Chapter 2

Electric Vehicle Production Costs and Financial Impacts

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Abstract

Factors such as global warming, energy supply security, and environmental sustainability have made a profound transformation in the transportation sector inevitable. This global shift has positioned electric vehicles (EVs) at the center of automotive production. Sustainability targets, carbon-emission regulations, fluctuations in oil prices, and concerns regarding energy supply security further reinforce this position. However, despite the growing demand for electric vehicles, various financial and structural challenges persist throughout the adoption and production processes. EV manufacturing costs are shaped by the high share of battery systems in total costs, supply-chain organization, economies of scale, software-based vehicle architectures, and capital-intensive manufacturing processes. Therefore, examining EV production costs is critically important in terms of economic accessibility, financial sustainability, investment strategies, and competitive advantage. This study aims to analyze the cost structure of electric vehicle production and to evaluate the financial effects of these cost components.

1. Introduction

In recent years, the transportation sector has been undergoing a transformation process on a global scale. This transformation process has brought electric vehicles (EV) to the forefront of the automotive industry. Concerns such as sustainability goals, carbon emission policies, fluctuations

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in oil prices, and energy supply security seem to be further solidifying this position.

As the world moves toward a more sustainable future, EVs have emerged as a promising alternative to traditional internal combustion engines (ICE) (Bege and Tóth, 2024: 937). The automotive market is undergoing a shift from internal combustion engines to alternative powertrains, particularly EVs. By 2030, approximately 70% of new vehicle registrations in Germany, approximately 30% in the US, and approximately 55% in China are expected to be battery electric vehicles (BEV) (Deloitte, 2022). Essentially, this transformation is based on factors such as sustainability, efficiency, and performance, and is a response to the call for green energy and sustainable mobility (Zhao, 2024).

As demand for EVs continues to grow today, the adoption process is occasionally accompanied by certain setbacks. This is because the adoption process is shaped by technological innovations, the structure of production costs, and the financial implications of these costs. The significant share of battery systems in overall costs, supply chain organization, economies of scale, software-based vehicle architectures, and capital-intensive production processes directly affect the economic accessibility of EVs. Therefore, analyzing electric vehicle costs emerges as a comprehensive assessment area that must be addressed in the context of financial sustainability, investment strategy, and competitive advantage.

2. The Economic and Strategic Importance of Electrification

Factors such as global warming, energy supply security, and environmental sustainability have necessitated a fundamental change in the transportation sector. Road transport accounts for approximately a quarter of total carbon emissions, contributing to the acceleration of climate change (IEA, 2023). For this reason, many countries have accelerated policies aimed at reducing emissions in transportation in line with their national climate goals.

The European Union's Green Deal, the US Clean Vehicle Program, and China's New Energy Vehicle (NEV) strategy have made electrification a systematic transformation area in the automotive sector. Electrification is seen both as a necessity due to environmental impacts and as a strategic value in terms of reducing energy dependence and making energy costs predictable in the long term (BNEF, 2023).

However, the impact of electrification on the automotive industry is not limited to reducing environmental impacts and improving energy strategies. Furthermore, fully realizing this transformation requires re-examining and thoroughly evaluating all economic dimensions, such as production costs, capital requirements, supply chain structure, and pricing strategies.

The widespread adoption of EVs is critical to maximizing environmental, economic, and social benefits. However, achieving this success depends on comprehensive economic assessments and simultaneous implementation of necessary steps. These steps can be listed as follows (Güray and Merdan, 2021: 31):

- Vehicle prices should be lowered to make them more affordable.
- The automotive industry must quickly adapt to government policies and user expectations.
- Vehicle ranges should be extended and access to charging points should be made easier.
- The charging infrastructure should be expanded simultaneously, and electrical grids should reach a capacity that can efficiently handle this increased load.
- Battery performance should be continuously improved.
- Regulations should be implemented to ensure the economic and environmental sustainability of battery supply chains.

