Charging Poland

Fundacja Promocji Pojazdów Elektrycznych
Electric Vehicles Promotion Foundation

cambridge econometrics
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DriveNow

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Disclaimer
The stakeholders who contributed to this study shared the aim of establishing a constructive and transparent exchange of views on the technical, economic and environmental issues associated with the development of low-carbon technologies for cars and buses. Each stakeholder contributed their knowledge and vision. The information and conclusions in this report represent these contributions, but should not be treated as binding on the companies and organisations involved.

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Executive summary

The electrification of individual and public transport is one of the priorities of the Polish government. 2017 saw the adoption of two governmental strategic papers focusing on e-mobility[1]. A dedicated e-mobility law was adopted, in January 2018, to speed up the spread of e-mobility. Undoubtedly, Poland has large ambitions to enter this new market. This study proves that significant benefits are in sight and that electric vehicles can boost the Polish economy. However, significant challenges lie ahead and they will require clever navigation.

The adoption of electric vehicles in Poland promises to yield numerous benefits. This study shows that the electrification of transport would:

- increase growth,
- bring new jobs,
- improve energy security,
- cut CO_2 emissions.

It could also spur modernization in the electricity sector. More difficult to calculate but equally important is the impact on quality of life through improvements in air quality and noise reduction.

Electric vehicle manufacturing already has a solid foundation in Poland, and the potential for electric bus production in particular is quite strong. According to this study, by 2020 up to 20% of buses sold for public transportation in cities could be battery powered, Plug-in hybrid buses would add another 10% of sales. In 2030 these numbers are respectively 50% and 14%.

This corresponds well with a proposed target for green procurement in transport proposed by the European Commission on 8 November 2017[2]. It obliges Poland to procure at least 37% of buses as a zero-emission option in 2020, with this share rising increasing to as much as 56% in 2030.

Our analysis shows that in 2050 almost all buses sold for public transport in Polish cities could be powered by batteries (98%). This internal demand will give domestic producers room to grow and expand into foreign markets, which would lead to beneficial spillover effects into wider economy. With proper policy support, electric bus manufacturing could become a Polish trademark – at least in Europe.

The E-mobility revolution will also create new jobs and boost GDP growth. By 2030 there could be approximately 50,800 new jobs in the Polish economy in total, with the potential to increase to 81,000 in 2050, including 56,000 in services. On the other hand, some jobs will disappear, mainly in the traditional automotive sector.

Overall, the net impact on employment is likely to be positive in the long term, but this should not mask the significant transformational changes in the automotive sector that will have to be carefully managed. Our study estimates that the Polish economy will be 0.3% larger in 2030 and 1.1% larger in 2050.

An aggressive e-mobility strategy will be instrumental in cutting the oil bill. Today Poland imports approximately 95% of its oil, most of it from Russia, leaving the country vulnerable to shocks in price and supply. The most ambitious set of policies would cut fossil fuel consumption of passenger cars by approximately 50% by 2035 and by as much as 90% by 2050. An important challenge will be the resulting decrease in tax revenue. Around €2bn a year will be lost by 2030 rising to €6bn euro in 2050. However, as the analysis shows, the structural shifts created by the electrification of transport will lead to an economic boost that will partly offset the reduction in fuel tax revenues.

The spread of e-mobility will play a key role in improving the air quality. The most ambitious e-mobility scenario shows that by 2050 both PM10[3] and NO_x[4] emissions from passenger vehicles will drop by approximately 90%. The electrification of transport will also be instrumental in reducing CO_2 emissions. Today, the switch from petrol to electricity just transfers emissions from a tail pipe to a power plant. However, research shows such a transfer is good for climate even in Poland where approximately 85% of the electricity is generated from coal. According to Vrije Universiteit in Brussels[5], cars fuelled by diesel emit more greenhouse gases than cars running on Polish electricity. Moreover, today's large carbon footprint will inevitably drop in the future. With more diversified power mix electric cars will become even more green.

One of the most significant challenge to the spread of e-mobility is infrastructure. A robust charging network will be necessary for the future electrification of road transport. Today only around 300 public chargers exist in Poland, meaning a significant expansion of the network is a must. In order to fully grasp the potential of electric cars, our study estimates that Poland needs around 127,000 charging points by 2020 and just under 1 million by 2025. This will require an aggressive investment programme that will reinforce not only the existing charging network but also the entire electricity sector. The large number of new power outlets will need better transmission and distribution systems, as well as smart grids and meters. Implementing all of this will radically modernise the electricity sector, whose new demand for electricity will amount to 18TWh by 2050.

Another key challenge in the way of the e-mobility revolution is the issue of diesel-fuelled cars in Poland. In 2015 the Polish car fleet numbered 17 million cars, 3.9 million of which were fuelled by diesel. An average Polish car is 14 years old and the turnover of the fleet of Polish cars is very slow, only 2,5% yearly. Approximately 60% of cars put into use each year are imported, second-hand units.

This already constitutes a challenge for air quality and fuel economy but could become an even bigger problem in the near future. As more cities around Europe copying the examples of London, Paris, Madrid, Athens and Stuttgart opt for diesel limits or bans, the attractiveness of discounted diesel cars will grow in countries like Poland. The low price of second-hand cars that are unable to meet new air quality standards and therefore regarded on other markets as obsolete could become a problem for the local authorities across the country. The inflow of traditional cars could not only block the renewal of Polish car fleet with all its environmental consequences but also undermine the government's e-mobility programme. A fast uptake of electric cars on Polish roads would only be possible in tandem with targeted policy measures ready to tackle the problem of imported diesel.

[1] „Electromobility Development Plan in Poland", „The national policy framework for the development of infrastructure for alternative fuels",
[2] Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL amending Directive 2009/33/EU on the promotion of clean and energy-efficient road transport vehicles, COM (2017) 653 final, Brussels, 8.11.2017.
[3] PM10 is an atmospheric particulate matter with a diameter between 2.5 and 10 micrometers suspended in Earth's atmosphere. They have impacts on climate and precipitation that adversely affect human health.
[4] NO_x is a generic term for the nitrogen oxides that are most relevant for air pollution, namely nitric oxide (NO) and nitrogen dioxide (NO2). These gases contribute to the formation of smog and acid rain, as well as tropospheric ozone. NO_x gases are usually produced during combustion of fuels such as occur in car engines.

[5] Life Cycle Analysis of the Climate Impact of Electric Vehicles, Dr. Maarten Messagie, VrijeUniversiteit Brussel, research group MOBI.

