Electromobility in the Automotive Industry. What Role Does Technology Change Play in the Geographic Pattern of Production?

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Abstract: *The current internal combustion powertrain technology of road vehicles is unsustainable in the long run, due to the possible exhaustion of fossil fuels, and the socio-economic changes which are accompanied by increasing environmental impacts. Furthermore, there are limits to the emission reductions that can be achieved by developing or improving the efficiency of internal combustion powertrain technology, as well as stricter emission targets and a move towards electromobility. Therefore, automotive manufacturers implement technology change, although current technology will be in use for a long time to come. However, since the 2008 crisis, the territorial distribution of the automotive industry has been undergoing a major transformation. China's role has been growing and is now the world leader in terms of production and consumption. The forecasts assume a decline in consumption in developed regions. This results in a major restructuring of the automotive industry owing to the technological change.*
The purpose of this study is to examine this transformation, taking into account the possible consequences of changes in technology and changes in global production. The focus of our study is a group of Central European countries (Czechia, Hungary, Poland and Slovakia) that play a significant role in the European automotive industry.

Key-words: electromobility, automotive industry, global value chain, Central Europe

JEL classification: O33, F60, F15

1 Introduction

Gasoline-powered road vehicles and related manufacturing developments have been revolutionizing mobility since the first half of the twentieth century. Due to mass production, individual relocation is no longer just a privilege of the rich. Over the past decades, the previously underdeveloped part of the world has become a part of global consumption, and as a result of economic development, demand has been increasing. However, the internal combustion powertrain technology is unsustainable in the long run, due to possible exhaustion of fossil fuels, and the socio-economic changes which are accompanied by a growing environmental impact such as the increase of greenhouse gas and particulate matter emissions or the problems of waste management and recovery during and after use. There are limits to the emission reductions that can be achieved by developing or improving the efficiency of internal combustion powertrain technology and the stricter emission targets and move towards electromobility.

Furthermore, countries are increasingly tightening their environmental regulations on emissions. Not only the European Union has stricter emissions standards[1], but in the U.S. California State has forward looking regulations which has been adopted by more than a dozen federal states. Road vehicle pollution is on the increase and is the biggest problem in Chinese cities (Wang et al., 2019), therefore the Chinese government is enforcing strict environmental regulations in order to reduce emissions (Xinhuanet, 2019).

Despite the success of active and passive emission control systems in the reduction of air pollutants from transport (European Environment Agency, 2018), there are limits to the emission reductions that can be achieved by developing or improving the efficiency of internal combustion powertrain technology (Emőd,

[1] EU regulation 2019/631 targets by 2030 that the average emissions of the new passenger car fleet should apply a 37.5 % reduction of the target in 2021.

2012). Additionally, analyses pointed out that short term solutions i.e. hybrid and plug-in technologies are not real answers of emission reduction, although manufacturers prefer to use them (Stephan et al., 2019).
Automotive companies are turning to electromobility. Since 2008 when the first serial produced battery electric vehicle Tesla Roadster came out, the number of launches of new battery electric vehicle (BEV) models has increased worldwide.[2] The largest 50 car manufacturers (OICA, 2019) have 30 pure battery electric models on the market. So technological change is on the way in the automotive industry: producers are now moving towards electromobility, mostly battery technology, and some manufacturers (Honda, Hyundai) also see a future for fuel cell (FCEV) technology as well.

This transformation raises two important questions. Firstly, what will the production look like after replacing internal combustion powertrains? Secondly, what role does technology change play in the geographic pattern of production?

Taking into account these questions, in the present paper[3] we deal first with forecasts on the spread of electromobility, highlighting the advantages and disadvantages of the possible solutions. Second, in addition to developments in global sales, we also cover regional trends, which determine the prospects for local production due to the regional distribution of vehicle production and sales (Sturgeon et al., 2008).