3. The Development of Electric Vehicles and Strategic Objectives

Recent developments in the EV sector have significantly shaped the strategic investments and production targets of automotive manufacturers. In this context, the development of EVs and the strategic goals of leading manufacturers for the 2020–2030 period are summarized chronologically below (Deloitte, 2023):

In 2020, Tesla began production at its factory in China with an annual capacity of 500,000 EVs, while Jaguar Land Rover planned to invest £1 billion in EV production in the United Kingdom. In the same year, SAIC Motor Corporation and Volkswagen invested $2.33 billion in Chinese EV companies; Toyota and BYD established a joint venture to develop fully EVs; and BYD and Hino signed a strategic collaboration agreement to develop commercial BEVs.

In 2021, BMW planned to electrify 25% of its vehicles in Europe and to reach its target of 1 million EVs; Toyota launched 30,000 EVs, while Mazda released its first electric vehicle. In 2022, Fiat Chrysler announced that 60% of its vehicles in Europe would be hybrid or fully electric, Renault–Nissan–Mitsubishi stated that 42% of its European sales would be electric, and Honda announced that all of its major models would be electrified by 2022. Ford, meanwhile, planned 40 electric vehicle models and an investment of $11.5 billion.

In 2024, global EV sales exceeded 17 million, surpassing 20% of total car sales. In China, nearly half of all car sales were electric, accounting for two-thirds of global EV sales, and grew by 40% annually. Sales in Europe remained stable, while sales in the United States increased by 10%, with one out of every ten vehicles being electric (IEA, 2025: 10, 16).

By 2025, the VW Group planned to achieve 25% of its global sales with EV; Toyota targeted a total of 5.5 million sales and 0.5 million EV sales; BMW aimed to increase the EV share in the European market to 33%; and GM planned to sell approximately 1 million EVs. Volvo aimed for 50% of its global sales to come from EVs, while Hyundai targeted expanding its portfolio to 44 models and selling 670,000 EVs (Publive, 2022; IEA, 2025: 10, 16).

The 2030 targets reflect the transformation within the sector: BMW aims for a 50% EV share in the European market; Mazda plans for all its models to be electric or hybrid by the early 2030s; and Honda aims for two-thirds of its global sales to consist of EVs. The VW Group plans for 40% of its global sales to come from EVs and to introduce 70 new models; Daimler aims for more than 50% of its sales to be electric; and GM plans for Cadillac to consist predominantly of EVs (Deloitte, 2023).

These developments demonstrate that EVs have gained a central position in the automotive industry and that production and sales strategies are increasingly aligned with long-term transformation goals.

4. Cost Structure of Electric Vehicle Technologies

EVs differ significantly from traditional internal combustion engine vehicles (ICEV) both at the component level and in terms of production logic. In ICEVs, the majority of the cost is concentrated in mechanical components such as the engine block, fuel injection system, exhaust and emission control units, turbocharging systems, and complex multi-stage transmission structures. In contrast, in EVs, the number of mechanical moving parts is significantly reduced, and the cost components shift to energy storage, power transmission electronics, and software-based control architectures (Girardi, Gargiulo and Brambilla, 2015; Albatayneh et. al, 2020; Colombo et. al, 2024; Kurkin et. al, 2024).

In EVs, costs are primarily concentrated in the following components:

- Battery system (cell, pack module, BMS, and thermal management)

- Electric motor (including synchronous/asynchronous design choice)
- Power electronics (inverter, converters, DC/DC systems)
- Thermal management and cooling cycles
- Software and control algorithms.

The costs of these components vary depending on the material density used, production technologies, R&D investments, and supply chain structure. The cost distribution presented in Figure 1 shows that the battery system alone accounts for between 30–40% of the total production costs. This ratio clearly demonstrates that the cost structure of EVs is determined by energy storage technologies. Power electronics and motor systems account for approximately 15–25% of the cost (Mittal and Shah, 2024:4).

