Electric Vehicles Go Mainstream

Electric Vehicles are the future. Here, we examine the status of the EV market, and how it might grow over coming years.

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Until recently, mass adoption of Electric Vehicle (EV) technology has been concentrated primarily in the small vehicle category, targeted at reducing the numbers of the highly polluting two- and three-wheelers ubiquitous in Asia's cities. Through a system of subsidies to encourage mass adoption of these EVs, China has sought to improve air quality throughout its many bustling city-centres.

Policies encouraging adoption of more sustainable behaviours are beginning to shift from incentivising consumers to regulatory enforcement, although the economic impact of COVID-19 has resulted in countries temporarily prioritising economic recovery.

Furthermore, pressure to conform to more socially responsible practices is becoming increasingly mainstream.

Whilst China has led adoption of EVs and battery technology in recent years, European consumers and manufacturers are now rapidly turning to EVs, catalysed by incentives seeking to boost economic activity. Tesla of the US is the global EV standard bearer despite low adoption at home partly due to the Trump administration's policies to protect the Internal Combustion Engine's (ICE) interests.

EVs are generally regarded as 'green' technology, however the supply of mineral ingredients for batteries is likely to give rise to new sustainability challenges.

Regulations to Replace Subsidies

Regulations put in place by the Chinese government have increasingly focused on encouraging consumers and manufacturers to switch away from polluting ICEs to cleaner EV technology. Since 2019, China's vehicle manufacturers have been incentivised to produce and sell greater volumes of their EVs through a system of credits for each unit produced, reflecting factors such as type, energy consumption, weight and range.[1] Manufacturers that do not achieve agreed sales targets must either purchase credits from competitors or face financial penalties.[2]

This subsidy system – introduced in 2012 as part of a push to reduce air pollution in China's cities – has successfully stimulated EV adoption in the country. However, whilst the system was scheduled to be phased out in 2020, the combined impact of weaker-than-expected EV sales in 2019 and the shock of COVID-19 has meant that the withdrawal of purchase tax exemptions has been deferred until 2022.[3] On a similar note, efforts to protect economic growth in the face of COVID-19 have led to central government deferring the 'China 6 Standard' (designed to further limit urban pollution from ICE exhausts) until the end of 2021, although certain cities including Beijing and Shanghai have gone ahead with independently implementing the standard.[4]

The European Union's 2014 Directive required member states to set targets for public recharging infrastructure; in 2017 it established the Battery Alliance, aimed at fostering co-operation between member states, industry and the European Investment Bank. As the EU has developed its environmental and sustainability policies, a combination of strategic support and regulatory pressure has been developed; for example, in 2019 stakeholders were consulted on how to use regulations to rapidly foster a battery market that provides high quality, cost efficient and competitive products in a sustainable manner.[4]

Leadership from China and EU, however, contrasts starkly with the US. Under the Trump administration, the nation had seen a pivot away from Obama-era commitments to EVs, towards a programme that solidifies the grip of ICEs, albeit with emissions marginally lower than in past decades. For example, Trump's Safer Affordable Fuel-Efficient Vehicles Rule was designed to freeze fuel economy standards until 2026, at the same time as he challenged the longstanding US Corporate Average Fuel Economy (CAFE) standards: a set of regulations brought in in the 70s designed to continuously improve the nation's automobile efficiency. Over the last four years it has been individual states such as California, rather than the federal government, that have been promoting EV adoption. Going forward, however, President Biden is expected to prioritise commitment to environmental standards and green technology, and has already signalled his intention to re-join the Paris Agreement which commits to increased used of electric vehicles[4].

Adoption

Battery technology limitations have until recently meant high uptake has been limited above all to smaller vehicles, with approximately 350 million two- and three-wheeled EVs in use worldwide, representing 25% of all vehicles in this category globally.[5] Use of these light vehicles has been centred primarily in Chinese cities, although adoption is spreading to other highly-populated cities in India and ASEAN nations.

