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McKinsey Center for Future Mobility

Electrifying the bottom line

How OEMs can boost EV profitability

September 2021

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Contents

Introduction and key messages

Electric vehicles[1] (EVs) are making up an increasing share of automotive markets around the world, and as such are becoming ever more central to automakers' business models. Although light vehicle sales dropped by 14 % in the year of the pandemic, BEV and PHEV sales increased by 43%. Across all electrification drivers we see a positive momentum and higher certainty of a path towards a zero-emission electric future. Electrification is not a regional trend anymore, but momentum has built globally across:

— **Regulation:** Net-zero climate goal commitments in some regions (e.g., EU Green Deal, US Biden program) result in stricter carbon emission targets and some ICE sales bans by 2030.

— **Total cost of ownership (TCO):** High level of subsidies and tax incentives (up to USD 10k per BEV) and the reduction in battery costs (best in class battery cells have crossed the 100 USD/kWh barrier) result in a TCO advantage for BEVs vs. ICE today in most regions

— **OEMs:** Majority of automakers are committing to go all electric by 2040, while some even target 2030 and plan to launch 400 new BEV models by 2025, giving consumers options across all vehicle classes

— **Consumers:** Electrification has become mainstream (more than 50% of car buyers would consider EVs) and sustainability trend combined with larger EV model offering will further accelerate consumer demand for EVs

— **Infrastructure:** Infrastructure is still a major challenge and bottleneck for the EV ramp-up as ~10 k charging points need to be installed every week in theory to keep up with the EV ramp-up (Example EU). However, some acceleration can be observed, also driven by public funding (i.e., USD 42 bn for US EV infrastructure)

With this shift, incumbent OEMs and new EV players alike are searching for profitable EV business models and a sustained competitive advantage as mass market EV profitability is still a challenge. The accelerating pace of change in the EV market and consumers' emerging loyalty to EV brands present a unique opportunity for OEMs to redefine their automotive business models and elevate profitability[2] significantly beyond the market average. Many OEMs are going to great lengths to push EVs into the market to meet new CO_2 targets and avoid significant financial and nonfinancial penalties.[3] Despite the strong momentum behind design and production, many automakers are still defining their path toward reaching target profitability for their EV business.

This report aims to support industry players in improving their EV business strategies by answering some key questions that are currently on the minds of most OEM executives:

— What is the current profitability for typical EVs across different vehicle segments – and how will the profitability of EVs develop through 2030?

— Which incremental cost levers can automakers pull and which more radical strategic moves can they make to boost their EV profitability?

— How can automakers select and then successfully implement the measures that best fit their current capabilities and strategic claims?

To provide answers to these questions, we engaged in a course of research that assesses EV profitability from two distinct vantage points: benchmarking and bottom-up modeling (Text box 1).

1 EVs include battery electric vehicles (BEV) and several forms of hybrid-electric vehicles, such as plug-in hybrid-electric vehicles (PHEV). This article focuses on BEVs as they are likely to sustain beyond hybrid vehicles.
2 In this report, we will discuss profitability as the profit margin, i.e., sales revenue minus cost of goods sold (COGS).
3 In China, Europe, and selected states in the US.

Text box 1: How we derived the insights presented in this report

- **Benchmarking profitability among current EV models.** Outside-in analysis of current vehicle models in standard configurations, comparing vehicle sales price (MSRP[4]) and estimated costs, including COGS, SG&A, and other markup costs.

- **Analyzing EV profitability along three vehicle classes.** Bottom-up modeling of EV profitability in 2021, 2025, and 2030 across the entry-level, mid-point, and high-end vehicle segments, taking into account significant cost drivers, e.g., the decline in battery costs, scale effects in component costs, and intensifying competition. In this context, please note that our bottom-up analysis of the 2021 cost structure for the mid-point vehicle segment – compared with our 2019 EV perspective, which was published in January 2020[5] – shows not only some cost reduction, but also increased battery sizes. For further details, see Appendix I. Additionally, the data was compared with McKinsey's benchmarking of 10 Chinese EV models[6] to validate the figures.

- **McKinsey expert insights.** Leveraging models from McKinsey's Center for Future Mobility (MCFM) and condensing the latest findings, knowledge, and methods from McKinsey's Product Development and Procurement Practice (PDP) along with our access to global automotive experts forms the basis of the comprehensive and global perspective presented in this report. The aggregation of these insights shaped the design and quantification of both the incremental levers and the radical moves frameworks presented in this report.

We have distilled five insights from our research on EV profitability:

- **While market penetration is up, profitability remains low for current EV models.** Although the penetration of EVs in key markets is on the rise, profitability currently remains low (slightly above breakeven). This is especially true for mid-point and entry-level segments as scale effects from volume increases are not yet sufficient to compensate for price pressure in an increasingly competitive market.

- **Despite price pressure, EV profitability is expected to rise.** Continuing the business-as-usual scenario, profit margins are likely to reach 8 to 10% by 2030. However, OEMs can likely achieve greater margins by going beyond current practices.

- **Incremental measures have the potential to raise the bar and improve margins.** With an incremental levers approach (i.e., through adopting industry best practices), automakers can increase their profit margin by an additional 8 percentage points by 2030.

- **More radical moves could contribute to even higher profitability.** To increase EV profitability further, automakers can take a bolder approach with radical moves to their EV business models. This could increase profit margins again by an additional 5 to 12 percentage points to up to 20 percentage points over the business-as-usual scenario by 2030.

- **Some improvement measures are OEM-agnostic, while others consider organizational maturity and vehicle class.** The applicability of others will depend on region. All of the incremental moves are rooted in industry best practices and are available and appropriate for consideration by all OEMs. The more radical strategic moves, however, will have varying degrees of relevance based on both whether an OEM is new to the EV business or relatively experienced and which vehicle segment is primary to its EV business.

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4 MSRP = manufacturer's suggested retail price.

5 "The road ahead for e-mobility: How can automakers captivate consumers and achieve mass-market electric-vehicle adoption?," Andreas Tschiesner, Russell Hensley, Patrick Hertzke et al., January 27, 2020; https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/the-road-ahead-for-e-mobility.

6 "How to drive winning battery-electric-vehicle design: Lessons from benchmarking ten Chinese models," Mauro Erriquez, Philip Schäfer, Dennis Schwedhelm et al., July 10, 2020; https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/how-to-drive-winning-battery-electric-vehicle-design-lessons-from-benchmarking-ten-chinese-models.

