**Title**

Future Electric Vehicle Production in the United States and Europe – Will It Be Enough?



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# Future Electric Vehicle Production in the United States and Europe – Will It Be Enough?

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## Abstract

The US and Europe have ambitious plans and targets for light-duty electric vehicle (EV) market growth. This study estimates planned EV production capacity in both regions and investigates whether coordinating their combined production capacity would help them meet targets. We find that, while each region is developing a strong EV production capacity domestically, either may fall short of their targets given investments in EV production announced to-date. Transatlantic trade can serve as a critical “spare capacity” to add assurance. Yet, in scenarios where both regions seek higher EV sales targets, a combined shortfall in annual EV production capacity could reach over 6 million EVs compared to the 20 million needed by 2030. An additional investment of about $42 billion across both regions could address this concern, however, time is getting short to build new plants and bring them online. The capacity shortfall may persist even with planned EV production capacity from other major manufacturing centers such as Canada, Mexico, Japan and South Korea. Additional policies and incentives will be needed to ensure planned capacities are developed in a timely manner. Some options include providing incentives to invest and reducing barriers to trade. Exploring the potential supply of vehicles from other major EV manufacturing countries, such as China and India, is recommended.



**Keywords:** Electric Vehicle; Production; Investment; Transatlantic; Trade; North America; Europe; European Union

# 1 Introduction

The electric vehicle[1] (EV) market is growing rapidly, with more than 3.1 million units sold worldwide in 2020 and more than double that—6.6 million—units sold in 2021 (Rives, 2022). Rapid growth is expected to continue. Recently adopted policies in major EV markets such as California, the United States (US), and the European Union (EU) are designed to drive a transition to EVs globally (IEA, 2021). Many original equipment manufacturers (OEMs) and suppliers have seen policy signals and begun investing heavily in EV production.

In the US, President Biden signed an executive order that calls for 50% of all new vehicles sold in 2030 to be zero-emission (The White House, 2021a). The Bipartisan Infrastructure Law, the Inflation Reduction Act, and the US National Blueprint for Transportation Decarbonization represent historic investments that encourage US domestic manufacturing and provide strong commitments and incentives for both consumers and the private sector (The White House, 2022, 2021b; US Department of Energy et al., 2023).

In California, regulators have passed rules banning the sales of new gas-powered cars by 2035 (Powell, 2022) and freight-hauling trucks by 2036 (CARB, 2023a). "Section 177 states[2]" have adopted California's zero-emission vehicle programs (CARB, 2023b), which could more than triple California's impact (California Governor, 2022; Tal et al., 2022).

The EU has adopted legislation banning sales of new petrol and diesel cars beginning in 2035 (Abnett, 2022). The European Commission adopted the Fit for 55 legislative proposals which are designed to reduce the EU's greenhouse gas emissions by 55% by 2030 (European Council, 2021).

The EV transition is well underway in the manufacturing realm. Suppliers and OEMs have announced more plans for a rapid increase in EV production (Lienert and Bellon, 2021). The business community is responding to clear policy signals with a surge of investments in battery production, research and development, factory retrofits, and advertising. Global investment for general EV manufacturing in the US reached $210 billion in 2023, up from just over $50 billion when President Biden took office in 2021 (Gabriel, 2023).

Since the COVID19 pandemic began in 2020, the nature of global connection and interdependence has been clear. A pandemic can rapidly spread to every country on the planet, disrupting supply chains and economies. Similarly, it has been shown that a war in one region can disrupt the global supply chains in both the electricity and automotive sector (Harrison, 2022). Therefore, global cooperation and partnership are needed to improve the resilience of the supply chain in the automotive industry and to generate new opportunities for various players in the EV market. With more countries and regions re-opening their borders as the global pandemic eases, we expect to see more trade activities. In the long run, as the global EV transition continues, a strong domestic EV market can help nations generate trade revenues through EV export (Bui et al., 2022; Horowitz et al., 2021).

Leading up to the present day, the Obama Administration started the Transatlantic Trade and Investment Partnership with the EU to seek a free trade agreement in 2013. The objective was to "increase trade, lower costs, create jobs and improve the international competitiveness of the industry" in both North America and the EU (Bromund et al., 2014). However, the negotiations ended without a conclusion at the end of 2016. In 2021, several associations representing US and EU motor vehicle manufacturers made a joint statement in support of

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[1] Unless otherwise specified, EV in this paper refers to plug-in electric light-duty vehicles (PEV) which includes both battery electric light-duty vehicles (BEV) and plug-in hybrid electric light-duty vehicles (PHEV).

[2] In accordance with Clean Air Act § 177, "Section 177" states have indicated they will follow California's lead, although not all have signed on to the California ZEV program at this time. As of April 2023, states adopting California's ZEV standards include Colorado, Connecticut, Maine, Maryland, Massachusetts, Minnesota, Nevada, New Jersey, New Mexico, New York, Oregon, Rhode Island, Virginia, Vermont, and Washington.

the US-EU Transatlantic Trade and Technology Council reviving coordination on trade issues arising from supply chains (ACEA, 2021). On August 16, 2022, US president Joe Biden signed the Inflation Reduction Act (IRA) of 2022 (Smith, 2022). This law provides an opportunity to strengthen relationships with existing trading partners and provides a set of new EV tax credit rules which have specific requirements on critical minerals (Office of the US Trade Representative, n.d.), battery components, and vehicle assembly (Congress, 2022). This may attract more OEMs to come and build assembly plants in the US if there is enough consumer demand. This potential outcome poses concerns for regions like Europe[3], which are also trying to meet ambitious EV sales targets, and for foreign OEMs who are trying to plan their production capacities in different markets (Baschuk, 2022).

We have produced two separate papers investigating planned EV production capacity and required new EV sales in the US (Yang and Fulton, 2023a) and Europe to 2030 (Yang and Fulton, 2023b) and with targets in 2035. This paper continues the analysis and addresses the following questions:

> Question 1: Are the US and Europe on track for preparing sufficient EV production capacities to meet their ambitious EV sales targets by 2030?
>
> Question 2: Could trade between them help achieve targets? Could trade with other Organization for Economic Cooperation and Development (OECD) vehicle producing countries (i.e., Canada, Mexico, Japan and South Korea) help?

[3] Unless otherwise specified, Europe in this paper refers to the 27 European Union (EU) members, European Free Trade Association (Iceland, Norway, Liechtenstein, and Switzerland), and the United Kingdom.

# 2 Background

The US led in the value of EV exports from 2017 to 2019. Germany took the lead in 2020, setting a new record with $8.5 billion worth of EV exports (Busch, 2021). In 2021, Europe sold 2.3 million units of EVs while the US sold 0.63 million units of EVs, an increase of 60% and 46% compared with those in 2020, respectively (Bui et al., 2022). The US was the largest EV exporter in 2020, with close to 0.22 million units exported. Nearly 70% of these were exported to Europe. The US imported more than 90,000 EVs in 2020, with over 40% coming from Europe. Therefore, the net trade of EVs in 2020 was about 118,000 units of vehicles going from the US to Europe. Besides the US, Japan is another major market exporting EVs to Europe.

Bui and others have evaluated US vehicle manufacturing plant capacities and some automaker commitments (Bui et al., 2021) and have explored the potential for US automotive trade of EVs (Bui et al., 2022). Several industry reports have compiled some EV-related investment plans in the US and Europe (CIC energiGUNE, 2022; Environmental Resources Management, 2022; Taylor and Gabriel, 2022). To our best knowledge, there has not been academic research investigating how fast capital investment will need to scale up for increased EV production in relation to different EV sales targets and EV penetration levels, and how global cooperation—such as trade—may help or not.

