

SSCG Auto Outlook

Global Electric Vehicle (EV)
Market and Economic Mega
Trends Transforming The Auto
Industry

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Automotive Industry Evolution Megatrends from Internal Combustion Engines to Electrified Vehicles



The global automotive landscape is changing rapidly. Traditional centres of demand are being overtaken by fast growing emerging Electric Vehicle (EV) markets. The world is on the cusp of a transport revolution as the system shift toward cleaner fuels, governments focus on limiting pollution and Greenhouse Gases (GHG).

Urbanisation, congestion, energy scarcity, technology advancement, policies and pollution are harnessing new forms of mobility and key pillars of EV transformation. Electric mobility (e-mobility) is widely seen today as a way to improve air quality and meet climate goals thus considered the automobile technology in the future.

Bolstered by stringent regulatory pressures on Internal Combustion Engines (ICEs), combined with advancement in electric powertrains (e-powertrain) and batteries technologies, are driving rapid transformation of the industry and a surge of demand for EVs. Globally, EVs are proliferating at a rapid pace, sales and adoption are on the rise. As demand rises, EV technology and design continues to evolve, and strategic challenges are also arising. Established vehicle manufacturers and their traditional suppliers need to rethink their approaches to preserve their market share, revenue and profitability. Adoption of EVs in their fleet will not only have an environmental and social impact, but also an economic impact.

A shift in driver expectations and policy along with continued declines in battery costs are driving an increase in EV penetration and market growth. Today EV's are both viable and in many cases superior to Internal Combustion Engine Vehicles (ICEVs).

As EVs become more affordable, some are predicting that they will constitute almost a third of new vehicle sales by the end of the next decade. In 2018, new registrations of EVs has hit a new record globally. By 2035, it is forecasted that 1 in 9 vehicles sold globally will be electrified, bringing the total EV fleet to 125 million. By 2050, 81% of 132 million new vehicle sales will be electric as predicted by Morgan Stanley.

According to a study by the International Energy Agency (IEA), the number of EVs globally is forecasted to rise to be 35% of all vehicles by 2040. Latest forecast shows EVs sales increasing from a record 1.1 million worldwide in 2017, to 11 million in 2025 and then surging to 30 million in 2030 as they become cheaper to make than ICEVs. China will lead this transition, with sales there accounting for almost 50% of the global EV market in 2025. Likewise Bloomberg New Energy Finance (BNEF) predict a similar trend and viewpoint, EV share of new vehicle sales in 2040 is estimated to be 55% and will represent 33% of 500 million vehicle fleet on the road.

EV adoption is almost to reach a tipping point, car buyers and fleet owners across the globe are starting to give EVs a second look. While it's difficult to predict when the S-curve inflection point of demand will hit, as battery costs come down and economies of scale grow, various industry players expects EVs to reach price parity with their gasoline counterparts by 2022 or sooner.

The pace of auto technology advancement, transformation and innovation is accelerating creating new use cases for EVs. These use cases will be influenced by geographic location (urban versus suburban city), ownership model (shared versus privately owned), and city, state, and national regulations factors.

Industry disruptions has and will bring new players, set of metrics and revenue distribution along the value chain. EVs are radically different and needs new offering logics. E-powertrains are markedly different from their ICE equivalents in necessary competencies, value add, and component complexity. The growth in EV sales therefore threatens the competitive position and market shares of both manufacturers and their ICE-powertrain suppliers.

In the short term, vehicle makers face the challenge to comply with tightening regulatory fleet emissions and fuel-economy targets while remaining profitable despite costly battery packs. It's important to keep focus on ICE models, which are the profit engine for today's business. However, need to explore new business models with more attractive economics for future EV consumers.

Base EV configurations already contain many options. The high base price, driven by the cost of the battery, compels manufactures to include more options in the configuration than in a comparable ICE, thus losing a high-margin income stream. In total, the industry is expecting 127 battery-electric models to be introduced worldwide over the next five years. More options combined with greater familiarity is expected to accelerate EV demand.

Battery sales volumes are currently doubling annually and vehicle manufacturers are partnering with battery makers to invest and increase production at a low costs. Recent concerns regarding the future of the raw-material supply availability for batteries and the impact of rising commodity prices on battery production costs have highlighted risks that might create divergent futures for these two commodities. To realize the strong growth prospects of lithium and cobalt industries, all players from mining companies to battery and automotive manufacturers to financial sectors will need to understand the battery value chain as an ecosystem and collaborate to provide transparency and agreement on key areas, such as battery technology, supply-side growth, and pricing mechanisms to ensure the new era for battery raw materials is truly golden and not just gilded.

The charging infrastructure are evolving to improve accessibility and remains an influence on consumers' preferences. The rush is on to build electrical grid infrastructure, adjust business models, and roll out enough charging stations to meet growing EV demand. The investment and infrastructure required to support EV mobility will vary significantly from regions. Charging facilities should be developed and easily accessible to keep pace with current demand and to address a range of anxiety issues by making charging stations.

Finally, favourable policy recommendations and subsidies that encourage the purchase and adoption of EVs, drive investment and construction of charging infrastructure must be a priority for governments if they are keen to accelerate the speed of adoption.

Economic and Market of Electric Vehicles (EV)



A major catalyst for EV mass production is coming from the global momentum against auto emissions. China, India, Norway, Britain and France plan to slowly phase out gas and diesel vehicles. Sales of EVs in China, the world's biggest auto market, are already on pace to hit 1 million this year.

Forecasts for global EV sales by 50% to 14% by 2025 or 14.2 million vehicles compared with its previous projection. It raised the forecast for 2021 to 3.1 million from 2.5 million. Europe will lead the way with 30% of its sales electric by 2025. The current share is close to 1%.

Costs will draw level for traditional cars by 2023 in China, and 2025 in the U.S., UBS said. Its forecast for U.S. electric car sales was increased to a market share of 5% in 2025 from 3%. Mainstream forecasts for electric car sales range from between 10 and 15% of the global market by 2025.

Megatrends Transforming Automakers Business Models, Industry Landscape and Electric Vehicles Market



Notable shift from vehicle manufacturers:

- Volvo, Jaguar and Land Rover, Volkswagen, Mercedes, Audi and BMW have all promised to roll out electric models over the next decade.
- Toyota plans to electrify its entire line-up by 2025.
- General Motor (GM) recently announced an all electric future where it aims to launch at least 20 electric vehicle models by 2023.
- Volvo announced that all models introduced after 2019 will either be hybrids or all-electric.
- Ford investing \$4.5 billion into 13 new EVs and plans \$11 billion investment, 40 electrified vehicles by 2022.
- PSA Group has created a new electric vehicle business unit and reorganized its powertrain management structure as it prepares to launch electrified versions of all its models starting in 2019.
- BMW group announced that electrification is one of the central pillars of BMW corporate strategy as the company gears up to mass produce EV by 2020.
- Mercedes-Benz and smart cars to offer electric versions of all car models by 2022.
- Chinese are acquiring foreign brands by buying up parts suppliers, making batteries for the world's EV fleet and corralling supplies of the metals. The most prolific buyer is Li, who spent almost \$13 billion on stakes in Daimler and truck maker Volvo. Tencent Holdings Ltd., Asia's biggest internet company, paid about \$1.8 billion for 5% of Tesla.
- Chinese companies have announced at least \$31 billion in overseas deals during the past five years, buying stakes in carmakers and parts producers.
- Tesla Inc. (TSLA.O) has registered a new EV firm in Shanghai, as China prepares to scrap rules on capping foreign ownership of new-energy vehicle (NEV) ventures
- 2018, China's BAIC plans \$4.5 billion backdoor listing for EV unit.
- China's Chongqing Changan to stop selling combustion-engine cars from 2025.
- SAIC, the country's largest automaker by unit sales, invested more than 20 billion yuan in new-energy vehicles (NEVs) which include EVs, PHEVs and fuel-cell vehicles.