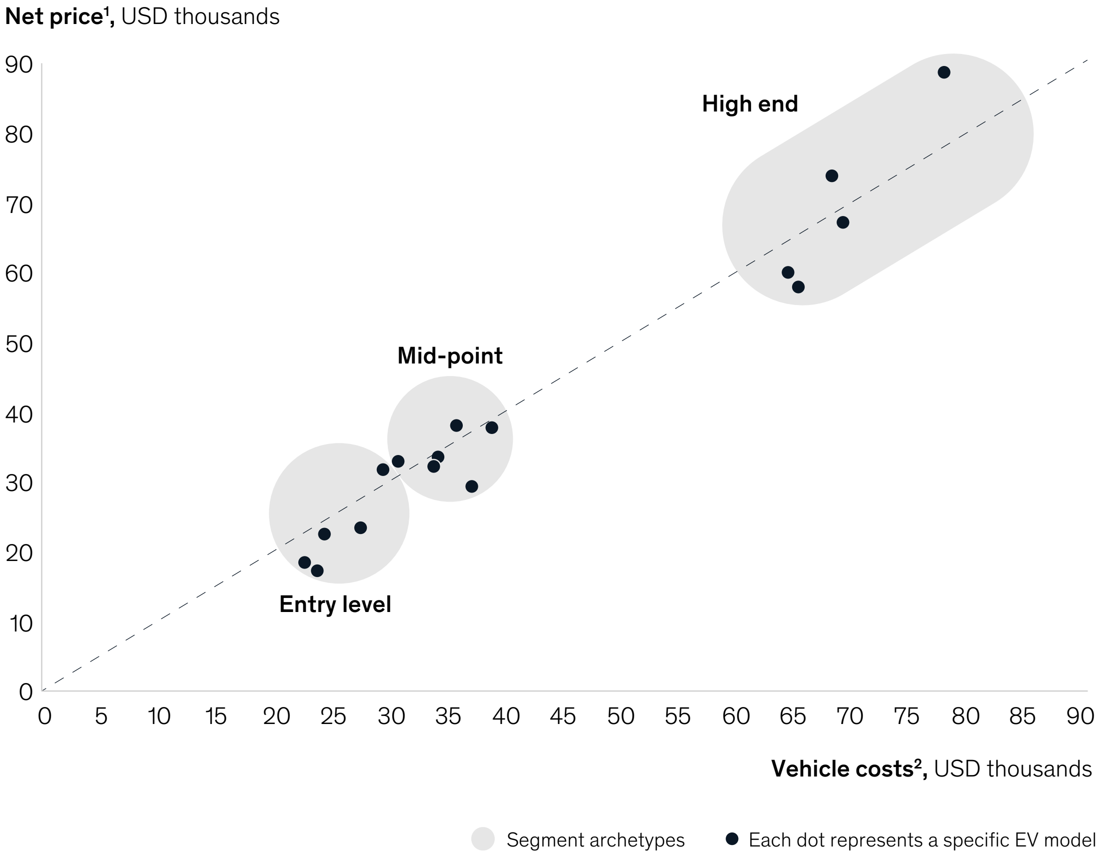
Key challenges and market-force realities test mass-market EV profitability

EV sales are on the rise in key EV markets around the globe. In Europe, sales have seen the strongest development over the last year from 4.4% market share in Q4/2019 to 15.9% in Q4/2020, fueled by tightening CO_2 regulations and strong purchasing incentives. In China, EV sales grew 79% in Q4/2020 compared to Q3/2020, soaring above pre-COVID-19 levels with over 600,000 units sold and a penetration rate of 7.9% (4.3% in Q4/2019). While federal subsidies have been scheduled to decrease and expire, more promotion of EVs by OEMs to customers in rural areas and incentive programs by local governments are currently key growth drivers. In the US, EV sales grew less rapidly at 23% in Q4/2020 compared to the previous quarter, mainly driven by strong demand for Tesla's Model 3. With 119,000 units sold in Q4/2020 and a market share of 2.9% (up from 1.9% in Q3/2019), EV market penetration in the US is still significantly behind that of Europe and China, which have stricter CO_2 regulations.

Despite growing sales, however, current EV profitability is only slightly above breakeven in all three markets and for the three model segments[7] that we identified for the purpose of this report. Accordingly, our analysis of 16 current EV models (largely focused on the European market) also shows that despite a very small number of models in the high-end segment attaining significant profitability, for most models the net price is approximately equal to the cost (Exhibit 1).

Exhibit 1

An analysis of current EV models shows that EV profitability is breakeven and varies only slightly by model and segment



1. Manufacturer's suggested retail price (MSRP), excl. VAT
2. Total costs, incl. bill of materials (BOM), production, R&D, SG&A, warranty, cost of retail, incentives, and subsidy OEM share
Source: McKinsey Center for Future Mobility

7 Comparing different price and cost levels for EV models, we identified three model segments: "entry level," "mid-point," and "high end." For further details on these three segments, see Exhibit 11 in Appendix II.

Overall, OEMs are facing major challenges that are intrinsic to the EV market and make greater profitability difficult to attain (Exhibit 2).

Higher EV component costs. EV drivetrains require a significant price premium as EVs require a battery pack of 50 to 120 kWh at an average price point of approximately 120 USD/kWh plus e-motor and power electronics. Smaller, cost-saving batteries are less of an option because insufficient charging infrastructure compels OEMs to mitigate customers' "range anxiety" with bigger batteries. Overall, component costs for EVs exceed that of an internal combustion engine (ICE) powertrain by USD 3,000 to 14,000.[8]

Necessary charging infrastructure investments. Seamless charging with a dense charging station network and available chargers is a key requirement for consumers to switch to EVs as our research on consumer preferences has shown.[9] For markets with significant EV penetration, this means that the number of charging poles needs to grow somewhat proportionally with the number of vehicles in the market.

A McKinsey analysis[10] estimates that an EV ramp-up requires an infrastructure investment of USD 110 to 180 billion.

High R&D and capex investment. Upfront R&D and capital expenditures (capex) is significant. Leading automakers plan to invest billions in EVs in this decade – including in new platforms, models, and manufacturing plants – while announcing plans to phase out ICEs. A REUTERS analysis[11] shows that global automotive OEMs have announced approximately USD 300 billion in investments in EVs and related infrastructure. These high investments are depreciated over initially lower volumes compared to ICE vehicles.

