THE FARADAY INSTITUTION

The Road to Electrification – from the Internal Combustion Engine to the Battery Electric Vehicle

Stephen Gifford,
Chief Economist, Faraday Institution

The global automotive industry is transitioning from the internal combustion engine to electric vehicles. The UK is at the forefront of this dynamic change and push towards the electrification of road transport with electric vehicles representing 34% of new sales in the first quarter of 2022. Nearly all new cars bought by the UK consumer are expected to be electric vehicles by 2030.

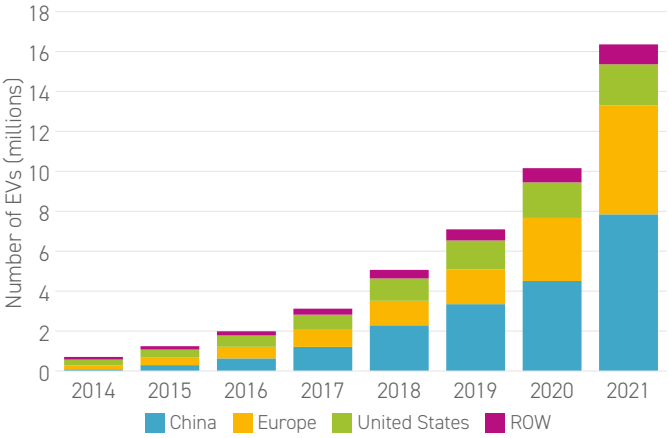
Electric Vehicles Enter the Mainstream

The global automotive market is going through a period of fundamental technological disruption. Business models, customers and suppliers are all in a state of flux as demand and supply move away from the petrol and diesel engines of the previous century towards a future dominated by electric vehicles (EVs). The global stock of EVs increased by 61% to reach 16.5 million in 2021 (Figure 1).[1] China is currently by far the biggest market, accounting for 48% of the global fleet. Norway has the highest EV market penetration in 2021 at 86% of new car sales.[2]

"Electric vehicles have now gone mainstream. Sales have grown steadily in recent years as a result of improved performance, lower purchase price and falling battery costs. In the UK, take-up reached 27% of all new car sales in 2021 compared to just 6% in 2018."

The number of EVs on UK roads is also increasing sharply. At the end of 2021, the UK's stock of EVs reached around 1.6 million or 4.3% of all licensed cars (Figure 2).[3] But it is in the sales market where the presence of EVs is being felt the most. EV new sales increased by 59% per annum in 2021 and accounted for 27% and 34% of new sales in 2021 and the first quarter of 2022 respectively.[4]

Figure 1: Global stock of electric vehicles



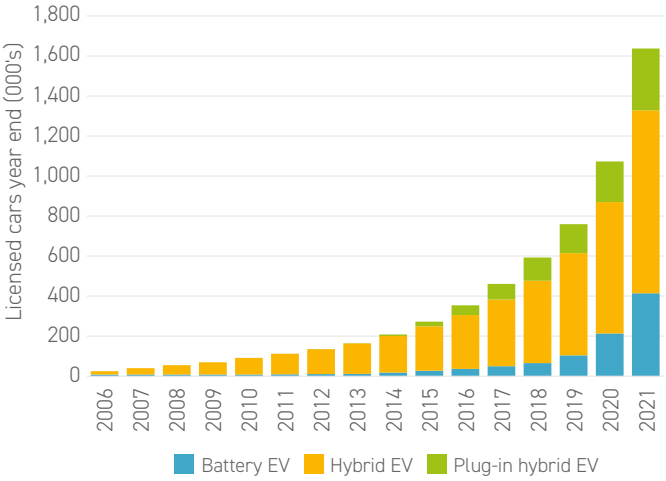
Source: International Energy Agency, Global EV Outlook 2022

Battery EVs (BEVs) have become the most popular type of EV in recent years. In 2021, BEVs outsold hybrid EVs (HEVs) and plug-in hybrid EVs (PHEVs) with the market shares as follows (along with definitions of the different EV types):

* This Faraday Insight 1 is an update to the version first published in July 2019.
[1] International Energy Agency (IEA) Global EV Outlook 2021.
[2] Inside EVs (January 2022).
[3] Department for Transport Vehicle Licensing Statistics.
[4] Society of Motor Manufacturers and Traders (SMMT).

UK Research and Innovation

Figure 2: UK stock of electric vehicles



Source: Department of Transport, Vehicle Licensing Statistics

- 42% BEVs: vehicles powered entirely by a battery that can be plugged in to recharge;
- 33% HEVs: vehicle with both an internal combustion engine and an electric motor; and
- 25% PHEVs: hybrid vehicle that can be charged from the electricity mains supply.

If the future EV industry in the UK can match the historical strength of the UK automotive industry, it would remain one of the most important sectors of the UK economy. In 2019, before the impact of the global pandemic, the UK automotive industry directly contributed £17.4 billion to the UK economy (Gross Value Added), representing 8.7% of the UK manufacturing output[5] and directly supporting 180,000 full-time-equivalent jobs.[6] A new EV industry will help deliver the Government's levelling up commitment given that 56% of automotive companies operate in UK regions with productivity below the UK average.