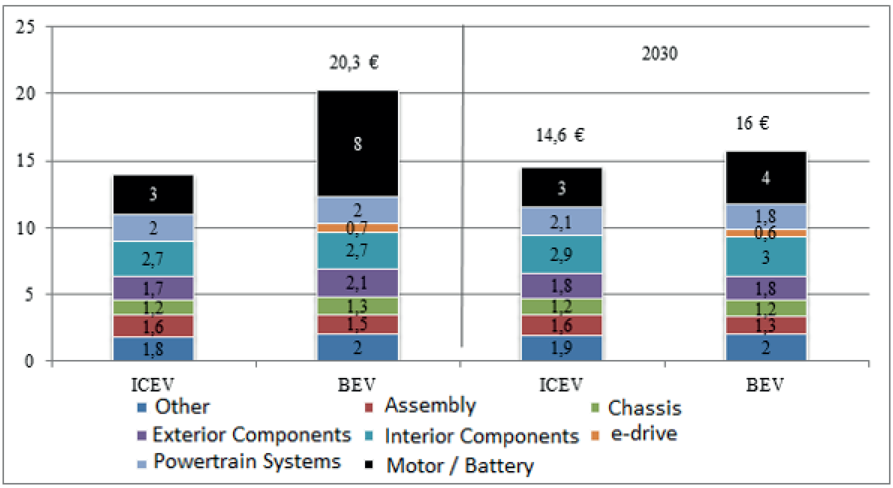

Figure 1: Cost structure of EVs compared to traditional vehicles

Source: Mittal and Shah, 2024:4; Ruffo, 2020

Figure 1 shows that the largest portion of costs in EVs stems from the battery system. This distribution reveals that battery costs are a decisive strategic factor in terms of intra-industry competition, pricing, product diversification, and market penetration. However, it is observed that the share of software and power electronics components is gradually increasing as vehicles become more digitalized and gain greater autonomous driving capabilities.

The proliferation of autonomous driving technologies is leading to the addition of new and high-value components to the cost structure. Radar sensors, LIDAR systems, cameras, processor-based central control units, and artificial intelligence-supported driving algorithms not only add to a vehicle's hardware costs but also increase its life cycle costs due to the constantly updated software infrastructure (König et al., 2021:2). Therefore, in the automotive industry, software is no longer just an auxiliary component of production but has become one of the fundamental elements determining cost and competitive advantage.

While engine performance was one of the key features distinguishing brands in traditional vehicles, energy efficiency, software quality, and the battery management system (BMS) have become the main determinants of competition in the era of EVs. Since the BMS controls the charge-discharge cycle, thermal stability, and battery life of the cells, it has a critical impact on cost, safety, and vehicle range. For this reason, manufacturers are increasingly positioning BMS development as a strategic area of know-how.

The increasing strategic role of software and battery management systems in electric vehicles necessitates a component-level analysis of manufacturing costs. In this context, Table 1 presents the distribution of electric vehicle manufacturing costs based on a traditional vehicle production cost structure.

Table 1: Distribution of Electric Vehicle Manufacturing Costs

1. Vehicle Structural Systems		**.≈28%**
Body-in-White (BIW)	≈15%	
Chassis & Suspension	≈8%	
Interior Systems	.≈5%	
2. Electric Powertrain System		**≈12%**
Electric Motor	≈5%	
Inverter & Power Electronics	≈4%	
Reduction Gear	≈3%	
3. Energy Storage System		**≈38%**
Battery Cells	≈25%	
Module & Pack Assembly	≈7%	
Battery Management System (BMS)	≈3%	
Thermal Management	≈3%	
4. Electrical & Electronic Systems		**≈8%**
High-Voltage Cabling	≈3%	
On-Board Charger (OBC)	≈3%	
DC/DC Converter	≈2%	
5. Manufacturing & Overhead Costs		**≈14%**

Assembly Labor	≈6%
Factory Overhead Costs	≈5%
Logistics & Supply Chain	≈3%
Total Production Costs	**100%**

References: Argonne National Laboratory (2024), produced using data from the U.S. Department of Energy (2023).

As shown in Table 1, energy storage systems account for approximately 38% of electric vehicle production costs, followed by vehicle structural systems (28%), electric powertrain systems (12%), electrical and electronic systems (8%), and manufacturing and overhead costs (14%).

