

Electric vehicles in the Nordic countries – analyses and experiences from the NEP project

In the research project Nordic Energy Perspectives (NEP) we have made extensive analyses of how the EU's climate and energy package influences the Nordic energy system's development. In this connection we have also studied the development of the transport sector and the effects of introducing electric vehicles.

We have based these NEP analyses on the vision of 600,000 plug-in hybrids and electric vehicles in Sweden by 2020 as stated by the Royal Academy of Engineering Sciences. Scaled up to the Nordic level, this corresponds to 1.3 million plug-in hybrids and electric vehicles in the Nordic countries by 2020.

A large commitment to electric vehicles strongly contributes to the Nordic countries' reaching the EU targets by 2020

NEP's analyses show that a large commitment to electric vehicles can make a significant contribution to our reaching the EU's climate and energy targets by 2020 in the Nordic countries:

1. Electric vehicles can reduce the carbon dioxide emissions strongly in the non-trading sector and can become a decisively important measure for fulfilling the national obligations, which are difficult to reach throughout. The energy conversion is moved to the trading sector (petrol and diesel engines are exchanged for electricity production).
2. Nordic electric vehicles utilize much renewable electricity and, since the EU scales up renewable electricity for electric vehicles by a factor of 2.5, the contribution from electric vehicles becomes large.
3. Electric operation makes plug-in hybrids and electric vehicles very energy-efficient. An electric motor converts more than 90% of the electrical energy to mechanical energy. A petrol engine can convert only 20-30% of the petrol's energy content for propelling the vehicle.
4. With introduction of electric vehicles in the Nordic countries, the Nordic electricity export becomes less than would otherwise be the case, due to the increased domestic use of electricity. No new fossil-fuel-based electricity production need to be built in the Nordic countries.

Large-scale introduction of electric vehicles also actualizes issues of distribution of responsibility (e.g. for reaching the EU targets) between the energy and transport sectors, and the possibilities of collaboration and synergies. The ambition in NEP has been to try and understand the mechanisms that are influenced when we go from sector responsibility to holistic responsibility. The researchers in NEP have analyzed several important points of contact between the stationary energy system and the transport sector, and drawn important conclusions.

Nordic electric vehicles can be driven with Nordic electricity by decreasing the export of electricity

The electricity requirement for 1.3 million electric vehicles in the Nordic countries amounts to 3-3.5 TWh. This corresponds to less than 1% of our electricity production (year 2020). NEP's analyses show that the Nordic electricity system can meet this greater need by our reducing the export of electricity (which is estimated to grow until 2020, since Nordic electricity then becomes more competitive on the North European electricity market as a result of, for instance, the EU's renewable directive). Thus, according to NEP, no extra production of electricity is required in the Nordic countries for electric vehicles, but the exports are decreased.

In NEP we have also analyzed the electrical power need due to introducing electric vehicles. An introduction of 1.3 million electric vehicles can yield an increased need for power in the Nordic electricity system by 1000-1500 MW, if the vehicles are to a great extent charged – in a “non-directed manner” – during times of high load. But if we can redirect the charging to low-load times, the increase in need for power does not have to exceed 300-400 MW.

Electric vehicles reduce CO₂ in the non-trading sector, and contribute strongly to fulfilling the national commitments

A large investment in plug-in hybrids and electric vehicles would reduce the carbon dioxide emissions greatly and contribute to reaching the Nordic countries’ national commitments within the non-trading sector. If 1.3 million plug-in hybrids and electric vehicles are introduced in the Nordic countries by 2020 (of which 600,000 are in Sweden), the carbon dioxide emissions from private cars is reduced by up towards 20%. For the transport sector as a whole, these electric vehicles yield a decrease in the carbon dioxide emissions by 8-9%. Calculated with the Nordic countries’ total commitments in the non-trading sector (in CO₂ equivalents), electric vehicles provide a decrease of around 4% (corresponding to almost a fourth of the entire commitment by 2020).

Carbon dioxide emissions are thus reduced in the transport sector. Moreover, the energy conversion is shifted to the trading sector (electricity production instead of petrol/diesel engines). Electricity production is covered by the EU system of emission rights trade, and at a given emission ceiling of carbon dioxide for the trading sector¹ the introduction of electric cars will result in a rising price of emission rights. In NEP we have calculated a price increase of 5-10 Euros/ton, if electric cars are introduced in the entire EU by 2020.

Electricity for vehicle power is an efficient way of reaching our national renewability targets

In the EU renewable directive, electricity for vehicles can be counted in the country’s electricity mixture, which means that the Nordic countries can count almost two thirds (about 65% according to NEP’s analyses) of the utilized electricity as renewable by 2020, and as contributing to the national targets within the EU renewable directive. In addition, renewable electricity for vehicles is to be counted 2.5 times, implying that one kWh is equivalent to $0.65 \cdot 2.5 = 1.63$ times the electricity put into the transport sector. Using electricity for vehicle power is therefore an efficient means of attaining our renewable targets.

Electric vehicles influence the mix of measures for the renewable targets

NEP’s analyses also show that a large-scale introduction of electric vehicles influences the mix of measures for the renewable targets, which are required in order to fulfil our obligations in the Nordic countries. Not only does the renewable part (times 2.5) of the vehicle electricity go into the mix – an introduction of electric cars will change the balance between other measures for renewable energy. Wind power and biomass CHP increase at the same time as renewable heat production decreases (compared to a case without electric vehicles).

The importance of not locking into a predetermined mix of renewable measures for the national obligation

If an introduction of electric cars also raises the price of CO₂ it will further strengthen the profitability of wind power and biomass power in the Nordic countries (because electricity production from coal and gas in Europe becomes more expensive). Since the Nordic countries have great potential for renewable power production, this trend gives us yet another motivation for increased Nordic electricity export. (However, we have not analyzed in NEP whether the increase of electricity export due to this CO₂ price rise would be larger or smaller than the decrease of electricity export when electric cars are introduced.)

If the EU ultimately also allows trade with green certificates (or the equivalent) within the renewable directive, the driving forces for renewable Nordic production and export of electricity will become even stronger. NEP’s advice to our Nordic politicians is therefore, now that the policy instruments for renewable energy are being reviewed, to stay open for great flexibility in the mix of renewable measures.

¹ Since the emissions in the trading sector in the EU are limited, possible added fossil-fuel electricity production in the EU does not lead to any net increase of emissions – all growth must be compensated with a corresponding decrease.