Electric Vehicle Charging Power Demand Forecast Assumptions

PJM Interconnection

Preliminary Assumptions

August 1, 2024

S&P Global
Commodity Insights

Contents

The assumptions provided are S&P Global's initial assumptions. We acknowledge the possibility of changes based on internal analysis, project work, and stakeholder feedback

Source

Assumptions in this deck are from S&P Global's "off-the-shelf" assumptions and last year’s analysis delivered to PJM

Adjustments

These assumptions may change over the development of the forecast due to internal forecast updates, ongoing project work, and feedback from stakeholders

Importance

We consider is crucial to review and update these assumptions to ensure the accuracy of the analysis

S&P Global would like to share the following key assumptions and inputs for stakeholder review

Project phase	Type of EV vehicles	Assumptions and inputs
EV forecast	Light-duty	EV national targets and performance relative to targets
	Light-duty	EPA regulations
	Medium- and heavy-duty	EV national targets and performance relative to targets by class
	Medium- and heavy-duty	Description of vehicle types within classes 3 – class 8 by function
	All	Approach to developing EV forecast. Key economic inputs, policies and incentives
Charging impacts	All	Miles per kWh per vehicle type (normal operating conditions)
	Light-duty	Miles driven (weekday/weekend)
	Light-duty	Loss in battery efficiency due to temperature
	Light-duty	Access to home and workplace charging
	Light-duty	Type of home/workplace charging (Level 2 vs Level 1)
	Light-duty	Penetration of managed charging
	Medium- and heavy-duty	Miles driven and charging strategy based on duty cycles
	Medium- and heavy-duty	Loss in battery efficiency due to temperature

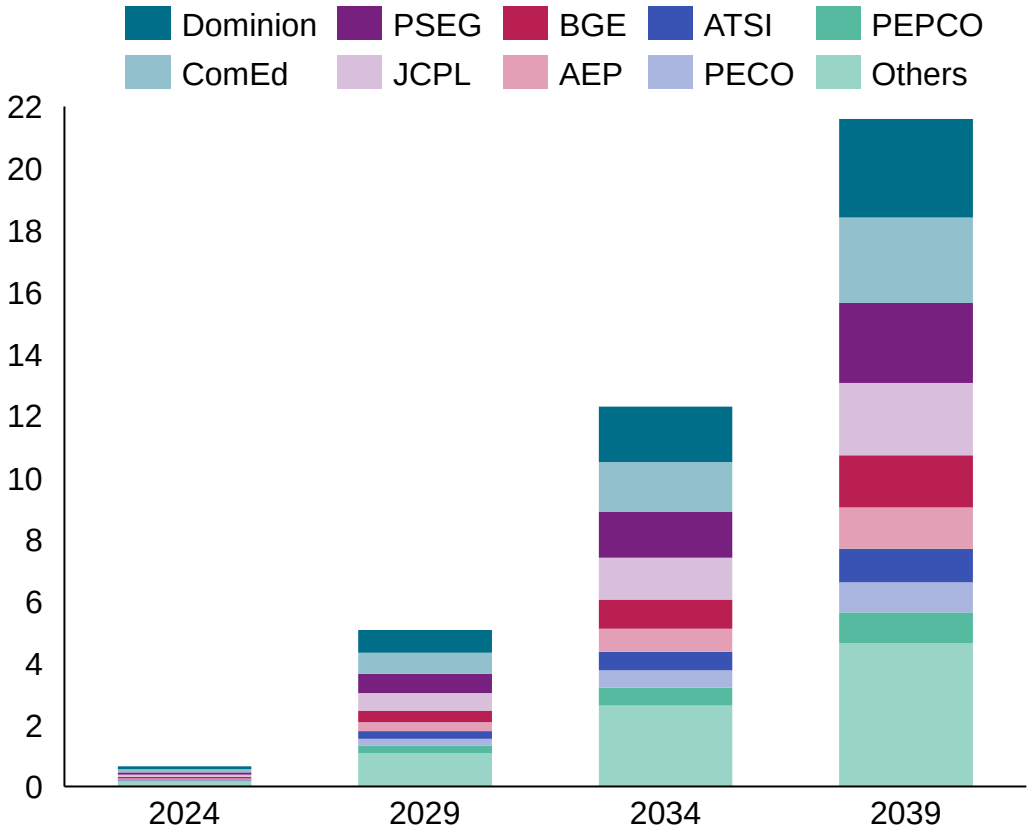
Source: S&P Global Commodity Insights

We welcome stakeholder feedback on key assumptions to enhance accuracy and are specifically interested in comments, data, or insights regarding the following themes

