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Description:	Daniel Nelli, Jennifer Goncalves, and Shengnan Shao, PG&E
Filer:	Raquel Kravitz
Organization:	PG&E
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Forecasting Electric System Impacts of New Large Loads: Challenges and Opportunities

Daniel Nelli, PG&E

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Together, Building a Better California

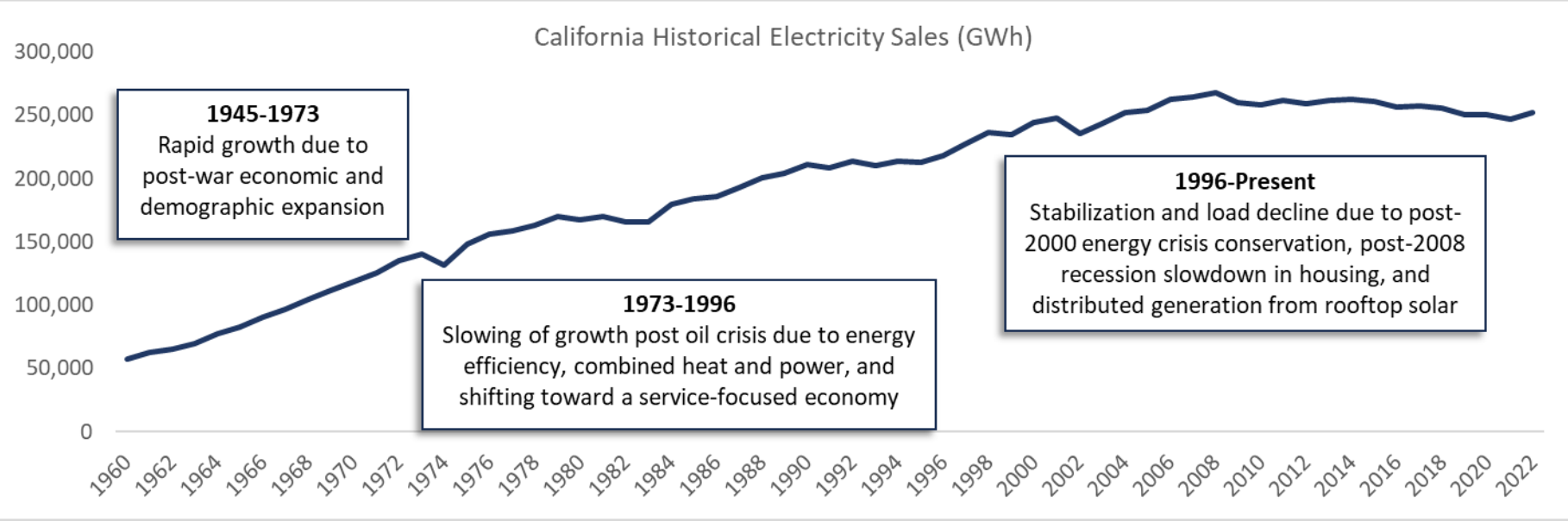
Key Messages

- New large loads present a load growth opportunity, which deviates from historical trends and may not be captured by current forecasting methodology.
- PG&E currently has ~4,000 MW (installed capacity) of large load applications, the majority being data centers. However, new large load forecasting is challenging due to numerous uncertainties.
- PG&E combines data and expert assessments to quantify forecast uncertainty.
- PG&E anticipates using its forecasting approach, including the Delphi method, to address uncertainties in data center load.
- Hydrogen production is another example of new large load. PG&E has completed a forecast for the electricity impact of hydrogen fuel cell electric vehicles.
- PG&E looks forward to collaborating with the CEC on the IEPR's large load forecasting process.

Motivation and Level-setting

New large loads present a load growth opportunity, which deviates from historical trends and may not be captured by current forecasting methodology.

- Driven by decarbonization and emerging industries, new large load applications have been entering the interconnection queue.
  - Data centers
  - Manufacturing
  - Hydrogen manufacturing
- Industrial loads are currently forecast using regression-based approaches, which rely on historical trends.
- The potential impact represents a departure from the relatively flat or declining electricity demand over the past 15 years.
- Forecasting these loads is important due to impacts on:
  - Interconnection planning
  - Resource adequacy and generation planning
  - California's infrastructure and economy



DATA SOURCE: EIA 2022 State Energy Data System

Challenges of Forecasting New Large Loads

PG&E currently has ~4,000 MW (installed capacity) of large load applications, the majority being data centers. However, new large load forecasting is challenging due to numerous uncertainties.