This study addresses this knowledge gap. In each scenario, we estimate planned EV production capacity and net EV export capacity in the US and Europe in 2030. We investigate whether US-Europe combined EV production capacity would be sufficient to meet their combined EV sales targets in different scenarios towards 2030. Similarly, we take other major EV markets—Japan, South Korea, Canada, and Mexico—into consideration and see if broader EV trade activities among the six countries and regions can help increase their chances of meeting EV sales targets.

# 3 Methods

We create four EV sales scenarios in the US and Europe, ranging from low- to high-ambition. In each scenario, we compare the EV sales target to planned EV production capacity to identify any excess or shortfall in capacity towards 2030. "Production capacity" refers to final EV assembly. Planned EV production capacity is estimated based on OEM investment plans for EV production (also as assembly) announced between 2020 and 2022, towards 2030 (Section 3.2). We compare US-Europe combined production capacity to their combined sales target in each combined scenario with one scenario for the US and one for Europe (Figure 1). With the same method, we estimate and add on the planned EV production capacity from the four other countries and compare the new combined capacity to the new combined EV sales targets in different scenarios.

In this study, we estimate possible net EV export[4] capacity based on the difference between national EV sales targets and planned EV production capacity. We do not identify exact EV import and export volume for two reasons: (1) EV trade usually happens in the form of automotive parts instead of a whole vehicle, and (2) the share of EV import and export in each country and region is volatile due to various factors, including local and international trade policies, supply chain disruptions, economic growth, and geopolitics. Therefore, we focus on differences between EV sales targets and planned EV production capacity in each region under each scenario. We assume that, when several regions are viewed as one combined region, any excess capacity in each region can be moved around freely to resolve any imbalances.

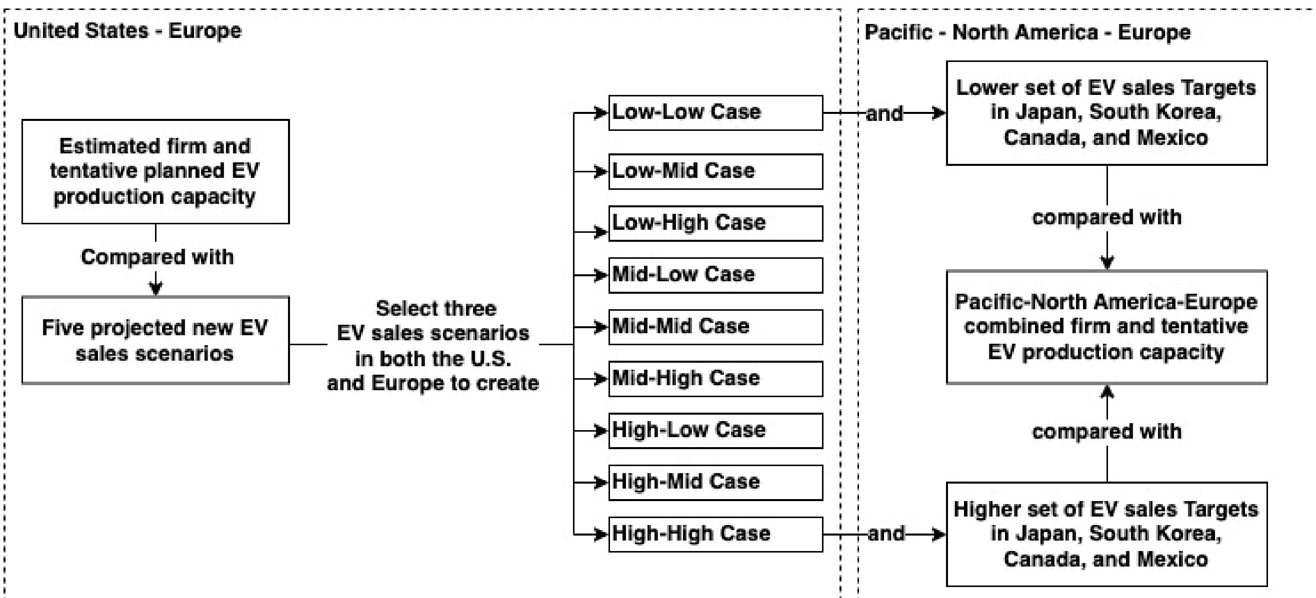


**Figure 1. Research framework.**

## 3.1 Required new EV sales

Projections for new EV sales required by policies in the US and Europe are based on separate models. For the US, we use the US Transportation Transition Model (TTM) developed by researchers at the University of California, Davis (Wang et al., 2023). The model allows users to investigate scenarios of market penetration by new vehicle technologies and transportation fuels as well as impacts on economic costs and GHG emission

[4] A negative net EV export value means that there is a shortfall in EV production capacity, or the EV import value required.

reductions. Most studies of the European region focus on the European Union (EU). Because we wish to study all of Europe, we rely on multiple publications and sources to model new EV sales by projecting total Light Duty Vehicle (LDV) sales and EV sales share.

### 3.1.1 US Projections

In each US scenario (Table 1), vehicle sales percentages by vehicle type and technology are specified every five years from 2021 to 2050, and yearly sales percentages are extrapolated accordingly. Long-term results for the US are not shown in all tables and figures because results in Europe only extend to 2035, and comparing projected EV sales in both regions on the same time scale is of interest (Table 1; Figure 2). The zero-emission vehicle[5] (ZEV) penetration level is assigned to three groups: (1) California, (2) Section 177 States, and (3) the remainder of the US. The overall ZEV penetration level[6] is calculated based on the weighted average market share of all three groups. Notably, the Biden Administration's EV sales share targets—50% EV sales share by 2030—fall between the LC 0-5 scenario and the LC-CA scenario.

**Table 1. Scenarios in the US Transportation Transition Model.**

| Scenario | Definition | EV Share of New Light-duty Vehicle Sales |
|---|---|---|
| **Low-carbon emission scenario, California (LC CA)** | The whole US achieves 100% ZEV sales by 2035 and achieves 66% EV sales share by 2030. | 4% in 2021<br>25% in 2025<br>66% in 2030<br>96% in 2035 |
| **Low-carbon emission scenario, with 0-year lag in Section 177 States (LC 0-5)** | California and Section 177 States achieve 100% ZEV sales by 2035 after adjustments complying Advanced Clean Car II rules. The remainder of US states achieve by 2040 (a five-year delay). The whole US achieves 40% EV sales share by 2030. | 4% in 2021<br>14% in 2025<br>40% in 2030<br>77% in 2035 |
| **Low-carbon emission scenario, with 5-year lag in Section 177 States (LC 5-10)** | California achieves 100% ZEV sales by 2035. Section 177 States achieve by 2040 (a five-year delay); the remainder of US states achieve by 2045 (a 10-year delay). The whole US achieves 19% EV sales share by 2030. | 4% in 2021<br>10% in 2025<br>19% in 2030<br>43% in 2035 |
| **Low-carbon emission scenario, with 10-year lag in Section 177 States (LC 10-15)** | California achieves 100% ZEV sales by 2035. Section 177 States achieve by 2045 (a 10-year delay); the remainder of US states achieve by 2050 (a 15-year delay). The whole US achieves 13% EV sales share by 2030. | 4% in 2021<br>10% in 2025<br>13% in 2030<br>22% in 2035 |

[5] Fuel cell vehicles (FCV) are also considered zero-emission vehicles (ZEV) but are not considered in this study.

[6] ZEV penetration levels and shares of electric light-duty vehicles out of all new LDV sales are specified in each TTM scenario.

### 3.1.2 European Projections

For Europe, we create four scenarios with different yearly EV sales shares from 2022 to 2035, based on two scenarios from the BNEF study and four scenarios from the International Council on Clean Transportation (ICCT) (Mock and Díaz, 2021) (Table 2).