Megatrends Transforming Automakers Business Models, Industry Landscape and Electric Vehicles Market

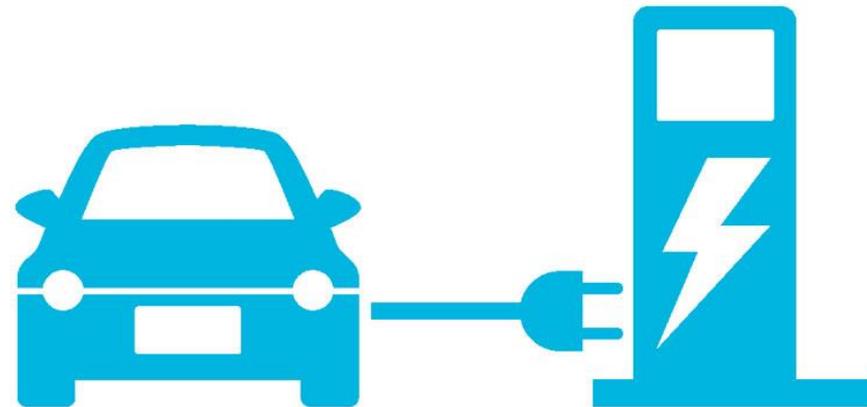
- China has made no secret of its ambition to have a really big and powerful auto industry,” China does intend to lead and dominate the EV industry. The Chinese government sees EVs as its best chance to seize global leadership in an emerging powertrain technology.
- EVs are expected to take just over a quarter of vehicles sold in the Asian nation by 2030, up from 2.2 percent in 2018. EV to account for 9% of global demand by 2050.
- China, whose EV market accounts for 40% of all sales globally, aims for five million EVs by 2020. Already the world’s biggest EV market, Its companies are beginning to dominate battery manufacturing.
- China is working on a timetable to stop the production and sale of vehicles powered by fossil fuels.
- India has declared its intention to make all new vehicles electric by 2030.
- Europe aims to achieve 10% by 2025. Like UK and France, these two markets are looking to phase out the sale of petrol and diesel vehicles over the next 20 years.



Megatrends Transforming Automakers Business Models, Industry Landscape and Electric Vehicles Market

On the acquisition front, the EV charging market saw several notable developments in 2017 by multinational energy companies:

- Engie started things off in March with the purchase of EV-Box, a Dutch EV charging management startups. Then, the international power and clean energy company Enel bought smart-grid EV charging leader eMotorWerks. EMotorWerks' nearly 30,000 charging stations deployed so far can aggregate vehicle charging load, allowing energy providers an easier method of balancing the grid, and drivers the chance to optimize their charging for renewables or the lowest electricity price.
- Another notable acquisition in the charging space came from Shell, which bought the Dutch firm NewMotion. The company manages charging points for electric vehicles in Western Europe and will operate alongside Shell's program of rolling out fast-charging points at its stations.
- In 2018, BP announced that it has entered into an agreement to purchase Chargemaster, the UK's largest electric vehicle (EV) charging company.
- The U.K. will boost investment in electric-car infrastructure, including a 400-million-pound (\$531 million) fund for companies that produce and install charging points, as it seeks to encourage consumers to move away from carbon-polluting vehicles. The bidding process follows the launch of the Road to Zero Strategy which sets out the government's long term plan to have at least half of new cars be ultra-low emission by 2030 and all new cars and vans be effectively zero emissions by 2040.



Megatrends Transforming Automakers Business Models, Industry Landscape and Electric Vehicles Market

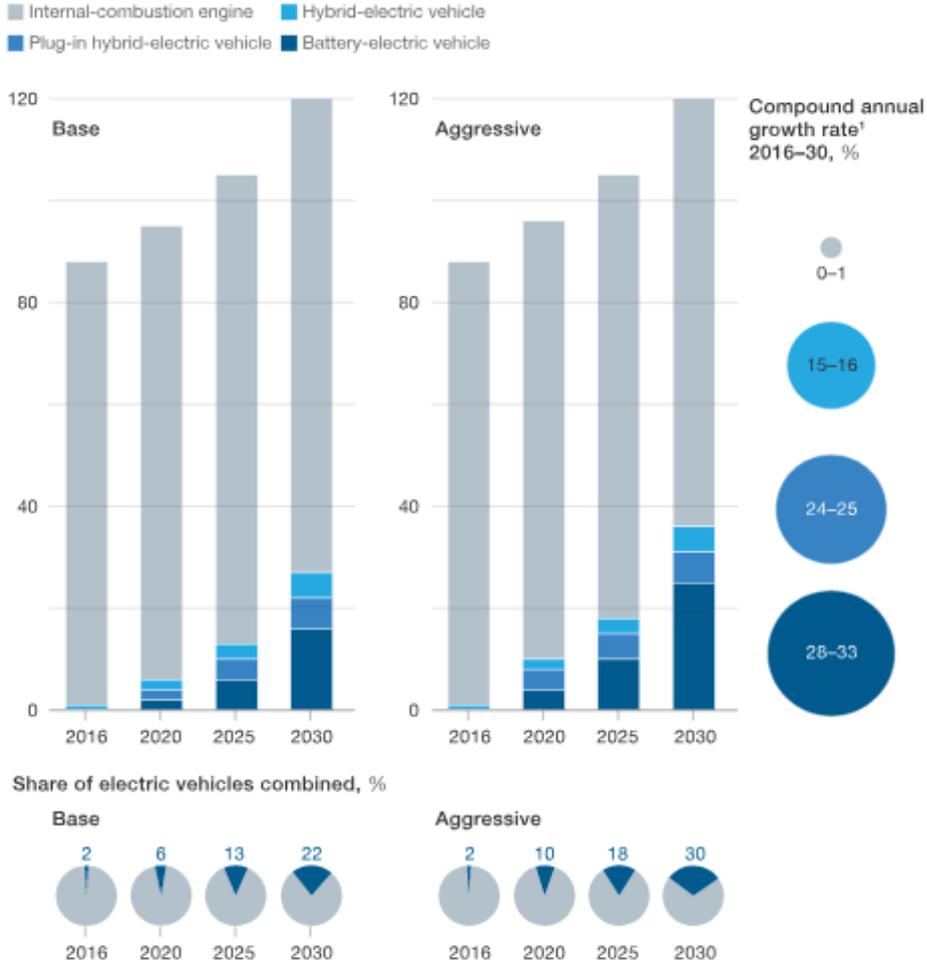


In terms of charging stations:

