NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Transportation Electrification

A Disruptive Technology and Potential Emerging BPS Reliability Risk

Ryan D. Quint, PhD, PE
Director, Engineering and Security Integration
North American Electric Reliability Corporation
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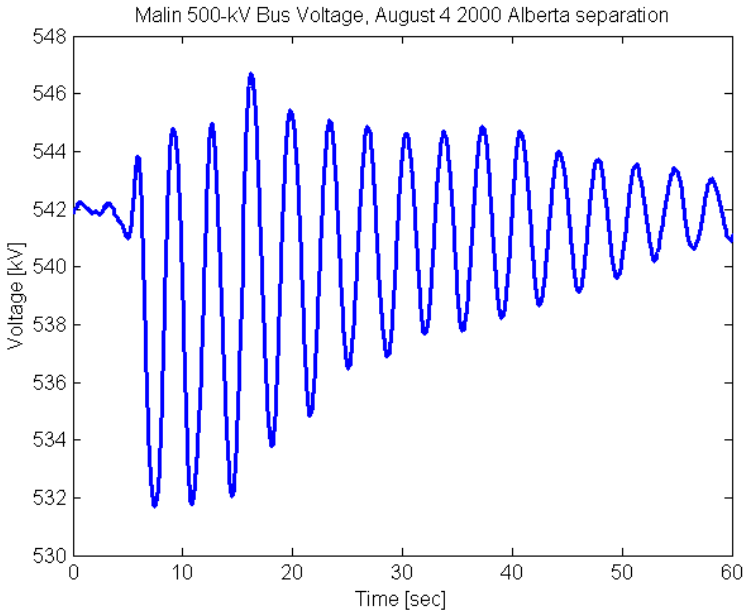
RELIABILITY | RESILIENCE | SECURITY