Bloomberg New Energy Finance (BNEF) has indicated that new EV sales in Europe are expected to be about 4.3 million units by 2025, or around 28% of all passenger vehicles sales in the same region (BNEF and Transport and Environment, 2021). BNEF expects Europe to reach 100% EV share of all new passenger vehicle sales by 2035 in their accelerated scenario. International Energy Agency (IEA) has indicated that total new sales of EVs in Europe in their Announced Policy Scenario are expected to be 7.6 million by 2030, which is about 52% EV sales share (IEA, 2022). Therefore 100% of EV sales shares of all new LDVs can be translated into 15.4 million (BNEF) and 14.6 million EVs (IEA). In this study, we treat the mean (i.e., 15 million) as the sales of new passenger cars that correspond to 100% EV sales share in Europe.

**Table 2. EV Sales Scenarios in Europe and their Definitions and Key Characteristics.**

| Scenarios | Definitions | EV Share of New Light-duty Vehicle Sales |
|---|---|---|
| **Fastest** | Like ICCT's Higher Ambition scenario, this scenario assumes that the phase-out of combustion engines occurs in 2030. The total new sales of passenger cars will stay steady between 2030 and 2035. | 10% in 2021<br>29% in 2025<br>100% in 2030<br>100% in 2035 |
| **High Ambition** | Similar to BNEF's Accelerated scenario and ICCT's Moderate Ambition scenario, this scenario assumes more supportive policies pushing for faster EV adoption without constraints. A full phase-out of combustion engine vehicles and 70% lower WLTP[7] $CO_2$ emissions are targeted by 2030. | 10% in 2021<br>21.5% in 2025<br>61.2% in 2030<br>100% in 2035 |
| **Accelerated Ambition** | Like BNEF's Base case, this scenario assumes the EV adoption slows down slightly in the early 2030s as some segments saturate. | 10% in 2021<br>18% in 2025<br>50% in 2030<br>85% in 2035 |
| **Moderate Ambition** | Like ICCT's Lower Ambition scenario, this scenario assumes the fleet average WLTP $CO_2$ emission target for 2025 is strengthened from the current 15% reduction to 20%. | 10% in 2021<br>20% in 2025<br>42% in 2030<br>64% in 2035 |

We note that the EU recently agreed on legislation that would ban the sales of new petrol and diesel cars from 2035. This aligns with our High Ambition scenario. The EV share of new passenger car sales is specified every five years towards 2035, and yearly sales percentages are extrapolated accordingly.

[7] WLTP is the Worldwide Harmonized Light vehicle test Procedure, a laboratory test measuring fuel consumption and emissions of $CO_2$ and other pollutants from passenger cars and vans.

## 3.2 Planned EV production capacity in the US and Europe

Previous studies have collected investment plans for future EV production announced by OEMs for a critical 3-year period (from 2020 to 2022) towards 2030, with major policy milestones in both the US and Europe (Yang, 2023a, 2023b). Twenty-nine of these plans are from the US and 18 are from Europe. Announcements have been categorized into firm and tentative ones. Firm announcements clearly state the intention of the investment, when commercial production starts, and either or both the planned production capacity and the investment amount. Investment plans that do not clarify the use or the volume of the investment, the start year of the production, or are still in the stage of "advanced discussion" or "proposal submission," are considered tentative. A tentative scenario is created when both firm and tentative announcements are considered.

Estimates for base production capacity for EVs are based on historical new EV sales in each region. The investment per unit of EV production capacity is about $6,596/vehicle/year in the US and $5,699/vehicle/year in Europe. These values are used to estimate planned production capacity and investment if they are not directly indicated in announcements (1). Total planned EV production capacity is the sum of the base and planned production capacity. All currencies mentioned in the investments are converted into real US dollars in this study.

Equation 1. Needed investment = Planned production capacity*Investment per unit of production capacity

## 3.3 Comparison between planned EV production capacity and the EV sales target

We compare regional planned EV production capacities with EV sales targets to estimate an excess or shortfall in domestic supply capacity or net EV export capacity. In this section, we first look at combined capacity in the US and Europe, then consider the major EV supply markets of Canada, Mexico, Japan, and South Korea.

### 3.3.1 US-Europe combined EV production capacity compared to their combined EV sales target

We select three scenarios in each region to create nine combined scenarios[8] (Table 3). In each combined scenario, we examine whether an excess capacity in one region can help mitigate an EV production capacity shortfall in another and, if so, by how much.

[8] ZEV penetration level is specified in the definition of each scenario and the share of electric light-duty vehicles out of all new LDV sales is specified in each scenario in the TTM.

**Table 3. Select individual EV sales scenarios for combined scenarios. We select three scenarios in each region to create nine combined scenarios.**

| Selected EV Sales Scenarios in the US and Europe (EV sales share by 2030) | | US | | |
|---|---|---|---|---|
| | | LC 5-10 (19%) | LC 0-5 (40%) | LC CA (66%) |
| **Europe** | Moderate Ambition (42%) | Low-Low | Mid-Low | High-Low |
| | Accelerated Ambition (50%) | Low-Mid | Mid-Mid | High-Mid |
| | High Ambition (61.2%) | Low-High | Mid-High | High-High |

### 3.3.2 North America-Europe-Pacific combined EV production capacity compared to their combined EV sales target

We follow the same method described in Section 3.2 to estimate firm and tentative planned EV production in these four countries. The projection of total passenger LDV sales is sourced from IEA's Sustainable Development Scenario[9] (IEA, 2022a). EV sales share targets are based on each country's stated commitment (electrive, 2019; Hawkins, 2022; IEA, 2022b; Transport Canada, 2022) (Table 4). The targeted EV sales volume in each country is derived by multiplying the targeted EV sales share by the total passenger LDV sales.

To explore possible benefits of broader cooperation and EV trade, we first extend the modeled US-Europe region to North America-Europe and then further extend it to Pacific-North America-Europe. To match the lower and higher set of EV sales share targets in Canada, Mexico, Japan, and South Korea, we select EV sales targets in the Low-Low (LC 5-10 scenario and Moderate Ambition scenario) and High-High (LC CA scenario and High Ambition scenario) for the US and Europe. Finally, we compare combined EV production capacity with the combined sales target in each scenario.

[9] The Sustainable Development Scenario (SDS) is a normative scenario used to model a "well below 2°C" pathway and the achievement of other sustainable development goals.

**Table 4. Lower and higher set of EV sales targets in Japan, South Korea, Canada, and Mexico by 2030, compared to their firm and tentative planned EV production capacity.**

| Country | Base EV production capacity (million) | Planned EV production capacity (million) | | Set of EV sales share target towards 2030 | | Projection of total passenger light-duty vehicle sales (million) |
|---|---|---|---|---|---|---|
| | | Firm | Tentative | Lower | Higher | |
| **Japan** | 0.054 | 0.06 | 0.00 | 28%[10] | 56% | 3.96 |
| **South Korea** | 0.091 | 0.59 | 0.05 | 1/6[11] | "One third" | 1.28 |
| **Canada** | 0.087 | 1.00 | 0.17 | "At least 60%"[12] | "About 1.2 million" | 1.39 |
| **Mexico** | 0.004 | 0.37 | 0.12 | 30%[13] | 50% | 1.51 |

[10] For Japan, we assume that the lower EV sales target is half of their current EV sales target towards 2030.

[11] For South Korea, we assume that the lower EV sales target is half of their current EV sales target towards 2030.

[12] Canada expects to reach at least 60% of EV sales share (or 1.2million EVs) by 2030 (Transport Canada, 2022]. We apply this baseline of 60% to the projected total passenger LDV sales (1.39 million) and derive 0.834 million. As it is lower than the 1.2 million, we treat the 0.834 million as Canada's targeted EV sales in the lower case for this study.