Additional battery disposal costs. The residual value of batteries currently remains negative, forcing OEMs to set up provisions for their disposal, which will cost USD 1,000 to 2,000 per battery. And while companies in the battery space have just begun to form partnerships and set up pilot plants that could lead to a second life and/or recycling ecosystem for batteries and, eventually, increase the lifetime value of the EV battery, disposal costs will continue to be a hurdle for the coming years.

Exhibit 2

Besides challenging price-cost dynamics, six major hurdles hobble EV profitability

OEM bound

Higher EV component costs
+USD 6,000/vehicle

High upfront R&D and Capex investments until 2030
~USD 300 bn

Lower aftermarket maintenance revenues
-60 %

Ecosystem bound

Additional battery disposal costs
USD 1,000-2,000/vehicle

Necessary global charging infrastructure investments until 2030
USD 110-180 bn

Consumers willing to pay zero premium for an EV
>80%

Source: Reboost

[8] Range of figures relates to "entry-level," "mid-point," and "high-end" segments. For details on how cost structures for the mid-point EV segment for 2019 and 2021 differ, see Appendix I.

[9] See page 14 in Andreas Tschiesner, Russell Hensley, Patrick Hertzke et al.: "The road ahead for e-mobility. How can automakers captivate consumers and achieve mass-market electric-vehicle adoption?," January 27, 2020; https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/the-road-ahead-for-e-mobility.

[10] Zealan Hoover, Florian Nägele, Evan Polymeneas et al.: "How charging in buildings can power up the electric-vehicle industry," January 5, 2021; https://www.mckinsey.com/industries/electric-power-and-natural-gas/our-insights/how-charging-in-buildings-can-powerup-the-electric-vehicle-industry.

[11] REUTERS Graphics web article, April 4, 2019; https://graphics.reuters.com/AUTOS-INVESTMENT-ELECTRIC/010081ZB3HD/index.html.

Lower aftermarket revenue. Aftermarket maintenance revenues for EVs are approximately 40% less than for ICE vehicles due to fewer moving parts and less wear and tear. Less service work means smaller profit pools in this high-margin business for automakers and dealers, especially concerning the sales of parts and components.

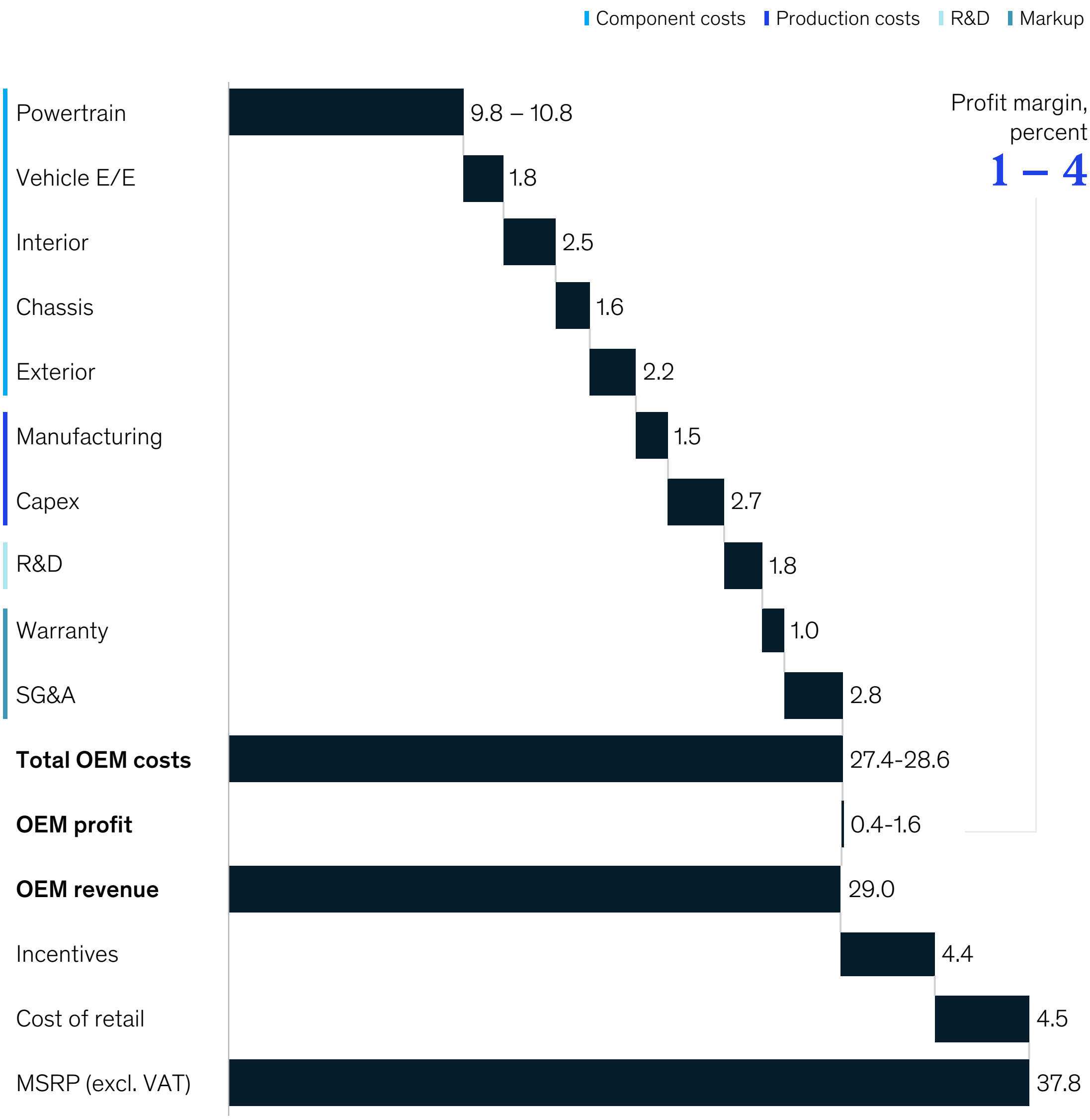
The basis for the EV profitability analysis is a 2021 cost base for the three EV model segments from Exhibit 1 (high end, mid-point, and entry level). An example cost breakdown for the mid-point segment is given in the following chart, Exhibit 3. The cost basis throughout the cost categories (components, production, R&D, and markup) is derived from various McKinsey benchmarks and expert knowledge (Text box 1). To represent variations in pack level battery costs for OEMs, we modeled average costs of about 120 USD/kWh as well as best-in-class costs of about 105 USD/kWh to create a range of powertrain costs and subsequent EV profit margins, which is 1 to 4%.