Electric Vehicles Set to Dominate

The Faraday Institution has developed a model to forecast global and UK vehicle sales of EVs and vehicles powered by the conventional internal combustion engine (ICE).[7] The take-up of EVs is a key forecast variable and we assume it follows an innovation S-curve – the pattern and life cycle that typically follows the breakthrough of new technology.

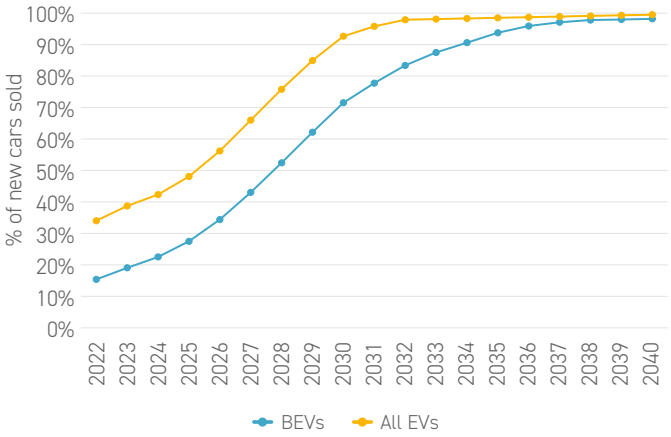
Under such an innovation model, the first group of buyers are often thought of as the innovators or early adopters. They have different socio-economic characteristics to the general population and different consumer preferences (for example, interest in technology or greater concern for the environment). As the typical buyer moves from the early adopters to the wider consumer, the product attains mass market appeal and experiences a growth spurt. Similar stages of growth were experienced for products as diverse as mobile phones, broadband and air travel, albeit that each had their own particular growth characteristics.

It is often difficult to predict exactly when the growth spurt will occur. Recent sales figures suggests that EV take-up has already started to accelerate up the S-curve and so the market is likely to grow rapidly over the next few years. In our model, EV take-up is combined with forecasts of the UK and global automotive sales and production. UK sales is expected to grow at a faster pace over the next 3 years as the UK and global automotive industry rebounds after the pandemic and then increase at the slightly slower pace of around 2% per annum.

Figure 3 and Figure 4 summarise the Faraday Institution's forecasts, with EV purchases expected to account for almost all sales of cars by 2030. BEVs are expected to increase their market share each year over the 2020s, reaching around 80% of EVs sold in 2030.

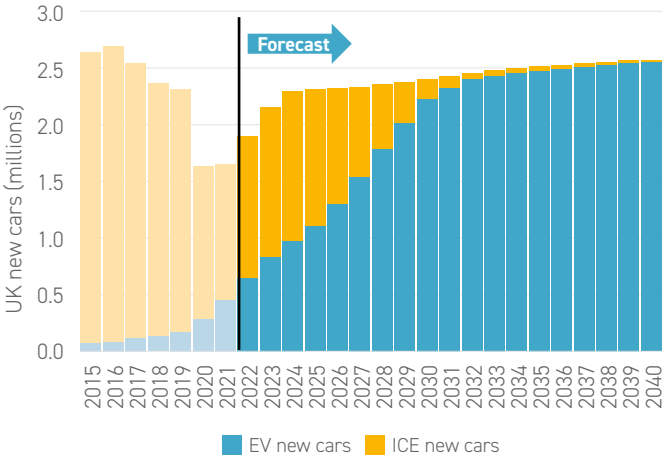
We forecast 2.2 million EVs will be sold in 2030 and nearly 2.6 million in 2040. The economic size of the automotive industry in the UK will, however, be largely determined by

Figure 3: UK EV take-up from 2022 to 2040



Source: Faraday Institution projections.

Figure 4: UK car sales from 2015 to 2040



Source: Faraday Institution projections.

[5] Office for National Statistics, GDP output approach – low-level aggregates.
[6] SMMT Motor Industry Facts 2020.
[7] Faraday Institution (2022). UK Electric Vehicle and Battery Production Potential to 2040.

UK vehicle production rather than sales. By 2030, the UK automotive industry is projected to manufacture around 1.6 million private cars and vans, with EVs representing around 95% of cars manufactured.[8]

Legislation, Falling Battery Costs and Lower Costs of Ownership

EV take-up is driven by legislation, strategy, policy and consumer tastes together with the cost of purchasing, owning and running an EV.

