CENTER FOR AUTOMOTIVE RESEARCH

White Paper

Affordability: The Twenty-Five Thousand Dollar Electric Vehicle

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August 2024

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Acknowledgments

CAR would like to acknowledge the input from the participants of the roundtables that included automakers, suppliers, market experts, industry economists, and local, state, and federal representatives.

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CAR's mission is to inform and advise, through independent research, education, and dialogue, enabling a more viable and sustainable automotive ecosystem

For citations and reference to this publication, please use the following:

Ganguly S., Harp T., Y. Chen & Prasad, K, (2024). *Affordability: The Twenty-Five Thousand Dollar Electric Vehicle*. Center for Automotive Research.

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Abstract

Mass adoption of electric vehicles (EVs) hinges on affordability. Using a "twenty-five thousand dollar" EV as a symbolic reference to affordability, this report presents a scenario where affordable EVs help accelerate the clean energy transition for transportation. To understand the drivers and implications of EV affordability, Center for Automotive Research (CAR) organized three roundtables on related topics. Each roundtable engaged subject matter experts and key industry stakeholders in discussions on three aspects of affordability: Supply, Demand, and Policy. Through these discussions and supplemental research, CAR explored what would have to be true for manufacturers and their supply chains to produce affordable EVs at scale for the US market, the necessities and the underlying challenges to adoption by consumers, and role for policy makers to both enable EV affordability and adoption, while continuing to help strengthen domestic manufacturing.

Introduction

The automotive industry is facing an affordability challenge. This challenge is multifaceted. Industry factors have played a role, trending towards larger and higher-margin vehicles accompanied by record profits despite historically low production[1]. Unprecedented investments in automotive electrification have further pushed automakers to rely on profitable internal combustion engine (ICE) vehicles to support electrification investments. The CAR Book of Deals has captured over $160 billion of automaker-announced investment tied to electrification since 2020[2]. Advanced vehicle technologies, such as autonomous driving and advanced driver-assistance systems (ADAS) require more technology in the vehicle – increasing not only the initial cost of production but also the cost of repair[3]. In addition to a rapidly evolving vehicle technology landscape, the industry also faces disruptive externalities like the semiconductor chip shortage, the long-lasting effects of the COVID-19 pandemic, and federal regulations that translate to increasing costs for the consumer.

[1] (Phillips, 2022)
[2] (Center for Automotive Research, 2024)
[3] (Aeppel, 2024)

In April of 2024, the average transaction price of a new vehicle was $48,510, up from a pre-pandemic April 2019 average of $36,843. This translates to an increase of over $11,000, or nearly 32%, in the transaction price of a new vehicle. To put this in perspective, the Consumer Price Index (CPI)[4] increased by 21% over this same period. This affordability challenge impacts the entire automotive industry, regardless of propulsion technology. However, the issue of affordability is particularly acute in the electric vehicle (EV) segment. In April of 2024, the average transaction price for a new EV was $55,252 – nearly $7,000 more than the industry average.[5]

The electrification of the automotive industry is arguably the most transformative and disruptive transition to face the industry in recent times. As with the advent of internal combustion engines and moving assembly lines, electrification affects both human (and societal) behavior and reshapes the boundaries of the transportation industry. Such a transition requires researching and applying new technologies, establishing new supply chains, sourcing critical minerals and materials, reskilling and upskilling the workforce, and the added challenge of building the necessary infrastructure to support such vehicles on the road. All this costs time and money, and automakers are committed but are faced with all the uncertainties that come with transition on a global scale. Their commitments are evidenced not by their capital commitment - a record amount of dollars, noted in the *Book of Deals* that the Center for Automotive Research (CAR) updates each month. The challenges, among others, are topped off by perhaps the most important hurdle – consumer adoption. This transition is not just spearheaded by industry; regulators are using both the incentives and demands to electrify the automotive industry in efforts to address both climate and national security concerns. As Western automakers work to surmount these obstacles, there looms the growing competitive threat of low-cost Chinese EVs dominating the global market and finding pathways into the U. S. market.

Affordability is a problem agnostic to propulsion technology and is not confined only to the United States. Average transaction prices have surged for the industry, not just for EVs. Europe faces its own vehicle affordability

[4] (Bureau of Labor Statistics, 2024); CPI All items less food and energy in U.S. city average, all urban consumers, not seasonally adjusted
[5] (Cox Automotive, 2024); (Kelley Blue Book, 2019)

challenges as it electrifies its automotive industry[6,7]. However, the affordability and EV transition challenges faced in the United States are ubiquitous and, at the same time, unique. CAR is exploring the topic of automotive affordability in the United States with particular attention to the EV market. In pursuit of this, CAR has engaged in independent research as well as convened industry experts in round table discussions. In this regard, there is a clear choice for customers to choose between used ICE vehicles, new ICE vehicles, used EV vehicles, and new EV vehicles. However, the new EV vehicles are the preferred direction from a national security, industry, and EPA standpoint.

CAR explored three aspects of affordability: Supply, Demand, and Policy. Economics 101 suggests that an increase in supply will lead to a decrease in price, all else being equal. Therefore, understanding the supply-side challenges facing the industry is critical to understanding vehicle affordability. However, a primary challenge of increasing supply is reaching economies of scale – which necessitates consumer demand. Understanding what is necessary for mass consumer acceptance of EVs is integral to developing a market that supports the business case of EVs. Finally, there is room for policy and regulation to impact both the EV transition and affordability concerns, an impact that can be either positive, negative or, as seen increasingly, both. CAR researched the challenges and opportunities of supply, demand, and policy regarding EV affordability, engaging a round table of automakers, suppliers, legislators, and industry experts on each of these aspects of affordability.

Affordability: A working definition

In discussing affordability, a clear "benchmark" on which to judge is essential. The industry appears to be coalescing around such a benchmark: the $25,000 EV. Tesla hinted at a future $25,000 car, named the "Model 2" by fans, back in 2020. This next-generation vehicle may come as soon as the end of 2024[8]. Ford is working on an affordable EV, forming a "skunkworks" project to design a low-cost EV platform with its first model planned to launch in late 2026 with a price tag of around $25,000[9]. Stellantis is following suit, planning

[6] (ACEA, 2023)
[7] (Gerner et al., 2023)
[8] (Levin, 2024)
[9] (Foote, 2024)

to launch a $25,000 Jeep EV in the United States "very soon"[10]. Other automakers are similarly working to introduce affordable EVs to the market: General Motors is reintroducing the Chevy Bolt EV to its lineup in 2026 after discontinuing the model in 2023[11]; Volkswagen has announced the ID.2all to be priced around €25,000 (about $27,000) with production scheduled to begin in 2025[12]; and Kia is expected to launch the EV3 later this year or by early 2025, with prices starting at around $30,000[13].

This industry sees affordability as a major issue facing the automotive market, especially in the EV space. Automakers are racing to bring affordable EVs to market as federal and global efforts to address climate change push the industry to electrify. The lack of affordable EVs poses a threat to environmental goals – the vehicles on the road are getting older. According to a report by S&P Global Mobility, there were 286 million vehicles in operation (VIO) across the US in January of this year. The average age rose to 12.6 years, up two months over 2023. The average age of the US fleet is up three years since 2022 when the average vehicle on the road was 9.6 years. A combination of "prohibitively high" prices, persistent inflation, and uncertainty surrounding the EV transition has led to consumers holding onto their vehicles longer[14,15]. This means keeping older, less fuel-efficient vehicles on the road – a threat to climate goals.

However, environmental concerns are not the only driver in the race to an affordable EV. The US automotive industry itself may be at stake. There is growing concern, among regulators and automakers alike, of a potential threat from low-cost Chinese EVs. These fears are best embodied by the BYD Seagull – a sub $10,000 EV sold in the Chinese market. While BYD stated that they have no plans to enter the US market anytime soon, the threat of a low-cost mass-market EV entering the market looms in the minds of automakers and regulators in the US[16]. This led to an increase of tariffs imposed on Chinese EVs, with the Biden administration raising tariffs to 100% in May

[10] (Johnson, 2024a)
[11] (Deslauriers, 2024)
[12] (Strong, 2023)
[13] (Johnson, 2024b)
[14] (Hodder, 2024)
[15] (Parekh & Campau)
[16] (Visconti, 2024)

2024, quadrupling the previous 25% tariff in place – a move supported by automakers like General Motors, emphasizing the need for fair competition[17].