Electrification of urban bus fleets is also seen as an area of potential growth, as their short routes and driving cycles are compatible with contemporary battery limitations. Globally, there are around half a million electric buses in use, about half of which are in Chinese cities. Extra-urban buses and lorries, however, do not readily lend themselves to electrification due to long distances and charging infrastructure requirements – today's battery technology simply do not possess the range to make uptake in this sector viable for now.

Electric car global sales in 2019 amounted to 2.1 million, taking the global stock of electric cars to 7.2 million; or 2.6% of global car sales and 1% of global car stocks.[5] As China experienced weak demand continuing into 2020 because of the COVID-19 pandemic, sales in Europe increased significantly, up by 57% in the first half of 2020, even as the overall trend of vehicle sales volumes showed a significant dip (down 37%).[6] This change was mainly in response to European countries introducing new economic recovery schemes targeting green technology, taking European sales volumes ahead of China for the first time.

Automakers are rapidly growing their product ranges while shifting away from plug-in hybrids (PHEVs). In 2019, 143 new EV models were launched, while a further 450 models are expected by 2030, mostly consisting of midsized and large vehicles.[7] Although the number of manufacturers and models is rapidly expanding, Tesla retains quite remarkable leadership. In the first half of 2020, global sales of the Tesla Model 3 amounted to 142,000 vehicles while the second most popular EV, the Renault Zoe, achieved a relatively paltry 38,000 unit sales.[8]

McKinsey estimates that by 2030 EVs could account for 20% of global vehicle sales, [9] whereas Deloitte anticipate significant regional variations, with China making up 48% of total sales, Europe 27% and US only 14%.[10]

One of the factors effecting adoption rates is the oil price, as consumers are highly sensitive to costs relative to ICE vehicles. The International Energy Agency calculates an oil price of US$25 per barrel will increase the payback period by 1 – 2.5 years compared to oil price of US$60. Fuel tax policy is also an influence; in countries such as Germany with 60% fuel tax, there is greater incentive to switch away from internal combustion engines than in the US where tax is around 20%.[11]

EV growth rates are expected to slow beyond 2030, as wealthy countries will have substantially adopted the technology as far as is practical. In poorer countries, adoption will be slower due to the significant capital requirements to construct charging infrastructure necessary to make day-to-day use feasible[12].

Battery Technology

McKinsey estimate the cost of an EV to be made up primarily of the battery pack, accounting for a full 40%-50% of the price while the power train represents another 20%.[13]

Lithium-ion (Li-ion) batteries commonly used in EVs presently use cathodes (a negatively charged electrode that’s the source of electrons generating the electrical charge) made from three mineral mixtures, with nickel cobalt aluminium oxide (NCA), nickel manganese cobalt oxide (NMC) and lithium iron phosphate (LFP) being the most prominent.

NMC, however, is the most widely used type due to its energy density properties. Energy density, or the amount of energy held in the battery per unit weight, is highly prized in many EV markets and is largely defined by the nickel content of the battery; this will likely represent one of the ways in which performance will be improved over coming years. On the other hand, it is worth noting that not all batteries are manufactured to optimise energy density. Other considerations such as cost or size constraints may be more important so that usage specifications vary; small battery packs are most common in Asia, whilst in Europe and US batteries are larger.[14]

NMC batteries vary in the use of cobalt: NMC 111 has all three chemicals in equal shares, NMC 622 is 60% nickel, 20% manganese and 20% cobalt and NMC 811 is 80% nickel, 10% manganese and 10% cobalt. The use of cobalt is under pressure due to cost factors, as its price increased by 200% between 2016–2018; furthermore, there are ethical considerations as 60% of the world’s production originates in the Democratic Republic of the Congo, where mining involves extensive child labour, exploitation, and corruption. Tellingly, Tesla’s Elon Musk announced a switch to cobalt-free, nickel-rich batteries at the company’s 2020 Battery Day , although it should be pointed out that nickel rich batteries are indeed subject

Battery Day – although it should be pointed out that nickel-rich batteries are indeed subject to safety concerns, following a handful of reported vehicle fires.[15]

LFP battery usage has fallen since 2018, in part due to the structure of Chinese incentives which greatly favour energy density,[16] although recent reductions in local authority subsidies is encouraging a switch back to LFP cathodes to avoid exposure to nickel price increases.[17]