2 Spread of alternative drives in the automotive industry

Currently there are two alternatives for pure electric drive. Battery electric vehicle (BEV) and fuel cell (FCEV) electric vehicle. The transition between battery and internal combustion engine (ICE) is hybrid technology. Plug-in hybrid (PHEV) and hydrogen fuel cell plug-in hybrid (FCHEV) vehicles play a significant role in this "transitional period", with manufacturers being able to reduce pollutant emissions without the need for a major technology change using mixed technology (ICE and electric drive or battery and fuel cell), although this does not provide an adequate solution to reduce pollution (Greenpeace, 2019).

Ideas for the future drive are divided along the question whether the power from the battery drive (BEV) or the fuel cell (FCEV) is the right way to go. If you consider the different aspects, the picture from the perspective of choice is quite complex. In terms of the ecological or carbon footprint, Well-To-Wheel (WTW) analysis shows that due to the high cost of hydrogen production, liquefaction and storage, battery-powered vehicles have lower carbon dioxide emissions then the fuel cell (Roland Berger, 2016). If we take into account not only operational emissions but also lithium-ion battery production, the picture for BEV vehicles is less favorable. Ellingsen and Hung (Ellingsen and Hung, 2018) calculated the lifecycle greenhouse gas (GHG) emission of the BEVs and the conventional internal combustion vehicles. Currently, battery manufacturing emits more greenhouse gases than fossil fuels, and even if electricity is produced using conventional energy sources, BEVs are also disadvantageous in operation. At last, in terms of efficiency, BEV vehicles are proven to be the most efficient. The U.S. Environmental Protection Agency has a database on the fuel efficiency of available cars.[4] The miles per gallon gasoline equivalent (MPGe) values show that BEV vehicles with the lowest efficiency (69 MPGe) are two times more efficient than the ICE vehicles with the highest values (35 MPGe). The fuel cell vehicles are amid these two groups with an MPGe value between 68 and 57.

There are calculations for the future costs of conventional and alternative drives, but the uncertainty of the cost factors that can be considered leads to different results. An almost ten years old study by Offer and his co-authors (Offer et al., 2010) estimated the costs of the various drive modes currently known for 2030. Regarding capital costs (purchase of the vehicle) conventional drive (ICE) will still be cheaper than the alternatives (FCEV, BEV and FCHEV). However, the costs are different if the lifetime (total) costs based on TTW (Tank-to-wheel) efficiency for 100 thousand miles are taken into account. ICEs and FCEVs have 1.75 times higher lifecycle costs than FCHEVs and BEVs. Tan and his co-authors (Tan et al., 2014) had the opposite result by taking into account the cost of the main components and costs i.e. fuel cell, battery pack, electric motor and controller, hydrogen storage and conventional engine. Based on estimates for 2030, ICE vehicles will be the cheapest, as the total cost of FCHEVs will be two times higher, followed by the BEV and FCEV.

On this basis, it is clear that consumers must in some way be made interested in paying more for electric vehicles (Bloomberg, 2016). In addition to state incentives, the importance of environmental/emission regulations on conventional cars should be emphasized (Porter et al., 2013). However, empirical studies show

[2] https://www.statista.com/statistics/871061/battery-electric-vehicle-model-launches-worldwide/
[3] Paper presented at the 13th Hungarian-Romanian round table, Budapest, September 26, 2019.
[4] https://www.fueleconomy.gov/feg/findacar.shtml

that, in addition to government benefits, regulation (Musti & Kockelman, 2011; Whitehead et al., 2019) or fuel prices (Beresteanu & Li, 2011) can more effectively influence the spread of alternative drives.