Key recommendations

Charging infrastructure – the chicken and egg problem
In order to enable the widespread manufacture and use of electric cars, the development of robust and dependable charging infrastructure is key. The challenge is enormous and leaving it to the whims of market forces will not work. State support is needed. A comprehensive grant programme for public charging stations must be established (for example Fund for low emission transport) and European funds must be used as much as possible for that purpose. Tax incentives should be envisaged for companies and individuals willing to install charging points. New building standards that include charging infrastructure, as proposed by the European Commission, should be embraced.

Electric bus – the cornerstone of Polish e-mobility
Poland is already home to electric bus manufacturers. Clever policy support can further boost this sector. The government should introduce ambitious quotas for electric buses in public tenders and impose obligations on local authorities to use electric buses in public transport. The obligations should be accompanied with grants and other forms of support for local authorities and bus fleet operators including the development of charging infrastructure. ESCO[6] services for bus fleet renewal should be facilitated.

The wave of second-hand diesel is a problem
Diesel bans across Europe are not an oddity anymore and will soon become common practice. By ignoring the issue of second-hand car imports, Poland is in danger of being flooded with old and regarded in many places as obsolete diesel-fuelled cars. Local authorities should be deputized to implement low-emission zones and diesel limits. Poland's car registration system should be changed to effectively penalize environmental externalities, levying higher fees upon people who drive heavily polluting vehicles. Such a system should be cleared with the European Commission.

Jobs will be created but some will disappear
The study shows an overall positive impact on employment. However, some jobs will disappear. Efforts must be made to ensure workers who are currently producing disappearing technologies are retrained for quality jobs producing the technologies of the future. In this context and in order to take full advantage of the economic benefits resulting from e-mobility, the government should prioritise e-mobility-related foreign direct investment, with a particular emphasis on batteries. Silesia, a region in energy transition, is a good location for new investment.

Oil bill fuels tax revenue will drop but decline will be moderate
Today, taxes on fuels make up a significant portion of Poland's central budget revenues. The electrification of transport will change that. Oil imports and sales will drop, decreasing the associated tax revenue accordingly. This, however, is manageable. The government should reform fuel taxes to anticipate this shift away from fossil fuels and to better offset the negative externalities these fuels have on air quality and CO_2 emissions.

[6] ESCO – An energy service company is a commercial or non-profit business providing a broad range of energy solutions including designs and implementation of energy savings projects, retrofitting, energy conservation, energy infrastructure outsourcing, power generation and energy supply, and risk management.

Introduction

Bloomberg reports that 84 million cars were sold worldwide in 2016, almost double the number of cars sold over the last 16 years since 2000. Electric cars represent only a small percentage of all cars sold today, but they are nevertheless the fastest growing technology in the automotive industry. At the same time, the price of batteries for electric cars is decreasing by around 20% every year.

The International Energy Agency states in its annual "Global EV Outlook 2017" that the Total Cost of Ownership (TCO)[7] of combustion vehicles and electric cars will reach parity, taking into account the cost of purchase, propulsion, servicing and disposal between 2020 and 2030. This has been confirmed by our analysis.

The introduction of electric vehicles of all types – from mopeds to passenger cars and city buses, and in the near future, commercial or service vehicles as well – will reduce Poland's dependence on oil imports and thus systemically support the development of the Polish electric energy sector. The shift away from oil imports will have a measurable impact on employment and GDP growth in the Polish economy. It will also improve the quality of life in cities as a result of the reduction of noise and emissions of not only CO_2 but also particulate matter PM10, PM2.5, and nitrogen oxides (NO_x).

The electrification of Polish road transport is one of the Polish government's most important economic priorities. In the last year, the Council of Ministers adopted, inter alia, the "National Framework for the Development of the Alternative Fuel Infrastructure" and the "E-mobility Development Plan in Poland". According to these programme documents, in 2020 there should be 77,000 electric cars registered in Poland, while in 2025 their number should reach 1 million. In January 2018 law on e-mobility has been adopted by the Polish Parliament. The following report aims to present the possible scenarios and expected macroeconomic effects related to the electrification of the road transport sector in Poland.

[7] Total Cost of Ownership - the total cost of acquisition, installation, maintenance and disposal of an item. For passenger cars, the TCO of electric and diesel cars will converge more quickly for vehicles with higher mileage.

Methodology

The methodology applied for "Charging Poland" is described in detail in the Technical Report.

Research team

The research team for the "Charging Poland" was managed by members of the Management Board of the Electric Vehicles Promotion Foundation, Marcin Korolec and Krzysztof Bolesta, included the Steering Committee, and a team of Cambridge Econometrics analysts, Philip Summerton, Jon Stenning and Jamie Pirie, supported by Christoph Wolff and Pete Harrison from the European Climate Foundation.

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  Fortum Charge and Drive;
- Tomasz Wcisło
  Volvo Polska sp. z o. o.

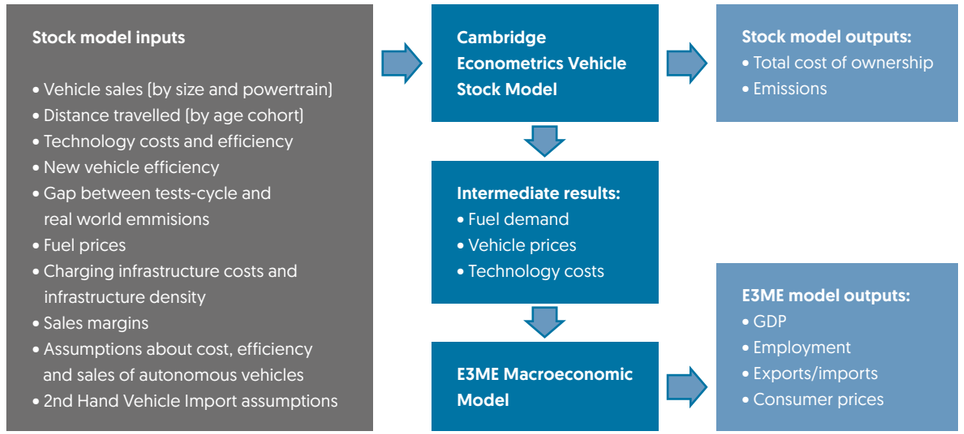
The Steering Committee managed the work of the analysts, who looked at historical data and trends in Poland's society, economy, transport and energy. The initial findings of the Steering Committee were then introduced by Cambridge Econometrics' analysts into a macroeconomic model.