Given the urgency of accelerating EV adoption in the US to address both climate goals and national security considerations, CAR explored three aspects of affordability. Through roundtable discussion and supplemental research, CAR examined the underlying supply, demand, and policy factors.

Supply factors

The fundamental economic theory of supply and demand stipulates that an increase in supply, all else equal, will lead to decreased prices. An increasing shift in supply can lead to decreasing price and increasing quantity – a potential solution, or part of the potential solution, to affordability. Common factors that can lead to such an outward shift in supply include decreasing input/material costs, technological advances, expectations, and the entry of new suppliers into the market. As such, each of these is considered an avenue to reach affordability.

Decreasing material costs can have a large impact on vehicle affordability. This is particularly true for EVs, where the battery can account for a substantial share of the total vehicle cost. For example, the 229kWh nickel cobalt manganese (NCM) battery in the 2025 RAM 1500 REV Limited is estimated to cost $25,853 – or nearly 32% of the total cost of the vehicle[18]. GlobalData reports EV batteries can account for up to 40% of the cost of a battery electric vehicle (BEV)[19]. However, progress is being made on this front. The International Energy Agency (IEA) reports that the average lithium-ion battery costs have fallen by 90% since 2010, falling from $1,400 per kWh in 2010 to less than $140 per kWh in 2023. Furthermore, the IEA projects the average lithium-ion battery cost to drop by another 40% globally from 2023 to 2030 due to innovation, with further progress made as sodium-ion grow in use and solid-state batteries become commercially available[20].

Furthermore, material cost reductions outside of the battery can also play a part in vehicle affordability. For example, generation-three steel's high

[17] (Lopez, 2024)
[18] (Venditti, 2023)
[19] (GlobalData, 2024)
[20] (Petropoulos, 2024)

strength-to-tensile ratio can allow less material to be used which in turn can lead to lower costs. As these new materials enter the market, this can allow redesign of vehicle structures and manufacturing processes to take advantage of their material properties. Figure 1 shows an example of how advanced materials can be leveraged by engineering decisions in vehicle design to both reduce weight and cost. Engineering decisions point to another avenue of cost reduction. As discussed in the round tables, material margin[21] is vital for affordability – there is room for cost reduction outside of just materials.

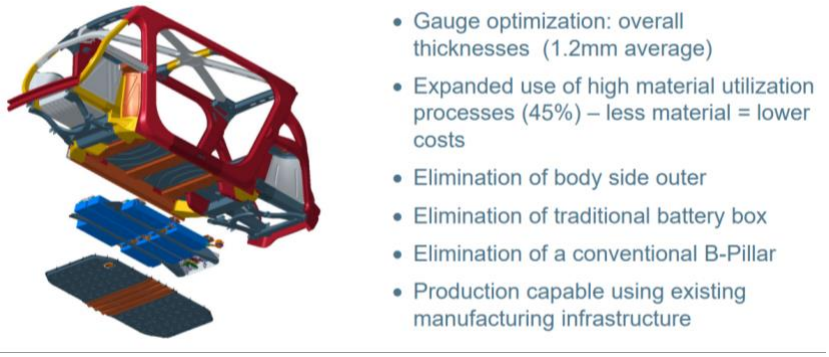

Figure 1. Engineering decisions to reduce cost, provided by U.S. Steel

Technological advances play a pivotal role in affordability. The CAR roundtable discussion highlighted the importance of efficiency in manufacturing. Next generation manufacturing processes and design, such as modular manufacturing, can create cost savings. Modular design allows for more flexibility and parallel processing of parts – leading to a reduction in manufacturing time and costs. Tesla's unboxed manufacturing takes this even further. Caresoft, a leader in automotive benchmarking and cost reduction consulting, estimates that unboxed manufacturing could lead to a 25% lead time reduction in general assembly and can significantly reduce the footprint and investment required for a new vehicle assembly plant[22]. Tesla claims these next generation manufacturing efficiencies can lead to a 50% reduction in cost[23]. Other advanced technologies can aid in achieving efficiency in manufacturing. Computer aided engineering, modeling, and

[21] Material margin is the revenue minus material costs – this is the portion of the total price related to non-material costs such as manufacturing costs, overhead, and profit
[22] From roundtable discussion
[23] (Armstrong, 2024)

artificial intelligence can all play a role. For example, constructing a digital twin of the factory floor can be used to uncover inefficiencies, predict and work to avoid machine failures, or trial alternative layouts and processes. Digital twins of vehicles can aid in the early stages of conceptualization all the way through sales and service[24]. Acknowledging the potential need for some upfront capital investment, EWI, a provider of advanced engineering services, discussed the application of AI and simulations to accelerate development and reduce costs and potentially energy consumption. One example: modeling crash worthiness. Also discussed at the roundtable, highlighted by NIRA Dynamics, was the importance of software and the opportunity to reduce costs through replacing hardware with software.

An example of how technological advancements in manufacturing processes and materials can help solve EV affordability challenges is seen in Figure 2. CAR estimated the impacts of applying the new manufacturing process of gigacasting, application of unboxed manufacturing, reductions in battery material cost, and finally federal tax incentives on the cost of a Tesla Model 3. This shows the potential for a multifaceted approach to affordability achieving the $25,000 EV.

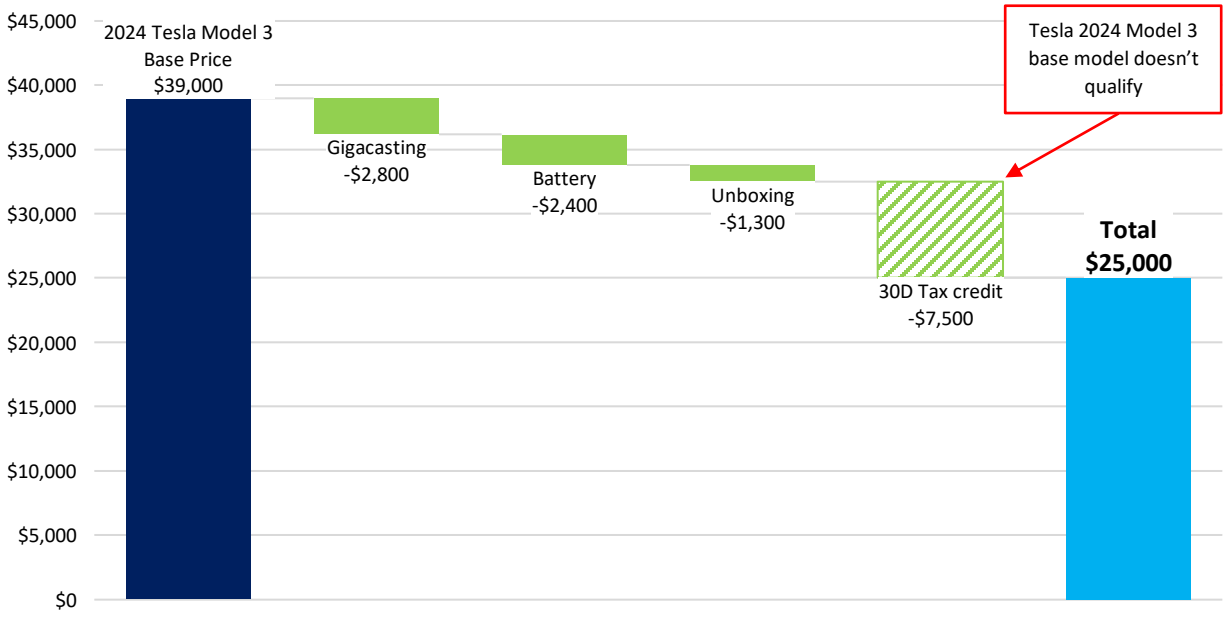

Figure 2. A possible scenario of Tesla Model 3 path to $25,000[25]

[24] (Sharma & George, 2018)
[25] CAR estimate based on (Fox, 2021) and (Anderson, 2024)

In order for automakers and suppliers to ramp up EV production and reach economies of scale, leading to decreasing costs, expectations must be justified. Automakers and suppliers have made record investment announcements in recent years. The CAR Book of Deals, which tracks the automotive industry's capital investments across North America, shows that automakers have announced over $160 billion tied to electrification projects since 2021. Tracked suppliers similarly announced record investment, planning over $80 billion in electrification projects since 2021[26]. The threat to this historic investment in EV and battery-related technology and projects? Uncertainty. Citing softer-than-expected EV adoption among consumers, some automakers have delayed or reduced initial investment plans, reduced EV production forecasts, and even delayed debuts of new EV models. This uncertainty in EV adoption faced by automakers leads to more uncertainty further up the supply chain – as automakers are reluctant to place long term offtake agreements as EV adoption wavers and government EV incentives face risk, suppliers cannot rely on large orders to help fund the retools necessary to make the transition to electrification. For suppliers, and particularly smaller and lower-tier suppliers, large and long-term orders are key for amortization of investments. Without this assurance, suppliers view heightened risk in the EV transition as automakers adapt investment plans to match market conditions. Further complicating this uncertainty facing automakers and suppliers is the rapid pace of technological change in the race for affordable EVs – components and materials in current EV models may need altering or may even become irrelevant as new technologies and battery chemistries enter the market.