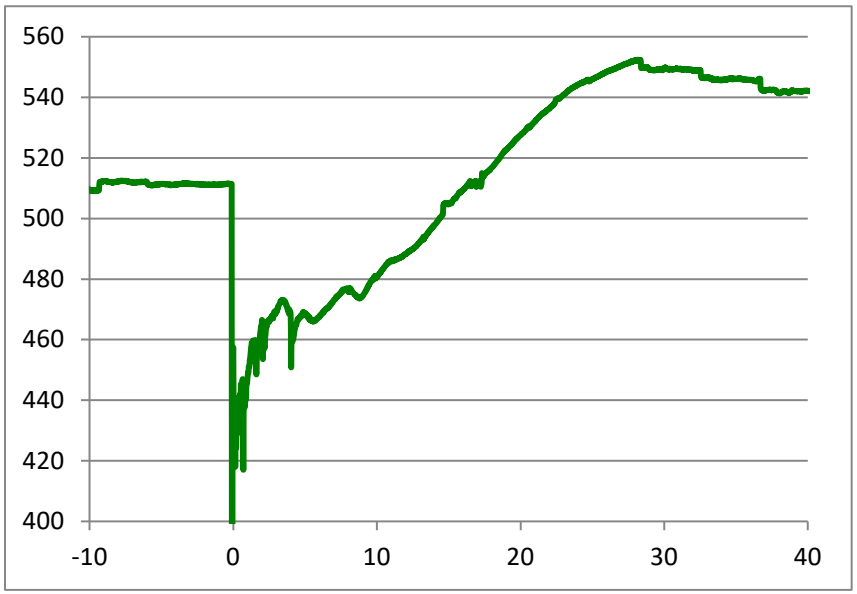



Why End-Use Loads Matter

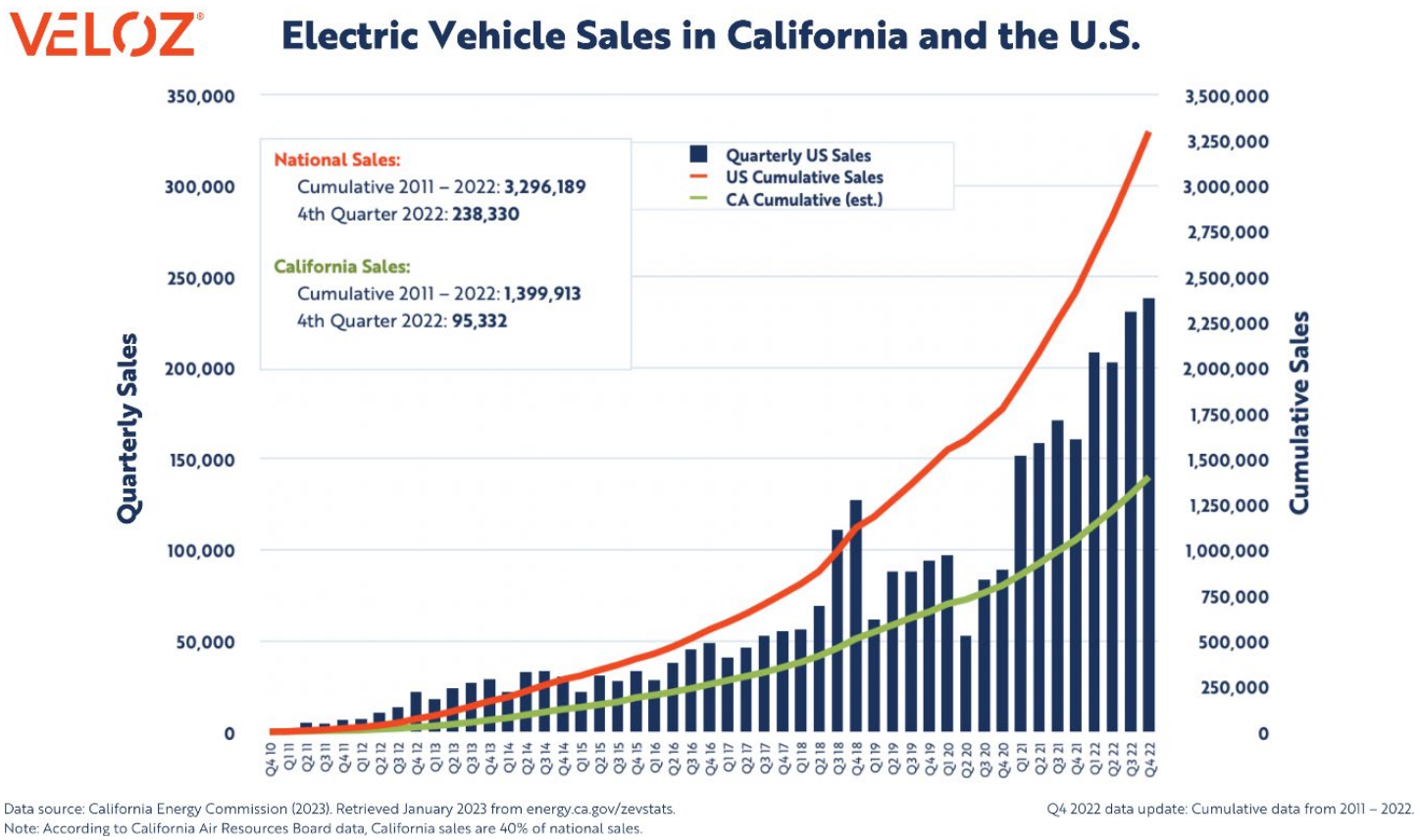
Oscillatory Instability (Poor Load Modeling)



Fault-Induced Delayed Voltage Recovery



Momentum Behind EV Adoption

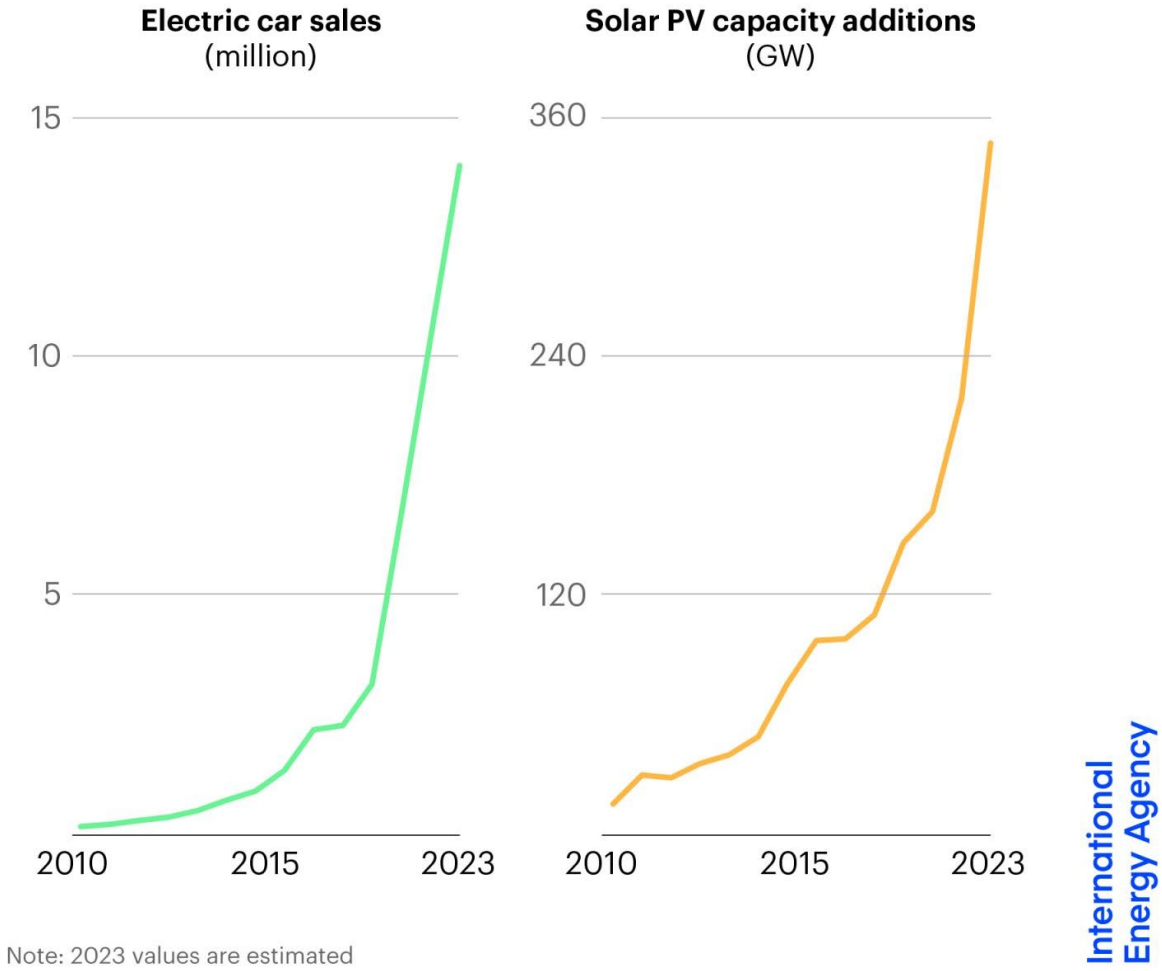


Data source: California Energy Commission (2023). Retrieved January 2023 from energy.ca.gov/zevstats.
Note: According to California Air Resources Board data, California sales are 40% of national sales.