- 2017 brought us the opening of Tesla's largest supercharger station in North America, located about halfway between Los Angeles and San Francisco -- something of a mix between airline waiting lounge and coffee shop. Tesla recently announced that it has begun mass production of its high performance lithium-ion '2170' battery cells, built in conjunction with strategic partner Panasonic from Tesla's \$5 billion Gigafactory battery plant in Sparks, Nevada.
- The Swiss group ABB has teamed up with Shenzhen Daimler New Technology Co to expand China's electric vehicle charging network to the largest in the world.
- In 2018, Volkswagen ordered \$48 Billion in EV Batteries and announced its plans to install 2,800 charging stations in 17 of the largest U.S. cities by June 2019, mostly in workplaces and multifamily dwellings, such as apartment buildings and condos (a part of its "dieselgate" reparations).
- In Europe, Shell released plans to charge EVs in just 8 minutes with the 80 high-power charging stations throughout the continent.
- Samsung unveils next-gen EV battery: 310 miles from 20 minute charge. Samsung's newest fast charging 21700 cylindrical battery cell won't see mass production until 2021.
- Faraday Future recently announced a 130 kWh battery pack capable of 378 miles per single charge; the three-time award-winning Chevy Bolt is said to have 238 miles of range.
- Lucid Motors is planning for a 400-mile range electric car, also powered by Samsung SDI battery cells.
- Contemporary Amperex Technology Ltd., the maker of electric-vehicle batteries that's planning a \$1.3 billion factory with enough capacity to surpass the output of Tesla and dwarf the suppliers for GM, Nissan and Audi.
- The Ningde-based company plans to raise 13.1 billion yuan as soon as this year by selling a 10 percent stake, at a valuation of about \$20 billion. The bulk of the new funds would pay for a manufacturing plant that would make CATL the world's biggest maker of lithium-ion batteries.



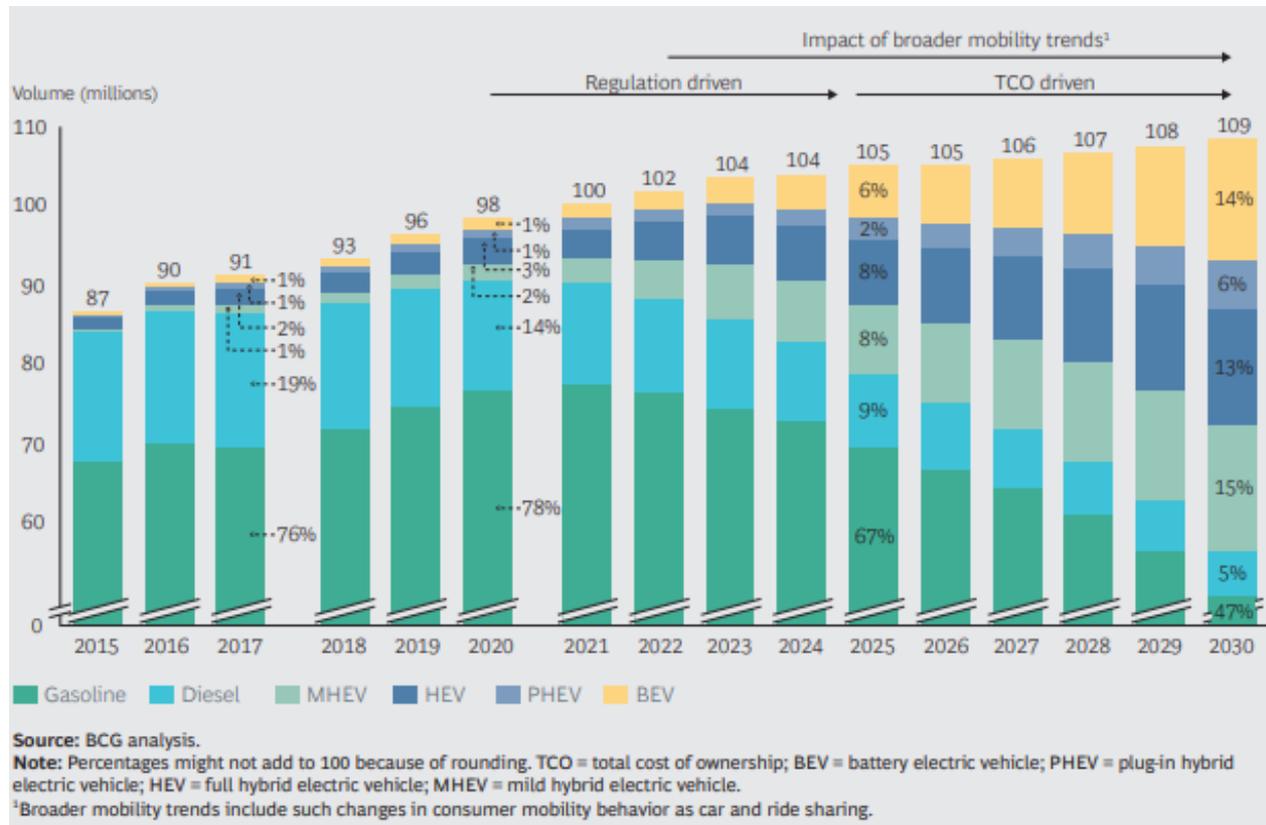
Global Light Vehicle Production



*Range of base and aggressive scenarios.

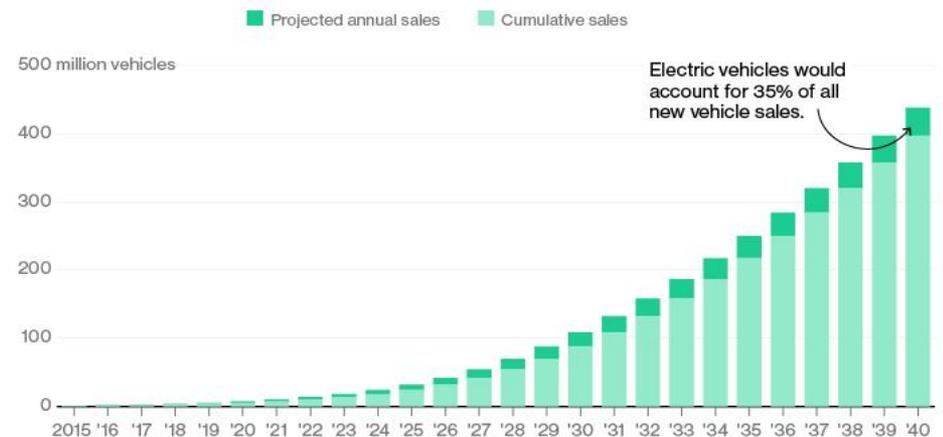
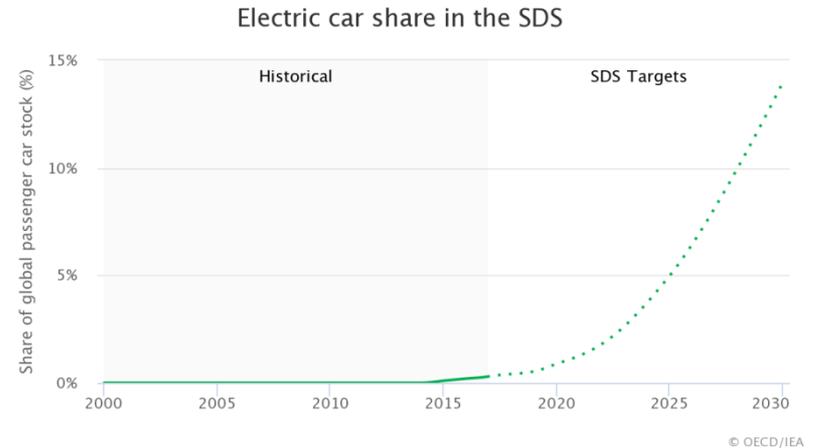
Global Sales Outlook and EV Turning Point