To combat some of the uncertainty between automakers and suppliers, which can lead to more affordable EVs in the long run, robust relationships are key. Unlike the traditional way of automakers developing a roadmap that is provided to suppliers, Nissan highlighted the importance of end-to-end supplier integration. Bringing in suppliers at the beginning of development processes enables more robust relationships along with increased supplier confidence and involvement in the decision making – helping in the amortization of capital expenditure and tooling. Furthermore, efforts to standardize parts and materials can go a long way in helping suppliers reach economies of scale and reduce production costs – though, as discussed at the supply aspect of affordability round table, standardization and indeed the act

[26] (Center for Automotive Research, 2024)

of establishing standards at all is a challenge as technology advances at a rapid pace.

Another avenue of increasing supply and lowering prices is the entrance of new competition – there has been progress on EV affordability along this road. Tesla is a prime example of this in the United States. Tesla began selling EV's in 2008, however, their first EV cost a little more than $100,000 – not an affordable car for the masses. Since then, Tesla has dominated the US EV market, capturing over 50% of new EV sales year-to-date through May of 2024[27]. They have also arguably sparked the EV price war and race for the $25,000 EV, with the average transaction price of a Tesla dropping by nearly 20% in 2023[28]. But other automakers are also contributing to this path towards affordability – an estimated 25 new EV models are expected to debut in 2024[29]. Here too lies risk – the threat of Chinese EVs entering the US market. Undoubtedly, the flow of Chinese EVs into the market would lower the average transaction price of EVs and would represent a huge step toward solving the lack of affordable EVs in the market – but letting Chinese EVs flood the US market comes with other risks, not the least of which would be the very survival the US automotive industry.

Automakers and suppliers face multiple challenges in supplying an affordable EV. In addition to those discussed already in this section, the automotive industry faces precarious battery mineral supply and potential key battery material shortages; geopolitical tensions and conflict threatening supply chains; and uncertainty in state and federal policy and incentives meant to aid in the transition to electrified propulsion. While some of these challenges can and will be overcome by industry, there is room for legislators to help. These opportunities and risks are discussed in more detail in the Policy section of this paper. However, for any of these challenges, the largest hurdle is consumer adoption. The benefits of economies of scale can only be achieved if and only if there is widespread acceptance of EVs among consumers. The affordability challenges faced by consumers, and potential opportunities, are discussed in the next section.

[27] CAR analysis of Wards Intelligence US Light Vehicle Sales, May 2024 release
[28] (Cox Automotive, 2024)
[29] (Phillips, 2024)

Demand factors

Robust consumer demand for EVs is necessary for a healthy (i.e., profitable) EV market. To understand the current demand for EVs, it is useful to understand who owns EVs today. A CAR analysis of data from the 2022 National Household Travel Survey (NHTS) confirmed two assumptions regarding EV ownership: an EV is a second car, and EVs are a luxury for the relatively well off. The 2022 NHTS shows that of households that own a BEV or a plug-in hybrid electric vehicle (PHEV), roughly 87% are multi-car households. Furthermore, the median household income was around $75,000. For EV owners, the median household income is over $150,000. Figure 3 shows a comparison of household income distribution of the general population versus that of households that own EVs. The data shows household income for EV owners is shifted right – implying that households that own EVs are likely to be more well off than the median household.

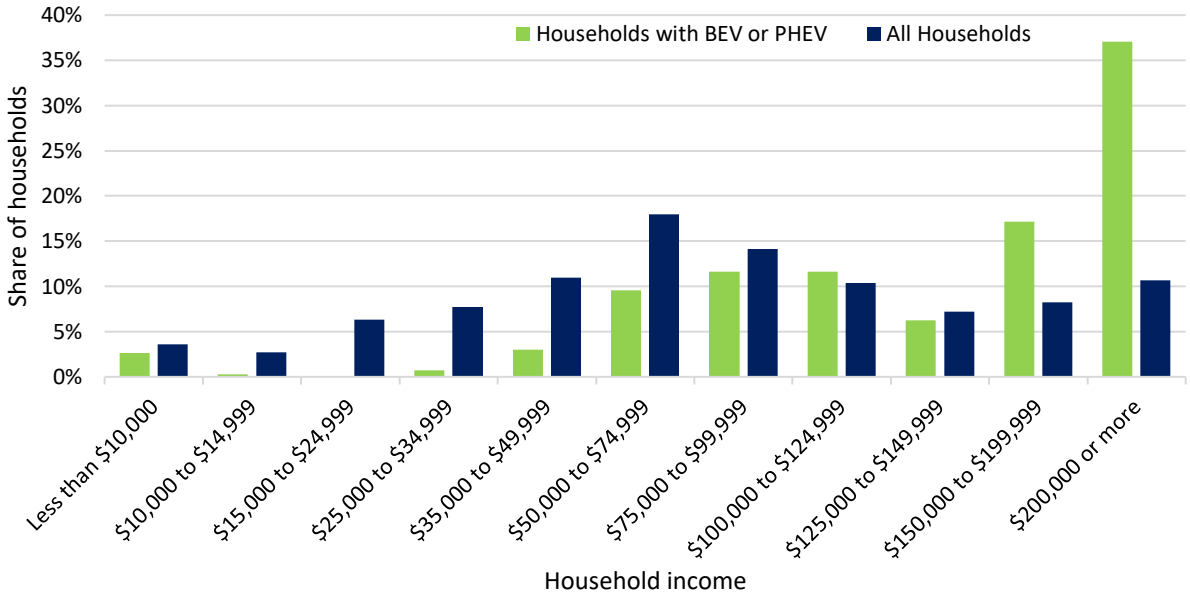

Figure 3. Household income distribution: all households vs. households owning an EV

Notably, the above analysis shows that the median EV-owning household has over twice the income as the median US household. Adopting $25,000 as the recently targeted industry benchmark for an affordable EV, Figure 4 shows the new vehicle models available in the US market with manufacturer suggested retail prices (MSRP) below that price point. Of these only three are

EVs, all of which only make the sub-$25,000 cut after EV tax credits are applied.

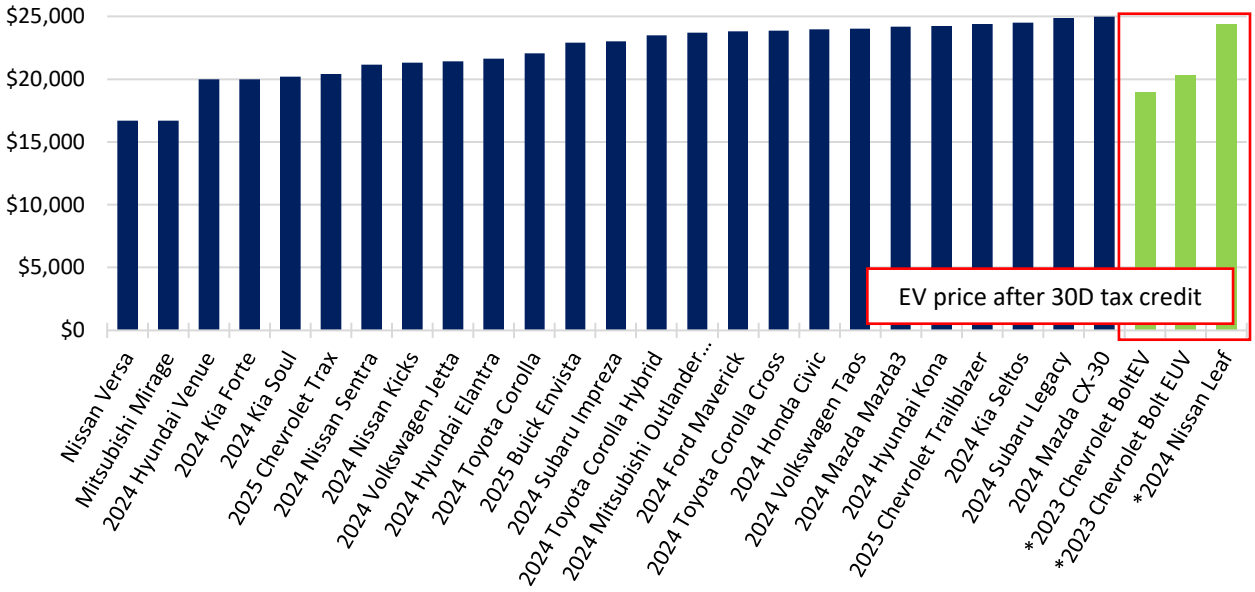

Figure 4. Available new vehicles in the US market under $25,000 MSRP [30]

