Electric vehicles

Electric vehicles and the energy sector - impacts on Europe's future emissions

A fundamental change within the road transport sector is required if Europe wants to achieve its objective of a long-term transition to a low-carbon European economy. Electric vehicles charged with electricity from renewable sources can reduce future emissions of greenhouse gases and air pollutants from road transport. This briefing (based on an assessment carried out on behalf of the EEA) presents the key implications for emissions and Europe's energy system arising from the potential wide-scale use of electric cars in 2050.

Main messages

Electric vehicles powered by renewable energy sources can play an important role in EU plans to:

- move towards a decarbonised transport system;
- meet its goal to reduce greenhouse gas (GHG) emissions by 80-95 % by 2050.

The growth in electric vehicle use will result in extra energy demand in the European Union (EU-28): Europe's total electricity consumption by electric vehicles will increase from approximately 0.03 % in 2014 to 9.5 % in 2050.

An increase in electric vehicle use will result in:

- lower CO_2 and air pollutant emissions from the road transport sector itself;
- higher emissions from associated electricity production;
- an overall net benefit in terms of lower emissions of carbon dioxide (CO_2) and the air pollutants nitrogen oxides (NO_x) and particulate matter (PM);
- an overall increase in sulphur dioxide (SO_2) due to emissions from the electricity-generating sector.

The need for sustainable road transport

Despite previous technological improvements, the transport sector contributes around one quarter of Europe's GHG emissions, thereby contributing to climate change. Emissions from road vehicles also contribute to high concentrations of air pollutants in many European cities, which often don't meet air quality standards set by the EU and the World Health Organization (WHO).

The potential of renewable energy sources to power electric vehicles can contribute to a considerable decarbonisation of the future road transport sector and improved resource efficiency. It also has associated co-benefits in terms of reduced air pollution. However, the extent to which this may occur varies greatly by country, in terms of how the demand for additional electricity for electric vehicles can be accommodated.

Approach

The assessment commissioned by the EEA explored the future impacts of greater electric vehicle use upon the EU-28's energy system, and associated emissions from the road transport and energy sectors. Two scenarios were explored:

1. the share of electric vehicles as part of the entire EU-28 car fleet in 2050 was assumed to be 50% (on average);

2. the share of electric vehicles in 2050 was assumed to be 80%.

The resulting changes in energy demand and CO_2 and selected air pollutant emissions were quantified. They were then compared with a European Commission 'reference' projection, which assumes that only 8% of Europe's car fleet would be electric in 2050. Other sectors and their potential future reductions in energy demand were not taken into account.

Increased electricity demand

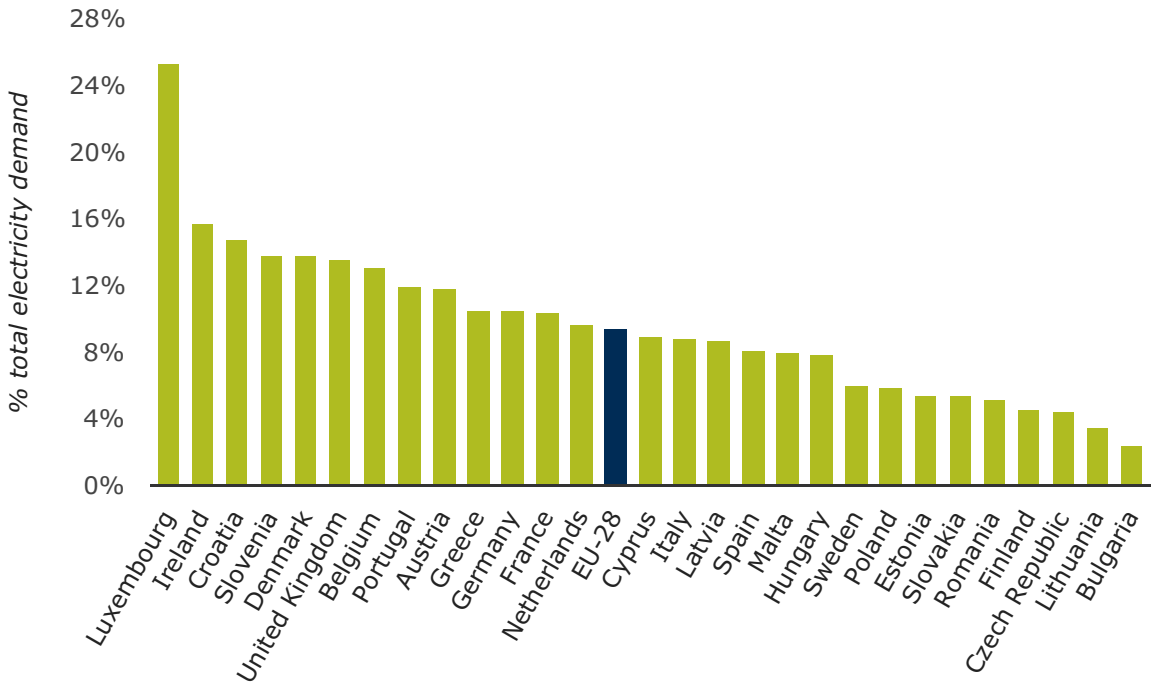
Additional electricity generation will be required in the European Union to meet the extra energy demand arising from an 80% share of electric vehicles in 2050. The share of Europe's total electricity consumption from electric vehicles will increase from approximately 0.03% in 2014 to around 4-5% by 2030 and 9.5% by 2050.