Looking ahead, the current trajectory of low profitability is expected to continue if automakers do not make targeted efforts. Any gains that come from cost reductions are likely largely erased by price reductions as the following discussion of the two trends show.

Exhibit 3

Cost breakdown of mid-point segment in 2021

Mid-point segment, USD thousands[1]



1. Derivations in ranges due to rounded values
Source: McKinsey Center for Future Mobility

Cost reductions. The rapid increase in battery production capacity, additional competitive pressure from new battery producers, and advancing battery technology will further decrease battery pack costs from about 120 USD/kWh (on average) in 2021 to an expected range from 85 to 90 USD/kWh (on average) in 2030.[12] In addition to this lower component cost, scale effects will become more relevant as production volumes increase. As EVs achieve longer lifetimes and higher volumes, fixed costs will decline even further. Moreover, scale effects in component costs from higher production volumes and the usage of modular product platforms across more than one vehicle derivative will apply.

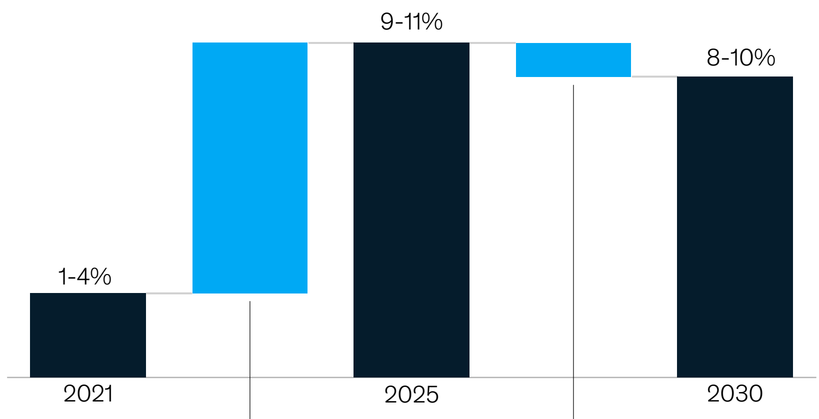
Price pressures. At the same time, average EV sales prices are expected to drop as OEMs shift their focus away from less price sensitive early adopters towards more average consumers. The eventual phasing out of government-provided purchase-price subsidies and tax reductions will be just one driver of price reductions. Purchase-related subsidies are expected to run out between 2025 and 2030 in most countries. Germany, for example, has decided to run subsidies until the end of 2025, and China[13] and the US have not confirmed budgets for purchase subsidies beyond 2021[14]. Still, customers have become used to significant price reductions. Regardless of what governments do, car buyers have an expectation of what the net price of a new EV will be to them, and OEMs will need to compensate for this, at least partially. Additionally, as more and more OEMs introduce EV models to the market – over 1,000 new EV models have been announced by 2030 – the increased level of competition will further pressure price.

Exhibit 4

Development of EV profit margins in a business-as-usual scenario through 2030 – without action only limited profit gains sustainable in 2030

Mid-point segment

Values rounded for simplification



Cost improvement

Volume increase resulting in fixed cost dilution and scale effects

Battery cost reduction

Price pressure

Compensation from expiring subsidies

Pressure to grant battery cost reductions to customers

Cost improvement

Scale effects and battery cost reductions

Price pressure

Pressure to pass on cost savings to consumers

Source: McKinsey Center for Future Mobility

[12] Best-in-class costs for battery packs are at approximately 100 to 110 USD/kWh in 2021 and expected to be at around 80 to 85 USD/kWh in 2030; numbers are based on the Mckinsey battery cost model.

[13] At the federal level. Local government subsidies might continue for longer.

[14] At the federal level. State government subsidies might differ.

Thus, unless automakers make significant efforts, any improvements in EV profitability will be hampered in size and duration (Exhibit 4). For the mid-point segment, for example, EV profit margins are currently between 1 and 4%, depending on the model. On the current trajectory, profitability in 2025 will reach 9 to 11%. By 2030, price pressures that even further outweigh cost reductions in competitive markets could take that to 8 to 10%.

Without additional action, the profitability of the high-end and entry-level segments is expected to develop in a similar fashion.

Two profitability-boosting approaches lead to desirable EV business outcomes

As EV automakers define their path towards EV profitability, they can consider two approaches to build their chances of a more profitable future: incremental levers and radical moves. The two approaches have different requirements and hence potential outcomes (Exhibit 5). The application of levers might differ by region.

Compared to the ICE business, the target profitability level for the EV business should be equivalent at minimum. Our analysis shows that there is a chance of EVs becoming more profitable than ICE vehicle. When combined, incremental levers and radical moves have the potential to boost EV profitability by up to 20 percentage points (6 to 8 percentage points from incremental levers and 5 to 12 percentage points from radical moves) (Exhibit 6). In this chapter, however, we will first discuss the two approaches separately and quantify their granular impact – per area and dimension[15] – on EV profitability.

Exhibit 5

To substantially improve EV profitability beyond the business-as-usual level, OEMs can rely on two different, but combinable, approaches

	Approach # 1 **Incremental levers**	Approach # 2 **Radical moves**
Objective	Improve current EV lineup	Create a sustainable business model for future EV lineups
Type of lever	Cost focus	Revenue focus
Time frame for profitability improvement	2021-30	2025-30+
Result	Cost-optimized EV lineup	Future-proof EV business model
Categories	Cost levers in the areas of – R&D – Component design – Manufacturing – Marketing and sales	Radical moves in the dimensions of – EV product efficiency – Go-to-market approach overhaul – Life cycle monetization

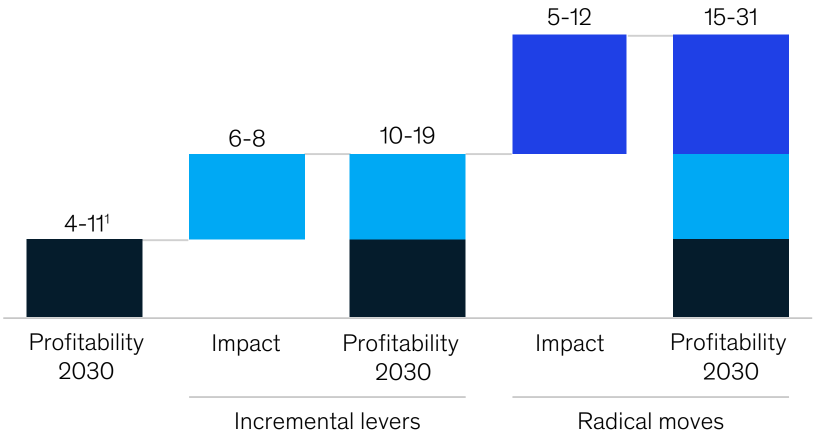
Source: McKinsey Center for Future Mobility

[15] As profit margins and the impact of levers are dependent on the vehicle segment (entry level, mid-point, or high end) the figures indicate the ranges of potential impact. Radical moves include new business models that are not yet proven, hence we only provide rough estimations of quantified impact.