The race to a $25,000 EV will be an arduous one. The vehicle producer price index, which measures the change in prices vehicle producers receive for their output, had been slowly trending upward since 2015, but saw rapid growth in the wake of the COVID-19 pandemic. This is seen in Figure 5, which tracks the vehicle producer price index against the seasonally adjusted annualized rate of light vehicle sales. This shows that prices have climbed quickly in the aftermath of the global pandemic and, while having recovered slightly, vehicle sale volumes remain below pre-pandemic levels.

[30] CAR analysis of Edmunds.com data

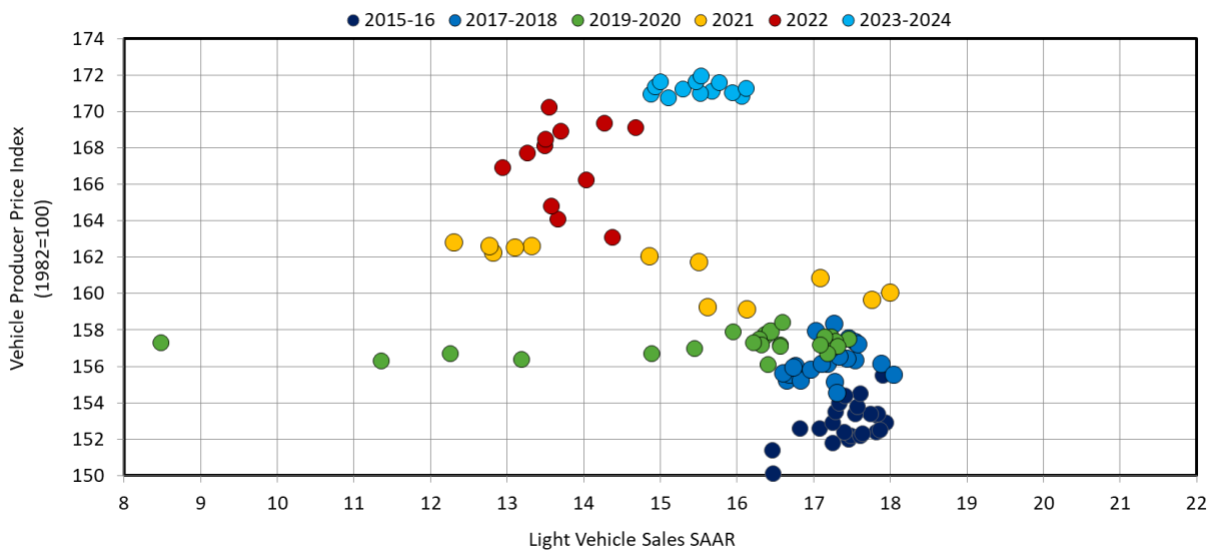

Figure 5. US light vehicle sales and vehicle producer price index (1982 = 100), 2015 – 2024

Figure 6 shows this march towards higher vehicle prices. Review of data from the National Automobile Dealers Association (NADA) and JD Power shows the increase in new vehicle average transaction price as well as the comparison of vehicle price inflation to that of general consumer prices. The average price consumers pay has increased significantly, by about 25% compared to 2019.

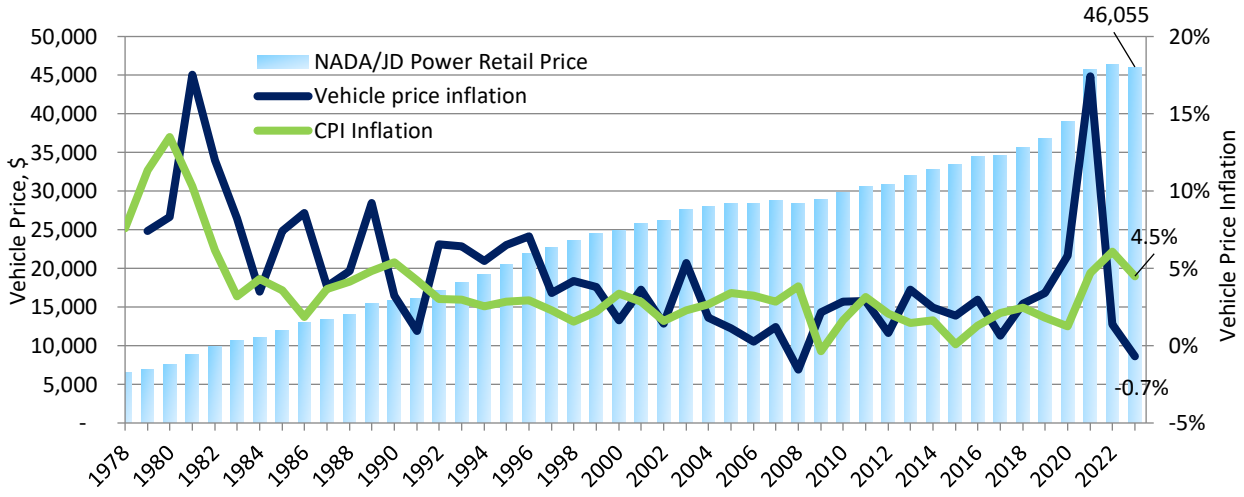

Figure 6. NADA/JD Power new vehicle average transaction price by year[31]

[31] CAR analysis of NADA/JD Power data

As prices for vehicles soared, regardless of powertrain technology, it is interesting to consider the potential impact of a car like the BYD Seagull entering the US market. EV prices have already been dropping in the US – increased competition and higher inventory levels have driven down costs by 11.6% to 12.8% year-over-year (February and January 2023 compared to the previous year). Even premium EVs like Tesla Model Y and Model 3 have seen price reductions (16.2% and 12% respectively). Despite this progress, EVs remain nearly 19% pricier than mainstream non-luxury gasoline-powered cars in terms of sticker price. However, even with these gains in affordability, competition with a Chinese EV entrant would be an uphill battle. The BYD Seagull could be priced $10,000 lower than traditional gasoline-powered vehicles in the same segment. But it is important to also consider consumer preferences. Would an average consumer be interested in a BYD Seagull type of EV, even with its affordable price tag? Passenger cars only account for about 20% of new car sales in the US – small cars, most of which are larger than the Seagull, only account for around 7% of new car sales as seen in Figure 7. However, even though the Seagull would enter the market in a relatively low-share segment, it cannot be understated how such an entrant with a price point $10,000 cheaper than even the current low-cost ICE vehicles could radically change the US light vehicle market.