[13] For Mexico, we assume that their lower EV sales target is 30% EV sales share by 2030.

# 4 Results

## 4.1 Required new EV sales in the US and Europe

For the US, 11.4 million and 6.9 million new EV sales are expected by 2030 in the two most ambitious scenarios, namely the LC CA scenario and the LC 0-5 scenario, respectively (Figure 2). For a moderate scenario, such as the LC 5-10 scenario, 3.3 million new EV sales are expected in 2030. For Europe, 15.0 million and 9.2 million new EVs sales are expected in the Fastest scenario and High Ambition scenario by 2030, respectively. And in our Moderate Ambition scenario, the new EV sales target needs to be about 6.3 million by 2030 (Figure 3).

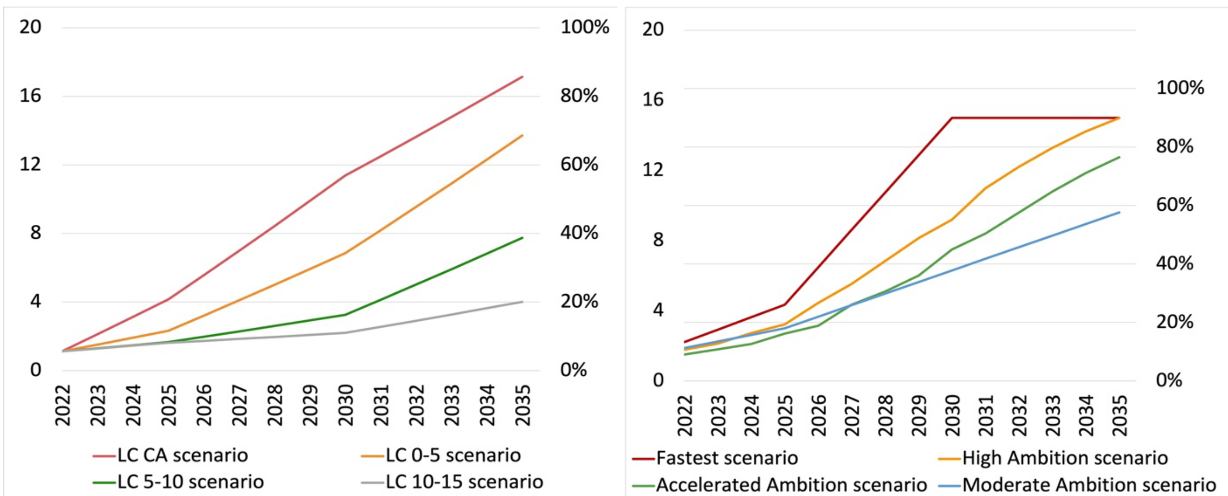


**Figure 2. Required new EV sales and corresponding EV sales share in the US (million), 2022-2035 (a) and Required new EV sales and corresponding EV sales share in Europe (million), 2022-2035 (b).**

## 4.2 Planned EV production capacity in the US and Europe

With only firm investment plans for future EV production, the US could reach an annual production capacity of 5.1 million EVs by 2030, which falls short of the LC CA scenario by over half (Appendix A1). With tentative investment plans included, planned EV production capacity would increase to 6.8 million, closing the capacity gap by 1.7 million (Appendix A2).

For Europe, firm planned EV production capacity can reach around 4.8 million annually by 2030, which is short of the Moderate Ambition scenario by 1.5 million (Appendix A3). With tentative plans included, EV production capacity can increase to 7.2 million and fall short of the High Ambition scenario by only 2 million EVs (Appendix A4).

## 4.3 Combined EV production capacity in the US and Europe, and four other countries

In this section, we examine the net EV export capacity in the US and Europe and investigate whether their combined EV production capacities reach combined EV sales targets. We then consider other major EV supply markets and explore possible outcomes when they participate in EV trade activities.

### 4.3.1 Net EV export capacity in each scenario in the US and Europe in 2030

Planned production capacity in the US ranges from 5.1 to 6.8 million EVs by 2030. Compared to the EV sales need in each scenario, we find that the US net EV export capacity could be up to 3.5 million EVs, in the case where the US meets our LC 5-10 scenario (19% EV sales share by 2030) and all firm and tentative planned EV production capacities come through adequately by 2030. On the other hand, the US could face a shortage in expected capacity of up to 6.3 million EVs, in the case where the US aims to meet the LC CA scenario (66% EV sales share by 2030) with only firm planned EV production capacity coming through by 2030 (Appendix B1).

For Europe, there could be a net EV export capacity of up to 0.9 million in the case where Europe ends up meeting its Moderate Ambition scenario (42% EV sales share by 2030) and all firm and tentative planned EV production capacities come through fully by 2030.

### 4.3.2 US-Europe combined EV production capacity compared to their combined EV sales target

Only in the Low-Low case scenario is the US-Europe combined EV sales target within their combined firm planned capacity (Figure 3). This means that, if the US achieves its LC 5-10 scenario and all firm EV production capacities come through in a timely manner, the US may have 1.8 million EVs available for export. If none of the tentative planned EV production comes through in Europe, the US could export 1.5 million EVs to Europe. This would help Europe meet its Moderate Ambition scenario by 2030.

All the other scenarios have different levels of potential shortfalls in capacity. For a subset of scenarios, the combined target usually falls between the firm and tentative combined capacity (yellow dots in Figure 3). This suggests that both regions can only meet their EV sales targets by 2030 if the planned firm and tentative planned capacity come through timely and adequately in one or both regions.

Notably, for over half of the scenarios we explored, the combined target is beyond the tentative combined capacity (red dots in Figure 3). In the High-Low scenario, the US could narrow its shortfall by 20% with excess tentative capacity from Europe, assuming European capacity is sufficient to allow enough exports to fill the gap. In most cases, shortfalls are more serious, especially when both the US and Europe seek very ambitious higher EV sales targets.

In the High-High scenario, an additional EV production capacity of 4.6 million and 2.0 million vehicles will be needed in the US and Europe to achieve their EV sales targets by 2030, respectively. As mentioned in section 3.2, the investment per unit of EV production capacity in the US and Europe is about $6,596/vehicle/year and $5,699/vehicle/year, respectively. Therefore, the combined shortfall of 6.6 million EVs in the US and Europe could likely be addressed by $42 billion more investment by 2030. Time is getting short, however, as it can take as many as eight years for a plant to be built and ramp up to its full production capacity.

