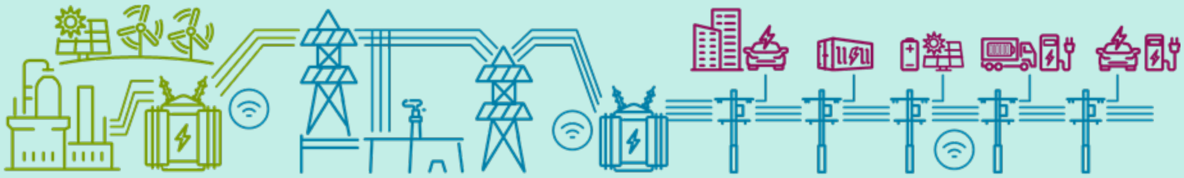
Decarbonized | Reliable | Resilient | Cost-effective



EVGrid Assist Webinar Highlights

U.S. DEPARTMENT OF ENERGY EVGrid Assist ACCELERATING THE TRANSITION

Load Forecasting Webinar Highlights

Determining the amount of electricity that will be needed to meet the increased requirements from electrifying transportation is more than a matter of answering the question of how much power will be needed. Well-established methods exist for forecasting traditional load growth (i.e., increased electricity demand); however, there's no established precedent for EV charging load. Electrifying transportation introduces new questions and new variables that can make it challenging to plan for new utility infrastructure investments. Beyond answering the question of what power will be needed, other questions, such as when and where it will be needed, are equally important.

Traditionally, future load growth happens in static locations and has predictable usage patterns. EVs, however, are mobile and charging may occur in different places at different times. Additionally, customer charging patterns are still largely unknown due to both the relatively small number of EV drivers and the lack of widespread adoption. Charging practices may change as more diverse drivers acquire EVs and as people become accustomed to the new technology. On top of that, while some rational patterns may come to light, consumer behavior is not always rational. These new variables make it a challenge to model and hard to predict where electricity infrastructure will be needed. Further, the number of EVs that are purchased and connect to the grid, and in what timeframe, will play a significant role in predicting load, but, while trends point to increasing sales, projecting the precise rate of EV adoption is challenging.

Addressing Uncertainties

Vehicle electrification dominates most projections of annual load growth. Currently, EV charging represents less than one percent of electricity demand in the United States. By 2050, the National Renewable Energy Laboratory (NREL) Electrification Futures Study (EFS) analysis projects that will increase to 23%, which corresponds to an additional 1,420 terawatt hours (TWh).

SOURCES OF UNCERTAINTY

- **Competing vehicle technologies**
  - EV versus hydrogen
- **Customer requirements**
  - Rural versus urban
- **Legislation/Regulations**
  - New clean vehicle laws
- **Modeling speculation**
  - Is history a good predictor of the future?
  - New incentives?
  - New market conditions?

Ensuring there is enough energy to meet customer demands will require proactive planning because some of the electricity infrastructure needed to meet EV charging needs may need to be planned 15 years in advance. While projections may vary depending on scenarios being considered or the organizations crunching the numbers, it is widely accepted that EV sales are growing and will continue to grow through 2050. The trend is unlikely to occur at a steady, leisurely pace and may spike at times, boosted by policies encouraging transportation electrification, charging infrastructure investment, and heightened consumer interest.

Elevating load management as a priority can help service that additional demand. Properly managing that additional load can offset the need for more power generation, and can prevent or minimize peak incidents, which already challenge grid operators and will be higher, sharper, and more frequent with unmanaged EV charging.

Forecasting future load growth is essential for planning to avoid costly delays or excessive expenditure. While no forecast is perfect and effort does not necessarily increase accuracy, uncertainties can slow progress. Proactive planning for investments requires reducing or bounding uncertainty to mitigate the risks of incorrect projections. Approaches to do so are:

- **Analyzie multiple scenarios.** Instead of seeking out a "best guess" compiled from all available data, explore "what if" ideas and make different assumptions to understand their implications and uncover futures that may be difficult to otherwise predict. If results from various scenarios converge, that can increase certainty in planning.
- **Include regional and/or scenario specific data.** Factors like household demographics, vehicle classes, travel requirements, and others will impact adoption and load, but will not be uniform across regions, states, or utility territories. Breaking these down and including them will improve models.

Factors in EV Adoption

Many variables will determine the number of car buyers who will choose to drive an EV. Improving technology, new makes and models and their availability, policies aimed at improving decarbonization efforts, and drivers' perception and awareness of charging infrastructure, charge times, reliability, environmental impacts, and others will factor into consumers' decisions.