Table 1: Electric car announcements of the OEMs

OEM	**Announcements**
BMW	15-25% of the BMW Group's sales in 2025 and 25 new EV models by 2025.
BJEV-BAIC	0.5 million electric car sales in 2020 and 1.3 million electric car sales in 2025.
BYD	0.6 million electric car sales in 2020.
Chonquing Changan	21 new BEV models and 12 new PHEV models by 2025, **1.7 million sales by 2025 (100% of group's sales).**
Dongfeng Motor	6 new EV models by 2020 and 30% electric sales share in 2022.
FCA	28 new EV models by 2022.
Ford	40 new EV models by 2022.
Geely	**1 million sales and 90% of sales in 2020.**
GM	20 new EV models by 2023.
Honda	**15% electric vehicle sale share in 2030** (part of two-thirds of electrified vehicles by 2030, globally and by 2025 in Europe).
Hyundai-Kia	12 new EV models by 2020.
Mahindra & Mahindra	0.036 million electric car sales in 2020.
Mazda	One new EV model in 2020 and 5% of Mazda sales to be fully electric by 2030.
Mercedes-Benz	0.1 million sales in 2020, 10 new EV models by 2022 and **25% of the group's sales in 2025.**
PSA	0.9 million sales in 2022.
Renault-Nissan-Mitsubishi	12 new EV models by 2022. Renault plans **20% of the group's sales in 2022 to be fully electric**. Infiniti plans to have all models electric by 2021.
Maruti Suzuki	A new EV models in 2020, 35 000 electric car sales in 2021 up to 1.5 million in 2030.
Tesla	Around 0.5 million sales in 2019 and a new EV model in 2030.
Toyota	More than ten new models by the early 2020s and 1 million BEV and FCEV sales around 2030.
Volkswagen	0.4 million electric car sales in 2020, up to 3 million electric car sales in 2025, **25% of the group's sales in 2025**, 80 new EV models by 2025 and 22 million cumulative sales by 2030.
Volvo	**50% of group's sales to be fully electric by 2025.**

Source: IEA 2019, pp. 84-85.

Forecasts predict further dynamic growth in sales of battery electric vehicles (BEV). Although in this growth government policies have a key role, it is not only due to direct state incentives (see Whitehead and his co-authors, 2019). Also with the advance in battery technologies and the lowering of the cost of batteries, manufacturers will enable more people to buy battery-powered vehicles (International Energy Agency 2019, p. 4). Currently the lack of electric vehicle charging infrastructure, price and driving range are the biggest barriers to the spread of battery powered electromobility (KPMG, 2019). According to the Bloomberg New Energy Finance (BloombergNEF), electric vehicles will impact road transport from 2040, when sales of the battery electric (BEV) and plug-in hybrid cars (PHEV) exceed traditional vehicles (Bloomberg Electric Vehicle Outlook, 2019). Other expectations agree with this and predict the complete changeover from the internal combustion engine powered vehicle to an electric car over the long term, roughly to 2050 (Robecosam, 2017).

Taking into account the OEMs announcements of the light-duty vehicles[5] to 2025 (see Table 1), figures are rather extreme, between 15 and 100 percent of OEM's sales. At the same time, figures refer not only to BEV vehicles, but also to PHEV, which indicates that technology change is a major step in terms of both market introduction and enterprise resources. And not only OEMs play a vital role here, but suppliers also make significant innovations (e.g. Lithium-ion like battery producers). As long as the major or well-known vehicle manufacturers are more conservative and have a lower rate of electromobility (in average of 15-25%), the newcomers like Chinese Chonquing Changan or Geely have the highest 2025 commitment. Of course, these are much smaller companies, so they are more responsive to changing expectations, and their products are less known to the market.

These remain mere speculations if the economic environment and the prospects for markets to develop do not meet. Regarding the possibilities, a PWC survey distinguishes (PWC, 2019) three scenarios for 2023, an optimistic, a pessimistic and a realistic: when EV development is fast-paced, delayed or when market conditions are difficult.