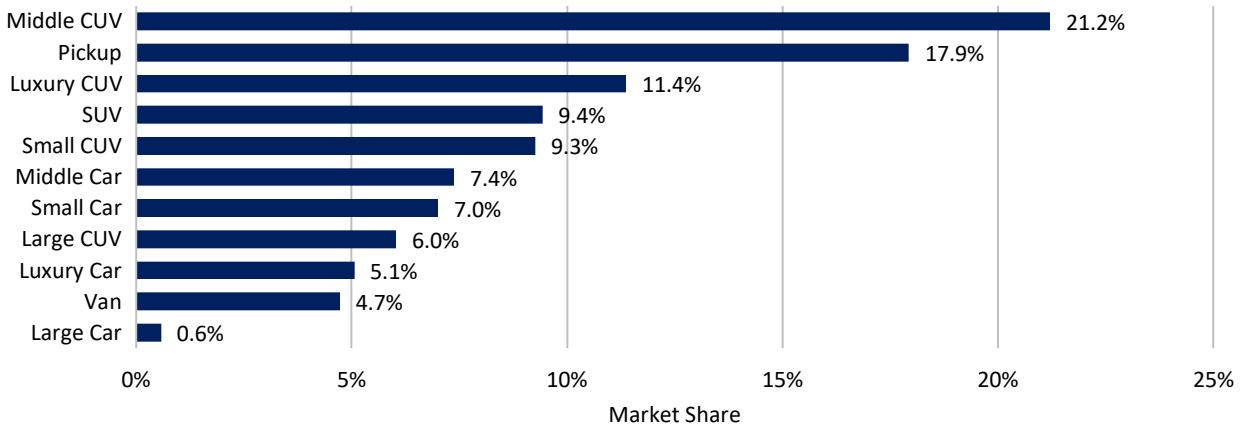

Figure 7. 2023 US light vehicle market share breakdown by segment[32]

CAR's earlier discussion and analysis uncovered a bit about who currently owns an EV, what affordable (i.e., sub $25,000) vehicles are currently available, and where such an affordable car may enter the market. Essential to the

[32] CAR analysis of Wards Intelligence US Light Vehicle Sales, December 2023 release

affordability question is identifying whether the $25,000 EV is indeed affordable. To answer this question, CAR conducted an analysis of transportation costs using household income estimates from the 2022 US Census Bureau and US Bureau of Transportation Statistics data. Figure 8 depicts the share of after-tax household income typically spent on transportation costs. While cost encompasses more than just motor vehicle payments, including other aspects of transportation like fuel, insurance, and transportation services such as buses and airfare, it does illustrate an upper-bound to vehicle affordability. What this shows is that household expenditure on transportation, as a share of household income, has remained relatively constant since 2008, with roughly 15% of after-tax household income spent in this category.

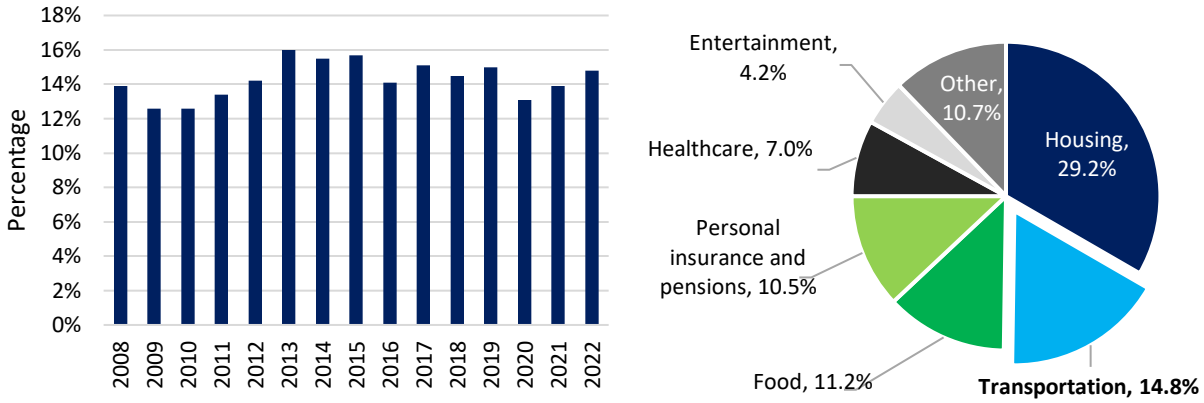

Figure 8. After-tax household income expenditure on transportation, 2008 – 2022 (left) and by major expense category, 2022 (right) [33]

CAR estimates that this translates to roughly 10% of pre-tax household income spent on transportation. Using this as a baseline, forming an upper bound for affordability in terms of the share of households that can afford a particular price is achievable. CAR analyzed the percentage of households that could afford a particular auto loan at three different maturity terms at an 8% interest rate[34]. As expected, as the price of vehicle/loan amount increases, the percentage of households who can afford it falls. Higher loan durations, resulting in lower monthly payments, can increase what auto loan is considered affordable. These results can be seen in Figure 9. Interestingly,

[33] CAR analysis of Bureau of Transportation Statistics data
[34] This assumes no down payment or trade-in, 10% of pre-tax income spent on auto loan payments

with a 48-month maturity, an estimated 51% of households can afford a $25,000 auto loan. This increases to 59% with a 60-month loan and 64% with a 72-month loan. This breakdown can be seen in

. This suggests that an 8% interest rate on a 48-month loan auto loan of $25,000 may be affordable to just over half of US households.

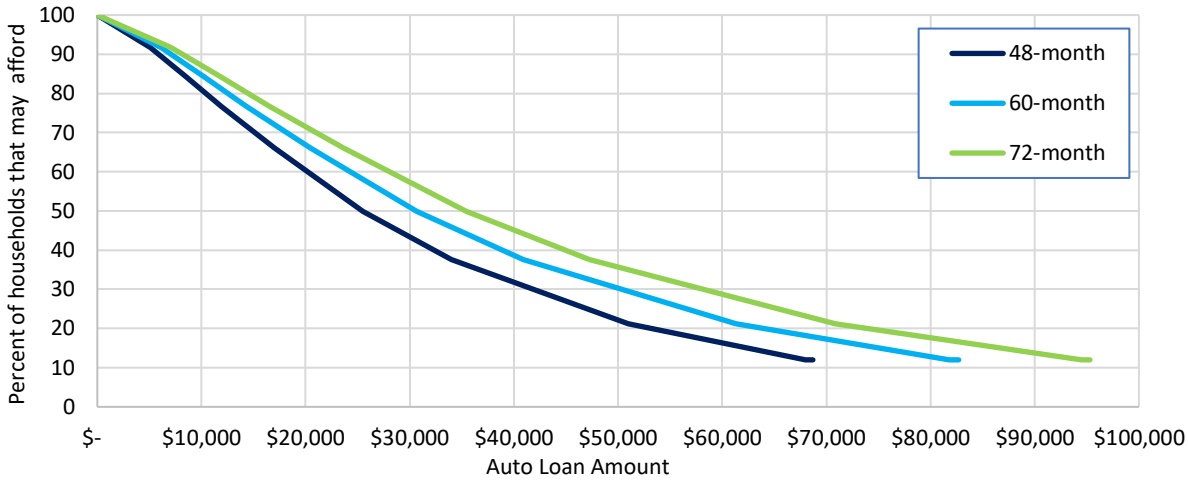

Figure 9. Percent of households that may afford an auto loan based on 10% of pre-tax income and an 8% interest rate[35]

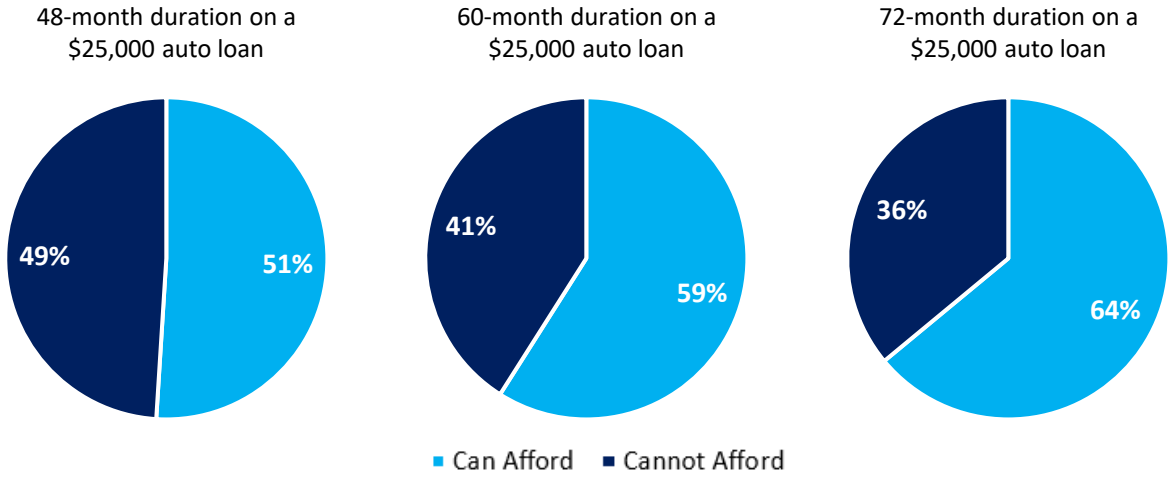

Figure 10.Percent of households that may afford a $25,000 auto loan based on 10% of pre-tax income and an 8% interest rate[36]