EV adoption potential depends on many factors

Additional factors that impact EV consumption include:

- Vehicle efficiency
- Adoption by size class (e.g., midsize, SUV, Pickup)
- Travel behavior (vehicle miles traveled)
- Temperature (battery discharge rates increase in hotter/colder temperatures)

Whether for personal, light-duty vehicles or commercial medium- and heavy-duty vehicles, these variables need to be considered along with the adoption rates of different classes of vehicles. All will impact the overall electricity demand on the grid.

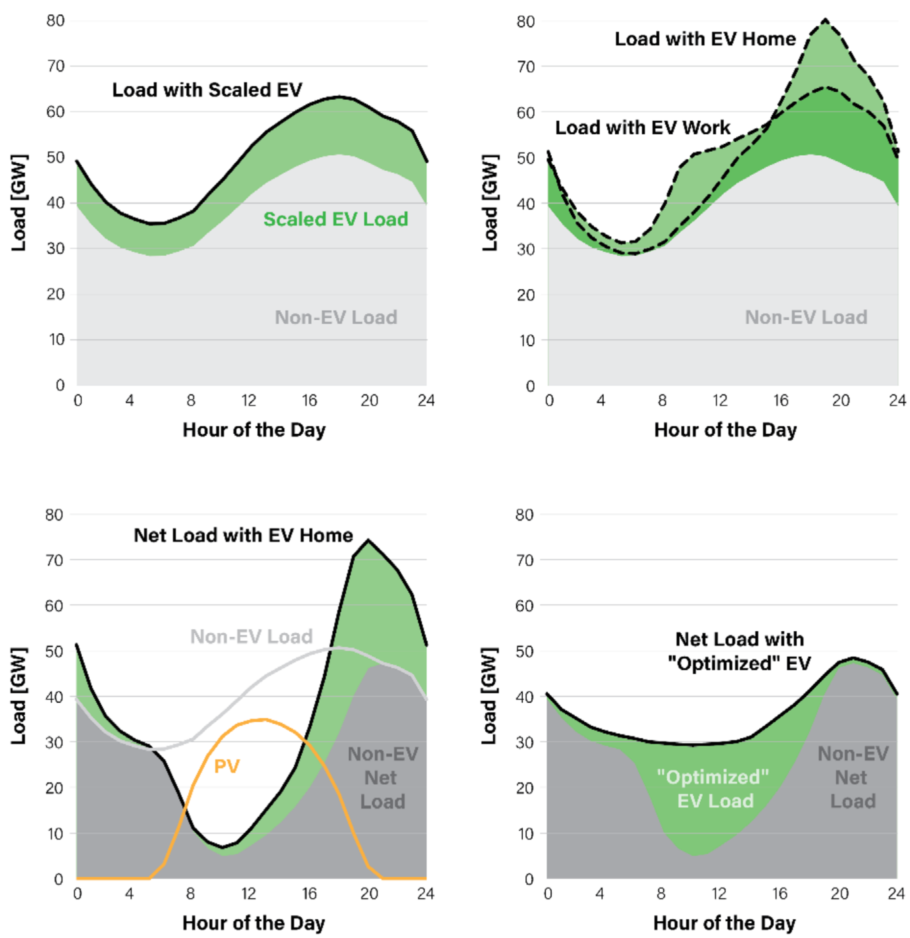
EV Charging Load: When and Where?

EV load will not necessarily be an additional load that will be evenly distributed on top of the current loads experienced by the grid (a). However, this is the assumption that is often made when projecting the load. Customers' decision of when and where to charge can affect the shape of the electricity load curve, for better or worse.

Unmanaged charging can result in demand spikes, such as if thousands of drivers all plugging in their vehicles when they get to work in the morning or when they get home in the evening, which are already high demand times (b). Pairing managed charging with additional generation technology like solar panels (c) can smooth out peaks and stabilize demand around the clock (d).

a) ASSUMPTION: EV charging is often assumed to simply scale up electricity demand.

b) COMPLEXITY: Future EV charging could change the shape of demand, depending on when and where charging occurs.