Forecasting Challenges:

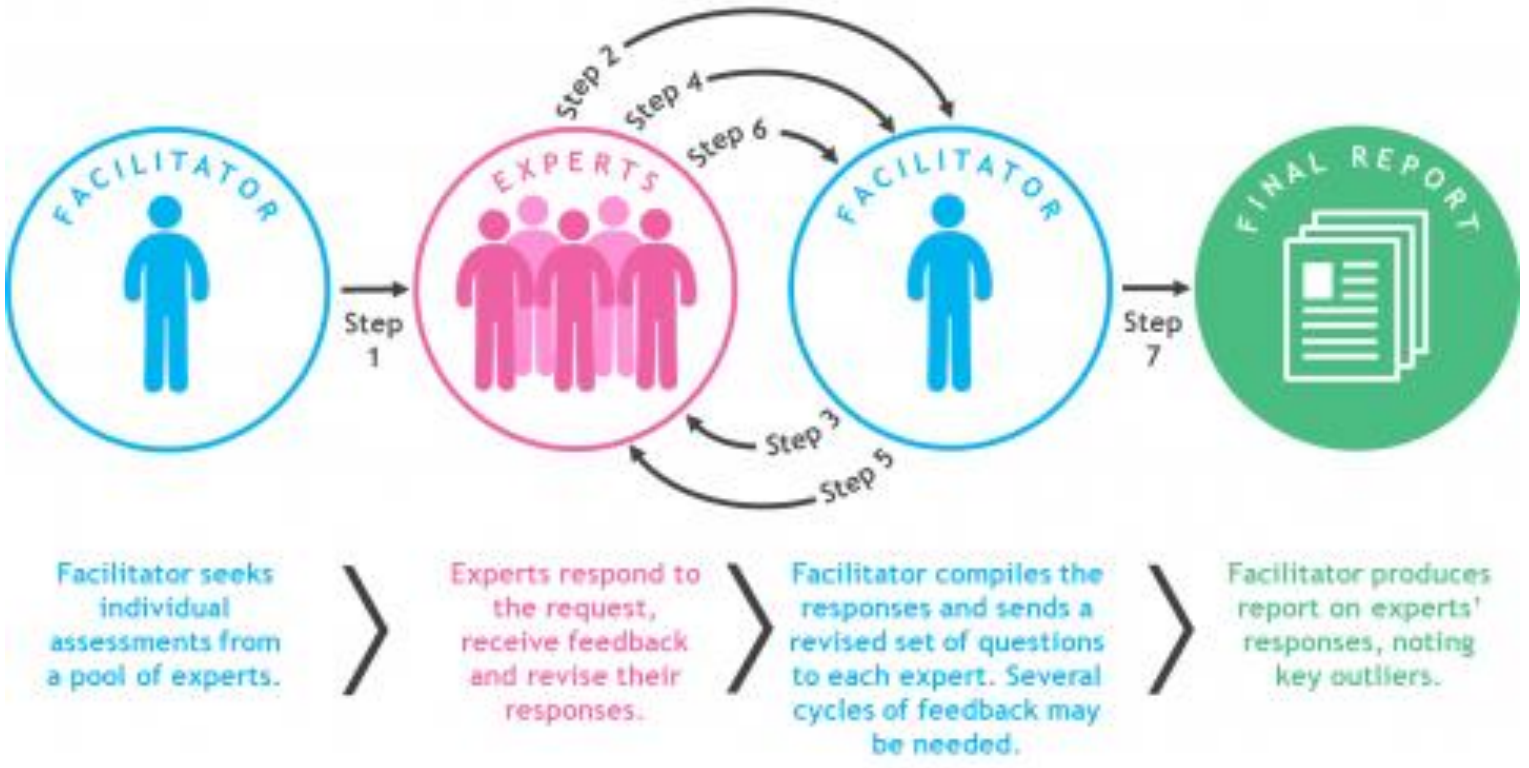
- Inherent uncertainty due to often developing nature of industry
- Discrete, yet difficult-to-predict timeline
- Installed capacity vs. load materialization
- Location dependence
- Behind-the-meter resources and generation
- Limited historical data that may not be representative of future trends

PG&E's approach to forecasting uncertainty

PG&E combines data and expert assessments to quantify forecast uncertainty.

- PG&E begins its forecast development by looking at external sources for information and data.
- PG&E also employs the Delphi Method with its internal subject matter experts, relying on expert assessments to establish assumptions about uncertain attributes.
- PG&E uses this forecasting methodology to estimate behind-the-meter generation (e.g., PV) and storage, electric vehicles (including hydrogen-powered), building electrification, and energy efficiency.