[35] CAR analysis of Census Bureau Current Population Survey data
[36] CAR analysis Census Bureau data

The above analysis considers the upfront cost of buying a vehicle. When considering affordability, another, and potentially more accurate, measure is not the sticker price of a vehicle, but the total cost of ownership (TCO). This considers more than purely the transaction price, considering factors such as resale value, incentives, and operation costs. JD Power considered this more holistic view of affordability, comparing the cost of a five-year purchase of a Tesla Model Y versus a compact premium SUV with an ICE powertrain. By these metrics, accounting for additional EV costs such as lower resale value and EV benefits such as fuel savings, JD Power posits that EVs have already reached parity and are now more affordable than comparable ICE vehicles, in TCO terms. In the previous example concerning the Tesla Model Y, JD Power estimates that the EV is around $4,500 cheaper than its ICE counterpart after five years of ownership. JD Power's affordability index can be seen in Figure 11 - showing that total EV affordability reached parity with ICE vehicles in August of 2023.

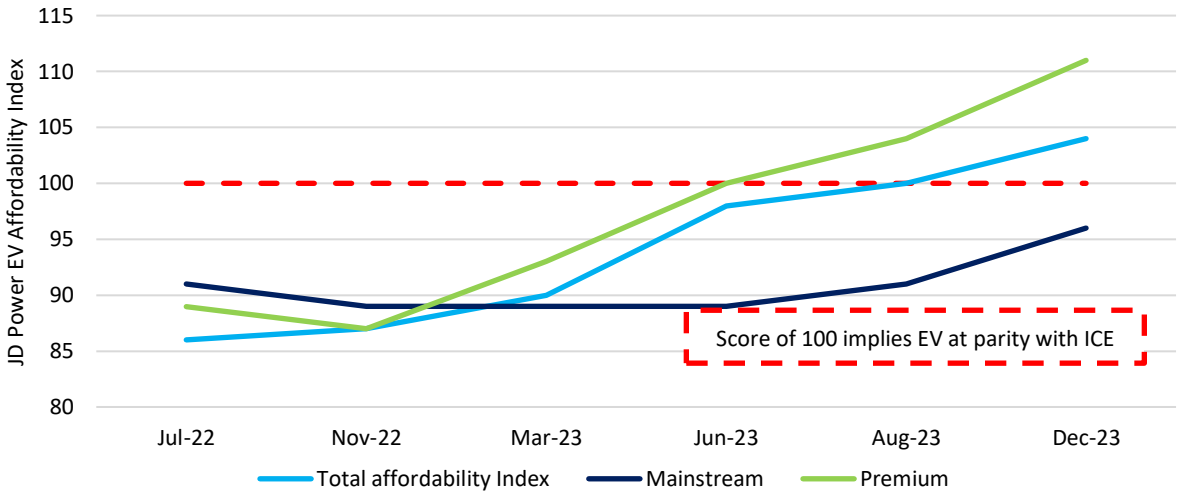

Figure 11. JD Power EV Affordability Index: The tipping point of affordability[37]

[37] J.D. Power conveyed data to CAR

Policy factors

There is ongoing regulatory effort to electrify the US car parc. The Massachusetts Institute of Technology's Climate Portal calls EVs a "part of a suite of tools for clean transportation."[38] US regulators have implemented rules in effort to green the nation's fleet. The Department of Transportation (DOT) finalized Corporate Average Fuel Economy (CAFE) standards requiring an industry-wide fleet average of about 50.4 miles per gallon (MPG) in model year 2031 for light vehicles[39]. The Department of Energy published the final rule for the petroleum-equivalency factor (PEF), revising the methodology and procedure for calculating the petroleum-equivalent fuel economy for EVs (used to calculate compliance to the DOT's CAFE standards) – effectively lowering the MPG equivalency of EVs[40]. The Environmental Protection Agency (EPA) finalized greenhouse gas (GHG) emissions standards, projecting that 56% of new vehicle sales would need to be BEV and 13% PHEV in 2032 for compliance[41].

These regulations and rules, among others, are aimed at reducing motor vehicle GHG contributions. However, consumer adoption of EVs is a significant requisite to achieve these goals. One hurdle to widespread EV adoption is affordability. CAR considered four scenarios with varied effects of affordability on EV adoption and subsequent GHG reduction. In the first scenario, affordability challenges remain an issue, regardless of powertrain, and EV adoption remains low. In this case, the fleet relies on used ICE vehicles, having the lowest impact on GHG reduction. In scenario two, consumers are able to purchase new ICE vehicles that are more efficient than used ICE vehicles, but EV adoption remains low. Here, the newer and more efficient ICE vehicles replaced the used fleet, having a mild impact on GHG reduction. In the third scenario, EV adoption is higher, but affordability remains an issue; EV penetration is slow as many consumers that want EVs must wait for them to transition into the used market, leading to a moderate impact on GHG reduction. Finally, the fourth scenario considered assumes that there is high demand for EVs and new EVs are affordable. Here, EV penetration would be fastest and have the highest impact on GHG reduction,

[38] (Keith & Krol, 2023)
[39] (National Highway Traffic Safety Administration, 2024)
[40] (Petroleum-Equivalent Fuel Economy Calculation, 2024)
[41] (Multi-Pollutant Emissions Standards for Model Years 2027 and Later Light-Duty and Medium-Duty Vehicles, 2024)

of these four scenarios. Scenario four is the ideal scenario if policy goals are to have the greatest impact on vehicle GHG emission reduction. However, for scenario four to be realized, both high consumer demand for EVs and affordable price points for EVs must be true. Policymakers can have an impact here.

EV penetration, however, is not the sole objective of EV policies in the US. Another objective is to protect US jobs and manufacturing in the future of mobility. These two objectives, increasing EV penetration and protecting US automotive manufacturing, are often at odds with each other. The fastest way to an affordable EV, which may lead to wider adoption, is to open the market to lower-cost imports – a strategy that could be detrimental to US manufacturing.

Figure 12 depicts potential scenarios considering the two objectives: EV affordability and adoption, and protection of the US automotive industry. The ideal scenario is in the top-left quadrant. Affordable EVs are available, leading to increased adoption, and are manufactured profitably in the US. In the worst-case scenario, EVs are kept out of the market, through policy or lacking consumer demand, and the US automotive industry does not transition to electric vehicles. In this worst-case scenario, EV adoption is minimal, and the US automotive industry becomes globally uncompetitive as the rest of the world electrifies. With these dual EV policy objectives in mind, CAR explored current policies in place that impact EV affordability while also considering areas of opportunity for policy initiatives to play a further role.

EV Affordability and Adoption

US Automotive Industry		*Win*	*Lose*
	Win	Affordable EVs produced profitably in the US and are widely adopted	Affordable EVs kept from market; Automakers produce high-margin/high-price vehicles
	Lose	Affordable EVs imported and are widely adopted; US automotive footprint diminished as imports take over market	Affordable EVs kept from market or EVs are not adopted, US automakers become uncompetitive globally and automotive footprint is diminished

Figure 12. Challenge of policy – support affordable EV adoption AND protect US automotive manufacturing

Starting with the demand side of the equation, the most obvious policy to encourage EV affordability and adoption is EV tax credits. Available at both the federal and, in some cases, state level, tax incentives for those who purchase an EV are a straightforward way to increase vehicle affordability. State incentives for EV purchases can be significant. A 2023 analysis compiled by the Tax Foundation found that "Nineteen states [including Washington DC] offer an additional incentive beyond the federal credit ranging from a $1,000 incentive in Alaska and Delaware to a $7,500 credit in California, Connecticut, and Maine."[42] These state incentives appear to be effective – contrasting this list of states against EV market share data from the Alliance for Automotive Innovation's Electric Vehicle Sales Dashboard[43], nine of the top ten states in terms of light-duty EV market share in 2023 offered such incentives. Though these state incentives are substantial and effective in making EVs more affordable, they vary by state. CAR's subsequent analysis focuses on federal incentives.