Q4 2022 data update: Cumulative data from 2011 – 2022.

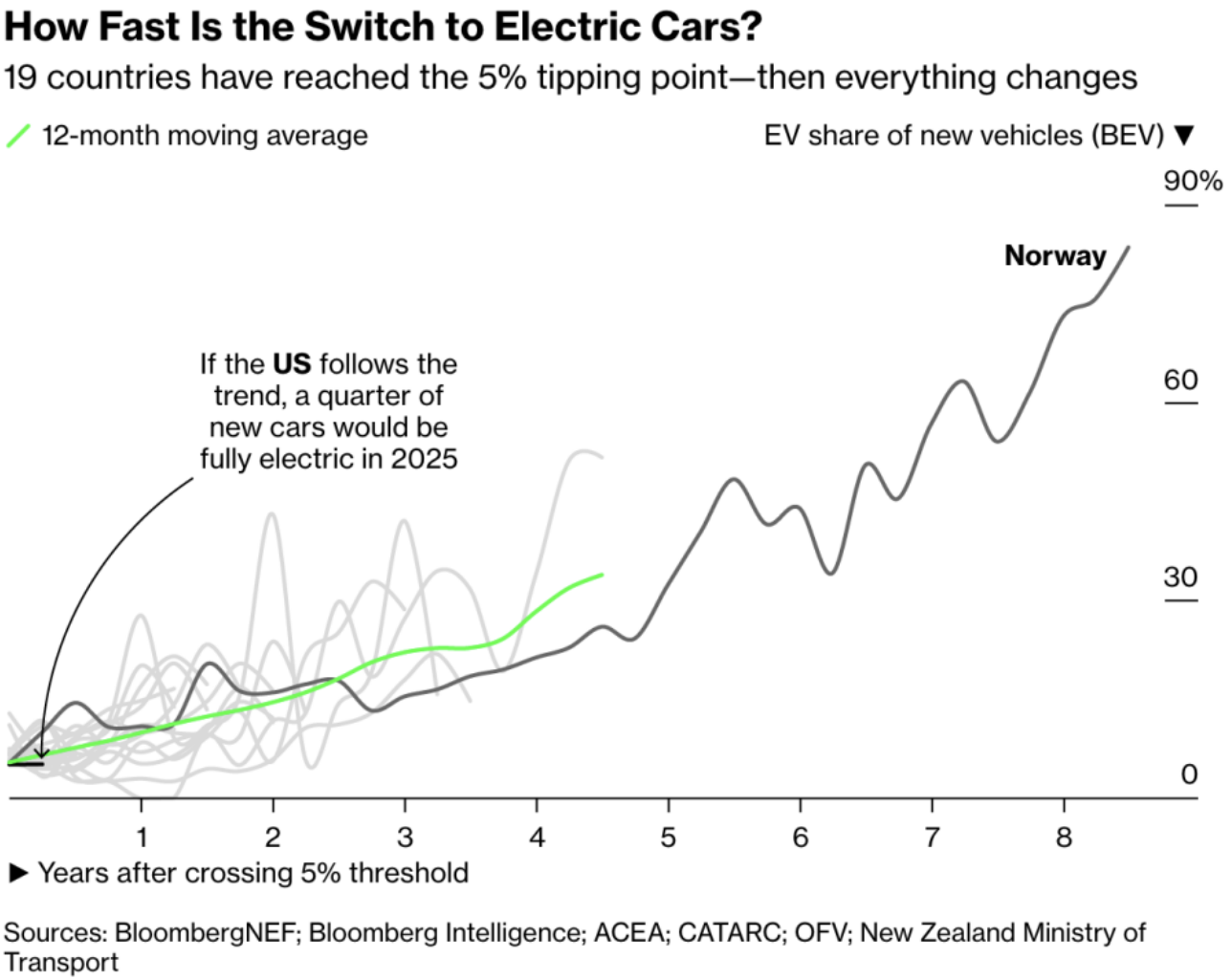
- Wood Mackenzie projects passenger and commercial EVs in the US to grow to:
  - **69.4 million and 3.14 million respectively by 2035**
  - **178.3 million and 5.76 million respectively by 2050**