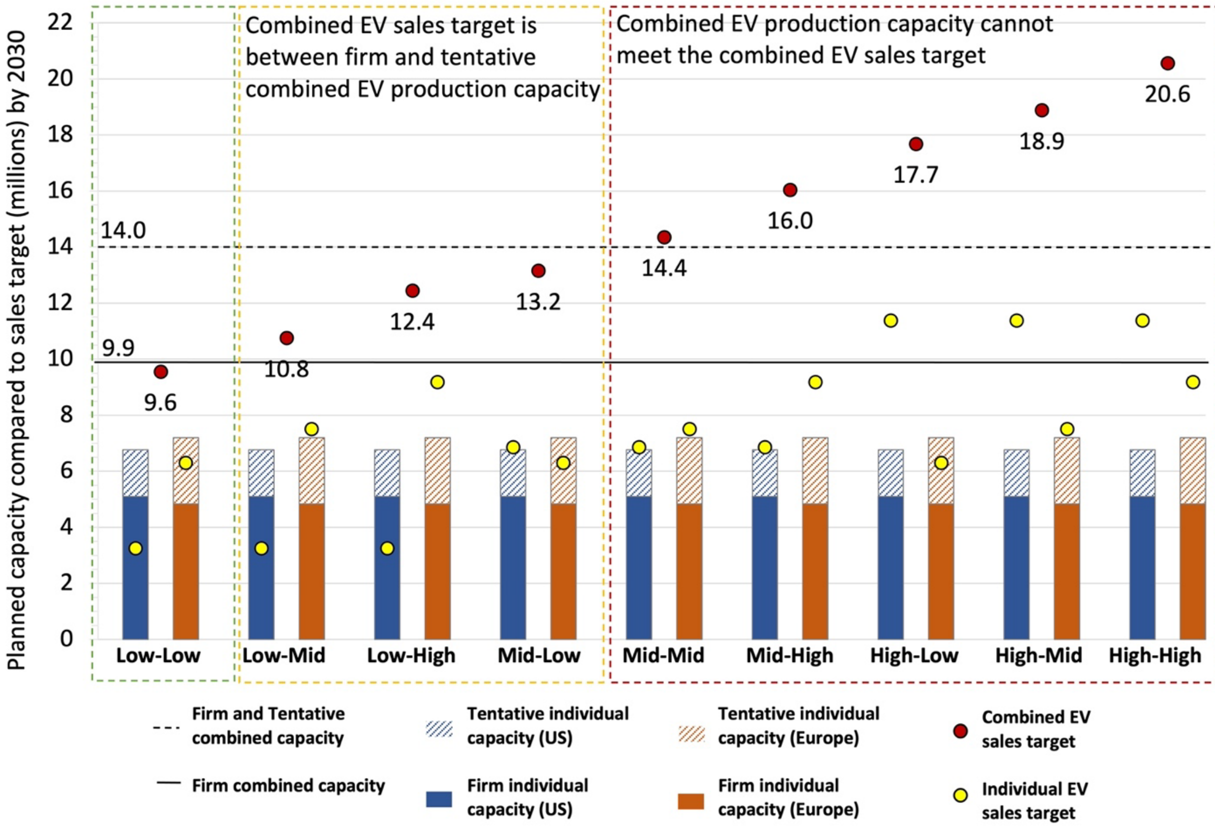


**Figure 3. Combined US-Europe planned EV production capacity vs. sales targets to 2030.**

### 4.3.3 North America-Europe-Pacific combined EV production capacity compared to combined EV sales target

We estimate that Canada and Mexico's combined lower EV sales target is about 1.3 million to 2030, falling between their firm and tentative combined EV production capacities of 1.4 million and 1.7 million, respectively. Their combined higher EV sales target is higher than their tentative combined EV production capacity by 0.3 million (Figure 4).

Domestic supplies in Japan and South Korea could fall short of targets. The tentative EV production capacity in the Pacific region is expected to reach only 0.7 million by 2030. This is not enough to meet combined lower EV sales target and is less than one-third of the combined higher EV sales target. When we look beyond the US-Europe EV market to other potential trade partners, the supply shortfall may persist (Figure 5). This is especially evident when considering a scenario where all regions seek higher EV sales targets at the same time, increasing the shortfall to nearly nine million EVs.

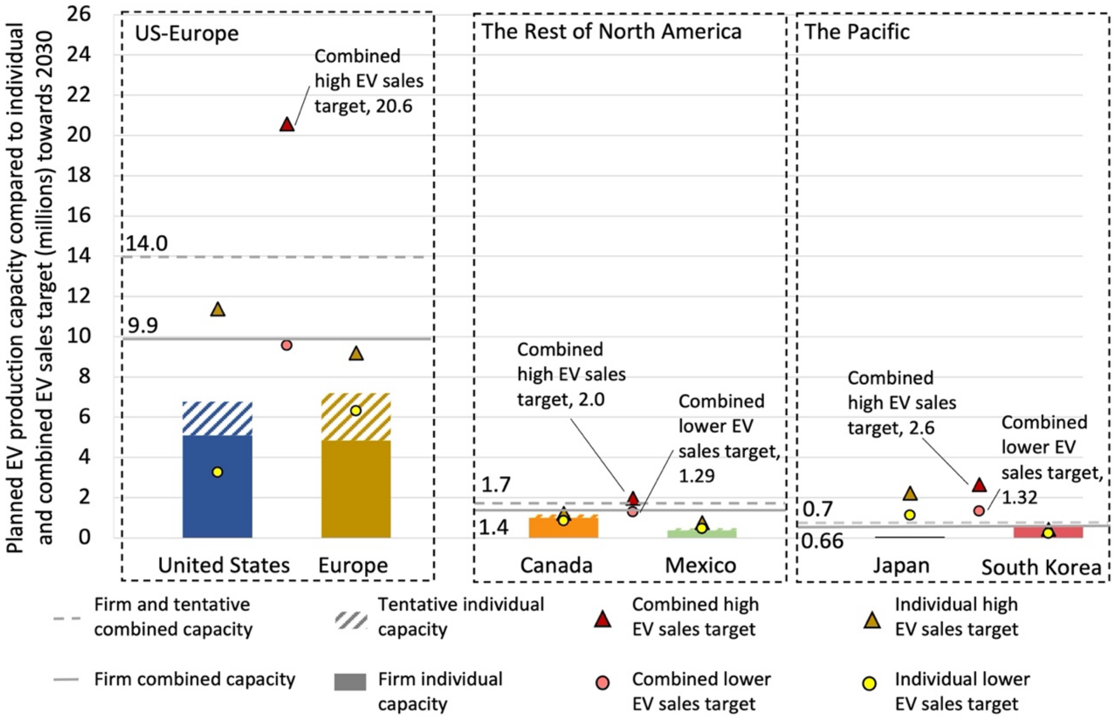


**Figure 4. Regional EV production capacity to 2030, compared to low and high EV sales targets.**

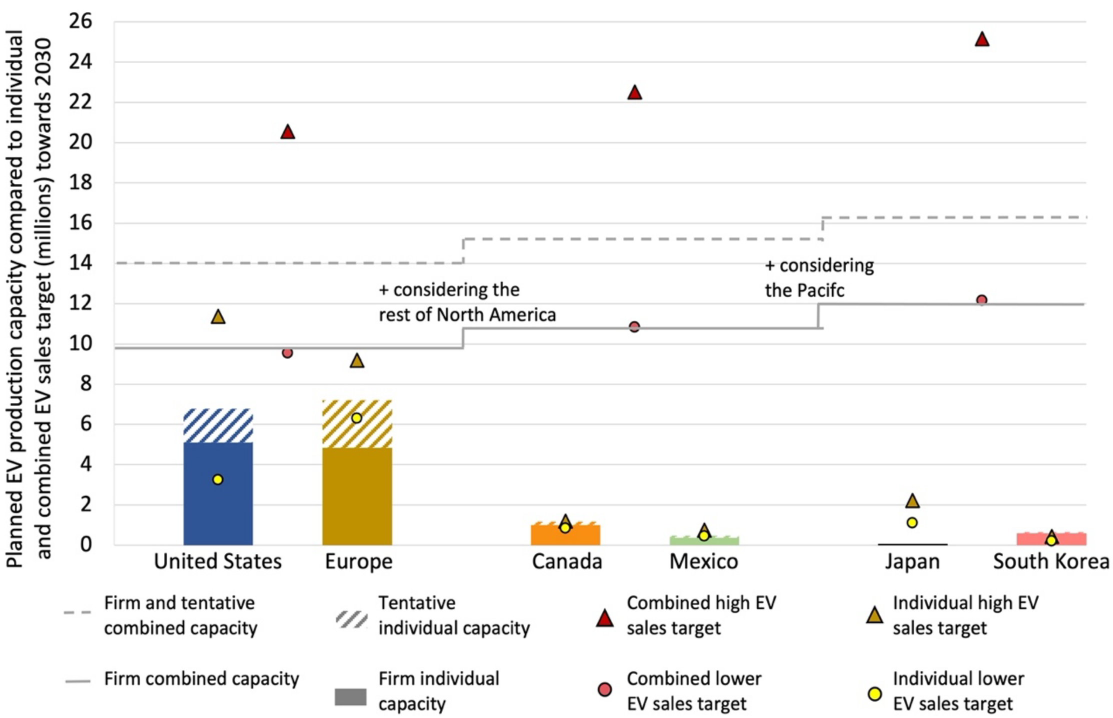


**Figure 5. North America-Europe-Pacific combined EV production capacity to 2030, compared with low and high combined EV sales targets.**

# 5 Discussion

This analysis assesses planned EV sales shares in relation to production capacity in the US and Europe, as well as four other countries, and compares combined EV production capacity to combined EV sales targets in different combinations and scenarios out to 2030 and with targets in 2035. We test two potential solutions to address estimated shortfalls: (1) creating additional EV production plans in both regions, and (2) diversifying EV import sources.