On the demand side, the flagship federal incentive also takes the form of an EV tax credit. The Inflation Reduction Act (IRA), signed into law on August 16, 2022, has provisions covering clean energy initiatives, climate mitigation and resilience, agriculture, conservation, as well as healthcare and corporate tax reforms. This includes provisions directly related to EV affordability and adoption, including section 30D, the New Clean Vehicle Credit[44]. Section 30D provides incentives of up to $7,500 for the purchase of a new clean vehicle, inclusive of BEVs, PHEVs, and fuel cell vehicles. There are requirements for eligibility – not just for the vehicle but also the buyer. For the buyer, eligibility is predicated on income limits and intended use. Vehicle eligibility is determined on the vehicle identification number (VIN) level, including manufacturer suggested retail price (MSRP) caps and manufacturing requirements including battery capacity, vehicle weight, and final assembly location. On top of these criteria, vehicles must also meet critical mineral and battery component requirements – which become stricter over time. Figure 13 depicts these increasing requirements for vehicles to qualify for New Clean

[42] (Jaros & Hoffer, 2023)
[43] (Alliance for Automotive Innovation, 2024)
[44] There are two other IRA tax credits that reduce the price of the vehicle. The Previously Owned Clean Vehicles Credit (Section 25E) and the Qualified Commercial Clean Vehicles Credit (Section 45W) both provide incentives to boost EV adoption through making EVs more affordable and are important when considering EV affordability. However, for the intent of this paper, which is focused on new EV sales in the US, Section 30D is the most directly applicable.

Vehicle Credits and denotes when the foreign entity of concern applies to both battery components and critical minerals. Section 30D is a perfect example of the dual policy objectives. The $7,500 credit helps to lower the price of EVs for consumers and the MSRP caps help limit EV prices while the final assembly requirement (final assembly in North America) and the increasingly strict critical mineral and battery component requirements are designed to support on- and near-shore manufacturing. However, Section 30D is also a perfect example of how these dual policy objectives can be at odds with one another.

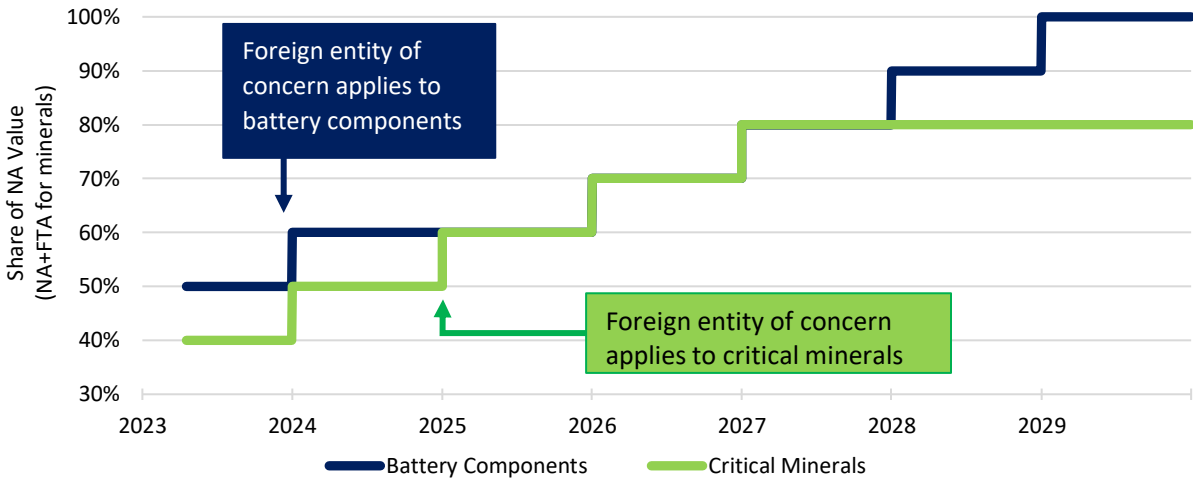

Figure 13. IRA section 30D new clean vehicle credit increasing sourcing requirements by year

The vehicle eligibility requirements, while encouraging investment in North America, can also render the incentive less impactful for encouraging EV adoption. Figure 14 shows sales volume of EVs in the US in the first half of 2024. As of this writing, only 21 of the 99 EV models sold in the first half of 2024 were potentially eligible for 30D credits. These potentially eligible vehicles account for roughly 58% of EVs sold through June of 2024. Note that this is a high-end estimate – a disclaimer on the www.fueleconomy.gov site listing eligible vehicles cautions that "not every version of the models listed below will necessarily qualify. Please check with the dealer/seller to determine the eligibility of your specific vehicle."[45] As sourcing requirements for critical minerals and battery components intensify in coming years, fewer models may remain eligible for this incentive in the future. Further

[45] (Office of Energy Efficiency and Renewable Energy, 2024)

complicating eligibility is the implementation of foreign entity of concern restrictions which, if this requirement is not met, can disqualify the vehicle for the entire 30D credit. US Geological Survey estimates that China, designated as a foreign entity of concern, produced roughly 65% of the world's supply of natural graphite[46] – a critical mineral for EV batteries. IEA, the International Energy Agency, estimates that China accounted for over 90% of the world's refined graphite in 2023 and 65% of the world's refined lithium – another critical mineral[47].

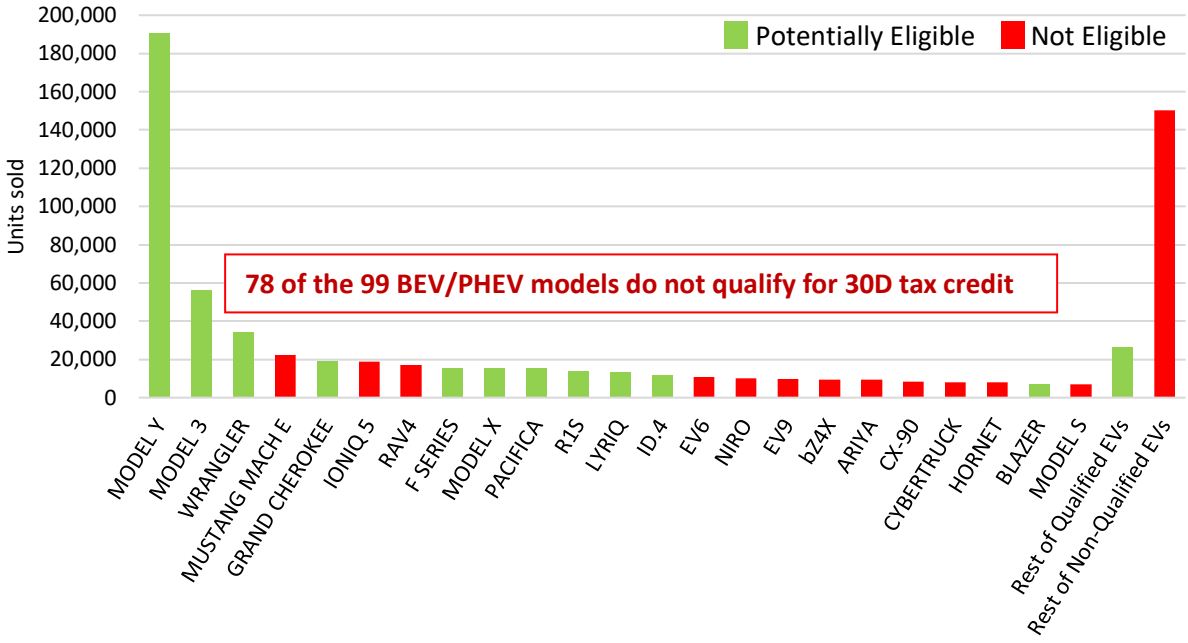

Figure 14. US EV sales in the first half of 2024, potential 30D eligibility by model

The 30D tax credit can and has increased affordability of EVs in the US. However, vehicle price is only one aspect of demand – consumers have other concerns that need to be met before widespread EV adoption and economies of scale can be reached. Policy can have a role to play here as well, although progress has been slow. The Infrastructure Investment and Jobs Act (IIJA), also known as the Bipartisan Infrastructure Law, was signed into law on November 15, 2021. The IIJA created the National Electric Vehicle Infrastructure (NEVI) program with the intent to build a nationwide network of 500,000 EV chargers by 2030 – as of June 2024, NEVI funding has only

[46] (U.S. Geological Survey, 2023)
[47] (International Energy Agency, 2024)

supported eight charging stations nationwide[48]. However, the number of public chargers has shown improvement, with the number of level 2 public charging ports growing by 58% since November of 2021 and the number of DC fast charging ports growing by over 110%[49]. Policy to expand access to EV charging is critical – the J.D. Power 2024 U.S. Electric Vehicle Consideration Study finds that the top five reasons cited by consumers unlikely to consider an EV are mostly related to charging concerns, including charging station availability[50].