EIA Projections from NetZero Roadmap

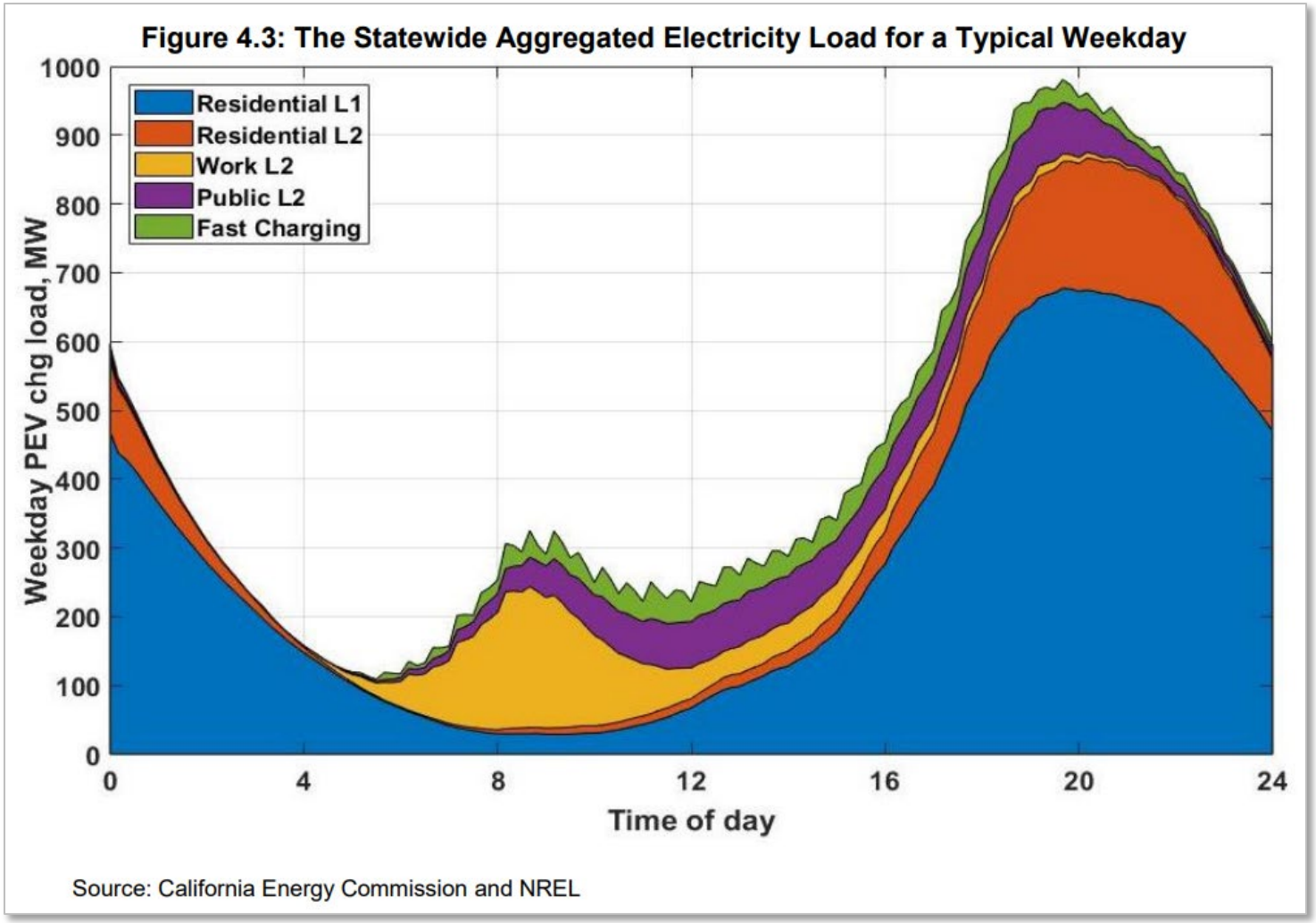


Note: 2023 values are estimated

The 5% Tipping Point

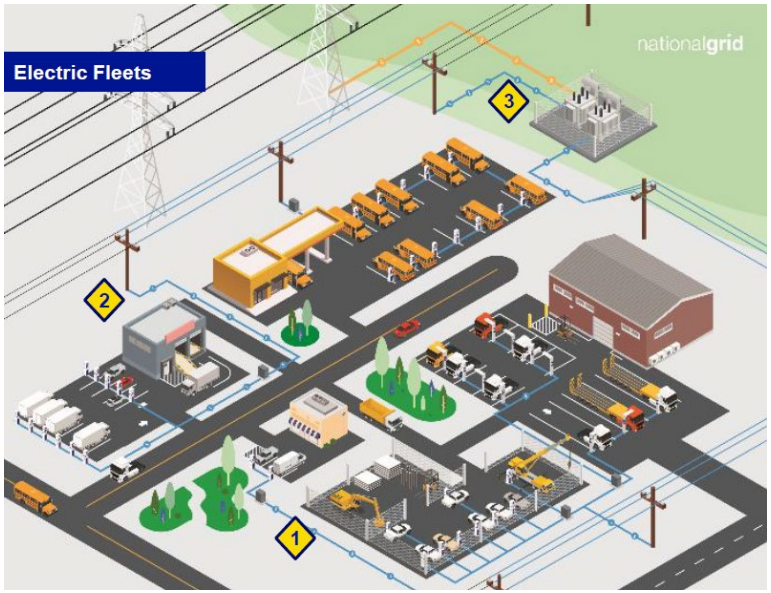


California Energy Commission Projections and Analysis



Medium and Heavy Duty EV Charging

- **Electric Highways:**
  - Fast charging needs
  - Converting fueling stations into EV charging hubs
  - Many highways near large transmission
  - 3-20+ MW loads tapped off transmission