The Steering Committee met four times between March and October 2017. Between the meetings, Committee members also worked directly with Cambridge Econometrics to provide necessary technical data[8] or to analyse the electrification processes of the road transport sector, in particular the production and potential development of the electric bus market in Poland and worldwide.

[8] While working on the "Charging Poland" report, data from the Ministry of Energy, the SAMAR Institute, the Energy Forum - "Polish Energy Sector 2050.4 scenarios" were used, as well as data from the International Energy Agency and the European Commission (PRIMES model).

Approach and research scenarios

The team of Cambridge Econometrics analysts used the E3ME macroeconomic model as the basis for the preparation of "Charging Poland". The E3ME model treats the economy, the energy system and the environment as integrated components, which makes it possible to analyse the interaction of these variables. The data's high level of disaggregation allows for relatively accurate sectoral analysis. The E3ME model describes the changes that may occur in GDP, household budgets, energy balance, consumption, employment, CO_2 emissions, NO_x and particulate matter.



"Charging Poland" analyses various possible scenarios for the development of electric drive technology, as well as possible scenarios concerning changes in the methods of electricity generation in Poland. The main assumptions of individual research scenarios are presented below.

Reference Scenario - assumes no changes in the technical parameters of new vehicles, no changes in the registration statistics for new vehicles. This scenario assumes no change to the import of second-hand vehicles from abroad compared to 2015 data, but adds some minor adjustments regarding reduced fuel consumption due to the slow replacement of the vehicle fleet.

The scenario resulting from the implementation of current or announced Polish legislation[9] **and European regulations** (CPI - Current Policy Initiatives) - assumes the improvement to combustion engine efficiency and a slight increase in sales of cars equipped with hybrid technology in order to achieve the European Union emissions target set for 2021 (95 grams of CO_2 per kilometre). This scenario assumes no improvement in bus efficiency due to the lack of legislation forcing such changes, and no improvement to the efficiency of new vehicles after 2021.

Technology scenario (TECH) - assumes that new cars placed on the market meet increasingly stringent emission reduction targets that are not in line with current or proposed legislation but technologically possible:

- in 2021 - 95g of CO_2 / km
- in 2025 - 70g of CO_2 / km
- in 2030- 55g of CO_2 / km

With the introduction of such restrictions, there will be an increase in sales of battery-equipped electric cars, plug-in hybrid by 2050. At the same time, the Polish energy mix will grow more diversified and will also include nuclear power.

[9] Report „Charging Poland" was finished before Polish Parliament adopted e-mobility law.

Coal technology scenario (COAL) - assumes no substantial changes in the Polish energy mix. These appear over time in response to the relative cost of the technologies. As a result, coal plays a less prominent role in electricity generation in 2050 than today, but the shift is limited.

Renewable technology scenario (RES) - assumes the use of an increased share of energy from renewable sources in the Polish energy mix.

Rapid technology development scenario (TECH RAPID) - assumes:

- greater application of new high-efficiency internal combustion engines
- a ban on the sale of new cars equipped with internal combustion engines after 2030
- a drop in the price of automotive batteries to such an extent that battery cars will become the dominant technology
- no development of fuel cell technology in passenger cars

Import of inferior technology scenario (TECH IMPORT) - assumes that:

- together with the introduction of incentives for purchasers of electric vehicles and discriminatory measures against vehicles equipped with internal combustion engines (e. g. ban on entry to city centres) in other European Union countries, the price of used vehicles with internal combustion engines will fall dramatically, and therefore their import to Poland will rapidly increase,
- statistics on sales of new cars and imports of "new" cars aged 0-4 years will remain unchanged as these purchases are made by fleet owners or for company cars and therefore cheaper second-hand vehicles aren't likely to make much difference to their preferences,
- import statistics will change, with a reduction in imports of "older" cars aged 11 years and over, while imports of vehicles aged from 5 to 11 years will increase as they become substantially cheaper and therefore more attractive to motorists.

Polish automotive market - possible electrification scenarios for the Polish road transport sector

According to data from the Automotive Market Research Institute Samar, almost 17 million cars were on Polish roads in 2015, about 12.8 million of which were fuelled by petrol engines and about 3.9 million by diesel engines.

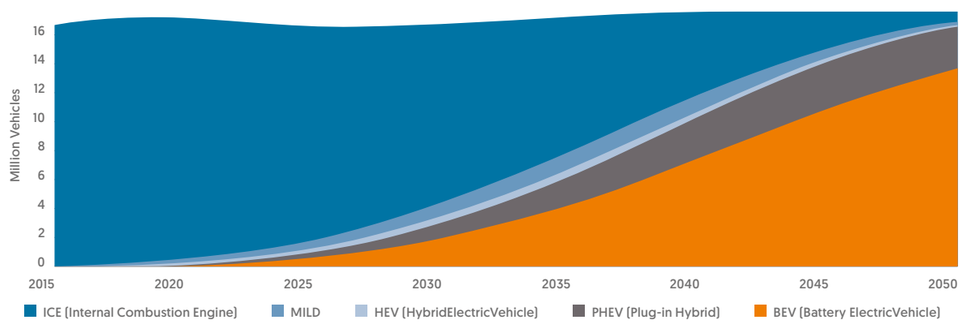
According to data from the Central Statistical Office, in 2015 1,045,000 cars were introduced on the Polish market, of which 425,000 were new and 620,000 were imported second-hand cars. Thus, the proportions of new and used cars introduced on the Polish market were at the level of approx. 40/60% in favour of second-hand cars.

The second very important factor that should be taken into account when analysing possible scenarios for the development of the automotive market is the age of Polish cars. In Poland, people drive much older cars than in the older member states of the European Union. For the purposes of this analysis the average age of Polish cars currently in use is 14 years, an assumption based on historical data of vehicle sales and stock size.

It is crucial to understand the above data, not only to see what the Polish automotive market looks like today, but especially to understand what the possible scenarios for the development of the Polish automotive market are in future. Additionally, this analysis assesses the long-term effects of consumers' car purchase decisions on the economy and society. New cars purchased today in Poland might still be in use in 20 years' time, and new cars purchased in 2030 might still be used in 2050. Even in the event of a complete ban on the sale of new cars with combustion engines in Poland and other European Union countries in 2030 (TECH RAPID), 20 years later, in 2050, around 5%, or about 700,000 cars in Poland would still be powered by combustion engines. That of course depends on regulations concerning registrations of second-hand cars.