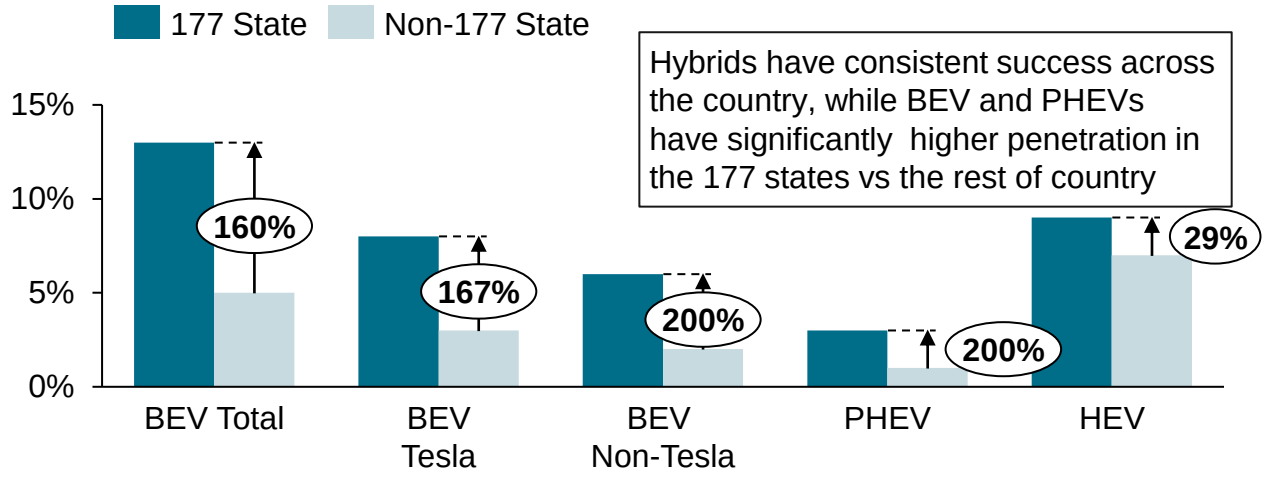
Themes	Topics
Insights or outlooks on charging infrastructure	▪ Charging infrastructure adoption: Trends and projections for Level 1 (L1), Level 2 (L2), and Direct Current Fast Charging (DCFC) stations, including for residential application. ▪ Charging infrastructure pairing with batteries: Integration of stationary batteries with EV charging infrastructure for peak shaving or other applications. ▪ Access to homeplace/workplace chargers: Availability and utilization rates of charging stations at residential and commercial locations.
Insights on current EV charging behavior and policy evolution that will impact it	▪ Charging patterns: Current EV charging patterns. ▪ TOU rates: implementation trends and their influence on EV charging behaviors. ▪ MDHV: Tariff and incentive structures that impact the operation of MHDV. ▪ Vehicle-to-grid (V2G): insights on V2G applications and wide-scale adoption.

Last year's analysis shows the trends across regions within PJM; Dominion and ComEd are leading PJM in EV load throughout the forecast period

2023 Analysis: Total annual light-duty EVs by PJM zone[1]
Million vehicles



EV penetration by vehicle type for 177 states and non-177 states[2]
(%)



States	ZEV Program	LEV Standard	Incentive Type – Status
NJ	Yes (ACC I ZEV)	Yes	Rebate – Yes
MD	Yes (ACC I ZEV)	Yes	Tax Credit – Yes
VA	Yes (ACC II ZEV)	Yes	Rebate – Not Funded
DE	Yes (ACC II ZEV)	Yes	Rebate – Yes
DC	–	Yes	NA – No
PA	–	Yes	Rebate – Yes
IL	–	–	Rebate – Yes

Source: S&P Global
Values will be updated during the project.
1. From previous year's analysis.
2. 177 States are those that have adopted California's Low-Emissions Vehicle (LEV) criteria pollutant and greenhouse gas emissions regulation and Zero-Emission Vehicle (ZEV) regulations under Section 177 of the Clean Air Act.

