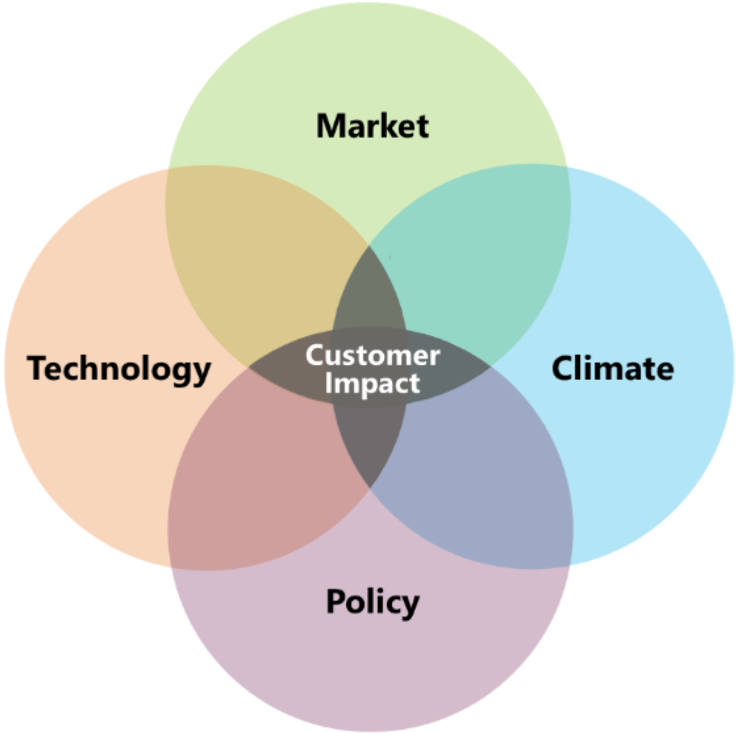
- ➢ Customer behavior, adoption, and needs drive change on the grid
- ➢ TE is the primary driver of change – and opportunity

From Fragmentation to *Orchestration*

- ➢ Grid operations are limited by existing tools
- ➢ Grid Orchestration is built upon the full understanding of locations, assets, and behaviors

*DERs include electric storage resources, intermittent generation, distributed generation, demand response, energy efficiency, thermal storage, and electric vehicles and their supply equipment (per CPUC and FERC).

External Factors Are Necessitating Change



Leverage Advanced Grid Management:

- Optimize the grid and operationalize assets to unlock load management flexibilities across different system levels
- Continue to operate the grid safely and reliably

Address Customer's Growing Needs:

- Support customers' electrification needs
- Adapt to additional challenges presented by climate change

Harness Customer as Partners:

- Enable customers and developers to make cost-effective technology choices
- Enable effective orchestration of the grid as a whole

Achieve State Goals:

- Achieve California's ambitious decarbonization targets
- Maintain affordability and improve equity

What Is Needed to Achieve Success?

Technology Evolution

- IOUs need to successfully execute on their existing in-flight Grid Modernization Plans.
- Effectively develop and implement new solutions as they are identified, such as Vehicle-to-Grid.

Policy Advancement

- Develop policy foundation to enable full grid orchestration, along with supportive rules to align and prioritize across needs.
- Encourage competition to mitigate market power concerns.