Exhibit 6

Effectively combined, incremental levers and radical moves have the maximum potential to boost EV profitability by up to 20 percentage points until 2030

Profitability based on respective cost basis, percent
All archetypes, theoretical maximum values



1. Mid-point archetype business as usual profitability at 8-10% (see exhibit 4)
Source: McKinsey Center for Future Mobility

Incremental levers for improving current EV business models with industry best practices

The incremental levers approach aims to take advantage of the resources that OEMs already have at hand to move toward greater profitability. At the core of this approach are incremental measures that, while they are meant to be implemented over a decade, can nevertheless bring about some profitability improvements in the short to medium term. Specifically, EV automakers can pull cost levers across 13 categories in four areas of the EV value chain to optimize profitability (Exhibit 7).

The lever categories contain detailed action items for profitability improvement based on a benchmark database.

A Cost levers in the R&D area
R&D for EVs makes up a significantly larger share of overall costs than in ICE vehicles (EV: 5 to 8% of overall costs, ICE: 3 to 5% of overall costs). In this context, OEMs can take three specific actions to reduce their R&D costs:

A1 Share R&D costs with partners. Partner with other companies to share R&D costs in areas where huge efforts are necessary to drive innovation. Potential fields for partnering are the development of e-drive platforms and autonomous driving functions (e.g., non-differentiating layers of the AV-stack).

A2 Optimize make-or-buy trade-offs for drivetrain technologies. Strike a strategic balance between internal versus outsourced R&D content related to batteries, e-motors, power electronics, and control units (e.g., battery management system).

A3 Take advantage of state-of-the-art R&D development methods. Maximize efficiency via agile development, virtual product development, and highly modular product platforms to accomplish significantly reduced development processes (e.g., cut development time to approximately 2 years and separate hardware and software development).

B Cost levers in the bill of materials (BOM) area
Four BOM moves can reduce material and component costs significantly due to new vehicle architectures, which hold sizable optimization potential:

B1 Apply design-to-value (DTV) levers. Optimize requirements and individual components to maximize the value to the customer while being as cost-efficient as possible. An example is to integrate components to reduce hardware complexity in the vehicle system design, e.g., integrated e-drive axles (including e-motors), power electronics, inverters and further mechanical components in the powertrain.

B2 Apply design-to-cost (DTC) levers. Optimize the costs of batteries, key electric drive components, and electrical and electronics architecture by considering all potential changes that will deliver

Exhibit 7

The incremental levers yield impact over three time horizons through 2030 and have a maximum profit potential of 6-8 percentage points

	Levers	In 2021	By 2025	By 2030	**Max. potential profit increase by 2030** Percentage points
A	**R&D**				**0.3-0.8**
A1	R&D partnering in crucial innovation areas	- - -	—▲		
A2	Optimization of internal and external R&D content		- - -	—▲	
A3	Implementation of advanced R&D methods	- - -	—▲		
B	**Component design**				**3.6-4.3**
B1	Design-to-value: requirements and component optimization	- - -	—▲		
B2	Design-to-cost – first wave	—▲			
B2	Design-to-cost - second wave with focus on EV-specific components	- - -	—▲		
B2	Design-to-cost – third wave with focus on non-EV components		- - -	—▲	
B3	Procurement cooperation	- - -	—▲		
C	**Manufacturing**				**0.5-0.7**
C1	Design-to-manufacturing (focus on industrialization)	—▲			
C2	Capex: Reuse of equipment and favorable material concepts	- - -	—▲		
C3	Optimization of make vs. buy of e-drive components		- - -	—▲	
D	**Marketing and sales**				**1.6-2.1**
D1	Dealer network redesign	—▲			
D2	Setup of online sales business	—▲			
Total (depending on the segment)		**~2.5**	**~2.0**	**2.0-2.5**	**6.5-7.5**

- - - Early start (optional) — Implementation process ▲ Profitability effect fully unlocked

Source: McKinsey Center for Future Mobility

the same product functionality at a lower cost. This can be rolled out in three waves. In the first wave the focus lies on quick wins and short-term cost reductions. The second wave is a structured approach regarding EV-specific components. In the third wave, non-EV-specific components are diligently analyzed regarding cost reductions.

B3 Source capacities of key materials directly from upstream suppliers. Engage with upstream players (e.g., raw material suppliers) to secure contracted capacities and prices to address the fact that several EV components require new materials that make up a significant share of the BOM price (especially lithium and other raw materials for batteries). Among other realities related to various types of input, supply chain risks can be mitigated by securing raw material stakes, OEMs can increase their influence via a partnering approach, and the procurement organization can build the additional skills required to accomplish the new set of tasks.

C Cost levers in the manufacturing area

EV production is characterized by low volumes and high capex along with a lack of relevant organizational and technical experience among automakers. Four levers focus on the optimization of the product concept and capex requirements:

C1 Implement design-for-manufacturing (DFM). There is room for EV optimization due to lack of experience with and the low maturity of product concepts, especially for EV-specific components.

C2 Reduce capex by reusing equipment. Production equipment is highly sophisticated and needs to be designed for the vehicle to be produced. As most EVs are based on a new product platform, production equipment from previous vehicle production mostly cannot be reduced. The earlier in the product development process manufacturers take production requirements into account, however, the more reuse – and therefore some capex reduction – can be realized.

C3 Optimize make-or-buy trade-offs for e-drive manufacturing. Instead of manufacturing the drivetrain in-house, different outsourcing scenarios can be pursued, including outsourcing battery cells and packs, power electronics, e-motors, or the complete e-chassis (including all drivetrain components, axles, and structural components[16]).

D Cost levers in the marketing and sales area
While incumbent OEMs often take a traditional go-to-market approach centering on dealers, customer preferences are changing and EV customers expect a more customer-centric approach. This gives rise to at least four different opportunities to increase profitability through improving the go-to-market approach:

D1 Redesign the retail approach toward a lower-cost model. Dealer network redesign consists of two major levers – optimizing the dealer footprint and changing the business model with dealers, e.g., by introducing an agency system with fixed dealer margins for the services dealers offer to sell vehicles.