The number of EVs has risen significantly, from 1.2 million in 2015 to around 100 million by 2035 (6% of the global fleet). Around a quarter of these electric vehicles (EVs) are Plug-In Hybrids (PHEVs), which run on a mix of electric power and oil, and three quarters are pure Battery Electric Vehicles (BEVs).



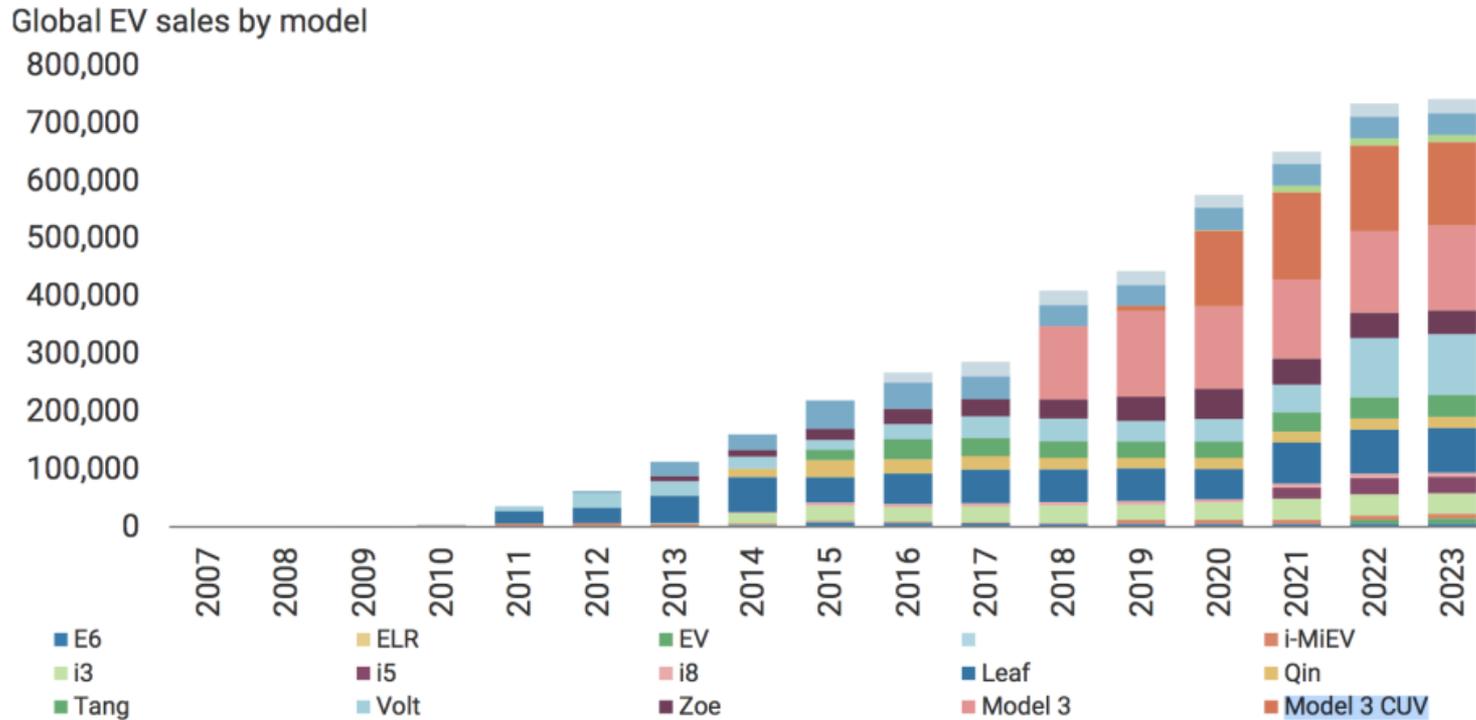
The Rise of EV Sales and Penetration by 2040

- EV sales have grown at a rapid pace over the past five years, with a recent surge in Europe and China.
- The shift to EVs is expected to continue to gain momentum.
- 2017 witnessed record global sales of electric cars (1.1 million), leading to a global stock of over 3 million. Global sales increased 54% in 2017, helping EVs remain on track to reach the SDS target. China accounted for nearly half of electric car sales, with Norway having the highest per capita ownership.
- Around 40% of the global electric car fleet is in China, where the number of electric cars on the road surpassed 1 million in 2017
- EV sales rate expected to double by the end of 2018.
- EVs will be cheaper much sooner than expected, with prices in Europe comparable with traditionally powered vehicles next year,
- By 2020, EVs cost expected to be the same as ICE
- EV taking a 40%-50% share of the global auto market by 2040, up from around 3% today.