On the supply side, the dual policy objectives of EV adoption and protecting the US automotive manufacturing industry are even more entwined. As discussed above in relation to the IRA's New Clean Vehicle Credit, provisions to support and encourage EV manufacturing investment in the US can potentially undermine the goal of making EVs more affordable. If affordability and adoption were the only goals of policy, all EVs would qualify for these credits. However, the IRA, and other policy initiatives, do include programs to help lower costs for the EV supply chain in the US. For example, expanding the Advanced Energy Project Credit which supports projects including the production of advanced vehicles; the new Advanced Manufacturing Production Credit supporting domestic manufacturing of components, battery cells and modules, and critical minerals processing; the Advanced Technology Vehicle Manufacturing Loan Program for loans to manufacture clean vehicles and their components; and Domestic Manufacturing Conversion Grants to help fund retooling of production lines for clean vehicles[51]. All these programs can lower the costs for manufacturers engaged in EV production and its supply chain while supporting investment in the US.

The IIJA also provides support for domestic manufacturers. The NEVI program discussed earlier requires at least 55% of the component costs for federally funded chargers to be manufactured domestically[52]. In addition to the NEVI funding, the IIJA set aside $43 billion in flexible spending to support "battery manufacturing, grid updates, retooling auto industry facilities, and retraining and rehiring existing auto workers."[53] However, roundtable

[48] (Joint Office of Energy and Transportation, 2024a)
[49] (Joint Office of Energy and Transportation, 2024b)
[50] (J.D. Power, 2024)
[51] (The White House, 2023)
[52] (Smith & Friedman, 2024)
[53] (Christianson, 2023)

discussions suggest these programs are long term solutions. In the short term, the Biden Administration expanded on tariffs imposed by the Trump Administration to protect US manufacturers from the potential of low-cost Chinese EVs entering the market. This increased the China Section 301 tariffs on EVs from 25% to 100%, increases the 7.5% tariffs on lithium-ion EV batteries and battery parts to 25%, and imposed a new 25% tariff on most critical minerals[54]. This is another example of the policy challenge with the dual objectives of EV adoption and supporting the US automotive industry – while these tariffs can provide protection for domestic manufacturers as they work to become more competitive in the transition to EVs, they can also lead to increased costs for the US consumer. A final policy to mention is the trade agreement that replaced the North American Free Trade Agreement (NAFTA), now known as the US - Mexico – Canada Agreement (USMCA). During the CAR roundtable discussions, USMCA rules of origin were highlighted as a driver of manufacturing investment in North America. In fact, some investment announcements captured in the CAR Book of Deals in 2024 cited compliance with these rules of origin as a driving factor in why a particular location was chosen.

Roundtable discussion of the policy aspect of EV affordability identified a few other areas where policymakers can have an impact. Participants reiterated the necessity for robust EV charging infrastructure before widespread adoption of EVs. On the EV charging front, the challenge of how to provide equitable charging access for consumers living in a multifamily home and addressing the cost differential of public charging versus home charging is an area where policy can play an influential role. The importance of rebate programs, both for EV purchases and for manufacturers was also highlighted – especially in conjunction with tariffs. Participants from REMI, a provider of state, local, and national macroeconomic policy analysis models, demonstrated that their model forecasted job losses with the implementation of tariffs alone protecting the automotive industry; however, the model forecasted net job gains in the event tariffs were accompanied by rebate incentives. On the manufacturing front, while there are some programs available, supporting small and medium sized manufacturers during this historic propulsion technology transition is necessary. As noted in the supply discussion, suppliers can not rely on large orders from automakers in the face of uncertainty in the market – creating even more uncertainty for

[54] USITC presentation to CAR, June 2024

small and medium sized manufacturers in the supply chain that rely on large orders to amortize retool investments. Here too there is an opportunity for policymakers to help remove uncertainty and risk further up the supply chain.

Building on potential roles for policymakers to reduce uncertainty in the EV transition, and in turn leading to more affordable EVs, the CAR roundtable discussion stressed the need for support to de-risk startups and entrepreneurs and support robust research and development budgets. As also discussed in the supply aspect of EV affordability, technological advancement is critical in the path toward affordability. Policies to de-risk startups and entrepreneurs can facilitate faster time to market for cutting edge technologies or new manufacturing processes that can reduce product cycle times that ultimately reduce costs in future EVs. Another area of uncertainty where policy can have great influence is in general EV incentives and EV regulations. Commitment to policy initiatives in the long run provides more certainty and confidence for automakers and suppliers as they announce record-high investment in the transition to electrification. Furthermore, standardization or harmonization of regulations across not just states but internationally can lead to reduced costs for automakers. Finally, and perhaps most importantly, CAR engagement with industry and policymakers has indicated the need for manufacturers to actively communicate with legislators to inform policy making. Healthy industry-policymaker relationships are critical to establishing a robust communication pipeline, helping to inform and create effective policy initiatives informed by the realities of the automotive environment.

Conclusion

Vehicle affordability is a nuanced concept. In the context of EVs, affordability is critical for the industry to meet climate goals put forth by policymakers. Furthermore, as the global automotive industry transitions toward electrification, affordability may be critical for domestic manufacturers to remain competitive in the future of electrified mobility. CAR explored three aspects of affordability: supply, demand, and policy – all of which are intertwined and necessary to meet the dual objectives of widespread EV adoption and maintaining a robust automotive manufacturing industry within the US.

The automotive industry has coalesced around an affordable price point – the $25,000 EV. CAR analysis supports this benchmark of affordability, suggesting that half of US households may be able to afford such a vehicle. Advances in battery technology and chemistries, the introduction of new materials, and implementing engineering decisions and manufacturing efficiencies all have a role in lowering production costs and, therefore, could lead to more affordable sticker prices. Strong automaker-supplier relationships are essential and can help provide certainty for small and medium sized manufacturers weighing the risks of investing in the tooling and talent necessary in the transition to support EV manufacturing. The largest source of uncertainty facing the supply side, i.e., manufacturers, in the transition to electrification? Consumer adoption.

To reach economies of scale that can lower supply side costs, widespread demand must exist in the market. While tax incentives like the new clean vehicle tax credit can make EVs on the market more affordable, sticker price is not the only hurdle to widespread adoption. Robust charging infrastructure is paramount to consumer adoption and both the private and public sector have a role to play. Another key consideration – the $25,000 EV - must be a vehicle consumers want to drive and one that fulfills the utility needs of the household.

Challenges from both the supply and demand side of the EV affordability equation can be mitigated in part through thoughtful policy. While some effective initiatives are already in place, roundtable discussions highlighted the difficulty of policy meeting the dual goals of both widespread EV adoption and supporting a robust domestic automotive industry. Expanding charging access in an equitable way can lead to greater consumer acceptance of EVs. Policies that de-risk startups, entrepreneurs, and research and development investments can incentivize innovation that could lower costs. There is a role for policymakers to facilitate electrification. Clear and consistent policy can lessen uncertainty faced by the industry in this historic transition. But the burden does not fall solely on policymakers – relationships are critical and open communication channels between legislators and manufacturers can lead to informed policy initiatives that understand the realities of the market faced by the industry.

This analysis focused on identifying and describing dimensions of affordability of new EVs in the US market. EV affordability, and vehicle

affordability regardless of powertrain, is multifaceted and warrants further discussion. The concept of total cost of ownership (touched on in the demand discussion) including maintenance and repair costs, the used vehicle market and EV leasing, and the interplay of affordability with the growth of advanced driver assistance systems and autonomous driving technologies are all areas that require further thought and discussion. CAR remains engaged on this topic and looks forward to further research, dialogue, and collaboration with the automotive industry enabling a more viable and sustainable automotive ecosystem.

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