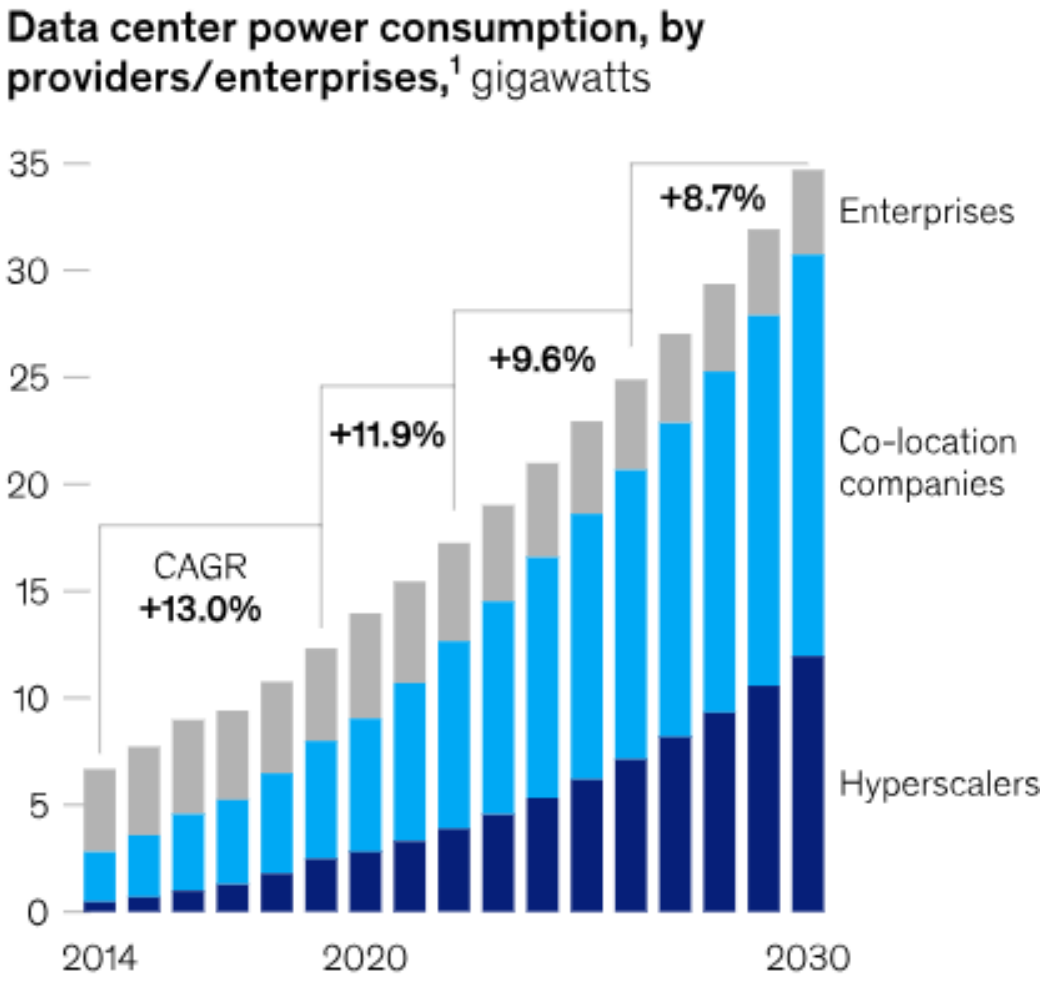
General Delphi Method



GRAPHIC SOURCE: University of Phoenix

Opportunities for Forecasting New Large Loads: Data Centers

PG&E anticipates using its forecasting approach, including the Delphi method, to address uncertainties in data center load.