The additional electricity demand due to the high rates of electric vehicle ownership assumed for the future will need to be met by additional power generation. Furthermore, this additional energy needs to be integrated into the grid infrastructure across Europe. Critical questions are therefore how much electricity is needed, what type of generation is used to cover this additional electricity demand and how are charging peaks managed?

Until 2030, the additional energy demand by electric vehicles will be limited and will not significantly influence the electricity system. But, in the longer term, with high market shares of electric vehicles assumed in 2050, the required electricity demand will have more significant impact on power systems in Europe.

The share of electricity consumption required by an 80% share of electric vehicles in 2050 will vary between 3% and 25% of total electricity demand across the EU-28 Member States (Figure 1), depending upon the number of electric vehicles anticipated in each country. On average, for the EU-28, the proportion of total electricity demand required in 2050 is 9.5%, compared with the 1.3% assumed in the European Commission's projection. Overall, an additional electrical capacity of 150 GW will be needed to charge electric cars.

Figure 1: Electric vehicle energy demand as a percentage of total electricity demand in 2050



Note:
Assuming an 80 % share of electric vehicles in 2050.

Data sources: Öko-Institut e.V.. Electric mobility in Europe — Future impact on the emissions and the energy system

Meeting the additional electricity demand

The integration of the additional energy demand caused by electric vehicles poses challenges for the management of power systems at local, national and European levels.

High shares of electric vehicles will require significant additional electricity generation which, in the absence of coordinated investment, may put stress on electricity infrastructure. Even between countries with a similar share of renewable energy, management strategies to accommodate the charging of a large number of electric vehicles can be very different, depending on the types of renewable energy and conventional power generation in each country. In countries with highly fluctuating renewable energy supplies, coordinating the energy demand from electric vehicles may become a major challenge.

It is clear, for example, that countries with high solar energy generation capacity, for which the preferred charging peak will be during the day, will need to apply different grid and power management strategies from countries that have only wind, or combined solar and wind electricity production. In regions with a weak network infrastructure, additional grid reinforcement or implementation of specific 'smart charging' approaches might be required to ensure an efficient and flexible electricity generation and distribution infrastructure.