Regarding technological change, there are two major consequences. Transformation from the internal combustion drive to electromobility is manifested not only in the built-in components, i.e. the product, but also in the structure of the industry's vertical integration, i.e. dividing the various tasks in the value chain (Klug 2013, 2014; Ciarapica et al., 2014; Slowik et al., 2016). Consequences on the product side are, on the one hand, the outdated products. Production of the whole powertrain system (internal combustion engine and transmission) will cease. After the Volkswagen's diesel scandal in 2015, experts thought that diesel cars would stop selling in the foreseeable future. However, the change of technology and the removal of polluting technologies are not proceeding as justified by the tightening of environmental regulations. In 2018 Toyota announced that it would discontinue the production of diesel-powered cars after 2020 in Europe.[6] However, globally the company was more cautious. In 2019 it stated that it won't discontinue diesel engines in the MPV (multipurpose vehicle) and SUV (sports utility vehicle) in India, because its diesel-powered cars have a major role in the company's sales in the country.[7]

On the other hand, new technologies and materials redound to new suppliers. In the BEVs the battery pack provides the highest rate, one-third of the cost, and it is projected that despite its decline in sales price in the next 5-6 years, its share of costs will remain unchanged (UBS via Portfofio.hu 2018). China has a leading position in the lithium-ion battery market accounting for two-thirds of the world production in 2019 (Electrec, 2019). In order to ensure its role in Europe in the battery production and cover the European demand for the new electric vehicles, it needs to build at least 20 giga factories in the next five years, according to the European Battery Alliance (via European Commission, 2018). Despite the high prices, there are sometimes stock shortages in the automotive supply chain. Currently, there are remarkable production capacities in Germany, Poland and Hungary[8] in Europe. In terms of battery production these Central European Countries will have a key role in the near future which will ensure their position in the global value chain. According to short term projections by Tsiropoulos and his co-authors (Tsiropoulos et al., 2018) and a study by Eddy and his co-authors (Eddy et al., 2019) there will be four countries in Europe with large capacity of production by 2023 and 2030, namely: Sweden (32.0 GWh), Germany (14.1 GWh), Poland (12.0 – 45 GWh) and Hungary (9.5 – 16 GWh).

In the former years, it has happened several times that production had to be reduced because the battery suppliers were unable to meet the delivery volume. This battery shortage happened in 2019 with the Koran Kia[9] and the German Volkswagen production of the Audi e-tron[10]. OEMs are vulnerable to battery suppliers, which are solved by purchasing from multiple sources (e.g. General Motors, Ford but even the Japanese Honda or

[5] any motor vehicle with a gross vehicle weight rating of 4,500 kg or less.
[6] https://www.irishtimes.com/business/transport-and-tourism/toyota-to-end-production-of-diesel-cars-this-year-1.3415933
[7] https://www.gaadi.com/car-news/toyota-to-retain-diesel-engines-in-innova-crysta-fortuner
[8] LG Chem (ROK) has in Poland the world's 5th largest (giga)factory, GS Yuasa Corporation (JP) , Samsung SDI and SK Innovation (ROK) have large capacities in Hungary.
[9] https://www.autoblog.com/2019/10/18/supply-issues-force-kia-to-delay-the-new-soul-ev-until-the-2021-model-year/?guccounter=1&guce_referrer=aHR0cHM6Ly93d3cuZ29vZ2xlLmNvbS8&guce_referrer_sig=AQAAAAMWNznWcEoJnKb0CupEAPHunCq_nm9IDvBYAoY0EvKbuORMa5JnyrB6L_lpahvNLi_ygKOJWcbk8bR89ucjg5aOttrq2V2ZV8qxTfm11qOvDM1UzaKtDmsFnaLdUWQ1J90zLIQDO3yhh3SkkxmqFvf5JCnoYY99NV6GjC-XGreM
[10] https://www.brusselstimes.com/brussels/55536/battery-shortage-forces-audi-brussels-to-slow-down-production/

Nissan) or creating their own production (e.g. Tesla with Panasonic).[11] How this develops and which paths each company takes will determine the future of the value chain, which has already affected the production side.