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US EV Market Framework Summary: industry rebalances its BEV ambitions as profitability and consumer demand remain constrained

Regulations

- **NHTSA** Aug 2023 CAFE proposal combined with DOE's Petroleum Equivalency Factor means **more room for HEV**[1]
- **Softening of EPA** on GHG[2] and partially on pollutants, but exhaust cleanup remains a challenging requirement
- **EPA super-credits on BEV/PHEV effective only 2023-2024**
- **CARB: mixed response on ACC2** as not all ACC1 members sign up (Connecticut, Maine, Minnesota, Nevada), but some new members join (Virginia, Washington, New Mexico)

Incentives

- **IRA passes** both houses of Congress
- **IRS strongly limits IRA eligibility** due to foreign entity of concern extending to battery raw materials
- **With tighter FEOC, PHEVs may be easier to qualify** for full tax credit due to lower amount of battery materials
- Politicization of BEVs is **creating uncertainty** around regulations and governmental investment support

OEM

- **Assumptions on BEV profitability have been re-evaluated** due to cost, strong price competition, and supplier volume shortfall claims
- **UAW deal** will result in higher costs for OEMs, meaning less room to cross-finance BEVs
- **Ford and GM** have **reduced and/or postponed EV investments**
- **Openness to PHEV** announced by **GM**, but portfolio allocation remains open
- **Toyota** says 30% BEV is reasonable, any gap in compliance to be closed with purchased credits

Customer Readiness

- **BEV growth slows down** under consumer uncertainty and technology + economic headwinds
- **Difficulty moving from early adopters to the early majority** due to expectations on range, ease of charging and upfront vehicle cost not being satisfied
- **NACS plug** standardization and timeline of vehicle-side rollout **defers some BEV purchases**
- **Reduced disposable income** driven by inflation and high interest rates creates an economic challenge for consumers
- **HEV gains further leadership as affordability remains key**

Forecast consequence: More powertrain flexibility and delay of BEV trajectory by minimum 2 years

Source: Sales-based Powertrain Forecast (March 2024)

1. The CAFE proposal by NHTSA is very demanding for BEVs due to the new mpg-e calculation by DOE, which requires 3.5x more BEVs to reach the previous equivalent fleet efficiency. It additionally relaxed the limit values.
2. The EPA Final Rule for GHG standards softened requirements in 2027-2031, but the 2032 value remains unchanged, with a 50% reduction against the 2027 standard. Also, the strict Tier IV pollutant limits have been adopted, although with a longer phase-in. Compliance will likely require more BEVs or additional exhaust management technology (GPF and potentially eHCC), making ICE/FHEV more expensive and closer to BEV in terms of compliance efficiency.

S&P Global maintains base-case scenario (Inflections, 2024-2050) which builds on integration of regional and sectoral analysis of energy future and will serve as foundation for this project

Scenario description

Inflections is the S&P Global Commodity Insights base-case scenario. It represents the integration **of regional and sector analysis** from across Commodity Insights, illustrating the pace of change in long-term global energy supply, demand and trade, based on current views and assumptions about markets, policy, consumer behavior and technology.

This scenario illustrates the challenges and opportunities in the global energy transition. It underscores the complexities of achieving ambitious climate and energy goals in an unpredictable geopolitical landscape. Inflections highlights the critical role of national and multilateral policies, corporate strategies, and public sentiment in shaping the future of energy markets, and despite the hurdles in delivery of targets and goals, paints a picture of gradual but sustained progress. Ultimately, Inflections suggests that while radical targets may be out of reach, the direction of travel remains positive, driven by incremental changes and a pragmatic approach to global energy governance

Key themes of this scenario include:

- Through the early years, Inflections sees a period of geopolitical instability and economic uncertainty
- Energy security, geopolitics and climate are inextricably linked
- Through the medium term, Inflections is a multidimensional world focused on national interested. In later years, there is a rejuvenation of multilateral cooperation
- While ambitious climate and energy transition goals set in the 2010s and early 2020s become increasingly difficult to achieve, there is incremental but sustained progress in global decarbonization and energy transition, even if climate targets are missed