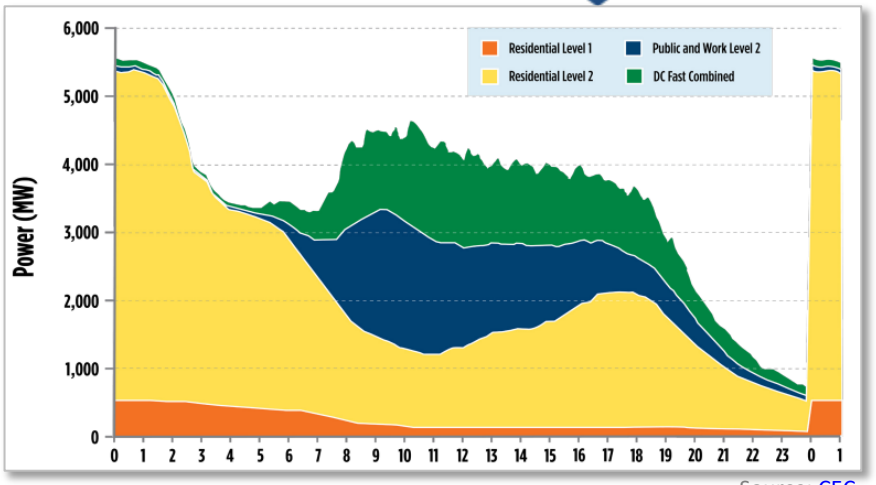


- **Electric Fleets:**
  - Buses, delivery vehicles, service vehicles, etc.
  - Smaller in MW size, but much more common
  - Significant aggregate load at distribution or even transmission

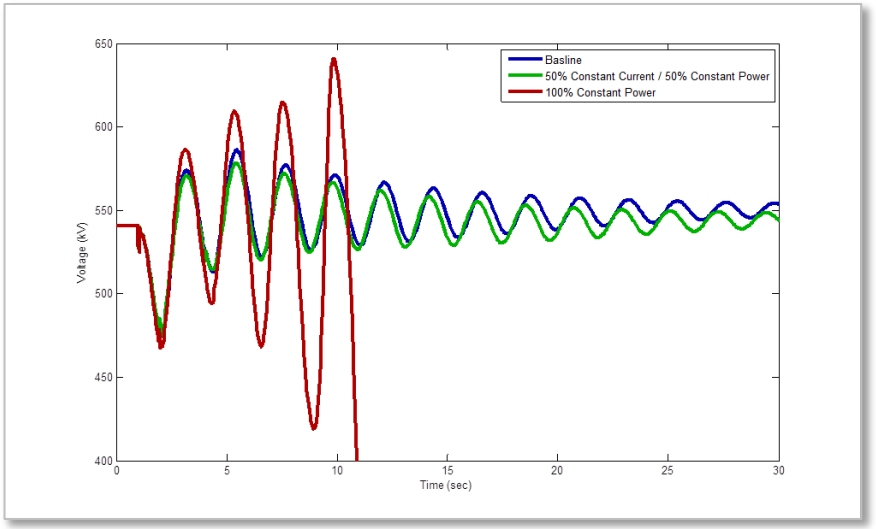
Source: National Grid

EV Impacts to the Bulk Power System

- **Rapid or unexpected changes in load consumption**
  - Time of use rates, “panic charging”, impacts to system frequency/voltage and overall load patterns
- **Ramping needs to manage critical charging hours**
  - Charging hours anti-correlated with solar PV profile, V2G support for variability
- **Constant power loads**
  - Slow and steady degradation of stability margins, wide-area oscillation problems, grid unfriendly
- **Fault ride-through performance**
  - Similar to solar, unexpected/unstudied response from thousands of EVs could be problematic, recovery matters



Source: CEC



EV Impacts to the Bulk Power System

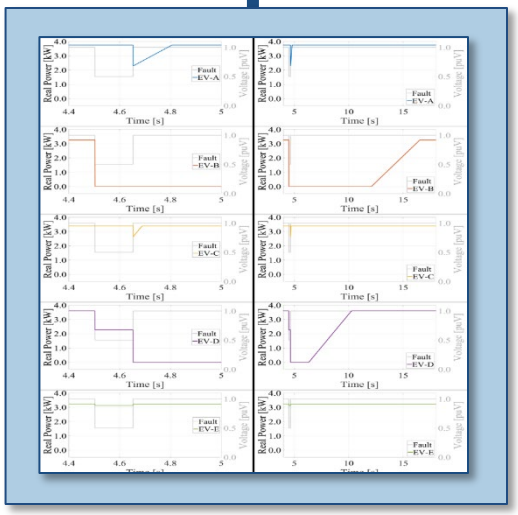
- **System restoration and blackstart plans**
  - Unexpected load steps during blackstart
  - Capabilities during large voltage/frequency swings
- **Participation in DER Aggregation**
  - EV smart charging as DER (FERC definition)
  - V2G as DER (NERC definition)
  - EVs part of DER Aggregators (FERC 2222)
  - Displacement of BPS generation and possible essential reliability services
- **Other possible impacts**
  - Power quality, harmonic, control interactions