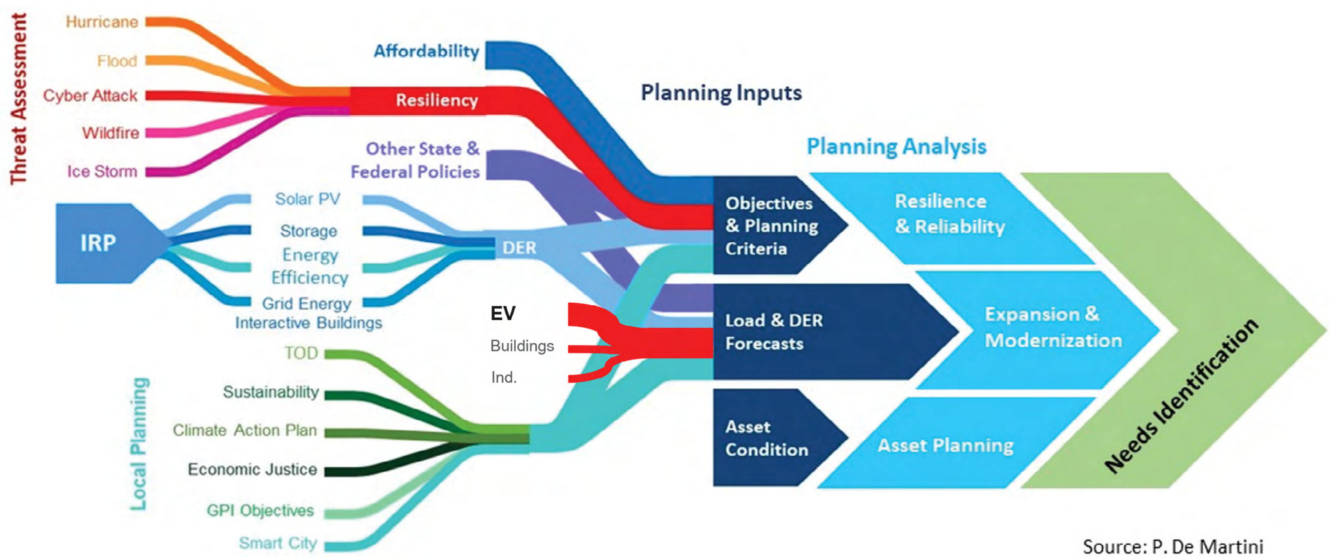


c) INTEGRATION: EV charging can impact power system planning and operations, particularly with high shares of variable renewable energy.

d) FLEXIBILITY: Optimizing EV charging timing and location could add flexibility to help balance generation and demand.

Forecasting Grid Impacts

As crucial as it may be in the years to come, the impact of EV charging is just one of many requirements that grid planners must consider as shown in Figure 2.

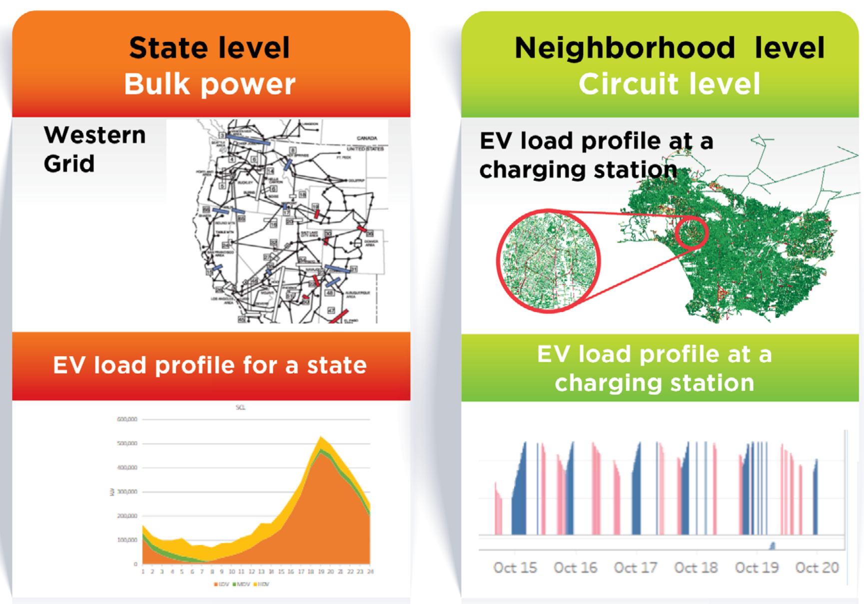


Source: P. De Martini

In determining grid impacts, scale matters, as the load profiles as shown in the graphic below.. As the analysis moves from the bulk (regions) to the distribution (home/neighborhood), load forecasting projections must be scaled down, going from large regions that include multiple counties with aggregated load for thousands of customers to individual locations for a single customer connected to a circuit, to determine actual impacts.