On the **production side**, because of the structure of the vehicles is much simpler, according to Volkswagen's CEO Herbert Diess, EVs are less complex to build, it takes 30 percent less time to assemble[12], therefore, don't require as many workers as conventional vehicles. Switching to electromobility could cost thousands of jobs[13] and would mean an allocation of the production to east. Union leaders on Volkswagen's board drew attention to the proposals that because of cost savings, the company wants to shift some production from Germany to the Czech Republic.[14] At the same time, industry 4.0 and robotics may cause a kind of reshoring of automotive investments from the semi-periphery to the core countries (Bailey and De Propris, 2014; De Backer et al., 2016). That will reshape the geographical pattern of the global value chains, including the demand for labour. Therefore, the technological transformation raises the question of the long-term sustainability of the current production capacities in the automotive-related and export-based economies (semi-periphery countries) and the core countries (North America, Western Europe, South Korea and Japan) as well. The economic and social costs of the transformation can be a shock, with layoffs, as well as export decline that threaten the sustainable economic development of these countries.

Scholars usually pay less attention to the value chain consequences of ongoing technological changes. This question is pertinent in the sense that the Central European countries have been deeply integrated into this international production network as part of the global vehicle production. Technological transformation raises the question of the long-term sustainability of the current production capacities in the automotive-related and export-based Central European economies.

3 The influence of global trends on the geographic pattern of electric vehicle production

The regional dimension of the automotive industry is not only described in terms of regional implications of OEM's strategies, but as market growth and the expected regional development trends. Although in some cases, a global relationship system may be discovered in the trading of individual affiliates (Túry, 2017), the automotive industry is a regionally embedded activity and this shows a larger regional breakdown for production and sales (Sturgeon et al., 2008).

Table 2: Global road vehicle (including cars, trucks, and buses) stock estimations (million units)

	2010	2030 (est.)	Increase
Brazil	65	84	19
China	77	390	313
Germany	47	58	11
India	21	156	135
Japan	75	87	12
South Korea	18	31	13
United States	247	314	67
other OECD	311	418	107
other non-OECD	465	542	77
Total	1,015	2,080	1,065

Source: Porter, Cunningham & Sanz, 2013, p. 5.

The triad countries heavily rely on the automobile industry. In Europe, the industry has been one of the most important growth engines for economic prosperity (Cornet et al. 2019, p. 32.). Core countries like the U.S. or the Western European countries built their value chain by integrating their peripheral countries (Mexico, Southern and Central Europe, South East Asia) into production via outsourcing the labor intensive activities. Additional overseas production after World War II began in the 1960s, when European and Japanese car

[11] https://www.marklines.com/en/report_all/rep1115_201210
[12] https://www.volkswagenag.com/en/news/2019/03/diess-safeguarding-our-future-can-only-succeed-together.html
[13] https://arstechnica.com/cars/2018/11/volkswagen-plans-to-make-50-million-electric-cars-ceo-says/
[14] https://www.ft.com/content/8cadb19a-e5c7-11e8-8a85-04b8afea6ea3

manufacturers intensified their production abroad. Therefore, changes of the regional allocation of sales also transformed the spatial structure of production. The pattern of the global vehicle production changed in the 1980s, when due to the significant increase in production Japan surpassed the U.S. and became the first in road vehicle production (Dicken, 2003). The dominance of the triad countries was ended by the increase in Chinese production following the global crisis of 2008. China became the world leader in road vehicle production in 2009, ahead of Japan's leading manufacturer (OICA, 2010).

Mid-term forecasts show that the increase will be outstanding at such emerging markets like China and India (Porter et al., 2015). However, car fleet will almost double in South Korea (see Table 2) and the increase of road vehicles in other matured countries like the U.S. and other OECD countries will be remarkable. Not only global uncertainties, as the consequences of the Brexit or the disagreements about trade treaties, will transform the global value chain, but also the restructuring of the focal points of global growth. The forecasts predict a decline in European production. KPMG (KPMG 2018, p. 15.) estimates that by 2030 the Western European production will account for less than a third of world production. Compared to the output in 2017 (about 15%) by 2030 less than 5% of the global car production will originate from Western Europe. If we accept electromobility forecasts, then regardless of the change in technology, the geographic pattern of the global value chain will fundamentally be transformed by spatial change in sales.