We find that, together, the US and Europe can achieve their EV sales targets in nearly half of the scenarios where their resources are pooled. Transatlantic trade may serve as an important "spare capacity" to assure targets can be met in the event that planned EV production capacity fails to come through adequately. However, EV trade has its limits. Looking only at US and Europe together, in over half combined scenarios, the total shortfall in expected capacity could reach up to 6.6 million EVs by 2030—nearly one-third of the 20.6 million needed to meet combined targets.

Additional planning for increasing EV production, paired with investment on the order of $42 billion across both regions, coming online by 2030, could address estimated production shortfalls. However, time is getting short for additional construction that would be fully on-line by then. In addition to the concern about limited time, it is also possible that ambitious sales targets might not be met, leading to EV availability overshooting demand. For this reason, manufacturers may be wary of over-investment, and resulting in an investment lag that stymies high target scenarios. Therefore, it is important to consider policies and incentives to ensure planned capacities will come through adequately. Creating more clarity and credibility with targets and building confidence that demand will be spurred to achieve them may be necessary to incentivize adequate near-term production investments.

Another possible solution is to diversify EV import sources. Other potential major EV supply markets include Japan, South Korea, Canada, and Mexico[14]. As shown earlier, the projected US-Europe combined shortfall in capacity may even increase to 9.1 million—over 44 percent of the target—to 2030 in several cases (Figure 6). This implies that, if a country aims for an ambitious EV sales target, it cannot bet on importing EVs from other major markets to close its own shortfall in capacity domestically. This is because other countries may also have ambitious targets and therefore do not have any excess capacity for export. For this reason, it is important to develop policies and make investments to build robust domestic EV production capacities, as well as deriving some assurance from the possibility of EV trade activities.

It may be helpful to open EV trade between the US, Europe, and other major manufacturing nations like China and India, which are not included in this study. We acknowledge that EV trade can get complicated for various reasons, such as regional or national trade policy and other geopolitical matters. Yet, the need for additional EV supply from other major markets can increase rapidly in the high-target scenarios considered in this study. Therefore, policies that reduce barriers to trade will allow each country to increase its options for meeting transitional targets.

Automakers' strategies can play an important role in the dynamics of trade as well. Battery suppliers and OEMs have invested heavily in both the US and Europe for EV battery production. Recent OEM announcements on battery plants suggest a preference for locations close to vehicle assembly plants, which will offset potential costs of a more distant plant and minimize supply-chain disruptions (The White House, 2021c). Our data and previous studies have suggested that Europe has more planned EV battery production capacity, so far, than the US to 2030. However, as more investment into batteries and EV production are announced in the near future, relative positions on investments and production capacity may change, as might EV trade dynamics.

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[14] Canada and Mexico can contribute to EV supply in the US market due to the US-Mexico-Canada Agreement (USMCA) which entered into force on July 1, 2020, replacing the North American Free Trade Agreement (NAFTA).

Proximity to battery suppliers is not the only factor influencing the siting of new battery and EV production facilities. Other factors include proximity to research institutions, skilled labor, and customers, difficulty of facility permitting and licensing, and local regulatory policies and financial incentives for investors (Eddy et al., 2019).

# 6 Conclusions

This study investigates planned EV production capacity and net EV export capacity in the US and Europe towards 2030. It develops nine scenarios to explore whether US-Europe combined planned EV production capacity can help both entities meet their EV sales targets and narrow any shortfalls. Together, EV sales targets in some ambitious scenarios, such as in the LC 0-5 scenario (US) and the Moderate Ambition scenario (Europe), become achievable. In other high-target cases, transatlantic trade could help narrow shortfalls in capacity in the US by up to 20%, with excess tentative capacity from Europe.

However, for over half of the scenarios we explored, the US-Europe combined target is beyond the tentative combined capacity. This potentially indicates serious shortfalls in EV production capacity in the US and Europe out to 2030 if (1) both regions seek very ambitious higher EV sales targets at the same time and (2) their planned EV production capacities are not achieved. Combined EV production shortfalls could be as high as 6.6 million vehicles by 2030, compared with the 20.6 million needed. This can likely be addressed with an additional $42 billion investment—exactly what has been firmly announced for EV production in the US and Europe, so far.

One alternative is to consider importing EVs from other countries, including Canada, Mexico, Japan, and South Korea. Even so, our study suggests that the combined shortfall may persist or be exacerbated due to the lack of EV production capacity of EV trade partners themselves. Therefore, clear and strong policies and incentives are needed to ensure that planned capacities will be realized and the investment to support additional capacity will be spurred. Having a robust domestic EV supply and production capacity is important. Going forward, it may be helpful to consider EV supplies from China and India, which are not included in this study.

Overall, while the level of investments into EV production in the US, Europe, and other countries considered here are substantial, it appears that more may be needed to meet ambitious targets ahead. At the same time, it is clear that government policies and incentives will play a critical role in effective trade strategies, and that an approach based on the opportunities presented by global trade will increase EV adoption in accordance with 2030 goals.

# Document Information

## Author Contribution Statement

Hong Yang: Conceptualization, Methodology, Software, Data Curation, Validation, Formal analysis, Investigating, Writing – original draft, Writing – review and editing, Visualization.

Lewis Fulton: Conceptualization, Methodology, Writing – review and editing, Supervision, Project administration, Funding acquisition.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could influence or have appeared to influence the work reported in this paper.