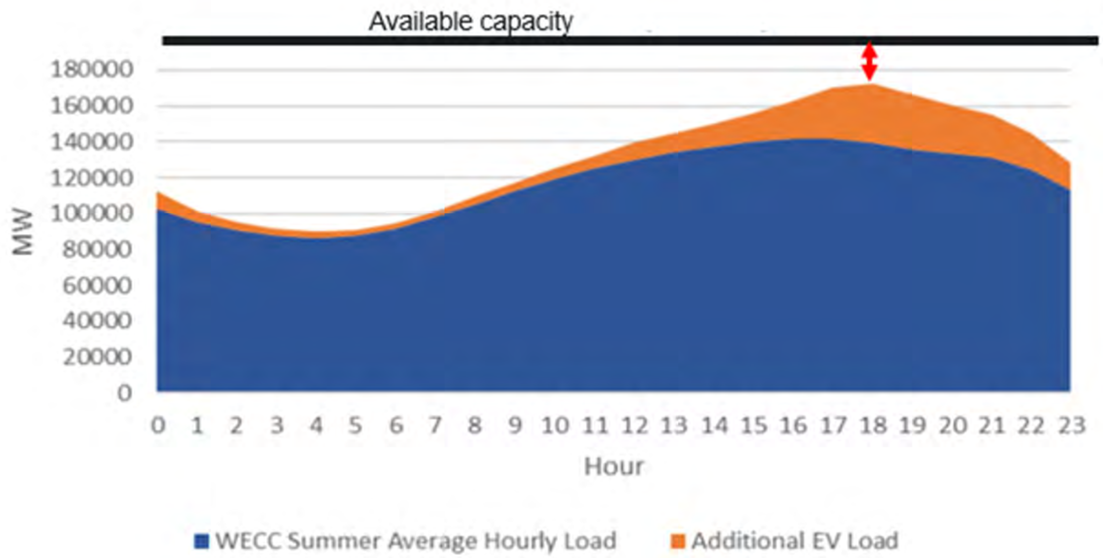
It is important to note that the impact from new vehicle charging load will be most acute on the distribution grid, and impacts will be highly localized. It will be essential that utilities perform an analysis to determine their specific capacity availability and constraints.

At the transmission level or when analyzing regional considerations, assessing the impact of the additional load is a matter of aggregating the power demands of thousands of customers across multiple counties.



	Bulk power	Distribution/circuit level
Where?	By counties	By customers
When?	By years	
How many?	Thousands	Individually
How?	Aggregated load	Individual load

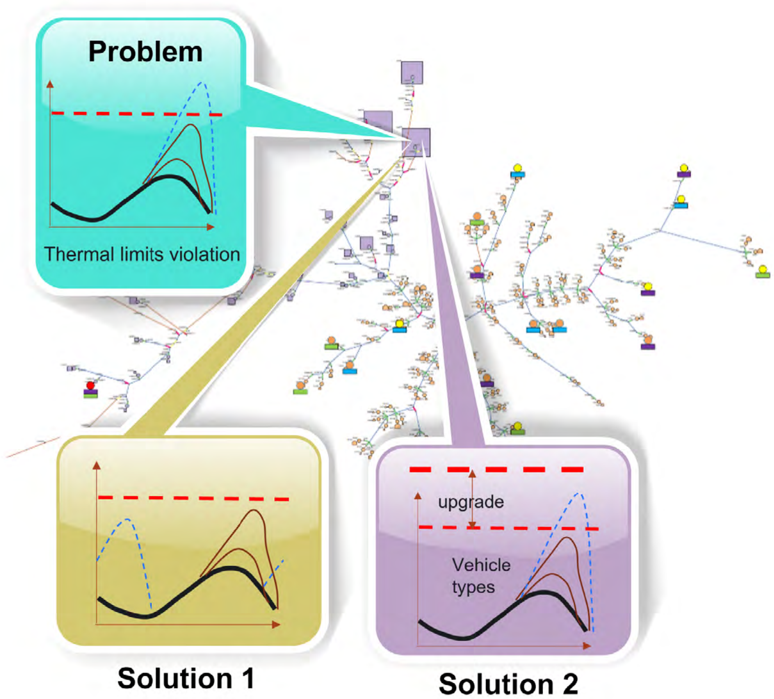
The need for additional infrastructure will hinge on whether overall demand exceeds the capacity of the bulk system. The graphic below illustrates how load is aggregated to determine the amount of overall electricity required.



New generation or transmission infrastructure investments will not be needed unless the projected peak exceeds the available capacity at any given time. If the new load from vehicle charging can be added during the "valley" between hours 0-8 through incentives or other managed charging approaches, there is the potential to delay infrastructure upgrades longer than if the load is added during peak times (around hours 16-21).