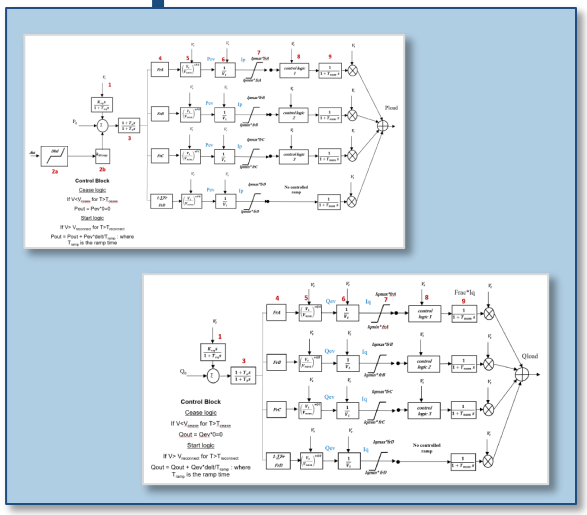
Source: History

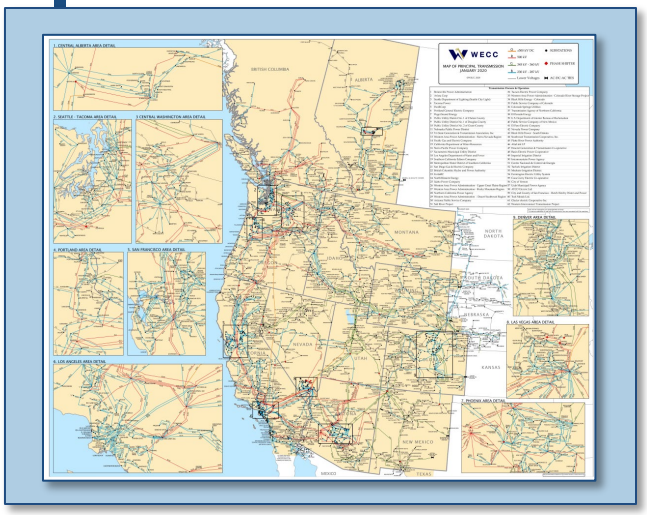
How do electric vehicle chargers behave ***during grid disturbances***?

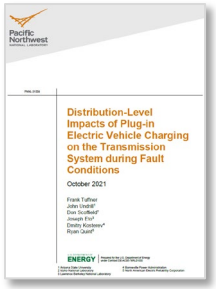
Driving Innovation: EV Modeling for Future Industry Reliability Studies