In the years since 2010, battery costs have fallen from US$1,000 kWh to US$147 kWh. Bloomberg New Energy Finance expects these will fall to around US$100 in 2023/4 and US$61 by 2030. It has been reported that Tesla is now working with Chinese battery manufacturer CATL on LPF battery technology which could reduce costs below the US$100 per kWh mark, helping to achieve cost parity with ICEs.[18]

Over the next 5–10 years batteries are likely to either continue with high nickel usage designs such as NMC811, or low usage designs such as NCA, with less than 10% nickel. While Li-ion batteries look likely to dominate EV usage for the next decade, next generation batteries are likely to use lithium-metal solid state, lithium-sulphur, sodium-ion or even lithium-air, although all will have their own cost, energy density and life cycle characteristics.[19]

In 2019, 60% of global battery production capacity was in China, with major manufacturers such as the aforementioned CATL, which accounted for 28% of global production in 2019, Funeng Technology, BYD and Tianjin Lishen. However high growth is now being seen in Europe at manufacturers such as the Swedish Northvolt, while Chinese CATL recently announced construction of a factory in Germany.[20]

Manufacturing is localising, with Tesla's Shanghai factory being completed at the end of 2019 and a plant set to commence construction in Germany in 2021, while Volkswagen and Toyota have also announced plans to build plants in China. Overall, it is anticipated that, between 2019 and 2028, manufacturing capacity will grow 400%.[21]

Sustainability

Recycling regulations primarily focus on making battery manufacturers responsible for waste through the entire life-cycle until scrapped, referred to as Extended Producer Responsibility (EPR). Batteries are also recycled by converting used packs for lower specification EVs, or reconfigured as part of electrical storage facilities.

In China, companies are mainly focused on recycling materials in preference to repurposing used batteries, in response to regulations and shortages in supply of lithium, 85% of which is imported.[22] In 2020 the EU brought forward new regulations intended to protect and improve the environment by minimising adverse impacts of batteries through prohibiting certain materials and requiring battery producers to take responsibility for end collection and recycling.[23] In the US, waste regulation is primarily set at the state level, with certain states having introduced battery recycling and disposal laws, while others have applied EPR principles.

While EVs are effective in reducing harmful air pollutants, large scale use of minerals such as cobalt and nickel bring their own challenges. High quality nickel, one of the main components of modern batteries, is extracted from rock containing just 1% of usable material. Such high quantities of waste product are potentially a major environmental concern; with increased demand its expected production will shift from Canada and Australia to Indonesia, where mining firms will have to sustainably dispose of large volumes of waste to ensure Indonesia's seas with their rich coral reefs and turtles are not endangered.[24]

Conclusion

The early stages of adoption by users of medium and large cars has commenced, with higher sales volumes shifting from China to Europe. At present, volumes of battery-powered EV sales are small as a proportion of global vehicle sales, although rapidly rising; Tesla retains leadership and dominates the mid- and large-sized EV market.

Over a decade battery power costs have collapsed; over the next few years it is likely unsubsidised EV costs will achieve parity with ICEs. It is unclear which of the battery technologies will be at the centre of next generation batteries, however demand for their mineral components will be high and the environmental implications challenging.

Higher levels of adoption are expected in wealthier nations where the significant cost of recharging infrastructure can be financed. Whether cost effective battery power solutions are identified to allow poorer nations and types of vehicles presently unsuited to battery power to follow in a similar path is not yet clear.

Governments around the world are embracing EVs as a green technology that reduces harmful air pollutants and are putting regulations in place which make battery manufacturers responsible for their products throughout their entire lifecycle. As consumers become more aware of the environmental impact of their actions and governments face growing liabilities from air pollution, adaption in many countries is now regarded as a necessity rather than a lifestyle choice.

With the election of President Biden, who has signalled his commitment to sustainability by rapidly moving to re-join the Paris Agreement and appointing John Kerry as the special envoy on climate change, there’s now the prospect the US will join China and Europe in forcing further change.

Footnotes

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