Key indicators (global)

		History		Inflections	
		2022	2023	2024	2050
Real GDP	(Billion 2023 $)	$102,201	$104,899	$107,593	$203,997
	Average growth	2.8%	2.8%	2.8%	2.5%
		(1990–2022)	(1990–2023)	(1990–2024)	(2024–2050)
Primary energy consumption	(Mmtoe)	14,956	15,183	15,407	17,149
	Average growth	1.7%	1.7%	1.7%	0.7%
		(1990–2022)	(1990–2023)	(1990–2024)	(2024–2050)
US light-duty EV penetration[1]	Sales (%)	7%	11%	14%	86%
	Fleet (%)	1%	2%	3%	73%
Primary energy intensity of GDP	(Metric tons of oil equiv. per Million 2022 $)	146	145	143	84

Source: S&P Global Inflections (2024)

1. Includes battery-electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs). Source: SPGCI Inflection (2023)

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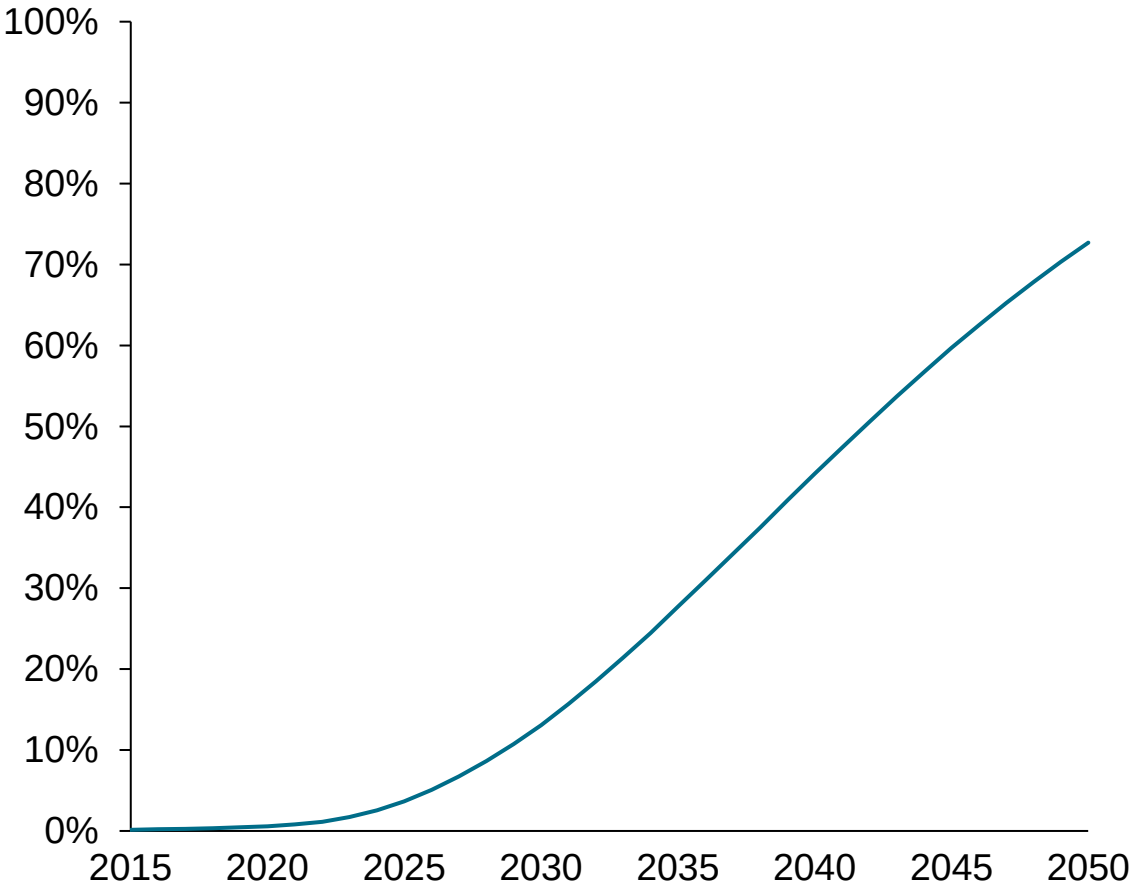
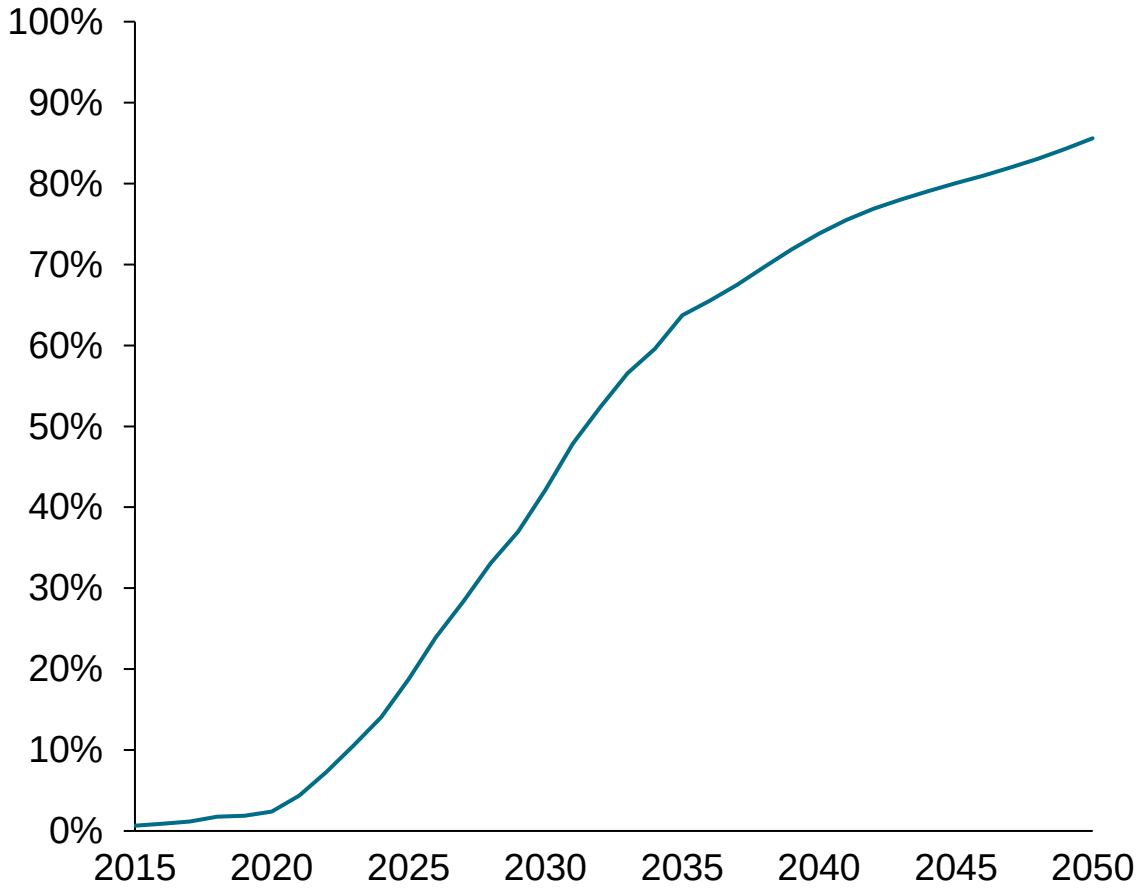
SP&P Global base case assumptions for US light vehicle sales and penetration metrics

US light-duty EVs as total on-road light vehicle fleet[1]



US light-duty EV sales as percent of light vehicle sales[1]



Source: S&P Global Inflections (2023)
Values will be updated during the project.
1. Includes battery-electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs)

Light-Duty Assumptions (Policy)

Type of Vehicle Applicability	Assumptions and inputs	Value	Source and notes
Light-Duty	EV national targets and performance relative to targets	Goal: 50% of sales BEV by 2030 S&P Global Forecast for 36% sales to be BEV in 2030	S&P Global Mobility
Light-Duty	EPA regulations	Goal of carbon neutral by 2050.	S&P Global Mobility

Source: S&P Global Commodity Insights

Light-Duty Assumptions (EV utilization and efficiency)