Understanding → **Models** → **Studies**



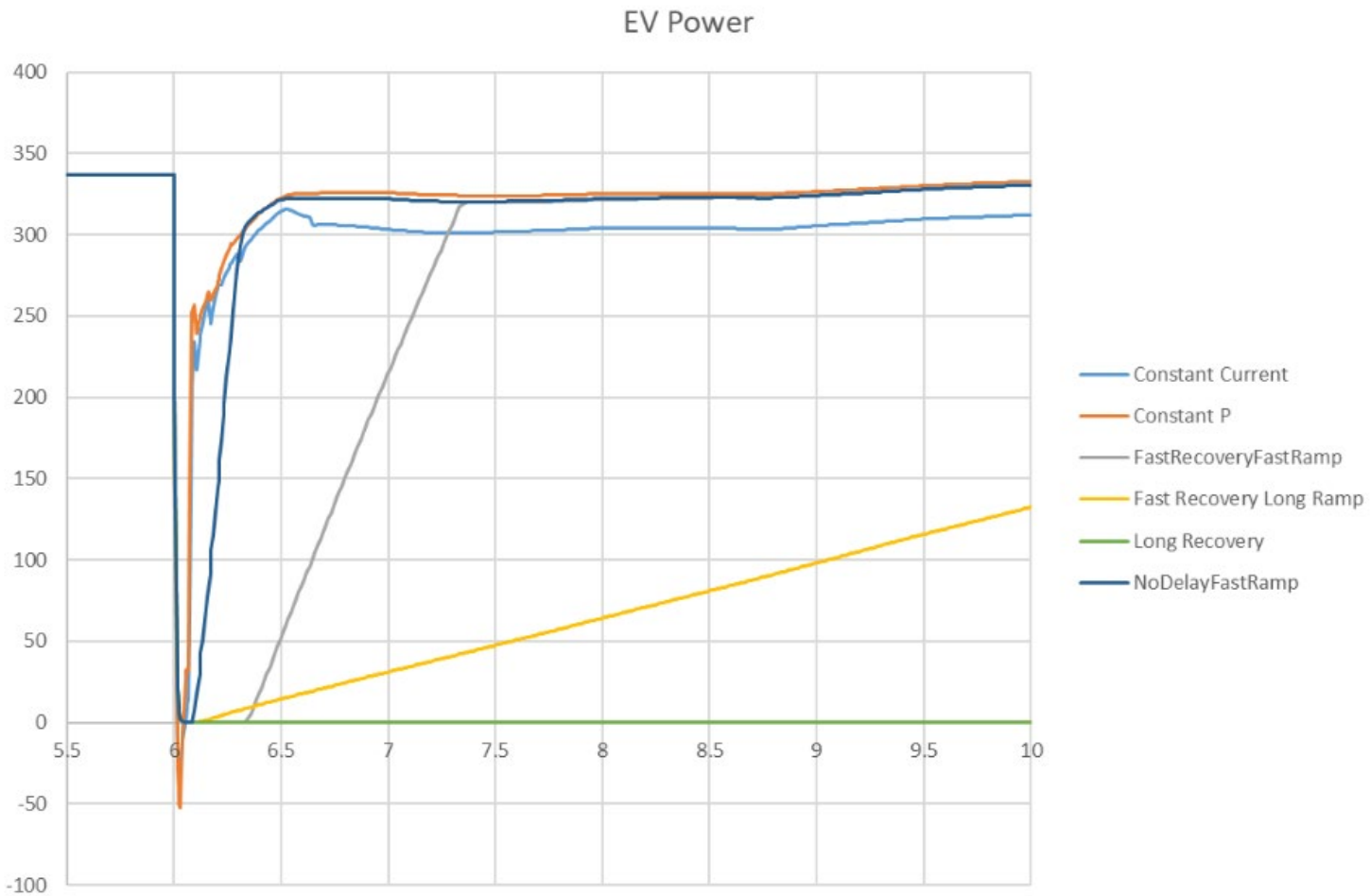




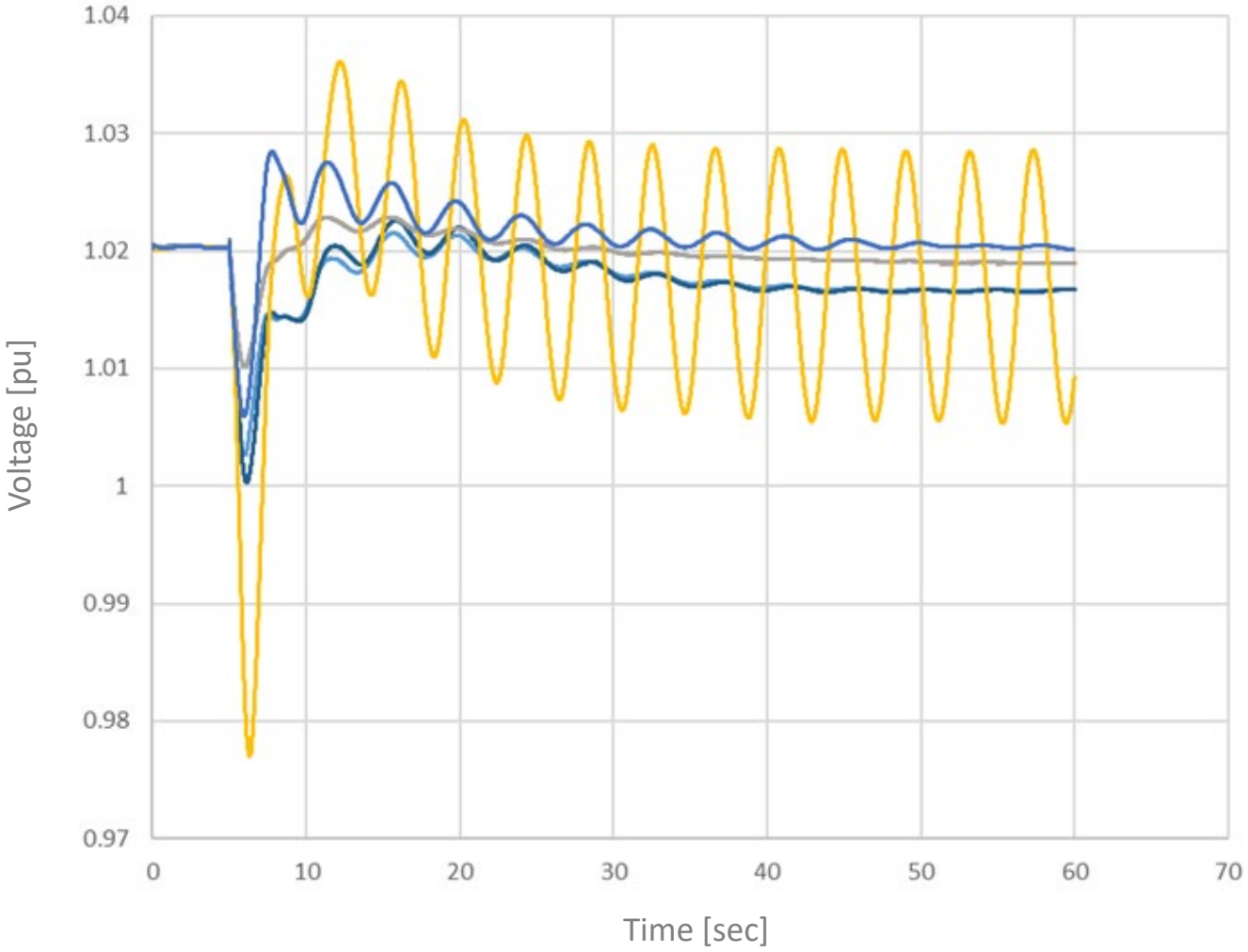


- Beta test and approve model
- Provide EV performance guidance
- Roll out model to industry broadly
- Provide study guidance