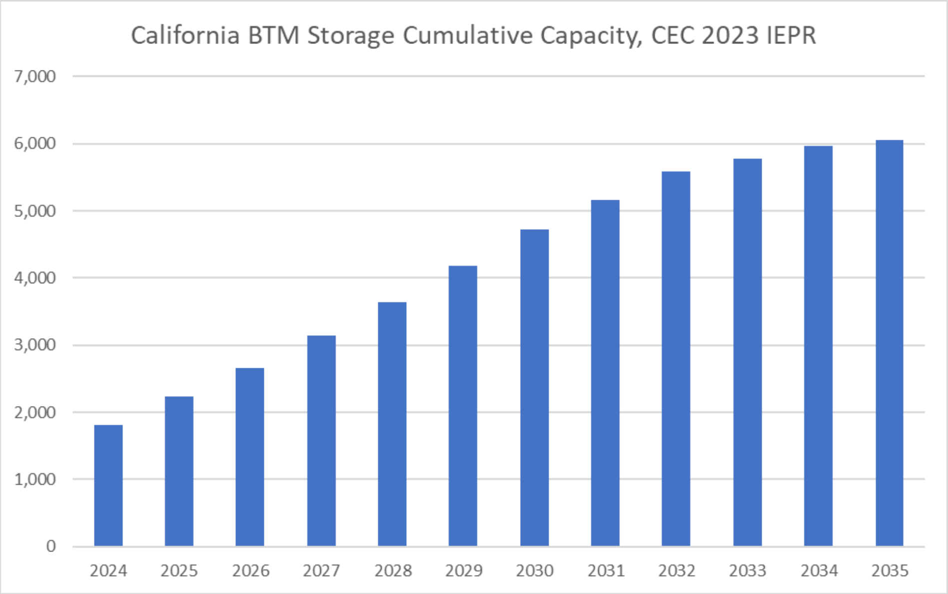
Customer Journey

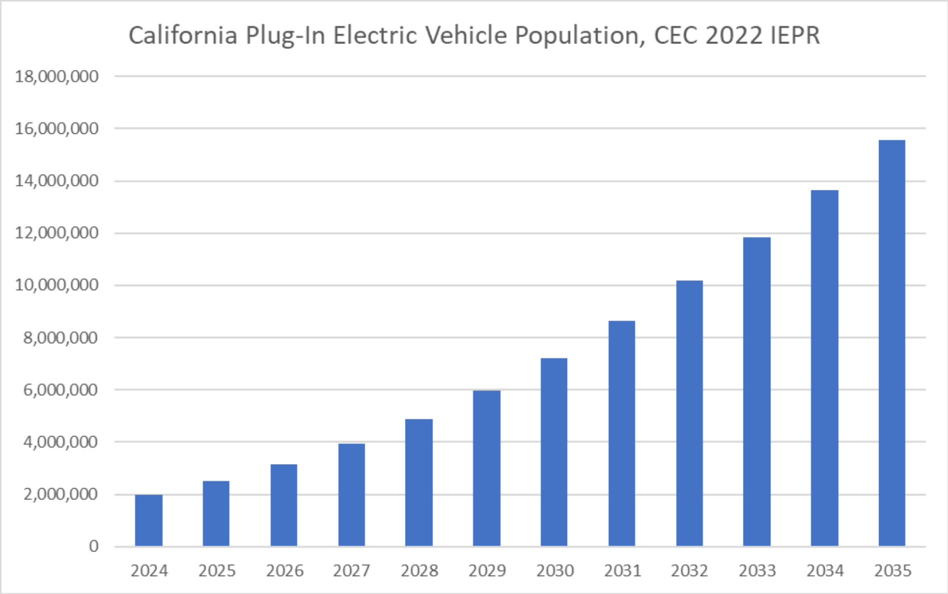
- Ensure customers are engaged, informed, and empowered.
- Promote equity for all customers, including disadvantaged communities, and both DER owners and non-owners.

Expected Future Customers and Their Grid Needs

The Landscape of Technology Capabilities is Rapidly Changing

- While projected growth of solar, storage, and building electrification will continue to play a role within the DER landscape, the sheer size of the projected Electric Vehicle growth and capabilities, not just as a flexible load, but with a potential as a 2-way power flow technology, will have an overweight impact that must be carefully considered





Grid Orchestration: Supporting Customers, State Policy, and Reliability

Supporting customers

Use Case – Reducing Service TX Upgrades

- Optimizing EV charging loads may allow customers to get home L2 charging without waiting for panel and/or service TX upgrades

Risk of uncertainty/non-performance

- Service TX failure results in outages to customer(s) during high load/need times
- Customers need to wait for service tx upgrades before getting L2 charging, potentially disincentivizing adoption

Use Case – Flexible Interconnection

- Customers can modulate loads on set schedules and thus can interconnect on constrained circuits prior to wires upgrades