4.1. Battery Systems and Determinants of Production Costs

Battery systems account for the largest share of electric vehicle production costs. Batteries can account for up to 30–40% of the total vehicle cost due to both the requirement for high energy density and the sensitivity of the supply chain and price fluctuations of the raw materials used in their production (lithium, nickel, cobalt, graphite, manganese, etc.) (Nicoletti et al., 2020:4). This ratio indicates that battery costs are determined not only by technical specifications but also by geopolitical, strategic, and economic conditions.

The main reasons for high battery costs include:

- Geographic concentration of global raw materials (e.g., most cobalt is processed in Congo, most graphite in China),
- Battery production facilities require high capital expenditure (CAPEX),
- Production consumes high amounts of energy,
- High precision process control is required in cell production.

Reducing battery costs is seen as a technical R&D issue, but it is also viewed as a matter of supply chain strategy, regional production policy, and capital planning. Furthermore, transformations aimed at reducing battery costs also play a decisive role in battery performance, safety, and vehicle range.

Table 2: Current Trends in Battery Technologies

Technology / Trend	Effect	Financial / Performance Outcome
Widespread adoption of LFP (Lithium Iron Phosphate) cells	Minimizes the use of cobalt and nickel	Increases battery safety; lowers cell cost; provides longer cycle life
High-nickel cathode structures (e.g., NCM 811)	Increases energy density and driving range	Creates a competitive advantage for long-range vehicles, but raises raw-material supply risks
Solid-state battery development	Replaces liquid electrolyte, reducing weight and thermal risk	Has the potential to reduce cost per kWh and enable ultra-fast charging in the medium to long term

References: Blomgren, 2016; Xu, 2014; Janek and Zeier, 2016; Dunn et. al, 2021; Rajaeifar et. al, 2022; IEA, 2023; Albatayneh et. all, 2020; Colombo et. all, 2024.)

Projections regarding battery systems, which are a key factor in the cost structure of EVs, provide an important framework for how production costs will evolve in the medium and long term. Estimates published by BloombergNEF (2023) and the IEA (2023) show that battery production costs were around $140–160/kWh in the early 2020s. With technological advances maturing, production capacity expanding, and raw material supply chains becoming more efficient, these costs are expected to decline to $70–80/kWh by 2028–2030. This decline is not limited to advances in cell production techniques; it is also the combined effect of factors such as increased production scale, the proliferation of regional battery factories, material optimization in cell designs, and the commercialization of battery recycling processes.

This improvement in battery costs represents a critical strategic and financial threshold in the electric vehicle market. The decline in costs is accelerating the shift toward electrification in consumer preferences by bringing EVs closer to price parity with internal combustion engine vehicles. Rapson and Muehlegger (2023:4) describe this as a positive feedback loop in terms of diffusion dynamics: falling costs increase price competitiveness, competitive prices increase demand, increased demand increases production volume, and rising production volume in turn reduces costs through economies of scale. This mechanism is one of the fundamental economic dynamics supporting the acceleration of electric vehicle market penetration.

Therefore, the decline in battery technology costs is considered a technical improvement area, but also a macroeconomic transformation factor that reshapes the automotive industry's competitive positioning, investment strategies, and production architecture.

4.2. Financial Impacts of Production Costs

Electric vehicle production is structurally a capital-intensive investment area. Battery cell production lines, packaging facilities, power electronics modules, thermal management components, software development platforms, and safety/validation testing infrastructure require a high level of capital expenditure (CAPEX) (Nelson, Santini and Barnes, 2009; ICCT, 2024). The financial impact of such investments is reflected in financial statements, particularly through increased depreciation expenses and the recognition of assets as long-term liabilities on the balance sheet (König et al., 2021). Consequently, cash flow management becomes critically important for businesses, and pressure builds on short-term profitability ratios.

Therefore, in electric vehicle development processes, investment evaluation and financial feasibility analyses are also decisive factors alongside engineering parameters. The design of new vehicle platforms and production capacity planning are evaluated using capital budgeting tools such as Net Present Value (NPV), Internal Rate of Return (IRR), and payback period (Kochhan et al., 2017:4). These analyses aim to measure both the technical feasibility of investments and the sustainability of their long-term strategic returns and profitability potential.