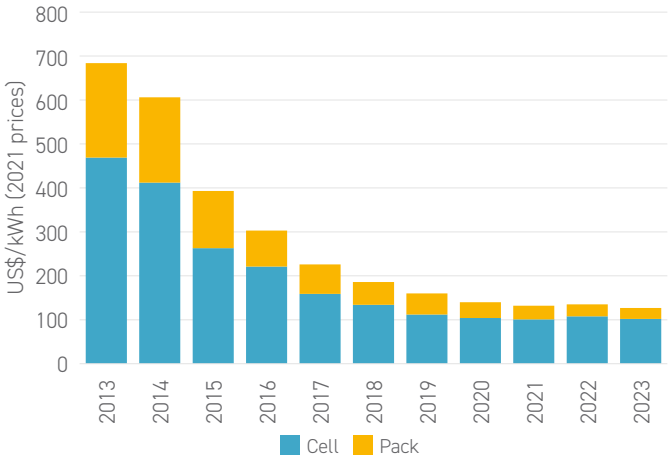
The UK Government was the first major economy to legislate in 2019 to bring all greenhouse gas emissions to net zero by 2050.[9] The legislation was subsequently strengthened in 2021 with a more ambitious medium-term commitment to reduce emissions by 78% by 2035.[10] Key strategies include the UK Government's Ten Point Plan for a Green Industrial Revolution,[11] which sets out a policy to end the sale of new petrol and diesel cars and vans by 2030 and for all new cars and vans to be zero tailpipe emission by 2035, and the Transport Decarbonisation Plan.[12]

The UK Government has also provided capital investment for the EV industry, both directly and indirectly increasing the take-up of EVs.[13] Key initiatives include investment towards the roll out of charging infrastructure with £1.6 billion already committed since 2020 and around £500 million earmarked for the development of gigafactories in the UK.[14]

The upfront cost of EVs is a major barrier to purchasing decisions, with EVs currently more expensive than ICEs. Costs are, however, reducing quickly and the total cost of ownership (which includes running costs) of EVs is much closer to or often even lower than that for ICE vehicles.[15] As the market expands and volumes increase, economies of scale in all parts of the automotive industry and the supply chain will likely drive costs down substantially over the next decade. In terms of the European average, small BEVs are expected to be cheaper than ICE vehicles in 2027, with medium and large BEVs reaching price parity a year earlier in 2026.[16]

Reduced battery costs are the key reason for improved EV affordability. Over the 2016 to 2022 period, the cost of the battery has fallen from around one-half to around one-third of the upfront cost of a BEV.[17] Average battery costs have fallen by around 80% since 2013 (Figure 5). Falling costs on this scale will change the economics of EV ownership and lead to the acceleration of EV purchases from the mid-2020s. Other factors driving take-up of EVs in the long-term are familiarity with EVs, the rising costs of fuel and environmental concerns.[18]

Figure 5: Average lithium-ion battery pack price



Source: BloombergNEF (Nov 2021).

A Dynamic and Fast-moving Industry

The analysis in this Insight have been updated since it was originally published in July 2019 to reflect updates to government policy and the latest data on EV sales and production. Forecasts of total UK sales and production of passenger cars are substantially lower than the previous projection due to the pandemic-induced sharp downturn in the UK automotive industry in 2020 and 2021.

However, the transition from ICE to EVs is expected to be much faster, due to the end to ICE sales being brought forward to 2030 instead of the original 2040 target date and higher than original expected consumer demand. Improved performance of EVs, lower purchase prices and falling battery costs are behind the recent increase in consumer demand for EVs.

The result is that although expected total car sales predicted for 2030 has fallen from 2.8 million to 2.4 million, the forecast for expected EVs sales has increased from 1.8 million to 2.2 million.

[8] See Faraday Institution (2022) 'UK Electric Vehicle and Battery Production Potential to 2040' for a more detailed discussion of UK vehicle production and UK battery manufacturing.
[9] UK becomes first major economy to pass net zero emissions law (June 2019).
[10] UK Government press release: UK enshrines new target in law to slash emissions by 78% by 2035 (April 2021).
[11] UK Government (2022). The Ten Point Plan for a Green Industrial Revolution.
[12] UK Government (2021). The Transport Decarbonisation Plan.
[13] DfT (July 2018). Road to Zero. Next steps towards cleaner road transport and delivering our Industrial Strategy.
[14] DfT (March 2022). Taking charge: the electric vehicle infrastructure strategy.
[15] Kate Palmer, James Tate, Zia Wadud, John Nellthorp, Total cost of ownership & market share for hybrid and EVs in the UK, US and Japan, Applied Energy, Volume 209, pp 108-119, January 2018.
[16] Hitting the EV inflection point. Transport & Environment & BloombergNEF (May 2021).
[17] Batteries share of large EV costs 2016-2030 (August 2021).
[18] Office for National Statistics. Over half of younger drivers likely to switch to electric in next decade (October 2021).

About the Faraday Institution and Faraday Insights

The Faraday Institution is the UK's independent institute for electrochemical energy storage research, skills development, market analysis, and early-stage commercialisation. We bring together academics and industry partners in a way that is fundamentally changing how basic research is carried out at scale to address industry-defined goals.

Our 'Faraday Insights' provide an evidence-based assessment of the market, economics, technology and capabilities for energy storage technologies and the transition to a fully electric UK. The insights are concise briefings that aim to help bridge knowledge gaps across industry, academia and government. If you would like to discuss any issues raised by this "Faraday Insight" or suggest a subject for a future Insight, please contact Stephen Gifford.

Sign up today to be added to the distribution list for future Faraday Insights www.faraday.ac.uk/subscribe

CONTACT
Stephen Gifford
Chief Economist
stephen.gifford@faraday.ac.uk
www.faraday.ac.uk
01235 425125
07741 853068

THE FARADAY INSTITUTION
UK Research and Innovation