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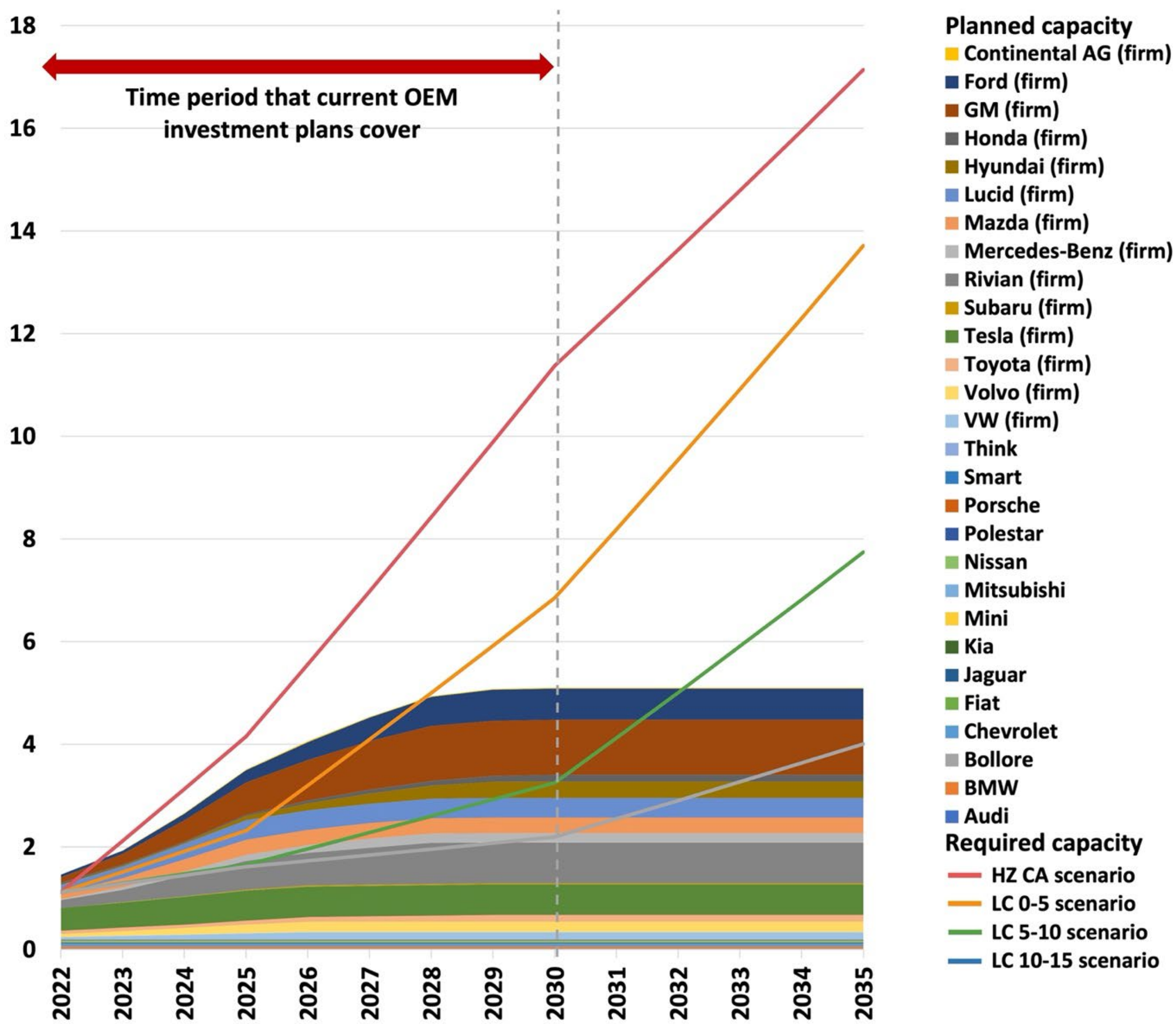
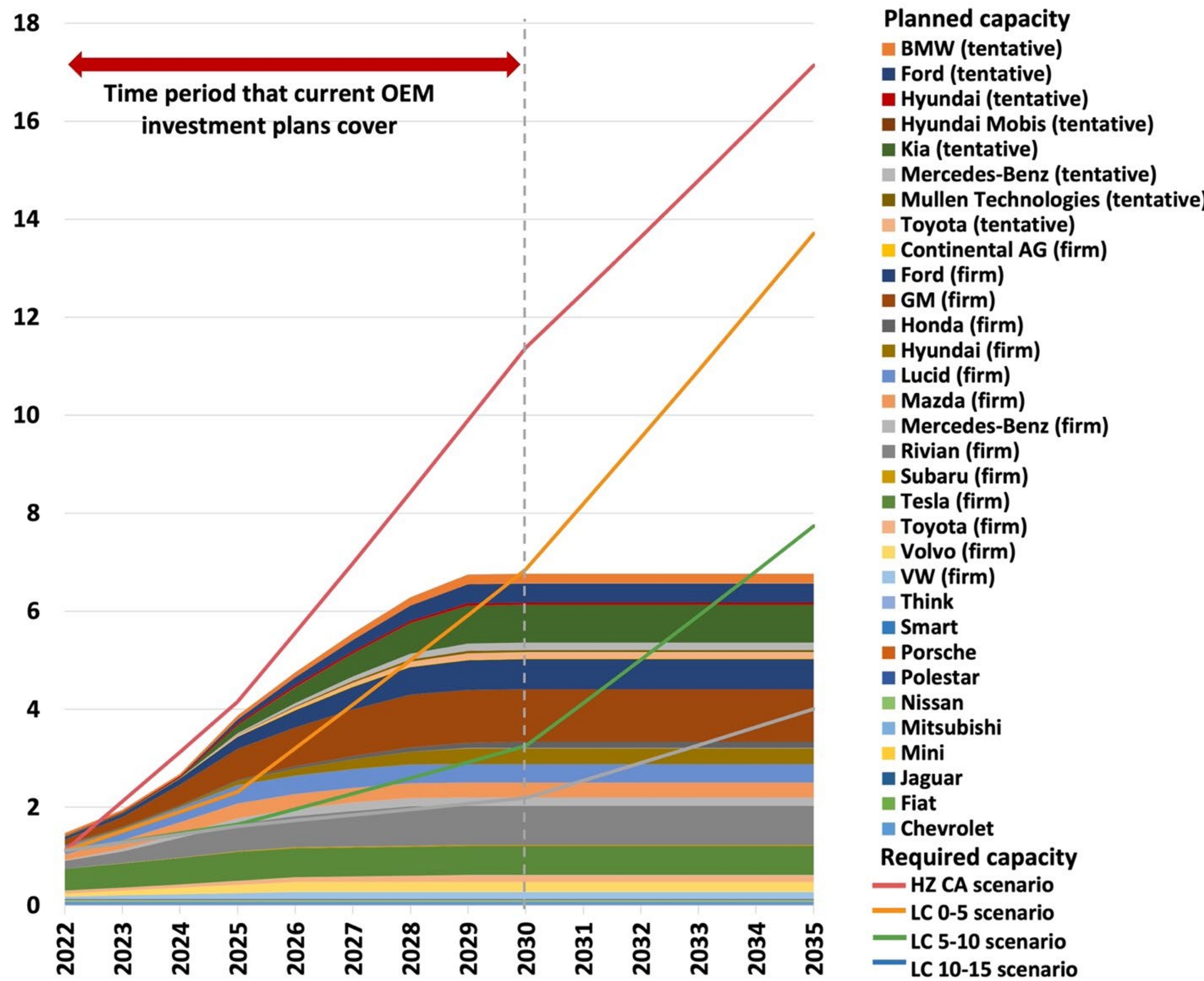
# Appendix A. Planned EV production capacity in the US and Europe to 2030 and with targets in 2035