D2 Promote and sell cars online. In urban areas with a concentration of high sales volumes, direct sales in flagship stores are a means of increasing margins and brand perception. The promotion of online sales can provide customers with the advantage of having a more efficient purchasing process.

In terms of timelines, implementing these activities and realizing their impact on profitability can be expected to span the current decade. Exhibit 7 outlines a potential scenario suggesting which levers can likely be pulled in which of the three time horizons, what their impact might be, and when the action would show up on the OEM's bottom line.

Radical moves for fundamentally evolving EV business models

Companies can also take more radical steps that could increase EV profitability beyond what is possible via the incremental approach described above. Altogether, nine moves across three dimensions could help EV OEMs boost profitability by of 6 to 12 percentage points[17] – thus surpassing ICE profitability (Exhibit 8). As the specific initiatives are tailored to the individual OEM, radical moves and descriptions are kept rather generic.

Exhibit 8

Individualized combinations of nine radical moves can boost OEM's EV profitability by 6-12 percentage points

		Profit potential Percentage points
E	**EV product efficiency**	**2-7**
E1	"Generation 3.0" EVs	
E2	Industry EV platform	
E3	Zero variants and despecification	
F	**Go-to-market overhaul**	**2-3**
F1	Full leverage of online sales	
F2	Radical EV aftersales service approach with OTA vehicle access	
F3	Fast-lane delivery	
G	**Life cycle monetization**	**1-2**
G1	EV-as-a-service	
G2	Battery-as-a-service	
G3	Smart charging	
Total		**6-12**

Source: McKinsey Center for Future Mobility

E EV product efficiency – pushing EV architectures toward high volumes and doubling down on scale effects
In recent years, incumbent OEMs have reengineered existing EVs via a conversion design approach, exchanging the drivetrain of existing ICE vehicles

16 This is referred to as rolling e-chassis and requires distinct vehicle architecture.
17 It is highly unlikely, however, that a single OEM will be able to implement all nine moves in a meaningful way; instead, OEMs will need to select moves based on the strategic context of their individual business. For further details on this, see chapter 3.

for a battery, e-motor, and other components. The result of this approach is a vehicle that neither optimally suits user requirements nor achieves the full specification and performance potential of EVs. Many OEMs recognize dedicated EV platforms as the way forward. In addition, the typical EV customer is tech-savvy, urban, and younger and has a different mindset toward vehicle specifications than ICE consumers. EVs should thus be designed to more fully meet the needs of this specific customer segment. Here, we identified three radical moves:

E1 Design "Generation 3.0" EVs. This move refers to extreme modularization and a focus on design for (efficient) manufacturing. This is to enable the deployment of many use case-specific vehicle derivatives on the same EV platform without losing scale effects. This is enabled by skateboard architectures – the current state-of-the-art approach for EV platforms, where the battery occupies the floor of the EV and the motor is situated between the wheels. This approach enables battery configurations to be customized for specific use cases with different levels of energy demand and, therefore, battery sizes. Ultimately, the same EV platform can potentially be used for passenger cars, light commercial vehicles (LCVs) with cargo space instead of back seats, pick-ups with a loading area in the back, etc.

E2 Extend the industry EV platform by selling to other OEMs. An industry EV platform is a modular vehicle platform with an electric drivetrain that is not used by only one OEM, but is extended to other OEMs and vehicle manufacturers through, e.g., partnerships or joint ventures. In effect, this would boost sales and maximize the scale effects of the EV platform. This is enabled by skateboard architectures with highly integrated chassis and powertrain parts, such as e-motors and batteries. Here, OEMs can also profit from the lower entry barriers for tech companies to deploy their software and vehicle infotainment systems.

E3 Advance with zero variants and drive consequent despecification. As the key aspects of product differentiation change over time (e.g., with increasing environmental awareness a high maximal velocity is not a major KPI anymore for most customers) and vary significantly between customers, OEMs can win by being very selective about the features they build in and the performance dimensions they optimize and despecify in other areas. For example, small battery sizes in entry-level vehicles for specific use cases.

F Go-to-market approach overhaul – revolutionizing sales and aftersales

With on-demand mobility on the rise, EVs offer new approaches in vehicle sales and aftersales revenue. As complex configuration processes have led to inefficient vehicle sales approaches, EVs represent a turning point with a chance to radically rethink vehicle sales. In this context, three radical moves are available:

F1 Focus on full leverage of online sales. OEMs can push their EV sales with only direct online sales for a fast-track sales process (e.g., from start to checkout in less than five minutes). In combination with an extension of aftersales on-demand options, this can lead to higher sales volumes.

F2 Drive EV aftersales with over-the-air (OTA) vehicle access. Instead of servicing vehicles in dealerships, OEMs can provide their customers with remote OTA vehicle access for any issue or software-related service, including software updates or the installation of new applications or features, or they can hop on live calls for maintenance checks. A service person is given access to the vehicle system by the customer, just like IT remote services from the helpdesk for computers. This service model can help to intensify the interaction between OEMs and end customers and potentially lead to a high conversion rate of on-demand subscription options as updates or new apps are released on a frequent basis and advertised through various online channels (e.g., in social media). OEMs could therefore gain attention from young customer groups in particular.

F3 Enable fast-lane deliveries through minimized variance complexity. Reducing complexity by offering fewer variants and combinations makes the configuration in the sales process easier. Additionally, OEMs could manufacture "high runner variants" on stock and provide the customer with fast delivery for a price premium (acceleration markup). This radical approach is generating additional revenue through a departure from the "pull principle" of vehicles built to customer order and toward a proactive, "push" approach to service-delivery for customers. In particular, this is a valid lever for OEMs offering many vehicle variations and options.

G Life cycle monetization – launching new EV business models

With the accompanying architecture and technology, EVs enable OEMs to generate new revenue streams during vehicle use by utilizing, for example, available vehicle data. OEMs can build new business models and create new functionalities to serve changing customer requirements – primarily through the three following radical moves:

G1 Offer EV-as-a-service to maximize total cost of ownership (TCO) advantages. For a subscription-based offer, OEMs can attract customers in two ways. First, a subscription-based model can be attractive to customers through reduced TCO. Secondly, B2B customers can benefit by getting top products and high service quality without the barrier or risk of upfront investments. For example, the EV-as-a-service offer could include an on-demand 24/7 remote service model at the OEM's own cost through which customers get instant support instead of having to wait to bring their car to a maintenance location.