Risk of uncertainty/non-performance

- Upstream protective device operates on over-current resulting in multi-customer outages

Supporting electrification

Use Case – Reducing Electrification Investments

- Flattened load curves may result in certain situations to reduce investments required to meet electrification load growth forecasts

Risk of uncertainty/non-performance

- New business loads (e.g. EV loads, data centers, etc.) will be unable to interconnect to the system, exacerbated with now delayed capital investments
- California's state goals for de-carbonization are delayed and economic growth is hampered
- Potential for overloaded circuits causing outages reducing local reliability and power quality

Supporting reliability

Use Case – Local Reliability

- Operators ability to call upon and reduce loads can enhance circuit switching abilities, minimizing outages and decreasing duration

Risk of uncertainty/non-performance

- Outage impact may be even greater than originally as upstream protective devices are triggered on over-current

Use Case – System Reliability

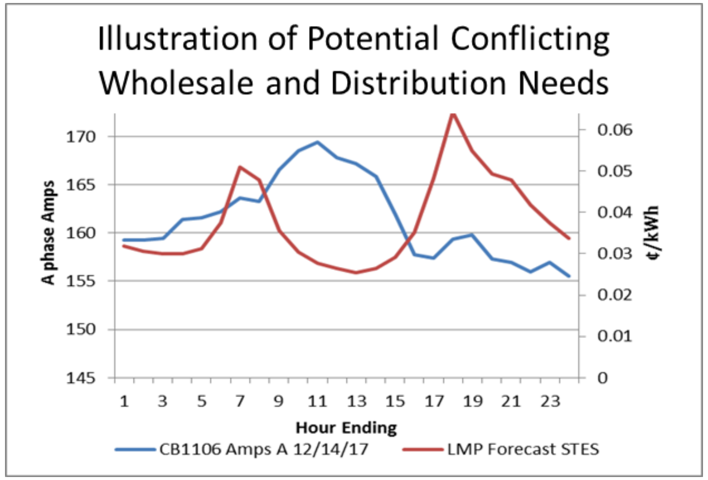
- System emergency conditions can be mitigated through DER dispatch (e.g. demand response)

Risk of uncertainty/non-performance

- Further mitigations will be required in order to ensure system integrity (e.g. rolling black outs)

Grid Orchestration: Energy Systems are Not Perfectly Correlated

Needs are not perfectly aligned, and so orchestration is needed to resolve conflicts



- Various local and system needs can be uncorrelated, or even worse, negatively correlated
- By only meeting and orchestrating the needs of the energy system as a whole, constraints can be even exacerbated for the grid
- Orchestration is required during those periods of conflict, whereby the needs of the hyper local are coordinated with the higher level and macro system
- Tariffs and/or policies may be needed to determine to support this orchestration, while also optimizing for customer value and considering customer preferences

Grid Orchestration Meets Transportation Electrification

Customers engagement will be key, and requires an investigation into the unknown

EVs: Transportation vs. a valuable grid asset

- How customers engage, and feel empowered about the utilization of their vehicle as an energy asset *is still unknown*.

Customer's engagement may change rapidly over time

- EV battery capacity continue to have step-change developments (e.g. solid state batteries)
- Customers become more comfortable with energy availability

More industry study is needed

- Customer optionality due to diversity in customer profiles
- Highly flexible program designs as the customer journey continues to evolve.

Future Operational Needs to Meet Customer Expectations

Evolving Grid Calls for Growing Operational Needs

Evolving Operational Needs

Grid Management Capabilities

Operational Needs	Grid Management Capabilities
Future Large amount of load growth, especially TE and BE. Conflicting management needs between different system levels	Complex and advanced grid management and orchestration, optimized asset management through advanced analytics
Present and Near Term Bi-directional power flow Growing number of DERs, especially EVs Increasingly dynamic and flexible loads	Smart grid, grid intelligence and grid management systems
Past Uni-directional Power Flow Large primary/front-of-meter systems Operate manually	SCADA, planning and forecasting tools

