SPEEDING-UP EUROPEAN ELECTRO-MOBILITY

How to electrify half of new car sales by 2030

September 2017

Report for Transport & Environment,
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Executive summary

In the wake of the "diesel-gate" scandal several cities with air pollution problems have called for an end to the diesel car, and some countries, among them Norway, the Netherlands, Austria, France and the United Kingdom, have made statements in favor of making new internal combustion engine vehicles (ICEVs) illegal within one or two decades. A second reason for wanting to ban internal combustion engine vehicles is to reduce emissions of carbon dioxide (CO_2) from road transport. Electrification appears to be the most mature and cost-efficient solution for decarbonizing car traffic and simultaneously putting an end to air pollution-emissions. The European Union's 2050 CO_2 emission reduction target will require most of the car fleet to become fossil-free. This report builds on the assumption that at least 80 per cent of the European fleet in 2050 must be partially or fully electrified. To achieve this, EVs would have to make up around 50 per cent of new sales in 2030.

The question is not if, but how quickly the shift to electrification will happen. Currently, combustion engine vehicles completely dominate car fleets and sales. In 2016, battery electric cars (BEVs) and plug-in hybrid electric cars (PHEVs) made up only 1.3 per cent of new sales in EU28. However, the driving range of electric cars is increasing, battery costs are rapidly declining, and sales are accelerating. According to several observers, a total cost of ownership (TCO) parity with ICEVs can be expected by the mid-2020s in some EU countries. However, large differences among national tax regimes will make TCO parity come later in other member states.

Aiming at 50 per cent electrification of new cars by 2030, i.e. 13 years from today, involves multiple challenges. In this report we investigate key aspects such as battery and vehicle production, critical materials supply, charging infrastructure, production and distribution of electricity, and policy design.

Battery material supply and production

A range of studies show that Li-ion battery costs and performance will continue to improve rapidly. In recent years, the industry has converged on two combinations as active cathode components: Lithium Nickel Manganese Cobalt (NMC) and Lithium Nickel Cobalt Aluminum (NCA). Various combinations of a graphite core mixed with silicon or lithium are used for the anodes.

Rechargeable batteries account for half of the global use of lithium and 40 per cent of the use of cobalt; however, most is used in consumer electronics and only a small fraction in EV batteries. This will change. If the global growth of EV sales parallels the assumed growth in Europe, there will be a 25-fold increase in EV production volumes until 2030 and the EV demand for lithium and cobalt will rise steeply, possibly increasing total cobalt demand five times in comparison to 2016.

New mining projects, increased extraction efficiency, and reduced content of critical metals per battery will be important to secure material flows and acceptable prices when the industry enters such a growth trajectory. For lithium there is also a vital need to industrialize recycling processes which so far are only at lab-scale. For cobalt, the most expensive component in the NMC-cathodes, there are two complications. First, cobalt is extracted as a by-product of the exploitation of other raw materials, mainly copper and nickel. Thus the supply of cobalt is dictated by the demand for these primary materials. Second, around 50 per cent of known reserves are located in the Democratic Republic of Congo with reputation for environmental and human rights abuses. The richness of the Congolese mines makes them difficult to replace with other resources and the lead-time for opening new mines is long, normally 6-10 years. To tackle this problem, systems for sustainable and transparent mining need to be established. Using its strength in the refining sector, and its role as a major market, Europe could be a leading force in such a development. There are also intensive R&D efforts to change battery chemistries by altering the proportions of nickel, manganese and cobalt, which may reduce the cobalt content by two thirds.

In 2015, 88 per cent of the world's total Li-ion manufacturing capacity for all end-use applications was located in China, Japan and Korea. These countries also produced a majority of the critical cell components. Less than 5 per cent of global battery production is located in Europe, and the same is true for critical components. Europe needs to ramp up battery production in the 2020s to match its assumed share of the expanding EV market. If eight million electrified cars will be sold in the EU in 2030, half of them BEVs with battery packs averaging 50 kWh, and half PHEVs with packs of 10 kWh, this would require an annual battery supply of 240 GWh, roughly equal to seven Giga plants of the Tesla

Arizona scale. We estimate that the total lead-time for planning, construction and commissioning might be five to seven years per battery plant.

Electricity demand and supply

If electric vehicles make up 20 per cent of new sales in EU28 in 2025 and 50 per cent by 2030, around 14 per cent of the car fleet will be electric (BEV or PHEV) in 2030. The demand for electricity caused by electrification of cars would only add around 4 per cent to overall demand in 2030. This will take place during a period when many of Europe's nuclear reactors will be decommissioned for political reasons or because of age. At the same time a large share of the coal-fired power plants will either have to close or become equipped with Carbon Capture and Storage (CCS) to meet the climate change requirements. Scarcity and higher costs associated with renewable power production and/or investment in CCS may push electricity prices upwards, although in the longer term the overall trend towards cheaper renewables is likely to prevail.

The amount of electricity required for propelling electric cars depends on the size of the fleet, average annual mileage, specific consumption (electricity per km), battery losses and the split between BEVs and PHEVs. Alternative assumptions concerning mileage and specific consumption may each increase or reduce demand for battery electricity by around 10 per cent. The growth of the fleet and how it is divided between BEVs and PHEVs play a greater role. In our calculations we assume the split to be 50/50. If the entire new EV fleet was made up of BEVs, demand for vehicle electricity would increase by approximately 25 per cent compared to the 50/50 case.

Fuel Cell Electric Vehicles (FCEVs) are much less energy efficient than BEVs, and in the less likely case that they will represent a substantial proportion of the EV fleet, demand for electricity would rise considerably, especially when electrolysis is used for producing the hydrogen needed. It should also be remembered that besides passenger cars, light duty vehicles and increasing numbers of city buses and distribution trucks will also use electricity in the coming decades.