Every year only 2.5% of cars in the Polish market are brand new. The analysis of the above-mentioned data shows that in the most ambitious scenario among those analysed (TECH RAPID), in 2025 the number of electric cars of all types could reach as much as 1 million (about 550,000 battery cars and approx. 400,000 plug-in hybrid vehicles). In 2030 there could be as many as 3 million electric cars (1.9 million battery electric vehicles and 1.1 million plug-in hybrids respectively) and in 2050,16.5 million electric cars, of which 13.7 are battery cars and 2.9 are plug-in-hybrids.

Polish Vehicle stock in the Tech RAPID Scenario



Polish specialty - electric buses

Poland today is already one of the largest bus manufacturers in Europe. In addition to domestic brands such as Solaris, major European bus manufacturers such as Volvo, also have their production plants in Poland.

The first electric bus in Poland was produced in the Solaris factory near Poznań, and it was first introduced during the meeting of the EU Council of Energy Ministers during the Polish Presidency of the European Union in September 2011 in Wrocław.

In 2017, Solaris Urbino was recognised as the bus of the year in Europe at the Hanover Fair 2017. This was the first time that an electric vehicle won the bus of the year title.

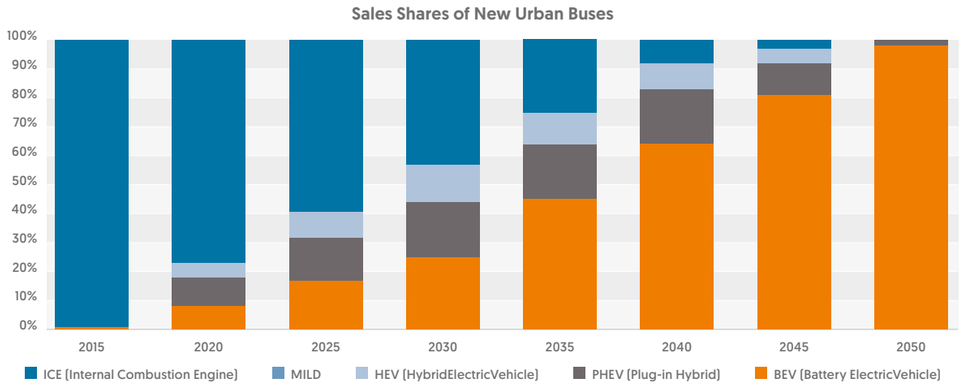
Urban electric buses have fixed routes which means they can use mandatory bus stops for charging stations during the day or bus depots for charging overnight. In the future, they will be able to charge on the go thanks to the use of inductive charging.

According to the analyses performed in TECH RAPID Scenario, 35% of new buses sold for public transport will be electrified, in which 20% will be battery-powered and additional 10% will be equipped with plug-in hybrid engines and 5% will be hybrid buses. In the same scenario, due to the expected decline in battery prices and much lower maintenance costs compared to other types of engines, it is expected that by the year 2050, all public transport buses will be battery electric buses.

This accords with the European Commission proposal of 8th November 2017 on the revising the directive promoting clean and energy-efficient road transport vehicles. It proposes targets for the Polish authorities so they buy at least 37% of zero-emission buses in all buses they procure in 2020.The share is expected to rise further to as much at 56% in 2030.

Today, buses used for intercity and international transport are not equipped with electric engines. Travelling much longer distances and lacking regular stops, intercity and international transport vehicles would be much more difficult to charge effectively along the road. The size of the batteries that would be required for such buses would also be too expensive given current parameters.

For these reasons, the electrification of the interurban and international bus fleet is likely to lag behind that of city buses. It is expected that in 2025, among the newly sold long-distance buses there will be 5% fully electric, 12% plug-in hybrids and 12% hybrids. At the same time, the rate

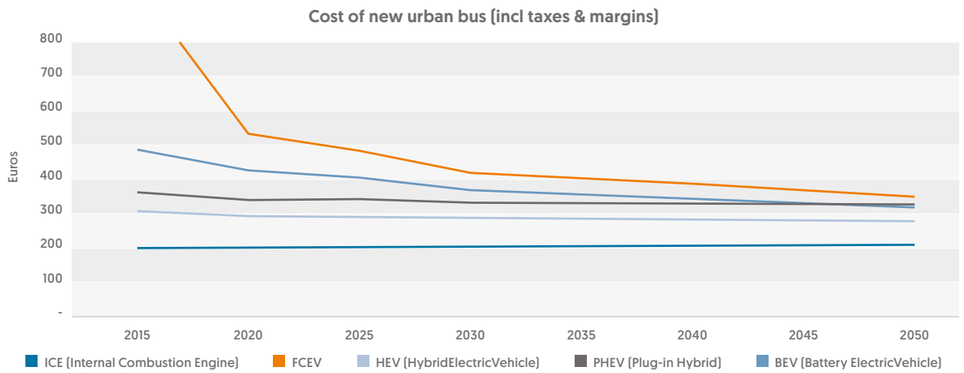


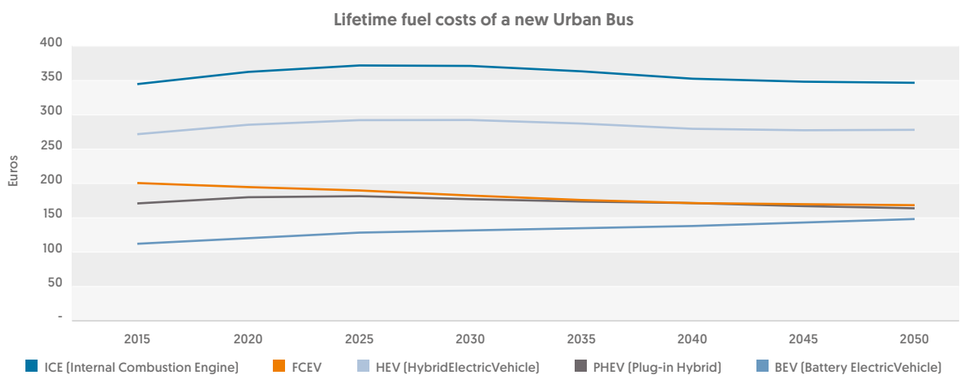
of electrification of long-distance buses will accelerate significantly around the year 2045 and later.

Today, electric vehicles are still expensive to buy, but at the same time, the cost of propulsion ("fuel") for electric vehicles is significantly lower. This is also the case for the production and use of buses. The price of urban electric buses is expected to fall by about 26% between 2015 and 2020. By 2035, the reduction in costs compared to 2015 will be 34%. Today the price of electric bus "propulsion" is 33% of the price of fuel for buses with traditional internal combustion engines. These proportions will fluctuate slightly around the 2050 perspective, when the price of electric propulsion will rise to 40% the cost of internal combustion.