Operational Needs - Capabilities

Advanced grid orchestration built upon visibility and data

Ability to see/model increasingly more assets and customer technology adoption

Ability to process the large volume of data and assist operators in making data-based decisions

Optimized asset management using operational and analytical tools

Reliable communication for load management capabilities

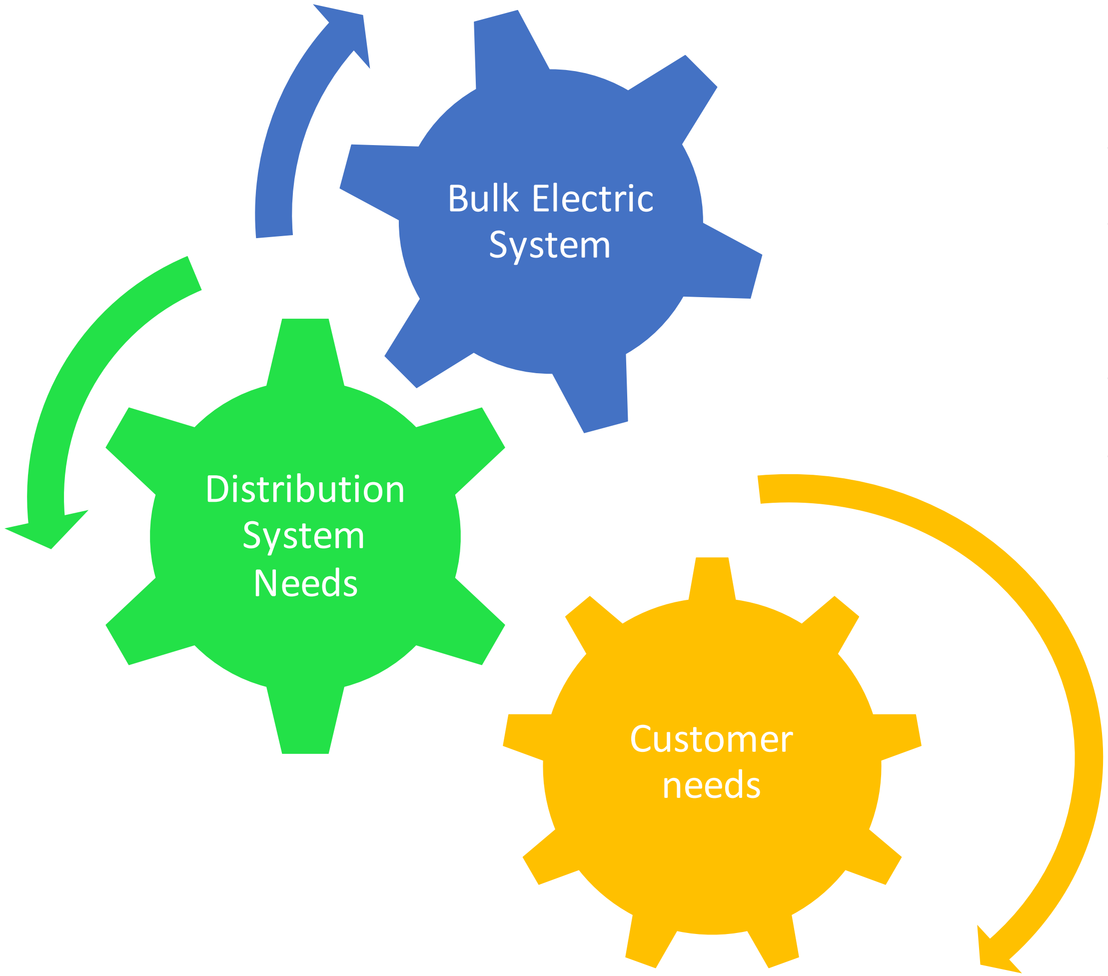
Efficient and secure grid architecture from grid edge to operation center