Grids and charging infrastructure

Slow charging at home or close to home dominates battery charging. Based on Norwegian experience fast public charging may be expected to account for only around 5 per cent of total vehicle battery electricity demand but is crucial along core highways for longer distance e-mobility. Priority should be given to developing the infrastructure for charging at home and at work places. Local grids will need enforcement in countries with less developed grids.

The environmental impact of electric vehicles

Electrical vehicles are vastly superior to internal combustion vehicles in terms of emissions during the operation cycle. However, the production of batteries is a highly energy-intensive process, which may generate significant greenhouse gas emissions. To reduce these emissions, three factors are important: (1) to operate the battery plants in their most efficient mode, which implies high capacity utilization; (2) to locate battery plants in regions with a low fossil share in their electricity mix; and (3) to counteract the risk that falling battery costs are used to increasing the size of batteries, without considering the GHG footprint. Ambitious requirements regarding recycling of battery minerals will also be needed to keep overall emissions low and to minimize the demand for virgin materials.

The average CO2 emission from European power production is being gradually reduced. A rapid electrification of the European car fleet will substantially reduce emissions of air pollutants and carbon dioxide without causing carbon emissions from power production to rise. This is explained by the fact that CO2 emissions from power plants are subject to the cap of the European Emissions Trading Scheme (EU ETS), which is gradually lowered over the years, and by the rising share of renewable energy in Europe’s power mix.

Achieving total cost parity with conventional cars

The purchase price of an electric vehicle is currently significantly higher than the price of an equivalent conventional car. However, prices can be expected to fall with lower battery prices and increasing EV production volumes. The running cost of an EV is low thanks to high energy efficiency and comparatively low taxes on electric power. Taking account of this and including the effect of significant increases in overall production volumes, several studies predict cost parity between EVs and conventional vehicles in the mid-2020s, measured as total cost of ownership over five years. However, the differences in taxation of fuel and electricity among member states are huge. The current surplus on running costs after four years leaves the first owner of a midsize BEV in Greece with €5,343 to balance the capital cost, while his/her German counterpart is left with a mere €2,315. These differences may affect the overall penetration rate of EVs within the EU.

The potential role of PHEVs

PHEVs can contribute as a transitionary solution for the shift to e-mobility if they are driven in electric mode predominantly. A majority of all trips by car are short and the average daily mileage of motorists is low. In sparsely populated Norway only 3 per cent of single car trips are longer than 80 km, and 85 per cent of all trip chains (home to home) are shorter than 50 km. We therefore assume that a PHEV with a battery capacity of 10 kWh would allow most motorists to cover at least 70 per cent of the annual mileage in e-mode. With a minimum range of 50 km, most urban driving can take place entirely in e-mode.

In case the lead-time for producing enough battery materials, in particular cobalt, for a general shift to BEVs turns out to be long, PHEVs driven in electric mode may temporarily play a role in the market transition. If, for example, half of all new EVs were to be PHEVs, this would reduce battery demand by around 44 per cent compared to a situation when all new EVs are BEVs. When comparing a PHEV with a 10 kWh battery with a long-range BEV (80 kWh battery), each kWh of battery capacity is used 5.6 times more effectively in the PHEV when the vehicle's annual share in e-mode is 70 per cent.

Choice of policy instruments

Current EU regulation requires average new car CO_2 emissions not to exceed 95 g/km in 2021. This regulation, however, is eroded by the provision of so-called super credits – a multiplier for each EV sold that OEMs benefit from when their corporate CO_2 average is calculated. The overall CO_2 standard has been supplemented by various incentives for low and zero emission vehicles financed by individual member states causing potential market distortions. Other member states have done little to promote EVs, in some cases due to severe budget restrictions.

To speed up the needed market penetration of EVs across Europe, we suggest that the EU should adopt regulation as a faster and more certain way of increasing the fleet. A regulation is less vulnerable to budget restraints, miscalculations and changing relative prices than financial incentives.

A Zero Emission Vehicle (ZEV) target in 2025 would be the best way of sending a clear signal to the automotive industry and investors in battery development and manufacturing that the EU is serious about a rapid shift to electric vehicles. Providing planning security, the target would require automakers to gradually increase the share of EVs among new sales. Building on the existing Californian scheme and announced ZEV quota in China, a European ZEV target scheme would reward zero emission vehicles with full credits, and half a credit for PHEVs with an e-mode range of at least 50 km under real driving conditions. Flexibility for car makers would be given by the possibility to bank and trade credits. An alternative could be to put a cap on ICEV sales that is gradually lowered over the years. A cap on ICEV permits should probably allow banking of permits and trade with permits in order to provide flexibility. As a last resort, non-complying automakers should have to pay a penalty, which should be set above the average permit price in the previous year.

To prevent the marketing of gas-guzzling PHEVs, the system with super-credits should be scrapped, and all cars with an ICE be equally treated in the EU´s cars and CO_2 regime. This would promote the development of dedicated PHEV platforms and engines optimized for fuel and electricity efficiency.

How 50 per cent of all new cars in the EU can be electrified by 2030

The report shows that electrifying 50 per cent of all new cars by 2030 is possible, but requires considerable efforts and investments in several areas. The EU will need massive investments in battery production capacity and a long-term commitment to sustainable supply of critical materials. Electricity demand needs to be satisfied at a time when coal-fired and nuclear-based power plants are decommissioned. Local grids and charging infrastructure have to be upgraded in many member states. A credible, union-wide regulatory framework based on an increasingly stringent Zero Emission Vehicle (ZEV) target needs to be established from 2025 onwards.

Further information

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