G2 Offer battery-as-a-service. With a battery-as-a-service ecosystem (including a digital twin to be able to use battery data and predict state-of-health and other battery indicators) and data monetization to generate aftersales revenue (e.g., by providing advanced battery functions on demand), residual battery value can be maximized to enable reuse/a second life as well as a circular economy[18] ecosystem.

G3 Provide a smart-charging service offering. With smart charging algorithms the vehicle's charging system can adapt to a customer's charging preferences and make suggestions for an optimized charging pattern to the customer. Such a vehicle-to-grid approach and the integration of the vehicles into a smart home system provides two advantages: first, the car can serve as home energy storage, powering energy demand when energy prices are high or regenerative power is not available at night. Second, customers can sell spare electricity back to the power grid. As innovative as the underlying technology may be, it is the business model that enables it that makes for a radical move: instead of developing and selling the technology themselves, OEMs can monetize access to it, generating revenue from customer usage. The business model could be deployed in the following way: the OEM partners with a utility and encourages their customers to charge at specific charging points. In return, the OEM gets a cash reimbursement from the utility and so does the customer when charging with electricity from the same utility or getting a home contract, including charger, etc.

Given these different approaches and multiple way ways of increasing profitability, the key question now becomes: how can incumbent automakers and new EV players effectively employ the incremental levers and radical moves approaches to drive profitability?

[18] Circular economy refers to the concept of using and reusing natural capital as efficiently as possible and finding value throughout the life cycle of finished products.

Outlook – getting started on a journey to boost EV profitability

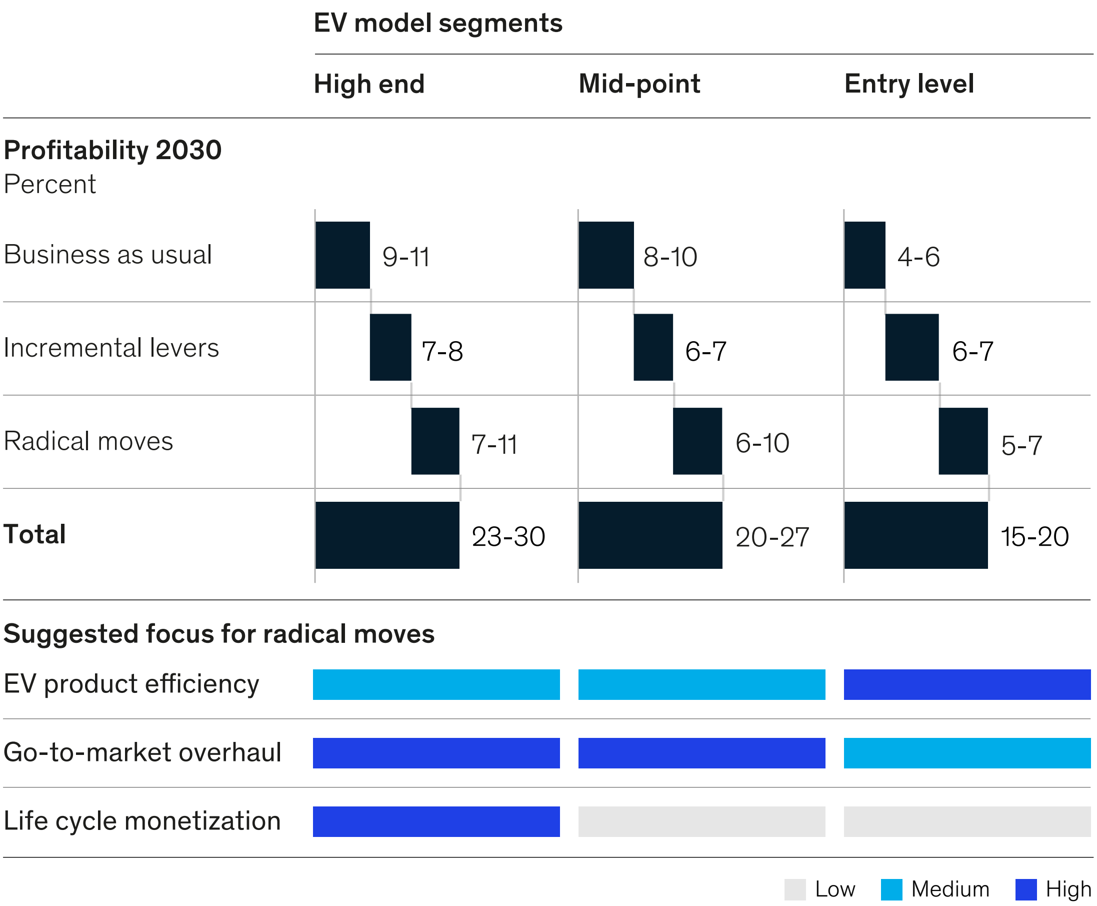
OEMs are currently radically shifting their powertrain portfolios, scaling up their EV production capacities to avoid high penalties related to fleet CO2 emissions targets. With this new focus, OEMs are now tasked with the challenge of making their EV business (more) profitable and sustainable in addition to dealing with the forces that are driving low margins in the EV business at the moment – high costs and price pressure – OEMs face growing competition in the EV space. The entry barriers to the EV market are lower than the ones to the ICE market, which allows new (tech) players with disruptive business approaches to enter the market.

OEMs will need to make courageous moves to boost their EV profitability and achieve sustainable margins, and they need to begin making those moves now. The cost-saving potential of various incremental and radical levers varies per OEM depending on both the EV segment/ archetype as well on the OEM's broader EV strategy. Both aspects are described in the following.

Regarding the three EV-model segments, i.e., entry level, mid-point and high-end, exhibit 9 outlines a conceptual, OEM-specific adaption of the lever categories.

Exhibit 9

Segment-specific insights reveal the profitability potential of the two approaches and guide OEMs toward which radical moves they should focus on



Source: McKinsey Center for Future Mobility

Looking at the incremental levers, the profitability increase is similar across the high-end, mid-point, and entry level EV segments. In the "radical moves" category, however, segment-specific differences in profitability potential become clear. With focuses on lifecycle monetization and go-to-market, respectively, high-end and mid-point segments can look forward to profitability increases of up to 11 percent. The boost for the entry-level segment, however, seems capped at 7 percent with a suggested "radical moves" focus on EV product efficiency.