As evaluations narrow in on where charging will occur, at the distribution level, additional load must be addressed from one individual customer – and their neighbors – to the next. A single EV can push a neighborhood's distribution system beyond acceptable operating limits (i.e., cause a thermal violation). Addressing this may require additional equipment or, as in the transmission example above, shifting the load to another time of the day through incentives, regulations, smart controls, or other means.

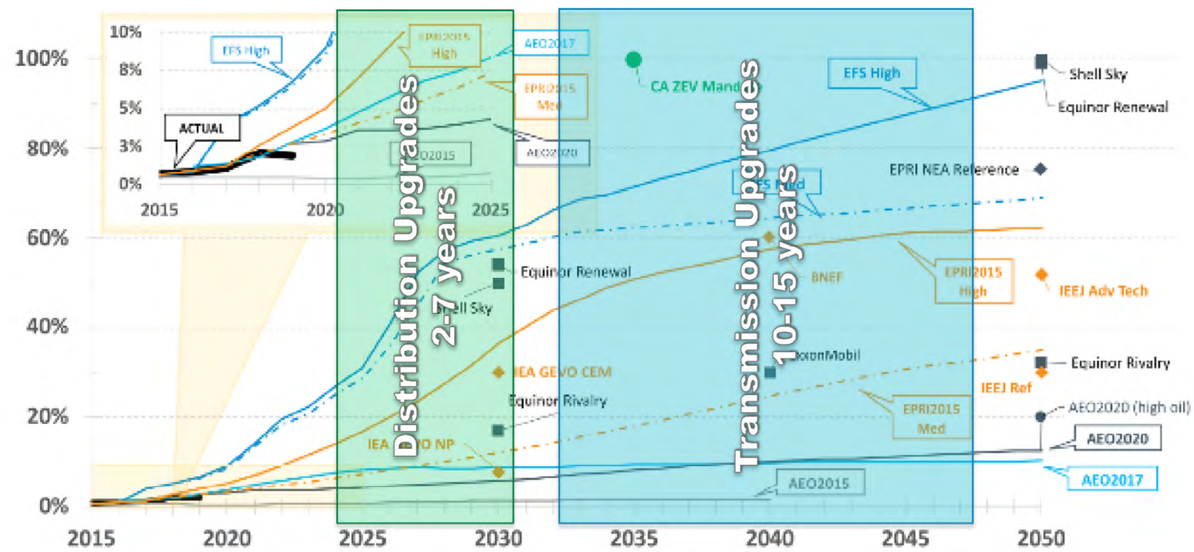
When a utility determines that charge management is not sufficient and additional infrastructure will, in fact, be needed, it can take time. Overlaying general timeframes for distribution and transmission investments onto adoption forecasts show the need to start planning for and anticipating this new load growth as early as possible.



Unmanaged charging can cause spikes that exceed an individual circuit's operating limits. In this case, the solution may be managing charging to another time of day when demand is lower (Solution 1) or upgrading the equipment (Solution 2).

Building Infrastructure Take Time

New Light-Duty Electric Vehicle (BEV+PHEV) U.S. Sale Projections



Actionable Steps Stakeholders Can Take

Collaboration and sharing are essential in planning for an EV future,

Regulators

- Integrated Distribution Planning can increase understanding of options. Provides a mechanism for utility to share plans and for stakeholders to provide input on priorities, future capability needs, and non-utility solutions.
- Require a distribution system analysis to identify constraints or opportunity areas; provide assistance on assumptions.
- Provide direction that can help to reduce uncertainty: specify areas of focus or priority areas (e.g., fleets, public charging, underserved communities.)
- Participate in regional and state-level efforts, provide external forecasts for stakeholders to use if possible

Utility

- Perform analysis of available capacity and distribution system constraints
- Identify areas with lowest impact (i.e., Hosting Capacity analyses)
- Work with stakeholders (e.g., fleet operators, charge network operators, etc.) to understand future plans
- Create easy pathway for receiving stakeholder input (e.g., stakeholder processes, dedicated EV team for new service requests)

Non-Utility EV Stakeholders (e.g., Fleets, EVSP/Network Operators, OEMs)

- Participate in commission proceedings
- Work with utilities to share future plans on the utility planning timeline (years in advance rather than months)
- If commercial or proprietary sensitivities exist, develop a version of the information that can be shared

Helpful Resources

DOE's Modern Distribution Project https://gridarchitecture.pnnl.gov/modern-grid-distribution-project.aspx
Electric Vehicles at Scale – Phase I Analysis: High EV Adoption Impacts on the Western U.S. Power Grid
https://www.pnnl.gov/sites/default/files/media/file/EV-AT-SCALE_1_IMPACTS_final.pdf