Sources: Data compiled by Bloomberg New Energy Finance, Marklines

Top Global EV Sales by Common Models



Source: IHS, Morgan Stanley Research

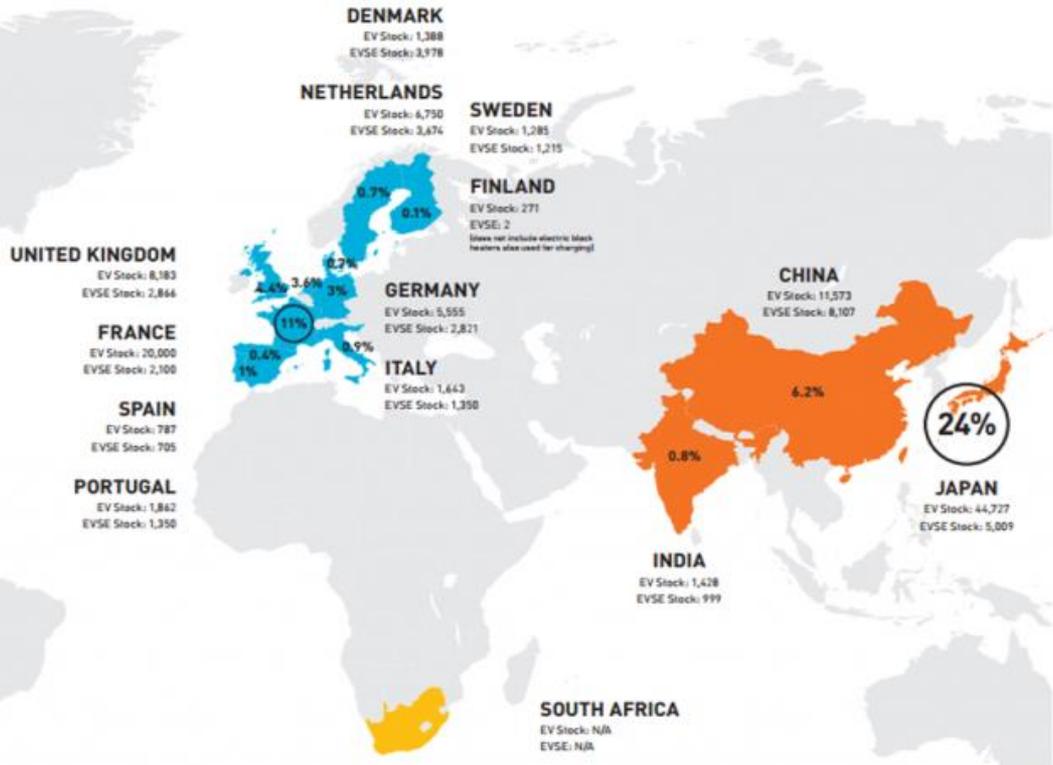
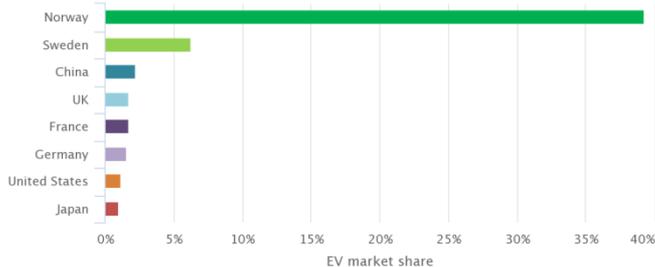
ELECTRIC VEHICLES INITIATIVE (EVI)

EVI MEMBER COUNTRIES HELD OVER 90% OF WORLD ELECTRIC VEHICLE (EV) STOCK IN 2012

8 of the world's 10 largest auto markets, represent 63% of the world's vehicle demand. These markets are expected to account for 83% of EV sales between now and 2020.



Electric car market share in the top eight Electric Vehicle Initiative countries



© OECD/IEA



Projected Growth Trends of EV Fleet Size

The global fleet of EVs is likely to more than triple to 13 million by the end of the decade from 3.7 million in 2017.

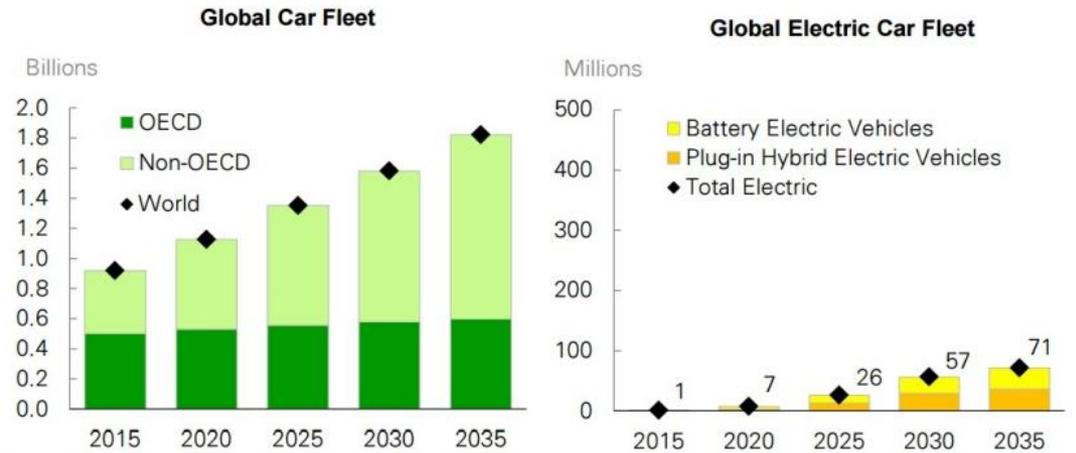
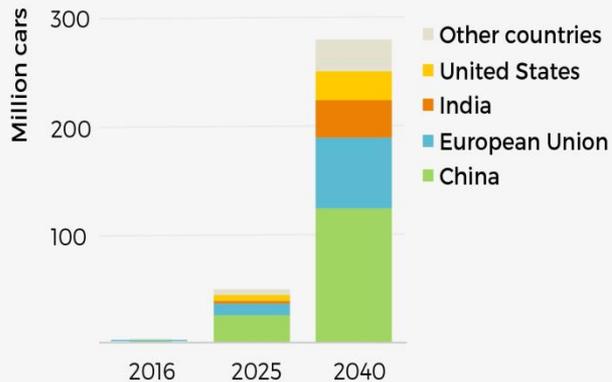