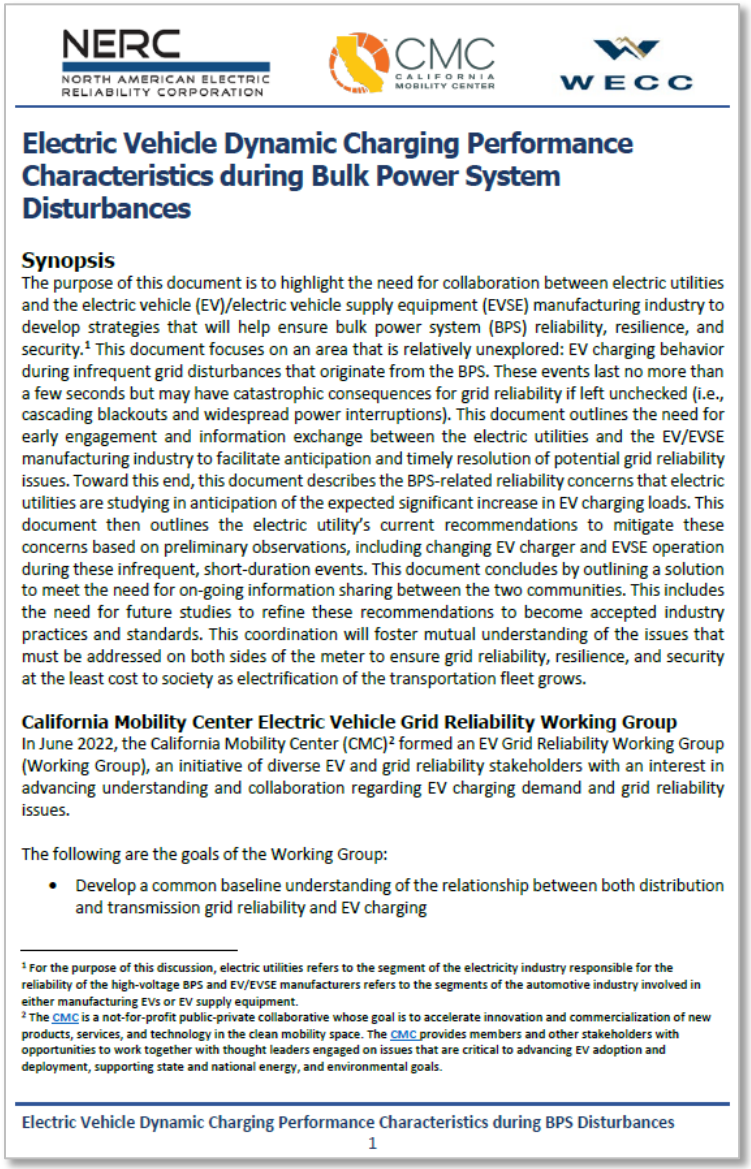
How EV Charging Load Behaves…



…Affects the Dynamic Performance of the Bulk Power System



Joint Partnership to Convene Key Stakeholders



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Electric Vehicle Dynamic Charging Performance Characteristics during Bulk Power System Disturbances

Synopsis

The purpose of this document is to highlight the need for collaboration between electric utilities and the electric vehicle (EV)/electric vehicle supply equipment (EVSE) manufacturing industry to develop strategies that will help ensure bulk power system (BPS) reliability, resilience, and security.[1] This document focuses on an area that is relatively unexplored: EV charging behavior during infrequent grid disturbances that originate from the BPS. These events last no more than a few seconds but may have catastrophic consequences for grid reliability if left unchecked (i.e., cascading blackouts and widespread power interruptions). This document outlines the need for early engagement and information exchange between the electric utilities and the EV/EVSE manufacturing industry to facilitate anticipation and timely resolution of potential grid reliability issues. Toward this end, this document describes the BPS-related reliability concerns that electric utilities are studying in anticipation of the expected significant increase in EV charging loads. This document then outlines the electric utility's current recommendations to mitigate these concerns based on preliminary observations, including changing EV charger and EVSE operation during these infrequent, short-duration events. This document concludes by outlining a solution to meet the need for on-going information sharing between the two communities. This includes the need for future studies to refine these recommendations to become accepted industry practices and standards. This coordination will foster mutual understanding of the issues that must be addressed on both sides of the meter to ensure grid reliability, resilience, and security at the least cost to society as electrification of the transportation fleet grows.

California Mobility Center Electric Vehicle Grid Reliability Working Group

In June 2022, the California Mobility Center (CMC)[2] formed an EV Grid Reliability Working Group (Working Group), an initiative of diverse EV and grid reliability stakeholders with an interest in advancing understanding and collaboration regarding EV charging demand and grid reliability issues.

The following are the goals of the Working Group:

- Develop a common baseline understanding of the relationship between both distribution and transmission grid reliability and EV charging

[1] For the purpose of this discussion, electric utilities refers to the segment of the electricity industry responsible for the reliability of the high-voltage BPS and EV/EVSE manufacturers refers to the segments of the automotive industry involved in either manufacturing EVs or EV supply equipment.
[2] The CMC is a not-for-profit public-private collaborative whose goal is to accelerate innovation and commercialization of new products, services, and technology in the clean mobility space. The CMC provides members and other stakeholders with opportunities to work together with thought leaders engaged on issues that are critical to advancing EV adoption and deployment, supporting state and national energy, and environmental goals.

Electric Vehicle Dynamic Charging Performance Characteristics during BPS Disturbances
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- Cross-industry collaboration to establish recommended practices for "grid-friendly EV charging loads" during grid disturbances
  - Coordination with utility industry, EV and EV supply equipment manufacturers, vendors, etc.
- Step towards joint collaboration
- Longer-term solution: Society of Automotive Engineers

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Questions and Answers

Ryan D. Quint, PhD, PE
Director, Engineering and Security Integration
ryan.quint@nerc.net