The mass popularisation of electric buses will undoubtedly have a positive impact on quality of life in cities by reducing harmful emissions and noise pollution.

Replacing busses powered by combustion engines with electric buses, be they urban, interurban, or international





will not significantly reduce CO_2 emissions overall. In Poland, emissions from buses account only for 4% of all emissions related to transport in Poland.

It must be reiterated, however, that the construction of charging infrastructure is a necessary prerequisite for the development of urban electric transport.

New jobs

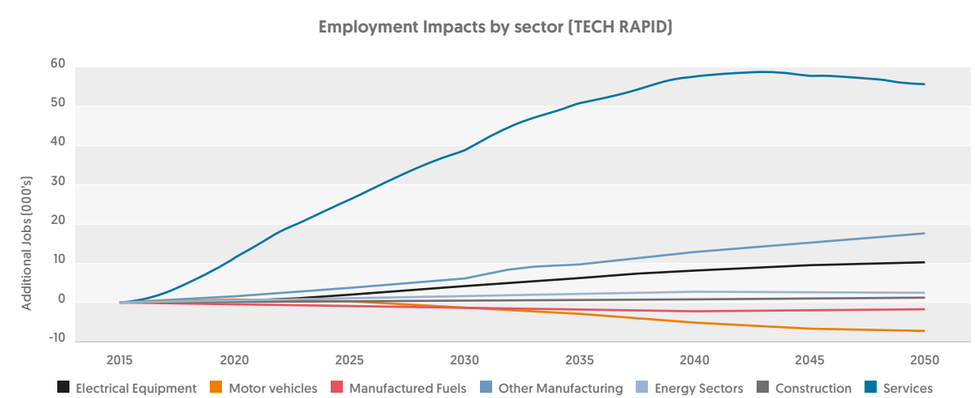
Most of the job creation will occur in the services sector and will appear as a result of increased purchasing power due to savings on transport fuels.

When studying the impact of the development of the electric vehicle market on employment, it is necessary to first take into account the need to build a charging network from scratch, i.e. tens and hundreds of thousands of charging points per year. By 2050 there could be approximately 81,000 additional jobs in the Polish economy, of which just under 56,000 are in services including retail. The breakdown of this figure shows that the industry and construction sectors add 17,000 and 1,400 respectively.

In addition to creating new jobs directly linked to the development of e-mobility, it is also important to pay attention to indirect effects. Most new jobs in the economy connected with e-mobility development will be created in services as a result of additional consumer spending and the redistribution of existing expenditure away from fossil fuels. Instead of petrol and diesel, Poles will buy more fuels produced domestically including electricity and hydrogen. This will allow Poland to capture a greater share of the value from energy used in e-mobility. This value will remain in the Polish economy, which explains the increase in both value-added tax revenue and the growth of employment in the services sector.

Moreover, electric propulsion is much cheaper than a combustion engine, which today constitutes about 60-80% of savings. Electric vehicles also require considerably less maintenance. There is no need, for instance, to replace certain filters or change motor oil. While this will mean less work for garages and manufacturers of certain components and spare parts, it will also result in significant savings for vehicle users. These savings will provide alternative spending opportunities for owners of electric cars. A part of these savings will be set aside for investment and another part will bolster other sectors of the economy through expenditure. This additional demand impulse for goods and services will also have a positive impact on the creation of new jobs.

As a result of the mass adoption of electric cars in areas such as services, the petrochemical industry, and the automotive industry, no significant change in the number of people employed is expected.



Electric cars may drive growth

Replacing combustion vehicles with electric vehicles is primarily about investment in infrastructure, but also about new types of services, research and development, and education.

Secondly, the replacement of electric motor vehicles creates savings because it could potentially reduce the consumption of liquid fuels, which are produced almost entirely from imported crude oil. The savings also result from the fact that electric propulsion is many times cheaper than combustion engines and requires much less maintenance.

Because the annual purchase rate of brand-new cars in Poland is low – only 2.5% of cars bought each year are new – changes in GDP may happen at a relatively slow pace. Nevertheless, the electrification of road transport means additional GDP growth. Under the TECH RAPID scenario, electrification would create an economy which is 0.3% larger in the year 2030 and 1.1% larger in 2050.

Supporting the energy sector instead of spending on imported oil

Poland imports almost all the crude oil needed in its economy (mainly from Russian Federation). The electrification of Polish road transport, apart from the unquestionable benefits to the environment and the improved quality of life in cities, will strengthen the Polish electricity sector and significantly improve Polish energy security overall.

An increase in demand for electricity along with money saved from a smaller oil bill could become a powerful source of investment to develop the electricity grid and new power generation technology.

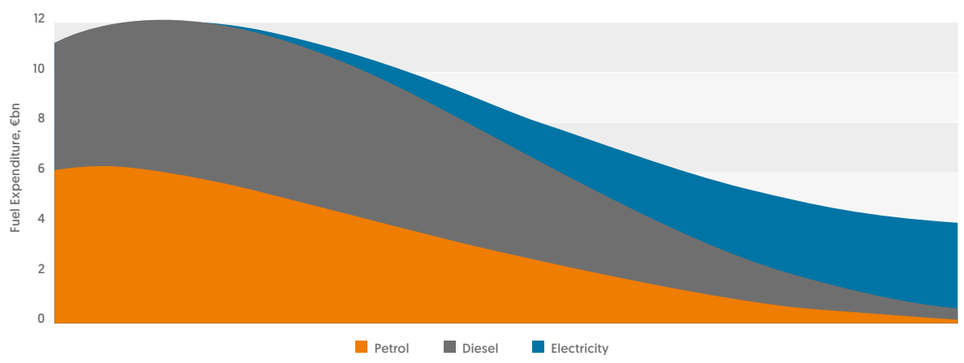
Moreover, the electrification of transportation will improve the balance of trade. For every €10 spent on fuel in Poland, €4.5 becomes tax revenue for the government, €3 pays for the refining and distribution, and €2.5 leaves the Polish economy and goes to Russia. Every electric vehicle deployed will therefore reduce Poland's dependence on oil imports mainly from the Russian Federation, the main source for Polish refiners. According to the TECH RAPID scenario, in 2035 in Poland the fuel consumption by passenger cars may be halved, and around 2050 might be limited to as much as 90%.