Chart 3

© BP PLC 2016

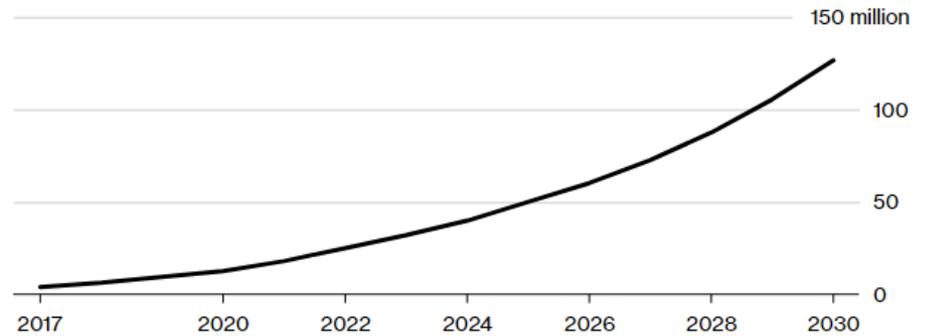
Electric car fleet, 2016-2040

World Energy Outlook 2017



Electric Boom

The global fleet of electric vehicles is set to soar

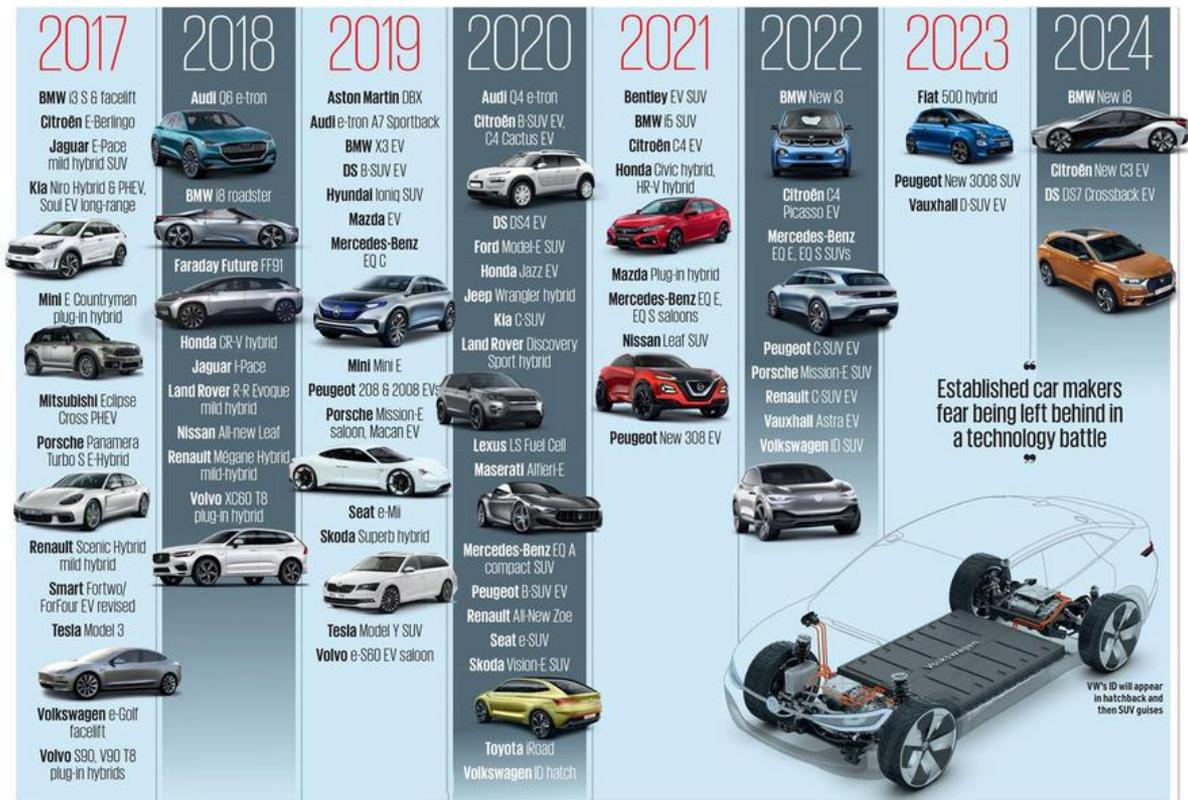


Source: IEA

China EV Transition and Sales Growth Leadership



China has solidified its leadership position and leads EV Transition and Sales Growth. The market is now the biggest globally for electric cars, ahead of the US. The Chinese government is providing subsidies to local makers of all the various parts that the EVs requires. To aid its local suppliers of electric cars, China has denied battery certifications to foreign competitors





The group who are willing to adopt electric vehicles embraces the characteristics of high income, EV as second vehicle, interests in new things and environmental sensitivity. Moreover, consumers are more likely to purchase electric vehicles when they perceive less risks such as short driving range and long charging time, as well as more social values.

Key consumer segments:

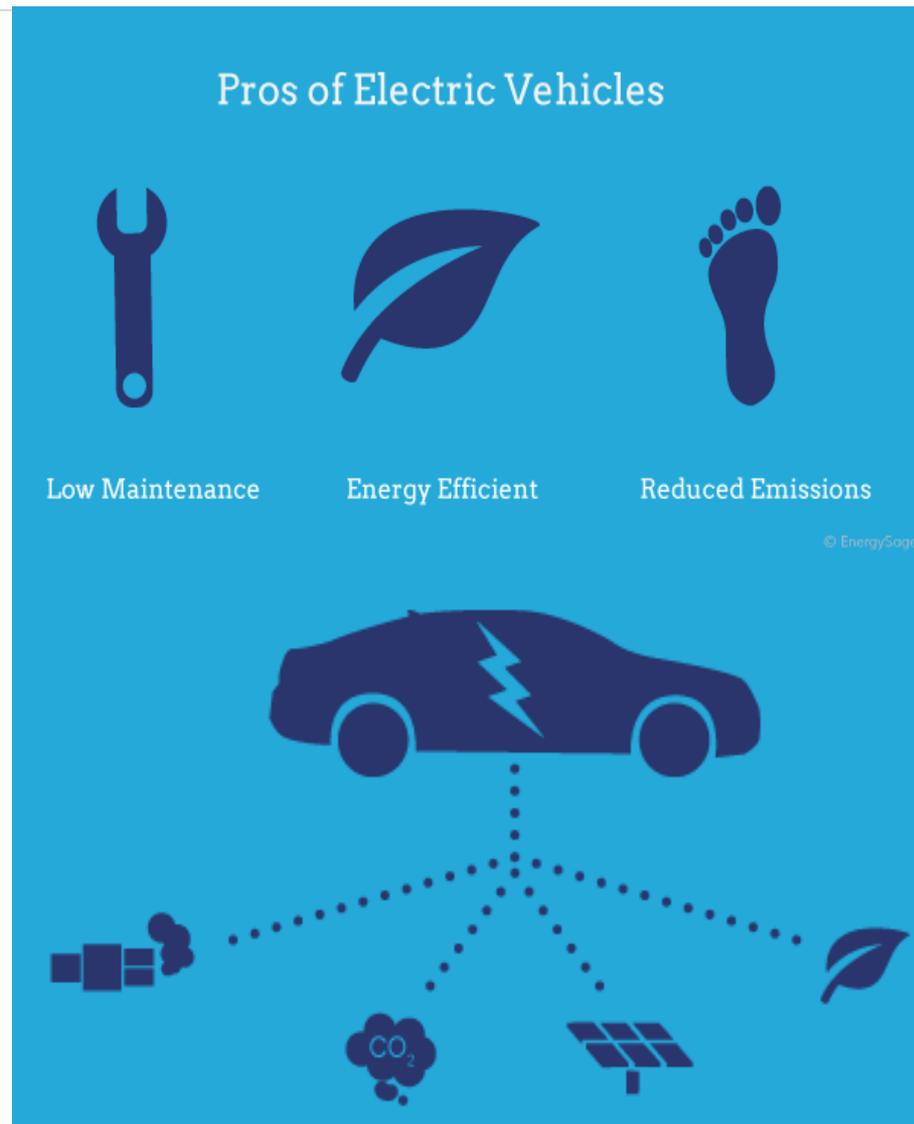
- Urban families
- Trendy families
- High-tech status seekers
- Feature-focused buyers
- Status and luxury enthusiasts
- Risk-averse greens
- E-hailing or taxi drivers



Factors Influencing Choice, Adoption and Market Growth

Several factors and advantages to EV ownership and adoption that have encouraged sales can be identified:

- Increased urbanisation across the globe, creating more pull for green mobility solutions.
- Accelerating regulatory forces at national, regional, and city levels.
- Faster-than-anticipated improvements in key technologies.
- Increased vehicle range.
- Accelerating scale of charging infrastructure, convenience to charge, and cost to charge.
- Consumer demand shifting in favour of e-mobility.
- The Volkswagen diesel demise "Dieselgate" .
- Monetary and non-monetary government subsidies.
- Total Cost of Ownership (TCO).
- Social values obtained from adopting electric vehicles.
- Faster-than-anticipated improvements in key technologies.
- Diversified EV models and options.
- Performance crossovers arriving from luxury brands.
- Utility programmes to support EV adoption.
- Decline in cost and advancement in battery technologies.
- Global CO2 emission targets.
- Bans on ICE vehicles.
- A surge in electric mass transit.
- Multiple affordable long-range EVs below competition.
- Moving toward true zero emissions.



