GLOBAL X ETFs RESEARCH

Q&A with Adam Panayi on Electric Vehicles

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Date: January 9, 2023
Topic: Thematic

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At Global X ETFs, we believe a chart is worth a thousand words, and then some, when it comes to our changing world. Charting Disruption, our annual thematic research project, depicts the disruptive themes changing our world through charts, graphics, and much more. While the topics of the four main sections, including Personalized Medicine, A Greener Economy, Experiential Technologies, and FinTech, Blockchain, & Web3 are each unique, they are connected by innovation and the ability to transform the world.

To explore the depth of these changes, the Global X ETFs' Research team partnered with handpicked experts from academia, consulting, and investing. Below, we discuss what is driving momentum in electric vehicle (EV) sales and innovation within battery technologies with Adam Panayi. Adam is the Managing Director and Founder of Rho Motion, a specialist electric vehicle and battery research and consulting business established in 2018.

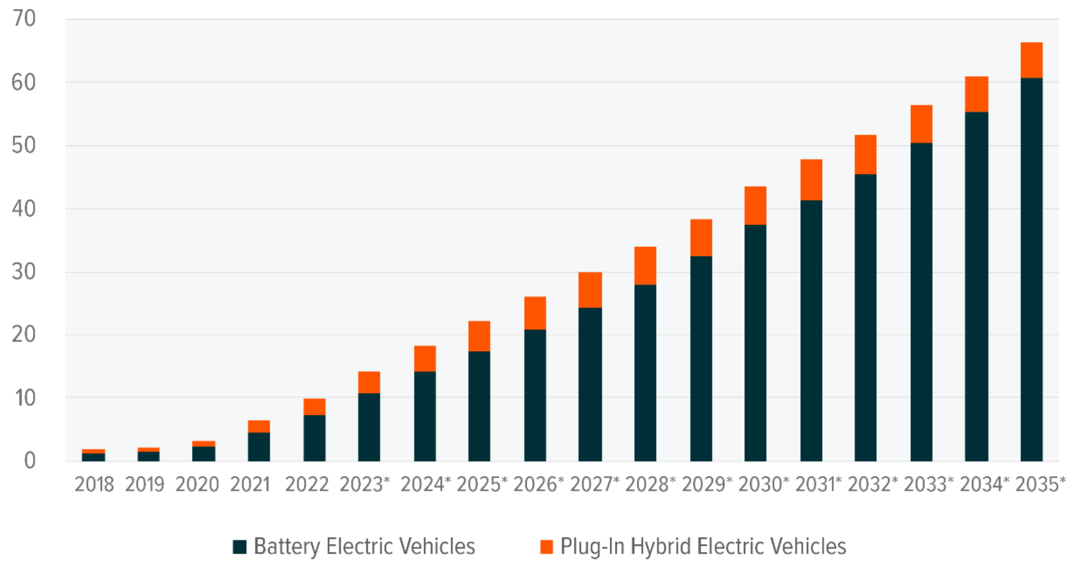
EVs can take a central role in creating a Greener Economy and reducing global greenhouse gas emissions. Accommodative government policies support rapidly increasing consumer adoption of electrified transport options. Advancements in battery technologies are also key to the transport industry's ongoing transformation.

1. What is Rho Motion's growth outlook for electric vehicle (EV) sales? Do you expect EVs to reach widespread cost parity with internal combustion engines (ICEs)?

We expect consistent growth in electric vehicles, including battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs), over next 10 to 20 years. We forecast annual EV sales to increase from around 10 million EVs in 2022 to more than 20 million EVs by 2025 and over 60 million by 2035.[1] The compound annual growth rate (CAGR) of unit sales to 2040 is forecast to be 12.8%.[2]

ANNUAL EV SALES THROUGH 2035 (MILLIONS OF UNITS)

Source: Panayi, A. (2022, December 7). EV & battery quarterly outlook Q4 2022. Rho Motion.



Note: *Indicates forecasts. 2022 is an estimate.

Widespread cost parity remains a contentious point. We are still in the early stages of BEV development, with multiple scale, manufacturing efficiency, and design improvements to be made across the vehicle, from chassis to powertrain. Battery costs are the main driver, of course, and some original equipment manufacturers (OEMs) foresee battery costs dropping to as low as $70 per kilowatt hour (kWh).[3] However, if raw material mining and processing capacity is insufficient, supply will become constrained and battery prices will rise. Generous incentives, such as those in the Inflation Reduction Act (IRA), can help mitigate costs and potentially help certain segments reach price parity by the end of the decade. Price parity in smaller segments will be more difficult due to razor-thin margins and very competitive pricing, at present.