The incremental levers and radical moves described above should not be the entirety of the EV sustainability conversation. The degree to which these various moves actually boost profitability has a lot to do with a broader EV strategy discussion with implications for individual OEMs, the sector, and the market.

We see four major themes whose careful consideration can shape a strategy that supports EV profitability:

1. **EV ambition –** The target share of EVs in an OEM's portfolio and the pace at which an OEM hopes to reach that target is the basis for the OEM's strategic planning. Additionally, the current and future product portfolio with the mix of EV segments (i.e., high end, mid-point, entry level) defines the optimal approach towards greater EV profitability

2. **Ecosystem partners –** Along with electrification and further ACES[19] trends the classical linear automotive value chain gets disrupted forming a new ecosystem with fluid industry boundaries. A successful EV business model implies that an OEM has a strong influence on the EV ecosystem and can offer seamless mobility services to customers. Therefore, it is imperative for OEMs to identify the right partners to build a powerful ecosystem that meets the needs of a diverse customer base. Such partners could be, for example, charging infrastructure providers, utilities, battery players, recyclers, etc.

3. **Supply chain resilience –** Rising uncertainty makes it difficult for OEMs to ensure the security of their supply chains. For example, component shortages can lead to price increases in the battery supply chain, and this would have a significant impact on EBIT. Just a 10% price increase in 2030 could impact EBIT by around USD 0.5 bn for a typical OEM with 1 mn annual vehicles sales. Building resilience and reliability into the supply chain can help avoid these negative financial effects.

4. **ESG performance –** "Zero carbon" products and sustainability in a broader sense have a high value potential. A brand built on the idea of "sustainability" may reap the benefits of better consumer acceptance, increased revenues, reduced cost (e.g., from less energy use), and better access to capital driven by better financial and ESG ratings.

Overall, the tremendous changes in the automotive industry and the move toward EVs challenge many of the industry fundamentals that incumbent OEMs have long relied on. Now is the time – while vehicle volumes are on the rise – to lay the foundation for a profitable and successful EV business in the future. Those companies who can best navigate the transition and are willing to take strategic action now will be able to outperform their competitors and excel in their respective segments. For outperformers, EVs not only have the potential to become profitable, but also are an enabler for new (software-backed) business models with significant value potential beyond what has usually been possible in the classic automotive industry.

[19] Autonomous, Connected, Electro and Shared

Appendix

I. Comparison of calculated cost structures for the mid-point EV segment for 2019 and 2021
Our bottom-up analysis of the 2021 cost structure for the mid-point vehicle segment – compared with our 2019 EV perspective, which was published in January 2020 – shows, despite slightly updated assumptions, that EV base costs have remained largely the same with the exception of decreased powertrain costs (Exhibit 10). This decrease results from three main effects:

— Significantly decreased battery cell costs to about 120 USD/kWh in 2021 (from approximately 200 USD/kWh in 2019).

— An increase in battery size and additional need for battery cells, which reduces the benefits of battery cost reduction (50 versus 65 kWh).

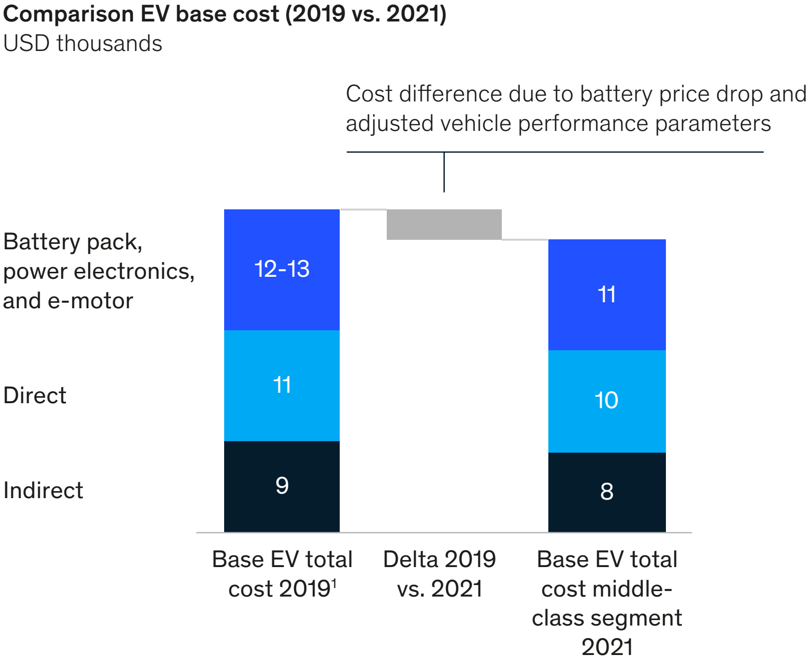
— E-drive and power electronics cost assumptions being updated to reflect higher costs as a result of higher performance assumptions, i.e., vehicle options for two or more emotors.

Exhibit 10 - appendix

According to our analyses, EV base cost structure has changed only slightly from 2019 to 2021

Mid-point segment

Values rounded for simplification



1. Sanitized for sales costs (removed from indirect costs) and government incentives as those are tied to country-specific price developments and government incentives
Source: McKinsey Center for Future Mobility

II. Overview of base case-related assumptions concerning EV model segments

The base case scenario for projecting the profitability of the EV business looks at six key EV characteristics – annual production volume, lifetime production volume, price, performance, number of electric engines, and battery capacity – as they pertain to the three vehicle segments – high end, mid-point, and entry level.

Exhibit 11 - appendix

End-to-end profitability assessments need to be conducted within vehicle classes and across six vehicle characteristics

Model segment-related assumptions for the base case

	High end D/E segment			**Mid-point** B/C segment			**Entry level** A segment		
	2021	**25**	**2030**	**2021**	**25**	**2030**	**2021**	**25**	**2030**
Annual volume Thousand units	30	60	80	100	200	400	30	80	150
Lifetime volume Thousand units	120	250	500	300	1,000	2,500	150	450	1,500
Performance kW		400			220			60	
Avg. number of electric engines no. of engines		2.0			1.5			1.0	
Battery capacity kWh	100	110	110	65	75	80	40	45	50
Examples	Tesla Model S, AUDI e-tron			Tesla Model 3, VW ID.3			VW e-up!		

Source: McKinsey Center for Future Mobility

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The authors would like to thank Jörg Hanebrink and KJ Ward for their support in preparing the report.

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McKinsey Center for Future Mobility
September 2021

Designed by Visual Media Europe

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