Factors Influencing Choice, Adoption and Market Growth

Three horizons of EV adopters

First horizon:
early adopters
(current owners)

Consumers with **higher incomes and/or an eco-friendly and high-tech mindset** who also value "new" and "different" products

Second horizon:
near-term buyers

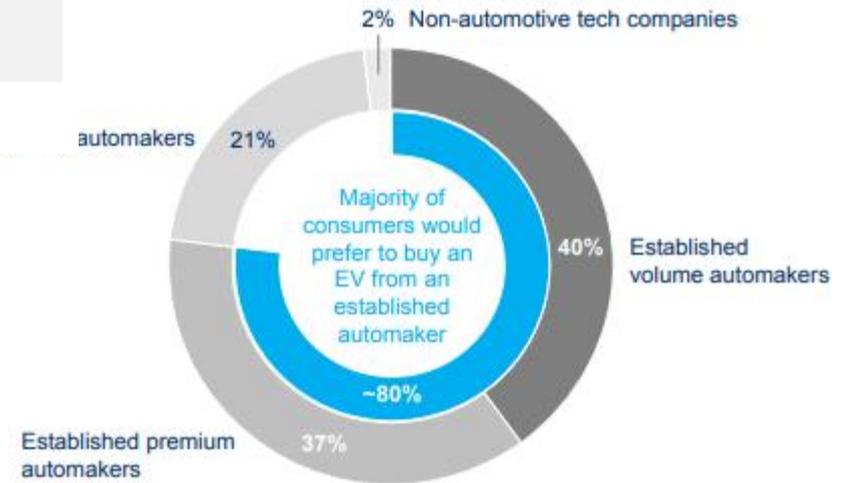
New segments that need **more basic mobility with shorter range and fewer vehicle options**; typically live in more urban areas

Third horizon:
long-term buyers requiring
new business models

Mainstream consumers, including families, who would purchase EVs over ICE for **driving performance and efficiency**, but also expect **more driving utility and equivalent range versus ICE**



SOURCE: McKinsey Sustainable Mobility Initiative – 2016 Electrified Vehicle Consumer Surveys



SOURCE: McKinsey Sustainable Mobility Initiative – 2016 Electrified Vehicle Consumer Surveys

Drivers' Perceived Concerns and Barriers to Adoption **SSCG**

As cost becomes a less relevant concern, many customers are still worried about depleting their battery's charge before reaching their destination or waiting for their EVs to charge, as shown in a recent survey among UK drivers. The availability of chargers and the distance that can be travelled on charge become the main barriers to EV adoption.

“Range anxiety” reflects a key concern about batteries in EVs losing power before reaching a destination or charging point. Gaps in driving range and interior space between models with native EV platforms and those based on ICE.

TOP CONCERNS OF PROSPECTIVE EV BUYERS



SOURCE: Altman Vilandrie & Company

Consumer barriers of EV Adoption



General vehicle ownership concerns

- ? Total cost of ownership
- ? Limited availability of parking
- ? One-way trips and multi-modality
- ? China: License plate restrictions

Source: Consolidated analysis of consumer research by Deloitte, McKinsey, Roland Berger, etc

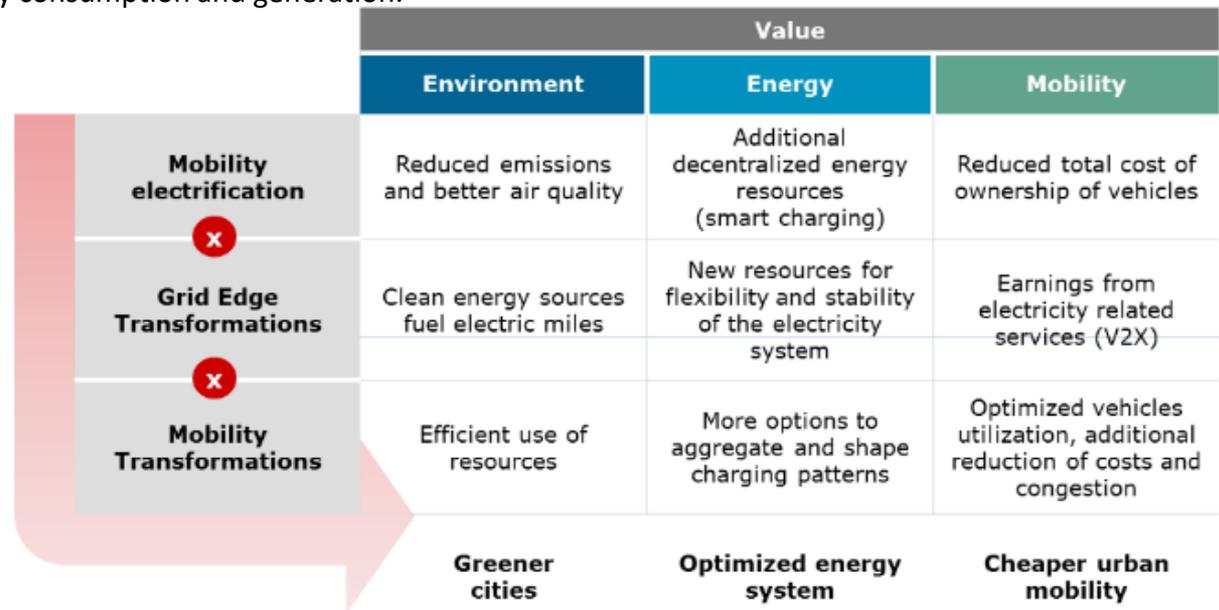
Reason for not purchasing an EV (multiple selections possible)



Source: UK Department for Transport (2016), N=649 licence holders

Electrified Mobility Opportunities and Value Potential **SSCG**

- Changing consumer attitudes, improved battery economics, broader access to charging infrastructure, and stricter regulatory policies all present growth opportunities.
- Electrification of transport supports national and local ambitions for cleaner mobility.
- As battery prices fall, EVs will soon provide cheaper mobility for individuals and fleets.
- Smart charging EV batteries can store surplus electricity and distribute it back to the grid on demand - a feature that could be particularly significant for large fleets of EVs.
- Electrified autonomous vehicles will revolutionise urban mobility by decreasing the overall cost per mile by up to 40% and reducing congestion in cities.
- Public and commercial fleets of electrified vehicles will introduce more flexibility to electricity systems through smarter charging and ancillary services, optimizing the electricity consumption and generation.



Mobility and energy transformations amplify the benefits of electrification

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The automotive, transport and wider mobility industries are currently at the start of one of the most social, technological and economic transformational of the century, as the way people and products are moved fundamentally shift.