In recent years, European demand has provided a solid backdrop for Central European production. Central Europe has significantly increased its share of the European production. Between 2000 and 2017 production of the Central European countries became more than two times higher, 3.6 million cars compared to 1.4 million, while European production stagnated, and the global production increased by only 20%. It was 3.7% of the world and 19.3% of the European output in 2017 (OICA 2018). Because of the wage increase in the Central European region low value added and labour-intensive activities, i.e. assembly and parts production, are moving further to low cost countries (Bloomberg, 2019) to Eastern Europe, Turkey, North Africa or China.

Currently, the Central European region is facing not only the problem of low value-added activities but also the challenge of moving to new technologies i.e. electromobility. Considering the technological change, the territorial distribution of BEV models of the largest 50 automotive manufacturers (OICA 2019) offers a significant role for the triad countries, South Korea and China (see Table 3). The spatial pattern of the production shows similar territorial order to the one described in the Vernon's product life cycle theory. The biggest producers are Germany, the U.S., South Korea and China. There are only three periphery countries like Slovakia, Turkey and Mexico where electric vehicles are assembled. The production in Slovakia was moved to the country due to the local production of the original internal combustion engine version (Volkswagen Up) of the electric model.

Considering the short-term market development projections, the current production trends and the electric vehicle forecasts show a rather mixed picture. Market development projections show a remarkable increase in the number of the vehicles in China and India. In contrast, in the electric vehicle sales China is the largest market followed by Europe and the U.S. (International Energy Agency, 2019, p. 4.). However, these predictions do not only take into account in-vehicles but also hybrid drives. Nevertheless, based on sales in recent years, the ratio between pure electric and hybrid propulsion is different in China, the United States and Europe. In Europe, the hybrid propulsion ratio is declining year by year, but it was still at its highest level of 50% in 2018. Europe, therefore, needs significant investment from OEMs, which will also affect production capacities in Central Europe. In addition to battery factories, this involves starting the production of an electric motor, as well as other major components of the electric vehicles.

Table 3: Regional distribution of the mass BEV production

Battery electric vehicle currently available, considering the production of the TOP 50 companies (OICA)

<table>
<tr><th>Region</th><th>Country</th><th>OEM</th><th>Model</th></tr>
<tr><td rowspan="9">Europe</td><td>France</td><td>Renault-Nissan</td><td>ZOE</td></tr>
<tr><td rowspan="6">Germany</td><td>Ford</td><td>Focus Electric</td></tr>
<tr><td>BMW</td><td>i3</td></tr>
<tr><td>Daimler</td><td>Mercedes-Benz EQC</td></tr>
<tr><td>Daimler-Geely</td><td>Smart electric drive</td></tr>
<tr><td>Volkswagen</td><td>e-Golf</td></tr>
<tr><td>Ford</td><td>Focus Electric</td></tr>
<tr><td>U.K.</td><td>Renault-Nissan</td><td>Nissan Leaf</td></tr>
<tr><td>Belgium</td><td>Volkswagen</td><td>Audi e-tron</td></tr>
</table>

	Austria	Jaguar	I-Pace
	Slovakia	Volkswagen	Volkswagen e-Up!
	Turkey	Renault-Nissan	Fluence Z.E.
Asia	India	Mahindra	e2o
	Japan	Mitsubishi	Mitsubishi i-MiEV, Peugeot iOn and Citroen C-Zero
		Renault-Nissan	Nissan Leaf
	South Korea	KIA-Hyundai	Hyundai Ioniq Electric
		KIA-Hyundai	Hyundai Kona Electric
		KIA-Hyundai	KIA Soul EV
		KIA-Hyundai	KIA Niro EV
		Renault Samsung	Renault Samsung SM3 Z.E.
	China	KIA-Hyundai	Hyundai Kona Electric
		BYD	BYD e6
		BMW Brilliance	BMW Brilliance Zinoro 1E
		Chery	Chery QQ3 EV
North America	U.S.	Nissan	Nissan Leaf
		Tesla	Tesla Model3
		Tesla	Tesla Model X
		Tesla	Tesla Model S
		GM	Chevrolet Bolt EV
	Mexico	FCA	FIAT 500e