At Rho Motion, we expect total cost of EV ownership to be lower than ICE vehicle ownership by 2029-2030 and remain so thereafter. However, higher electricity prices in Europe narrowed this gap recently, and there is disparity between those consumers with ability to charge at home overnight and those who rely exclusively on public charging. Higher energy prices combined with access to charging may cause challenges on the way to mass EV adoption, if it means total cost of ownership improves for some and not for others compared to ICE vehicles.

2. Most battery chemistries used in EVs, such as nickel cobalt aluminum (NCAs) or iron phosphate (LFPs), are ultimately lithium-based. Do you expect lithium will remain a vital component of future battery technologies such as solid state?

We expect lithium will remain essential to battery technologies for at least the next decade. Lithium is the most advanced battery chemistry at present and offers higher energy density and rate performance than alternatives like sodium. Sodium-ion technology has cost and safety benefits, but more validation must be done before commercialization is possible.

In terms of use of sodium in solid-state batteries, sodium ions are a less viable choice than lithium due to their size. When the sodium ions are inserted into the cathode material during discharge, the cathode expands significantly to accommodate the large sodium ions. Subsequently, when the sodium is removed during charge, the cathode then contracts. This constant expansion and contraction would be an issue, especially with solid state, because it would cause cracking of and disconnection from the solid electrolyte.

3. How could future innovations in battery technology boost the viability and adoption of EVs?

Future innovations are key for the continued adoption of EVs, with cost being one of the biggest considerations if EVs are to become standard for everyone. Currently, the component in EV battery packs that contributes the most to mass and cost is the cathode.[4] Hence, companies are already working to reduce the amount of critical material used in cathodes, such as through the removal of cobalt, and they're working to increase the use of more abundant and cheaper metals. For example, there is increasing adoption of LFP cathodes where the iron sulphate precursor used in the manufacturing of LFP is a by-product of steel and titanium dioxide manufacturing.

We expect further advancements in cathode technology will continue to reduce critical metal content, driving down cost and demand constraints while improving performance characteristics. LFP is better for the bottom line and safety than nickel-based cathode chemistries, but it is less energy dense and less conductive. There is work being done to explore modifications that can improve LFP performance, such as doping with metals like manganese (LMFP) or altering the cathode surface, such as carbon coating, to improve electronic and ionic conductivity.

Arguably the most promising future innovation to consider for EVs is solid state. Use of solid electrolytes in EV batteries can reduce the overall weight of battery packs and allow for higher capacity electrodes. Solid electrolytes remove the need for separator materials and take up less volume than their liquid counterparts. Solid electrolytes also create the opportunity to use lithium metal anodes, which offer high specific capacity at 3860 milliampere-hours per gram mass (mAh/g). They help prevent the growth of dendrites that occurs uncontrollably on lithium metal when using traditional liquid electrolytes, which has a catastrophic effect on cycle life. Lithium metal anodes' superior volumetric and gravimetric energy densities allows for smaller and lighter battery cells.

Solid electrolytes can also improve the safety of lithium-ion batteries because they are not flammable and therefore are operational at higher temperatures, unlike liquid electrolytes. Additionally, they are more mechanically stable and safer in the event of a collision. Hence, solid electrolytes dispense the need for certain safety components, such as thermal management systems and safety cages in EVs.

However, at present solid-state batteries still have hurdles to overcome before commercial EV use is possible. Whether they can be produced at scale remains uncertain. They also have some performance issues regarding their comparatively lower conductivity at ambient temperatures compared to liquid electrolytes.

4. In Europe, several countries boast EV market penetration rates above 20%, including Germany, Finland, Denmark, Sweden, and Norway. What have these countries done right to foster the adoption of EVs, and can other countries replicate these growth factors?

The EV penetration rate across Europe increased significantly in recent years, from 3% in 2019 to just under 19% in 2022.[5] Over that same period, this increase has been even more impressive in certain countries. Finland's penetration rate increased from 6% to 31%, Germany's increased from less than 3% to 25%, and Denmark's increased from 4% to 31%.[6]

A key driver of this progress was the 2020 reduction to the European Union's CO_2 emissions standard from 130 grams per kilometer (g/km) CO_2 to 95g/km CO_2, the New European Driving Cycle (NEDC). This stricter target required OEMs to mobilize quickly to lower their average fleet emissions in order to avoid fines. The only way OEMs could comply was to sell more BEVs and PHEVs. In 2021 and 2022, the 95g/km CO_2 standard became even more difficult to achieve given the reduction in incentives, including super-credits and eco-innovation credits.