First, the evolution will remain driven by environmental targets, regulatory policies and consumer demand in the near term, whilst three converging supply-side trends of vehicle electrification, autonomous driving and Mobility as a Service (MaaS) are also responsible.

Second, the number of global EV fleet and adoption is likely to more than triple to 13 million by the end of the decade, to around 100 million by 2035 and forecasted to rise to 35% by 2040. Majority of EVs will be mainly PHEVs in the near term. China will continue to solidify transition leadership and sales growth, remain the biggest market. With sales there accounting for almost 50% of the global EV market in 2025.

Third, EVs will transform global social economic landscape. The introduction into the market has and will massively influence consumers. In reality, driving an EV is still far more environmentally friendly than driving a gasoline-burning vehicles.

Fourth, as EVs come to market and adoption increases, disruption is anticipated across multiple sectors and industries. Manufacturers, the oil industry and governments are starting to wake up to the disruption that electrification could bring about.

Fifth, the rise of EVs means long established automotive incumbent manufacturers and suppliers will experience profound and prolonged challenges such as new technologies, products and competitors. From supermarkets to oil companies and from plastics manufacturers to power companies: many industries will be challenged by the inevitable breakthrough of the electric vehicle.

Sixth, the growth in EV sales will continue to threatens the competitive position and market shares of both OEMs and their ICE-powertrain suppliers. Industry disruptions has and will bring new players, set of metrics and revenue distribution along the value chain. Implications for vehicle EOM, supplier and manufacturing companies. Margins from ICEs in car manufacturing will continue to reduce. OEMs will need to adopt new strategies to realise the full potential of the evolving eMobility market.

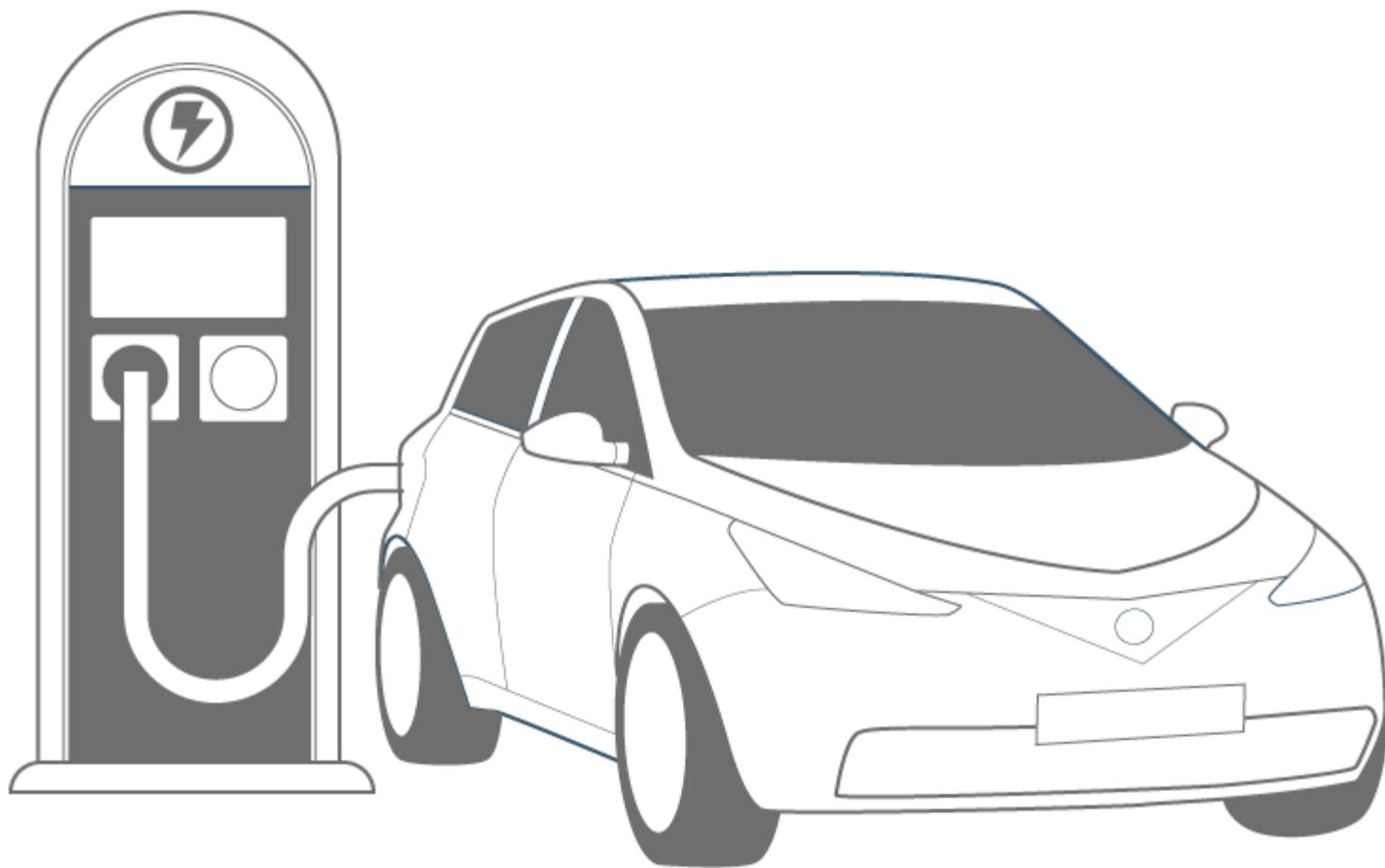
Seventh, besides challenges, the future of EV mobility offers major opportunities. As electrified mobility eco system and fleet grows, lithium and cobalt mining giants, technology conglomerates, battery suppliers, power companies and electric utility industry players look to benefit from increasing charging market demand. EV companies need to turn these trends to their advantage to accelerate adoption, build smart grid technologies and infrastructure to facilitate energy supply demand and increase accessibility of both wired and wireless EV charging infrastructure.

Eight, the increasing penetration of EVs and the broader mobility revolution will have an important bearing on future oil demand. With an estimated 130 million light-duty vehicles expected on the world's roads by 2030, it is estimated that about 2.57 million barrels of oil per day won't be needed.

Ninth, the demand for batteries is expected to rise by a factor of 15 by 2030, largely driven by light-duty vehicles such as cars and vans. China's burgeoning market is expected to make up half of the world's demand, followed by Europe, India and the U.S.

Tenth, the required charging infrastructure represents a major challenge for EV uptake. However, gradual buildout of charging infrastructure is helping to allay some buyers' range anxiety. Investment requirement in EV infrastructure vary widely, but the cost to build out charging infrastructure for the predicted EV fleet through 2040 may well reach into the hundreds of billions of dollars globally. Wireless charging to be installed in roads and parking lots, would require substantially more investment.

Finally, policymakers can help accelerate or delay the transition to EV. Many policymakers will be driven to act inline with economic, social and environmental benefits of EV. The dynamic policy developments that are characterising the EV market are expected to mobilise investments in battery production, facilitating cost reductions and ensuring that battery production takes place at scale that exceed significantly what has been seen so far.



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