# Editorial

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The carbon neutrality objectives for 2050, resulting from the Paris Agreement in 2015, as well as the numerous global regulations concerning the reduction of $CO_2$ and other polluting emissions are putting the automotive industry under great pressure to switch rapidly from internal combustion engine vehicles (ICEVs) to battery electric vehicles (BEVs).

The regulations that are currently being decided on in the world's three largest markets make this clear: Europe and California aim at 100% of zero emission vehicles (ZEV) by 2035, the US federal regulation aims at 50% of ZEV by 2030[1] (and 67% by 2032) while China aims at 50% ZEV, 50% PHEV by 2035.[2]

Switching from an ICEV to a BEV involves changing the energy source that allows the vehicle to move, i.e., a high-voltage (HV) battery instead of a fuel tank – as well as modifying the powertrain by replacing the internal combustion engine with an electric motor and changing the way power is transmitted and modulated to the wheels.

The greater modularity of the electric powertrain as well as the centrality and higher price of the HV battery system compared to conventional ICEV systems lead to a key hypothesis regarding the effects of electrification: specialist suppliers would gain power over automakers and reverse the traditional hierarchical relationships, taking over the dominant position of value added in the industry.

While most of the automakers have now strongly engaged in this transition, two recent studies (Alochet et al., 2023; Alochet and Midler, 2019) have shown that, *so far*, the architecture of the automotive industry has not yet been impacted by this transition.

Moreover, it is probably too early in the transition to draw definitive, broad-based conclusions: in 2022, a year in which the global automotive market has yet to return to pre-COVID-19 levels, BEV sales exceeded 10.5 million vehicles and accounted for approximately 13% of sales, up +55% compared to 2021.[3] This very significant result shows that we are still in the construction phase of the market and that many developments have yet to take place before its completion.

For HV batteries whose centrality is major for the future of the automotive industry, it is clear that we are still far from a period of stabilisation, for at least four main reasons:

1 Many major technology choices remain largely open: choice of electrochemistry, liquid or solid-state lithium-ion, 400 V or 800 V, cell to pack or even cell to chassis to name a few. We do not know if a dominant HV battery design will emerge. If so, when will it emerge and what impact will it have on battery and vehicle production systems?

2 Cost, which still represents about 40% of the cost of BEVs, while their high price is perceived as one of the main barriers to their mass commercialisation.

3 The impact on the performances directly visible to the customer: maximum speed, range and charging capacity are directly impacted by the characteristics of the HV battery.

4 The profound change in the organisation of the value chain that this implies.

But, we are just in time to frame the key questions and interpret the direction of trends. The objective of this special issue of *IJATM* is to offer keys to understanding this major question of the ongoing transition: "From oil to electricity, are HV batteries changing the game for the automotive industry?" To answer this question, we combine comprehensive contextual overviews with detailed analyses to identify trends and accurately inform next steps.

The starting point of this special issue is that the transition towards electrification is forced by regulations. In their paper, C. Midler and M. Alochet investigate whether and how those related to high voltage batteries could shape the future of the automotive industry. While China is leading the way, Europe and the USA, with very high levels of funding, are racing against time to catch up and develop a sustainable battery value chain controlled by local champions. As the US resorts to protectionism, they hypothesise that we may see the emergence of three geographic production hubs, ending the globalisation of the battery industry.

Battery production requires the use of scarce raw materials which are not in unlimited supply. B. Jetin demonstrates that the USA and the European Union are very dependent on the import of both many critical materials, some of which present certain risks of scarcity, and batteries. In a highly uncertain geopolitical context marked by rising US-China rivalries and the war in Ukraine, the USA and EU are deploying commodity diplomacy as well as supporting local mining and processing of critical materials to attempt to regain strategic autonomy. But both decisions are difficult to implement, and progress will be slow. China's almost unchallenged domination of the electric battery value chain will be difficult to circumscribe, especially since the USA, with the Inflation Reduction Act (IRA), does not hesitate to defend its interests at the expense of the EU. As already mentioned by C. Midler and M. Alochet in their paper, there is a strong risk of alignment of global production networks on these three regions.

A. Stocchetti and P. Verma focus on the introduction of (very) HV batteries (HVB, 800 V or higher), to explore how this technology might affect the competitive dynamics and players' strategy beyond the already known effect of car electrification. The results show that HVBs could significantly strengthen the diffusion of BEVs in general, although the incentive mechanism and the focus on premium segments

could play in the opposite direction, preventing or delaying the activation of the virtuous circle between size and scope economies and price reductions. Moreover, vertical networks with stable relationships are likely to be established, in order to create close technological coordination between charging service providers, carmakers and powertrain component manufacturers, including batteries, which could be vertically integrated by carmakers.

The rapid replacement of ICEVs by BEVs is destabilising vehicle manufacturing: the adoption of e-motors and single-speed gearboxes on BEVs is reducing foundry, machining and assembly activities, while the suppression of fuel, exhaust and pollution control systems is causing job reductions, almost exclusively at suppliers. By contrast, we still know very little about work and employment conditions in the lithium-ion battery industry and whether the new jobs created in this industry will be good or bad jobs. T. Pardi proposes to fill this gap by providing a broad overview of the key economic, political and institutional factors shaping the structure of the emerging lithium-ion battery industry for electric vehicles and their implications for the quality of jobs created. To do so, he analyses the evolution of the labour relations of the three main groups of battery manufacturers: the historical group of East Asian companies; the 'start-up' group of industrial developers; and the OEM-owned group (joint ventures and direct investments).

BEVs require less maintenance and repair than ICEVs, but the analysis and resolution of problems encountered on the former require a level of knowledge and expertise totally different from what is mastered today in the specialised or automaker networks. While Tesla has proposed a totally different model (online sales of vehicles, very rapid correction of software problems via FOTA[4] and agreements with specialised networks for body repairs), B. Jullien analyses the impact of the introduction of HV batteries for the sales and repair networks that often generate a non-negligible part of the automakers' revenue. Based on the observation that the transition from internal combustion engine to electric motor vehicles poses at least as many adaptation problems for all downstream players as it does for OEMs and suppliers, his work, which is essentially forward-looking, focuses on how the business models of all players will be affected. He analyses various possible forms of re-composition of the downstream ecosystem, and concludes that the changes underway are unlikely to revolutionise the ecosystem, but will enable the very diverse players cohabiting within it to reposition themselves in relation to one another.

## References

Alochet, M. and Midler, C. (2019) 'Reorienting electric mobility research focus on industrialisation issues', *International Journal of Automotive Technology and Management*, Vol. 19, Nos. 3–4, pp.229–256.

Alochet, M., MacDuffie, J.P. and Midler, C. (2023) 'Mirroring in production? Early evidence from the scale-up of battery electric vehicles (BEVs)', *Industrial and Corporate Change*, Vol. 32, No. 1, pp.61–111.

## Notes

1 https://ww2.arb.ca.gov/resources/fact-sheets/governor-newsoms-zero-emission-2035-executive-order-n-79-20; https://www.europarl.europa.eu/news/en/press-room/20220603IPR32129/fit-for-55-meps-back-objective-of-zero-emissions-for-cars-and-vans-in-2035; https://www.federalregister.gov/documents/2021/08/10/2021-17121/strengthening-american-leadership-in-clean-cars-and-trucks.

2 New Energy Automobile Industry Development Plan (2021–2035).

3 EVvolumes (https://www.ev-volumes.com/).

4 Firmware over the air.