When the world shut down to combat COVID-19 in the first and second quarters of 2020, so did the EV market. Sales dropped drastically, first in China, and then in the rest of the world. However, sales recovered strongly as governments in many major markets introduced huge COVID relief stimulus packages that included an emphasis on funding for environmental technologies, including those in the EV market. Importantly, some of Europe's biggest auto markets showed their commitment. Germany's relief package increased the country's EV subsidy to a maximum of €9,000 (~ $9,482 at time of publishing).[7] France's relief package increased the country's maximum EV subsidy to €7,000 (~ $7,375 at time of publishing).[8] As a result, sales started to increase sharply in the second half of 2020, with the European market growing very strongly.[9]

The EV market is even more developed in Scandinavia, led by Norway, which we estimate will have a 2022 EV penetration rate of 76%.[10] Norway took a different approach to EV adoption by raising taxes on traditional ICE vehicles to discourage purchases and exempting taxes for EVs to make them the better option economically.

Emissions legislation, incentivizing EVs, and disincentivizing ICEs can all promote EV adoption. Other countries and regions simply need to make the commitment and choose the blueprint that works for them. However they go about it, political will to drive the industry forward might be the most important factor.

5. In your view, how can hydrogen fuel cell electric vehicles (FCEVs) be a decarbonization tool within the transportation segment?

We expect limited traction for hydrogen within the passenger car (PC) & light-duty vehicle (LDV) segment, where most vehicles will transition to BEVs. The key limitations in this segment are the lack of refilling stations and the cost to install them, the high price of FCEVs themselves, and how costly they are to the manufacturer. The three major FCEVs in the PC & LDV segment are the Toyota Mirai, Hyundai Nexo, and Honda Clarity. BMW may launch its iX5 FCEV at some point after it introduced the vehicle in 2021, although it remains in testing as of December 2022.

Where hydrogen may come into play is in plugging some of the gaps BEVs struggle to fill. For example, hydrogen is a better fit for the commercial sector, particularly heavy-duty vehicles such as long-haul trucks and construction machinery, given the range limitations of BEVs. We expect heavy-duty vehicles to account for most of the demand for FCEVs. Several truck OEMs are already in the pilot testing phase for fuel cell prototypes.

The key selling point for FCEVs versus BEVs is that the energy density in a fuel cell stack is far greater than that offered by current and even future battery technologies. For comparison, top specification batteries in the market today offer a gravimetric energy density of roughly 280 watt-hour per kilogram (Wh/Kg), while fuel cells can go as high as 3,000 Wh/Kg, depending on efficiency losses. To put both technologies in perspective, diesel offers roughly 13,000 Wh/Kg before efficiency losses in combustion, which helps explain why the technology will be difficult to displace for long-haul heavy-duty commercial vehicles.

Another key advantage for FCEVs in the commercial segment is that refilling takes practically the same time as a diesel or gasoline vehicle and is arguably more intuitive to consumers used to refilling with fossil fuels. This feature is especially important for long-haul commercial transit because it results in less downtime compared to charging and a potentially higher utilization rate for the driver, a key cost consideration. These advantages also apply to passenger cars used for commercial applications.

The challenge of developing a refueling network is also easier for the commercial industry because its vehicles largely travel set routes, allowing operators to target stations across regional highways.

Currently, FCEVs have the most traction in the Asia Pacific region, led by Japan and South Korea. Japan has a hydrogen roadmap that plans for 200,000 units by 2025 and 800,000 units by 2030.[11] In February 2021, South Korea's Ministry of Trade, Industry and Energy announced a plan to produce 200,000 FCEVs by 2025 and 850,000 FCEVs by 2030.[12,13] However, progress on this plan is limited thus far.

Footnotes

1. Panayi, A. (2022, December 7). *EV & battery quarterly outlook Q4 2022*. Rho Motion.
2. Ibid.
3. Campagnol, N., Pfeiffer, A., & Tryggestad, C. (2022, January 7). *Capturing the battery value-chain opportunity*. McKinsey & Company.
4. Bhutada, G. (2022, February 22). *Breaking down the cost of an EV battery cell*. Visual Capitalist.
5. Data derived from Panayi, A. (2022, December 7). *EV & battery quarterly outlook Q4 2022*. Rho Motion.
6. Ibid.
7. Appunn K. (2021, July 9). *Germany extends e-car purchasing support to 2025*. Clean Energy Wire.
8. Randall, C. (2022, June 30). *France postpones EV subsidy reduction*. Electrive.com.
9. Panayi, A. (2022, December 7). *EV & battery quarterly outlook Q4 2022*. Rho Motion.
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11. Sugiyama, T. (2021, April 20). *Japanese perspective on the hydrogen economy*. The Canon Institute for Global Studies.
12. Stangarone, T. (2021). South Korean efforts to transition to a hydrogen economy. *Clean technologies and environmental policy, 23*, 509–516.
13. Ministry of Trade, Industry and Energy. (2022, May 20). *Achievements and vision of Korea's hydrogen economy policy*.

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