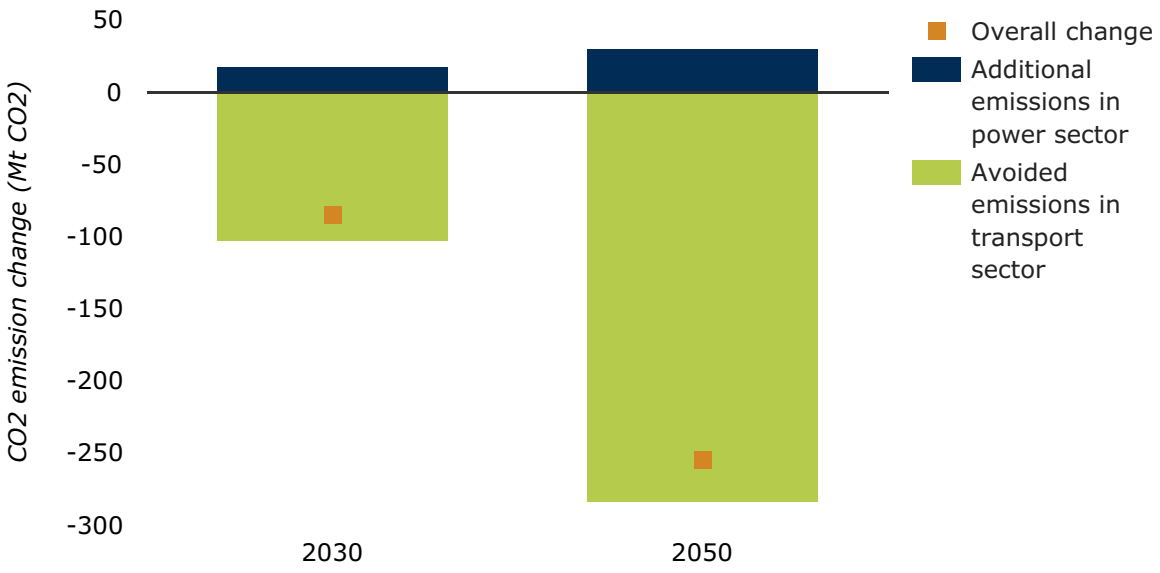
Impacts on climate and the environment

Increasing the numbers of electric vehicles can significantly reduce direct emissions of CO_2 and air pollutants from road transport. However, these positive effects are partially offset by additional emissions caused by the additional electricity required and continued fossil fuel use in the power sector projection in 2050.

An 80% share of electric vehicles in the 2050 passenger road transport fleet will result in lower emissions of both CO_2 and air pollutants from the road transport sector itself. However, higher emissions would result from the associated fossil fuel combustion in the electricity-generating sector if reductions in electricity demand are not made in other sectors, e.g. by energy efficiency improvements.

Overall, the avoided CO_2 emissions in the road transport sector outweigh the higher emissions from electricity generation. In the EU-28, a net reduction of 255 Mt CO_2 could be delivered in 2050 (Figure 2), an amount equivalent to around 10% of the total emissions from all sectors for that year, according to the European Commission projection. In countries with high shares of fossil fuel power plants, electric vehicle demand could, however, lead to higher CO_2 emissions. The environmental benefit of electric vehicles in these instances would therefore not be fully realised.

Figure 2: Future changes in CO_2 emissions in the energy and road transport sectors



Note:
Assuming a 30 % share of electric vehicles in the EU-28 in 2030 and an 80 % share in 2050.

Data sources: Öko-Institut e.V.. Electric mobility in Europe — Future impact on the emissions and the energy system

For air pollutants, an 80% share of electric vehicles in 2050 will significantly reduce direct exhaust emissions of NO_x, PM and SO_2 from road transport, for each pollutant by more than 80% in comparison with 2010 levels. However, as for CO_2, the overall reduction for NO_x and PM will to some degree be offset by additional emissions coming from the electricity-generating sector — by 1% for NO_x and 3% for PM_{10} (particulate matter with a diameter of 10 μm or less). The situation is different for SO_2. The already relatively low SO_2 emissions from road transport, coupled with the use of coal in power generation, will result in additional SO_2 emissions, which exceed the reduction made in the road transport sector by a factor of 5. Additional abatement of the higher SO_2 emissions would be required.

The difference in emissions of air pollutants from the road transport sector and electricity generation cannot be compared directly in terms of their respective impacts on human health. Their impact depends to a large degree on the location, intensity and type of emission sources. Emissions from road transport occur at ground level and generally in areas where people live and work, such as in cities and towns, so much of the population is exposed to them. In contrast, power stations are generally outside cities, in less populated areas. As a result of this lower exposure, a shift of emissions from the road transport sector to the power generation sector can therefore be beneficial for health.

Moving towards the future

A large share of electric vehicles on Europe's roads in the future will have implications for the electricity generation and distribution infrastructure. Integrating the additional electricity demand poses diverse challenges. It is important that the road transport and energy sectors become more closely coupled, and that policy and investment decisions across both sectors are closely integrated.

Electric vehicles are just one way in which Europe can move towards a more resource efficient economy and decarbonised transport system. Replacing conventional vehicles with electric vehicles can help reduce emissions, although how much it helps depends significantly upon the source of the electricity used to charge vehicles: renewable, nuclear power or fossil fuel sources. However, simply replacing conventional vehicles will not solve other transport-related problems such as growing congestion and increasing demand for roading infrastructure. A systematic transformation is needed, including further development of renewable biofuels, a shift towards non-motorised and/or public transport and changing the ways in which we use our transport systems. This will help achieve the EU's commitment to a more resource efficient, green and competitive low-carbon economy.

Underpinning assessment

Electric mobility in Europe — Future impact on the emissions and the energy system, Oeko-Institut and Transport & Mobility Leuven (TML), 2016.

European Commission projection

EU energy, transport and GHG emissions: Trends to 2050, 'PRIMES model for energy and CO_2 emission projections, Reference scenario 2013', European Commission, Directorate-General for Energy, Directorate-General for Climate Action and Directorate-General for Mobility and Transport, 2013.

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