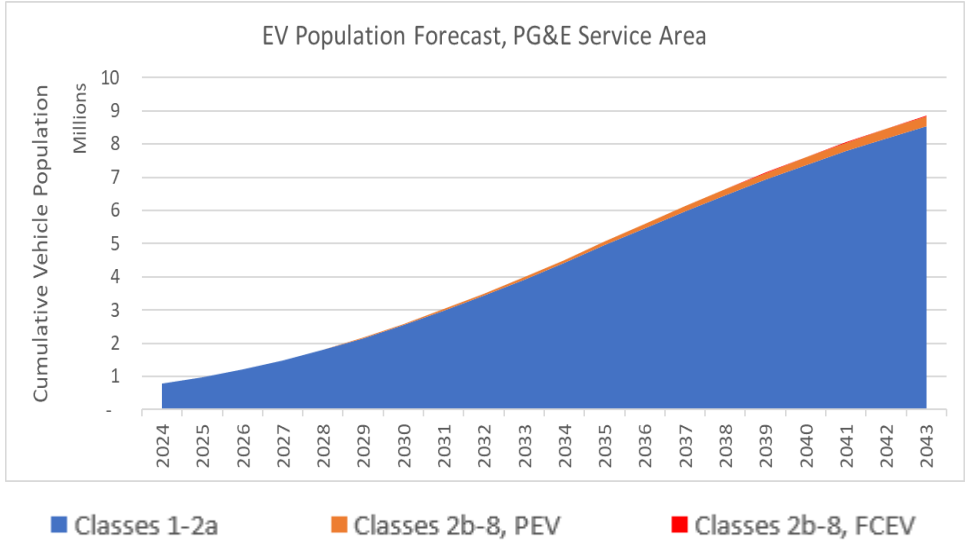
- Most third-party estimates of data center growth align around 10% CAGR over the next ~5 years.
- A 2022 study* showed significant divergence of global data center energy estimates (150-8,000 TWh in 2030).
- Key uncertainties (to investigate using Delphi method):
  - Pace of construction
  - Pace of interconnection
  - Impacts of future energy efficiency
  - The impact of generative AI
  - Behind-the-meter generation
  - Load factor
  - Peak impact
  - Pace of load materialization
  - Location-specific considerations

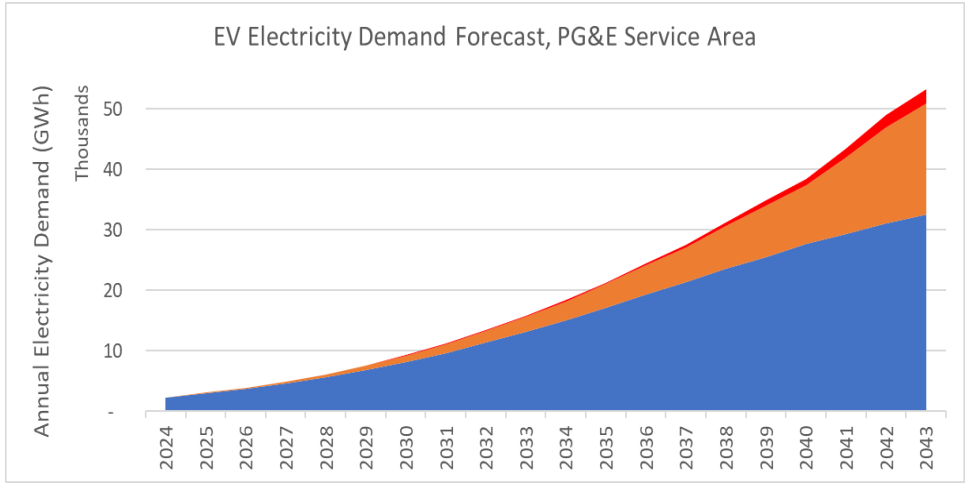
CHART SOURCE: McKinsey & Company's "Investing in the rising data center economy". Data scope is U.S.

** SOURCE: Mytton and Ashtine, 2022, Joule, "Sources of data center energy estimates: A Comprehensive review"*

Opportunities for Forecasting New Large Loads: Hydrogen for Fuel Cell Electric Vehicles (FCEVs)

Hydrogen production is another example of new large load. PG&E has completed a forecast for the electricity impact of hydrogen fuel cell electric vehicles.





- We assume a small portion* of future medium- and heavy-duty electric vehicles will be FCEVs (rather than plug-in electric vehicles/PEVs), comparable to the CEC's assumption in its 2023 IEPR.
- We assume 1) a minority of hydrogen necessary to power these FCEVs is produced via electrolysis which will increase PG&E's retail electricity sales, and 2) FCEVs are less efficient than PEVs – when considering total energy required to move the vehicle (including losses).
- Key uncertainties:
  - Future growth of hydrogen FCEVs
  - Method of hydrogen production
  - Location of hydrogen production
  - Hydrogen FCEV and electrolyzer energy conversion efficiency

GRAPHIC SOURCE: PG&E

**** In 2040, 7% of non-bus MDHD EVs***

Next Steps

- PG&E looks forward to collaborating with the CEC on the IEPR's large load forecasting process. For example, aligning on:
  - Data sources
  - Forecasting methodology
- PG&E will continue advancing its own data center forecasting methodologies to inform its load forecast.