Type of Vehicle Applicability	Assumptions and inputs	Value	Source and notes
Light-Duty	Miles driven (Weekday/Weekend)	2024: 11,952 miles per year 2039: 12,690 miles per year 75% of miles are driven during weekdays.	S&P Global Mobility
Light-Duty	Miles per kWh (normal operating conditions)	2024: 3.05 miles/kWh 2039: 3.35 miles/kWh	S&P Global Mobility
Light-Duty	Loss in battery efficiency due to temperature fluctuations.	▪ 40% additional energy at 20 Fahrenheit (heating) ▪ 17% additional energy at 86 Fahrenheit (cooling) *Non-linear curve corresponding to several observations. Historical daily average weather (last 10 years) for study horizon by zone.	NREL (EVIPro), Department of Energy

Based on 2023 analysis and research, will be reviewed.
Source: S&P Global Commodity Insights

Light-Duty Assumptions (Charging behavior and infrastructure)

Type of Vehicle Applicability	Assumptions and inputs	Value	Source and notes
Light-Duty	Access to home and workplace charging.	2024: 75% access to home charging 2040: 50% access to home charging	S&P Global Mobility – Charging Infrastructure
Light-Duty	Type of home charging (Level 2 vs Level 1).	80% Level 2 charging	S&P Global Mobility – Charging Infrastructure
Light-Duty	Charging strategy (For drivers with access to home charging)	2024: 90% Immediate / 10% Delayed 2040: 50% Immediate / 50% Delayed	S&P Global Energy Transition Consulting

The light duty charging shapes are a combination of different charging strategies:

Charging Strategy	Home Charging	Description	Preferred charging time	Type of charger
Immediate	Yes	Will choose to charge as soon as they get home, regardless of cost.	Evening	Level 2: 80% Level 1: 20%
TOU – As soon as possible (ASAP)	Yes	Starts to charge as soon as the on-peak pricing ends.	Late night to midnight	Level 2
TOU – As late as possible (ALAP)	Yes	Starts to charge a few hours before commuting for the day.	Early morning	Level 2
Work and public charger	No	Reliant on public and workplace charging	Middle of the day	Level 2 and DCFC
Ride – hailing	50%	Typically relies on public charging	Middle of the day	Level 2 and DCFC

Source: S&P Global Commodity Insights, NREL

MDHD Assumptions (EVs)

Type of Vehicle Applicability	Assumptions and inputs	Value	Source and notes
Medium and Heavy Duty	Miles driven (Weekday/Weekend)	Delivery Vans: 11,142 miles per year (90% of miles driven during weekdays) School bus: 11,583 miles per year (90% of miles driven during weekdays) Transit bus: 42,132 miles per year (75% of miles driven during weekdays) Medium trucks: 21,514 miles per year (71% of miles driven during weekdays) Short-haul trucks: 35,233 miles per year (90% of miles driven during weekdays) Long-haul trucks: 85,910 miles per year (90% of miles driven during weekdays)	S&P Global Mobility
Medium and Heavy Duty	Miles per kWh (normal operating conditions)	Delivery Vans: 1.27 miles/kWh (2024) to 1.43 miles/kWh (2039) School bus: 0.76 miles/kWh (2024) to 1.43 miles/kWh (2039) Transit bus: 0.61 miles/kWh (2024) to 0.69 miles/kWh (2039) Medium trucks: 0.61 miles/kWh (2024) to 0.69 miles/kWh (2039) Short-haul trucks: 0.44 miles/kWh (2024) to 0.49 miles/kWh (2039) Long-haul trucks: 0.44 miles/kWh (2024) to 0.49 miles/kWh (2039)	S&P Global Mobility
Medium and Heavy Duty	Loss in battery efficiency due to temperature fluctuations.	Delivery vans, school buses and transit buses: ▪ 40% additional energy at 20 Fahrenheit (heating) ▪ 17% additional energy at 86 Fahrenheit (cooling) Medium, Short-haul and Long-haul trucks: ▪ 3% additional energy at 20 Fahrenheit (heating) *Non-linear curve corresponding to several observations. *Historical daily average weather (last 10 years) for study horizon by zone.	NREL (EVIPro), Department of Energy, S&P Global Mobility

Source: S&P Global Commodity Insights

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