Source: Author's compiling, based on OEM's data

Hungary and Poland are favored in battery production, but there are also progressive developments in vehicle assembly, like in Hungary the Chinese BYD automotive or the Swiss Fox Automotive[15] companies established production (both in Komárom) where electric buses and cars and light commercial vehicles are assembled. Next to one of the largest internal combustion engine plant in Győr, Audi started the series production of electric motors in late 2018.[16] In Czechia the leading car manufacturer, the Volkswagen owned Škoda auto, started the production of electrical components for plug-in hybrid models in 2019.[17] Czechia has remarkable production capacity for public transport. Not only Iveco owned Irisbus in Vysoké Mýto (formerly Karosa), but main component producers of trolleybuses and electric buses. The major supplier is Škoda Transportation who produces traction drives and control systems for electric buses.[18]

In Poland, there is a private initiative 'Electro Mobility Poland' which was established by four Polish power companies.[19] In addition to promoting electromobility, the development and production of a domestically-produced electric car that meets the needs of the market is also an objective of the 2016 initiative. There is significant commercial vehicle production in Poland. Among the world's major manufacturers of MAN, Scania and Volvo are also present. Moreover, electromobility is the flagship of the Polish-based Solaris bus (currently owned by the Spanish CAF). The company is Europe's largest electric bus manufacturer[20] which purchases traction drives from companies such as[21] the Czech Skoda Transportation, the German Kiepe or the Polish Medcom.

[15] https://bbj.hu/business/fox-automotive-to-produce-mia-ev-reboot-in-hungary_171739
[16] https://www.volkswagenag.com/en/news/stories/2018/09/electric-motor-now-in-series-production-in-gyoer.html
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[21] https://www.solarisbus.com/en/vehicles/zero-emissions/urbino-electric

In Slovakia, Volkswagen e-ups are assembled in the company's Bratislava factory. In 2019 the French PSA announced the launch of battery production in its Trnava factory[22] where in the future the battery electric Peugeot 208e will be assembled.[23]

The prospects for electromobility, however, are greatly influenced by the development prospects of Europe and the developed countries, especially the German economy. In Slovakia, there are already visible signs of this[24], with production cutbacks or postponement of investments.

4 Conclusion

The purpose of this paper was to examine the transformation related to electromobility, considering the possible consequences of changes in technology and in global production. Changes of the structure of the product and production will transform the whole value chain and will modify the tasks of the individual suppliers. We analysed the global automotive trends as well as the current issues in electromobility.

It is predicted that the explosive propulsion will be dominant in the medium term, as the electric propulsion (BEV, FCEV) is uncompetitive under current frameworks, even though electric car sales (HEV, PHEV, BEV) have been growing dynamically for years. However, government policies have a significant role to play in the increase, and this often artificially maintained growth carries significant risks.

The vast majority of electric car manufacturing (BEV) comes from the triad countries to which China has joined, building significant capacities and knowledge. Medium-term forecasts for the global automotive market highlight China and India's growth in sales, while the US and Europe are the two most advanced regions in electromobility alongside China. Market prospects fundamentally influence opportunities and create challenges, especially for the European car industry. Central European countries play a decisive role in European production, but European manufacturing is declining, so if they want to remain competitive, European OEMs will have to take the lead in electromobility. It is a question for us whether this investment is made in the mother country or in the semi-periphery. There are offshoring and reshoring processes as well. Some manufacturers have moved towards electromobility in Central Europe, while other manufacturers are still developing the traditional driving production.

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