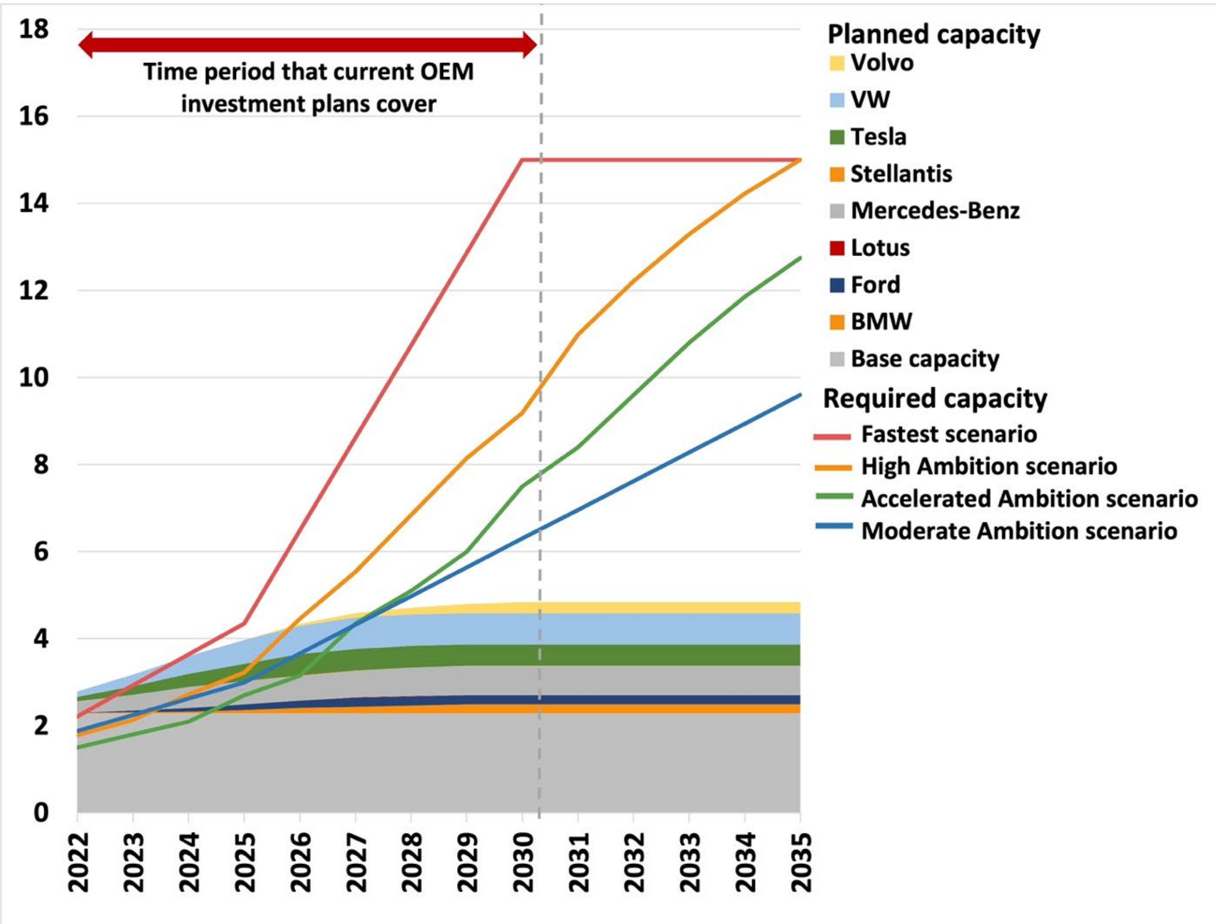
## Appendix A1. Firm planned EV production capacity in the US to 2035 (million), compared to required EV sales



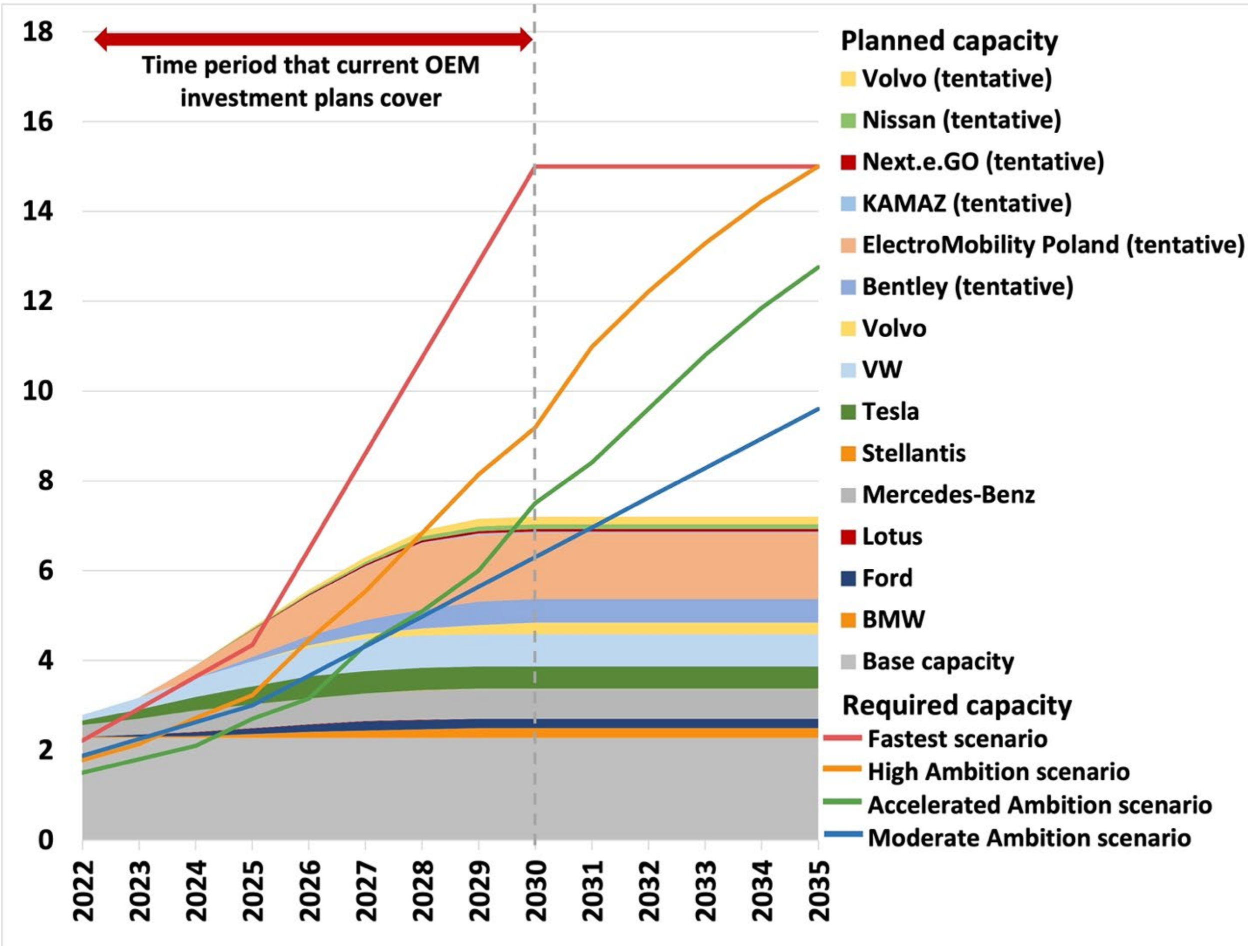
## Appendix A2. Tentative planned EV production capacity in the US to 2035 (million), compared to required EV sales



## Appendix A3. Firm planned EV production capacity in Europe to 2035 (million), compared to required EV sales



## Appendix A4. Tentative planned EV production capacity in Europe to 2035 (million), compared to required EV sales



# Appendix B. Net EV export capacity

## Appendix B1. US net EV export capacity to 2030

| | Planned EV production capacity in the US to 2030 | |
|---|---|---|
| | all firm announcements come through (5. 1 million) | all firm and tentative announcements come through (6.8 million) |
| **LC CA scenario (EV Sales Target: 11.4 million)** | - 6.3 million | - 4.6 million |
| **LC 0-5 scenario (EV Sales Target: 6.9 million)** | - 1.8 million | - 0.1 million |
| **LC 5-10 scenario (EV Sales Target: 3.3 million)** | 1.8 million | 3.5 million |

Appendix B2. Europe net EV export capacity to 2030

| | Planned EV production capacity in Europe by 2030 | |
|---|---|---|
| | all firm announcements come through (4.8 million) | all firm and tentative announcements come through (7.2 million) |
| **High Ambition scenario (EV Sales Target: 9.2 million)** | - 4.4 million | - 2.0 million |
| **Accelerated Ambition scenario (EV Sales Target: 7.5 million)** | - 2.7 million | - 0.3 million |
| **Moderate Ambition scenario (EV Sales Target: 6.3 million)** | - 1.5million | 0.9 million |

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