The decline in electric vehicle production costs over time has a direct positive impact on companies' financial performance indicators. Along with the decrease in unit costs:

- EBITDA margins expand,
- ROA (Return on Assets) and ROE (Return on Equity) ratios improve,
- Companies' market valuation strengthens.
- Credit risk premiums and capital costs decrease.

This situation both increases investor confidence in manufacturing companies and enables them to build their long-term growth strategies on more solid financial foundations. Therefore, cost management in electric vehicle production is not only a technical process aimed at increasing production efficiency but also a financial optimization process that shapes companies' capital structure, competitive positioning, and market strategies (Deloitte, 2024). In other words, cost control is a key determinant of strategic financial sustainability for electric vehicle manufacturers.

5. Economies of Scale, Increased Demand, and Market Dynamics

The transformation in the production cost structure of EVs is closely related to technological innovations, production scale, and market expansion. Increased demand in the electric vehicle market enables the expansion of production capacity and, consequently, the strengthening of economies of scale. As production volume increases, the distribution of fixed costs per unit decreases, leading to a reduction in unit production costs. In addition, platform and software development costs are spread across a wider product range with the addition of new models to the production line; thus, the marginal development costs of software-based control architecture are gradually decreasing (Becker et al. 2018:12).

On the supply chain side, increasing market size is accelerating the establishment of regional battery production centers, the conclusion of long-term supply agreements for critical minerals, and the trend toward localization in component logistics (Hafner and Modic, 2020; Zheng, 2024; Gadi, 2025). This effect is particularly evident in economies such as the European Union and the United States, which treat battery supply security as a strategic priority. Increased localization contributes to cost stability by reducing both transportation costs and currency and geopolitical risks (IEA, 2024; ICCT, 2023.

Cost reductions and the maturing of the supply chain are accelerating the approach of EVs toward price parity with internal combustion engine vehicles. Reaching price parity expands consumer demand and creates a self-sustaining economic cycle of market growth. This is described in the literature as a positive feedback loop (Ziegler and Trancik, 2021):

Demand increases → Production volume increases → Unit cost decreases → Price becomes competitive → Demand increases further.

In other words, cost reduction is not only a result of the production process, but also an accelerator of market growth. Therefore, the widespread adoption of EVs depends not only on technical progress, but also on market scaling and strategic industrial coordination processes. As electric vehicle technologies mature, cost advantages and price competitiveness will lead to a redistribution of the sector's value chain, the geographical positioning of production centers, and a reshaping of global competitive balances.

6. Conclusion and Overall Assessment

EVs are not merely a new transportation technology; they represent a structural transformation area where the global automotive value chain, production architecture, and competitive dynamics are being reshaped. Advances in battery technology, increased efficiency in power electronics, and the development of software-based control systems are progressively improving both the technical characteristics and economic accessibility of EVs. In particular, declining battery costs and regionalization trends in supply chains are accelerating the convergence of EVs toward price parity with internal combustion engine vehicles.

In the short term, electric vehicle production can put pressure on company balance sheets due to high capital investment, capacity expansion costs, charging infrastructure requirements, and supply chain scaling. However, in the medium and long term:

- decrease in unit production costs,
- improvement in profitability ratios,
- expansion of market share,
- reduction in operating and maintenance costs,
- increase in energy efficiency advantages.

This demonstrates that EVs have the potential to create sustainable value for both manufacturers and consumers, as well as for national economies.

Therefore, managing the production costs of EVs requires a coordinated approach that combines technical decisions aimed at engineering efficiency with strategic investment planning, financial sustainability analysis, and industrial policy coordination. For companies, this process necessitates striking a balance between the selection of new technologies and capital allocation, while for governments, it requires designing industrial support mechanisms in a way that creates long-term competitive strength.

As a result, EVs will continue to be a strategic technology area that shapes the automotive sector, energy infrastructure, urbanization trends, and the concept of sustainable mobility in the coming period.

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