A cut in oil consumption will inevitably lead to decreased tax revenue from fuel sales. This however will be partially offset by an increased activity in other sectors of the economy. Resources saved on oil imports and lower energy and maintenance cost for electric car owners will be spent elsewhere to generate growth but most importantly increase tax revenues. On balance, the loss in revenue would be minimal and easy to manage long-term. One can imagine after the electric cars become mainstream, a certain level of additional taxation could be reintroduced on motorists that would offset the loss in fuel tax revenue.

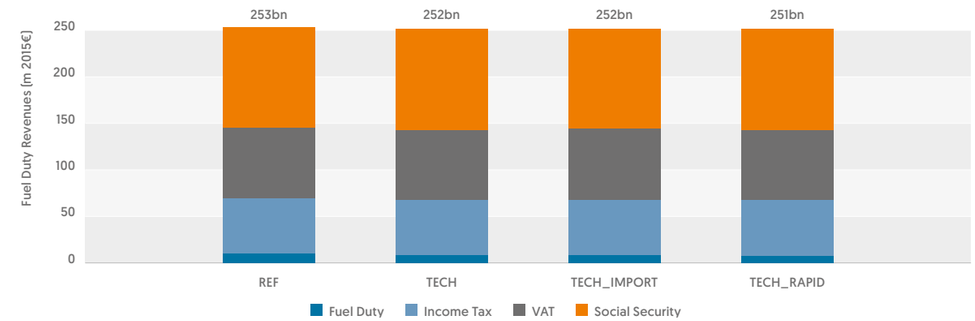
According to the most ambitious TECH RAPID scenario, the electricity demand from road transportation in 2050 could hit over 18 TWh. As the demand for electricity is estimated to grow from 150 TWh per year to 260 TWh between 2015 and 2050, the share of demand generated by electric vehicles will represent approximately 7.8% of the projected total electricity demand by 2050.

Given that electricity consumption forecasts are usually overestimated, the share of electric vehicles as total electricity demand may be higher. However, it should be stressed that the Polish energy sector will have sufficient time to prepare for the gradual growth in demand. The 2050 horizon is far enough in the future to make the necessary investments in electricity generation, transmission, and distribution.

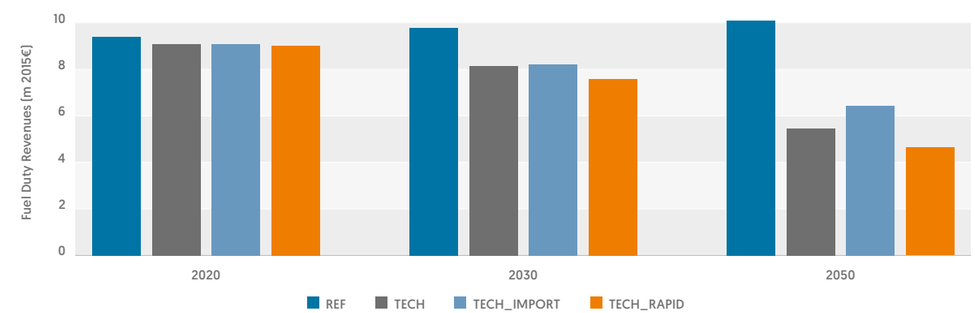
Fuel Expediture by Passenger Cars (TECH RAPID)



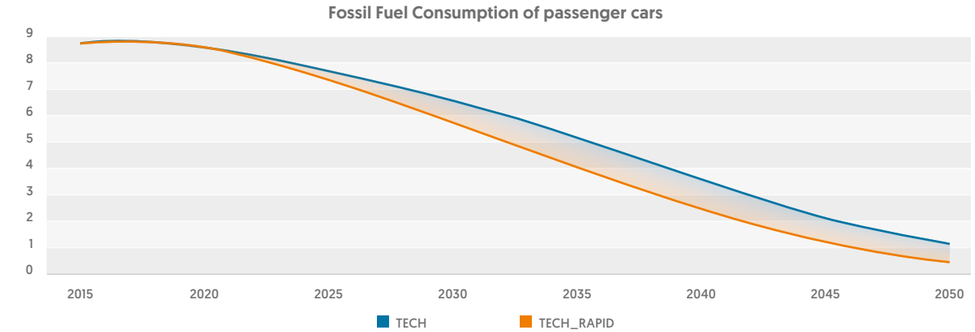
Total Government Tax Revenue 2030



Fuel Duty Revenues

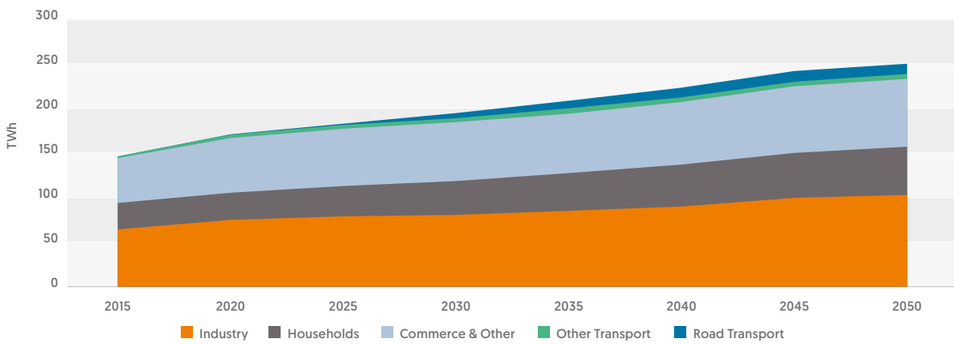


Fossil Fuel Consumption of passenger cars



It should be noted that driving the same distance using an electric propulsion today is between 60 to 80 percent cheaper compared to driving a combustion engine. This difference will bring considerable cuts to spending on fuel in the future. According to the analyses we have carried out under the TECH RAPID scenario, the total expenditure on fuel and electricity required to recharge electric vehicles will be halved between 2015 and 2040 from around 11.7 billion to around €5.8bn per year.

Electricity Demand by Final Consumer in TECH RAPID Scenario



Electric vehicles as a weapon in the fight against smog

Popularizing electric vehicles will improve the quality of life in cities and environmental benefits, reducing harmful substances in the air as well as reducing noise pollution.