Balancing needs across different operating levels

Evolving needs requires careful balancing across different levels

Ability to assess, analyze and come up with solutions balancing needs

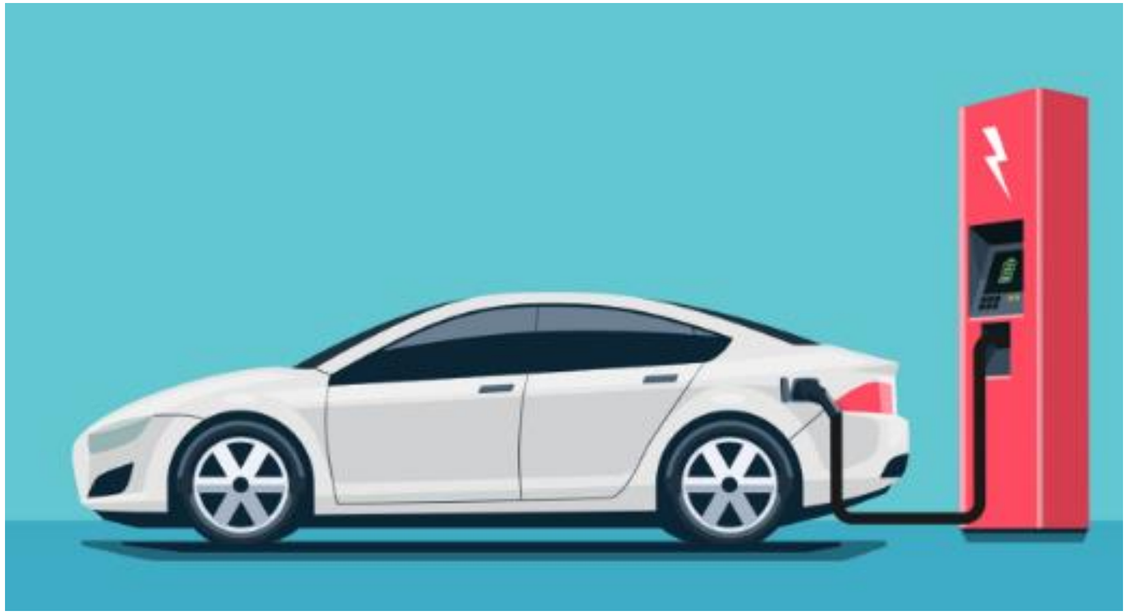
Operational Needs - Prioritization, Optimization and Conflict Resolution



- Operational hierarchy
- Determine whether balancing individual devices or aggregation
- Anticipate emergency vs typical dispatch
- Identifying compromises to mitigate customer inequity

Customer Experience is the Core of Grid Orchestration

- Support the customer of the future
- Define the customer's role in balancing future energy needs
- Communicate program participation opportunities



Q&A

Appendix

DERs and the Future Grid: New Capabilities and Opportunities

Category	New Capability	Description	Customer Benefit
DER/Smart Inverter Communication	DER Visibility	Real-time awareness of DER status and output	Improve reliability through better understanding of current grid conditions.
	DER Scheduling and Dispatch	Signal *participating* DERs to provide output at specified time (Day-ahead and real time)	Enable customers to provide grid services (and be compensated)
Operational planning and analysis	Short-term Forecasting	Highly granular forecast of DER output for next 24 hours	Improve reliability through better anticipation of expected grid conditions.
	Advanced Grid Analytics	Analyze grid conditions (current and forecasted circuit loading, DER output, etc.) to identify potential issues and suggest remedies	Improve reliability through anticipation of both grid problems and mitigations
	Grid/DER Optimization	Optimize use of grid assets and DERs to provide maximum value	Reduce expense and maximize opportunities for customer to provide grid services. Eventually, enable local pricing.
T&D Interface	Advanced CAISO Coordination / Communication	Mutual sharing of DER schedules, operations, constraints	Enable multiple uses, avoid operational conflicts. Eventually, enable market coordination
Physical Infrastructure	Grid infrastructure Automation	Real-time monitoring and automated grid control enabled by Intelligent sensors, switches, protection, communication devices	Improve reliability by responding faster to emergencies and changing grid conditions. Enable more granular ability to re-configure the distribution grid to re-route power during abnormal conditions