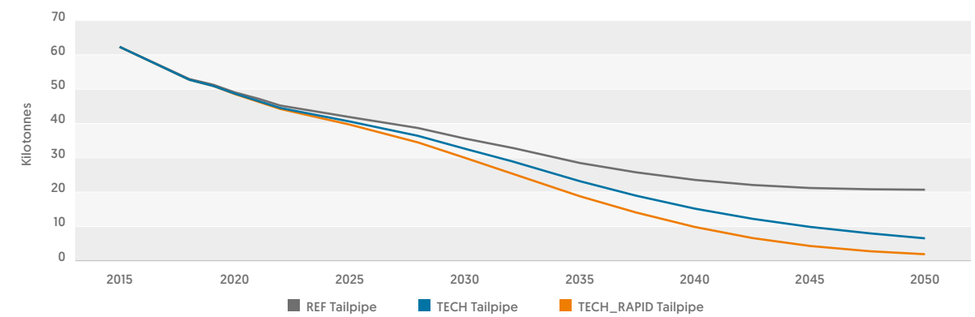
Emissions from road transport in Poland are the second-largest contributor to smog after emissions related to the heating of individual buildings. According to the TECH scenario, nitrogen oxides (NO_x) emissions would decline by over 80% by the year 2050, and under the TECH RAPID scenario, to almost zero over the same period. Very similar results are shown by data on the expected reduction of PM10 pollution.

The environmental benefits of the electrification of road transport are firstly, the reduction of emissions and secondly, the reduction of emissions in city centres, as power plants and CHP plants are built on the outskirts of urban centres.

Figure below shows the scale of achievable reductions to nitrogen oxides (NO_x) emissions due to the widespread use of electric cars.

Electric vehicles work almost noiselessly so they will also reduce the noise pollution, especially in cities.

NO_x Emissions



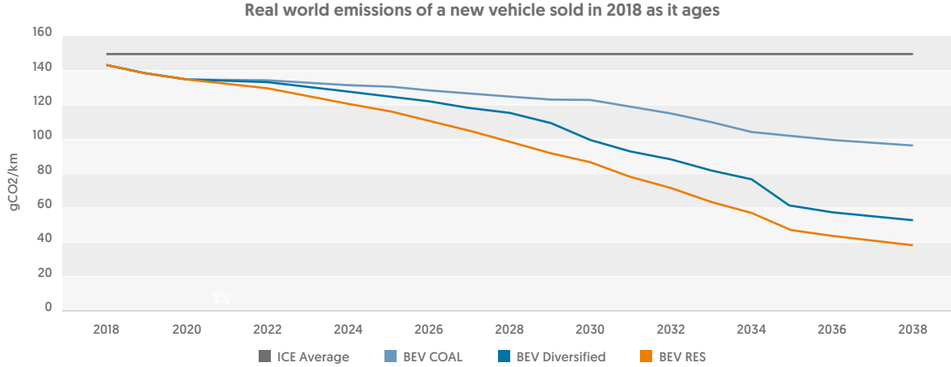
Electric cars mean less CO_2 emissions

Emissions from each new car introduced on the market, equipped either with an electric or internal combustion engine, are decreasing every year. In the case of electric vehicles, the reduction will come from the expected changes in the way energy is produced and the increased importance of renewable and carbon-free energy sources. Reductions in emissions from internal combustion engines are mainly driven by stricter standards in the EU.

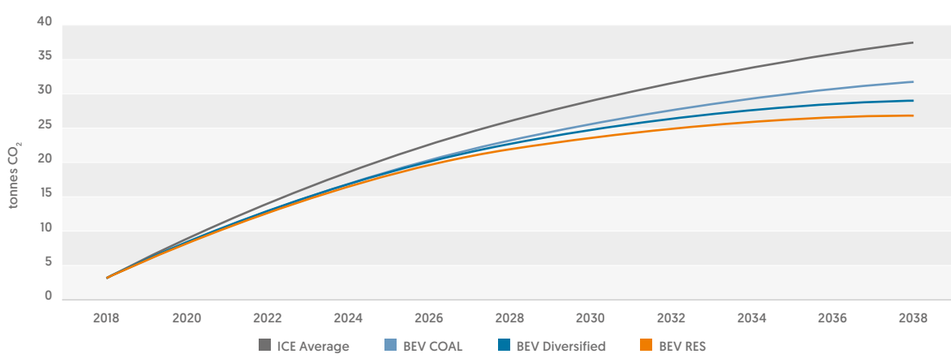
The analysis of possible changes in the Polish energy mix shows that under the most emission-intensive "coal"[10] scenario, electric vehicles will emit slightly more CO_2 each year than internal combustion vehicles until the year 2032, followed by a significant reduction of about 20% in emissions compared to combustion vehicles after that year.

On the other hand, under the so-called "renewable" scenario the reduction of emissions from electric vehicles compared to combustion vehicles occurs more rapidly. It is significant already in the year 2030 and amounts to 15-20%. In the year 2050, it reaches 75%.

Real world emissions of a new vehicle sold in 2018 as it ages



Cumulative emissions from a new 2018 vehicle as it ages



[10] For the purposes of this analysis, we have assumed that the Polish electricity sector will be evolving in accordance with the analysis entitled "Polish Energy Sector 2050.n4 Scenarios" performed by the Energy Forum and published in September 2017.

Big investment challenge - Charging network

Today, Poland is a blank spot on the European map of electric car charging networks, which constitutes a serious barrier to the development of e-mobility. A sufficient number of publicly available charging stations is one of the necessary conditions for the promotion of electric cars. The distribution of charging points should not only allow for the daily use of electric cars in cities, but also for long distance journeys.

An extensive, visible and publicly accessible charging network reduces so-called "range anxiety", i.e. the fear that electric cars have insufficient operational range. A developed charging infrastructure will enable the use of electric cars on 400 km trips or longer per day. For this purpose, charging points should be placed not only in city centres but also along established long-range transport routes.

As far as shorter journeys are concerned, according to the experience of countries where the market for electric cars is developing rapidly, 56% of all charging sessions take place at home, 33% in the workplace and only 11% at the public charging stations. The figures above indicate the proportions in which charging infrastructure should be installed.

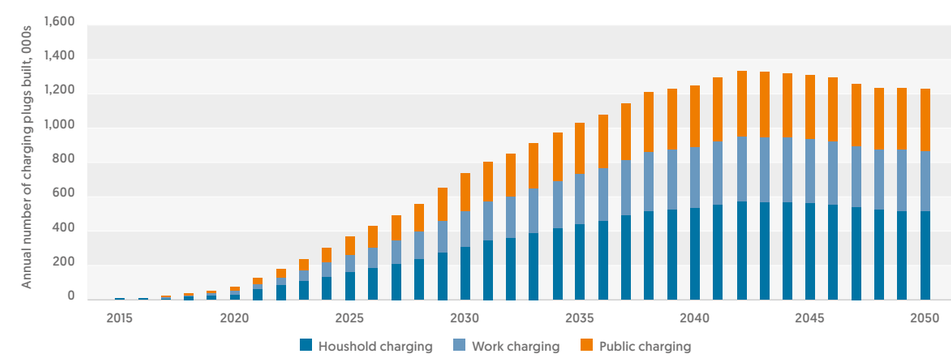
The ever-growing number of electric cars will force investment in the charging network to increase every year. The number of charging points is estimated to grow all the more rapidly over the next 27 years. In 2020 a total of 126,000 charging points will be needed. In 2025 there should already be about 1 million points, further increasing to 16.6 million in 2050.

The installation of the number of charging points described above will require very high capital expenditure. The cumulative expenditure on charging infrastructure up to the year 2030 could amount to almost €2.6 billion, reaching €7.5 billion in 2040 and around €12.8 billion in 2050.

Capital expenditure related to the construction of the charging network will constitute the driving force for the modernisation of the Polish electricity grid. The process of developing charging infrastructure will be a catalyst for the emergence of new business initiatives in the area of design and manufacturing of electric vehicle charging equipment.

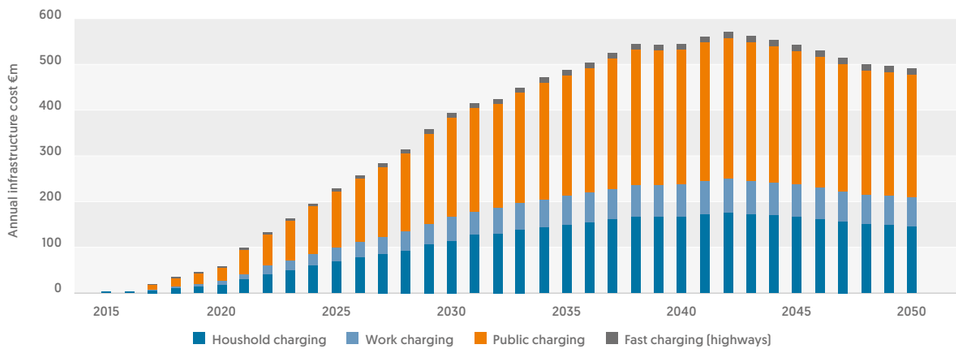
The demand for software services necessary for electric vehicle charging will grow as the stock of these kinds of vehicles increases. This will be another new area of economic activity that will be a boon to both tech start-ups as well as established companies or even traditional fossil fuels distributors – those who stand to lose the most from the fuelling system makeover.

Additional charging plugs required to support the EV Fleet



[10] For the purposes of this analysis, we have assumed that the Polish electricity sector will be evolving in accordance with the analysis entitled "Polish Energy Sector 2050.n4 Scenarios" performed by the Energy Forum and published in September 2017.

Total annual investment requirements to support the EV Fleet



Poland is not an island

According to the state's economic policy, supporting the transformation of the Polish road transport sector towards electric propulsion is not just one possible economic policy option, but a necessity resulting from well-conceived economic calculation.

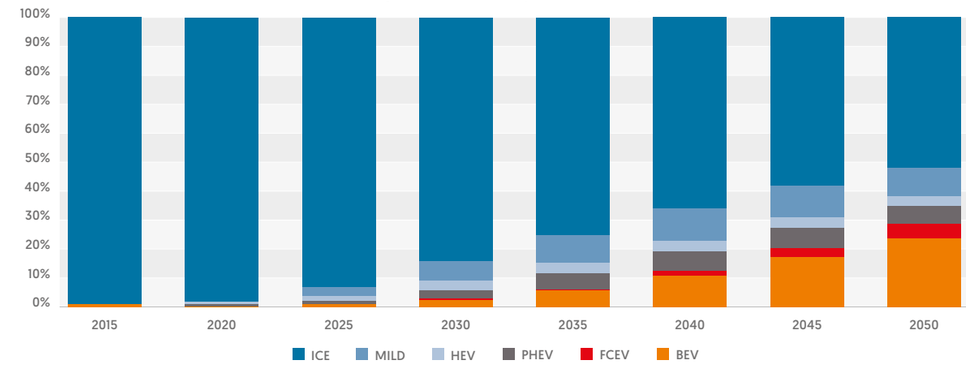
Firstly, the countries that set the limit for progress within e-mobility are taking radical steps that will change the automotive market landscape not only on their own markets, but also in Europe as a whole and worldwide. In addition to the usual incentives for owners and users of electric cars, Norway, the Netherlands, France and the United Kingdom have already agreed on long-term targets for a ban on the sale of combustion engine cars.

Additionally, Central European countries such as Hungary and Romania have attractive subsidy schemes for purchasers of electric cars.

other hand, bans and fines are being applied to discourage the use of cars with combustion engines. London has introduced a duty on entering the city in an older diesel car, while Paris, Stuttgart and other cities have announced the dates of introduction of a total ban on diesel vehicles entering cities. It is very likely that local governments will be most effective in accelerating the electrification of transport, as they will introduce new policies more quickly and can better adapt to inhabitants' expectations.

In these circumstances, the government and Polish local authorities can promote the use of electric vehicles by following the leaders from the European Union. They could impose their own diesel bans or face the challenge of mass import of second-hand internal combustion vehicles from other member states. In the latter, unwelcome scenario, the Polish authorities will need to manage not only the import of older used cars as is currently the case, but also lightly used cars that are only a couple years old.

Composition of stock (TECH IMPORT)



Secondly, local government authorities are toying with the introduction of incentives and prohibitions to speed up the development of e-mobility. Electric cars may be allowed to use bus lanes, exempt from parking fees or allowed to enter city zones inaccessible to other cars. (Zero-Emission Transport Zones or Low-Emission Transport Zones). On the

As electric cars grow more popular in other member states, the decline in the price of lightly-used vehicles threatens to block the electrification of the Polish road transport sector for a longer period and inhibit the benefits associated with the transformation to e-mobility.

Therefore, a set of policy measures, in line with EU single market legislation, should be ready for implementation in case diesel bans or equivalent measures increase the inflow of obsolete ICE cars into Poland.

Such developments are described in the analysed TECH IMPORT scenario. According to the data, under this undesirable scenario, combustion vehicles will make up the majority of vehicles travelling on Polish roads even as late as 2050.