Institute of Transport Economics
Norwegian Centre for Transport Research

Summary

An analysis of the increasingly closer relationship between the transport and electricity sectors in Norway

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Authors: Paal Brevik Wangsness, Sverre A.C. Kittelsen, Christian Steinsland, Finn Roar Aune & Eric Nævdal
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Electrification of the car fleet makes the electricity market and the transport system more intertwined. By applying specialized models for energy and transport together, we have analyzed a number of scenarios (including stress testing) for how these markets will affect each other in 2030. We find that the Norwegian power market as a whole is mainly robust to the challenges posed by charging of plug-in electric cars in Norway. In addition, the changes in electricity prices are not expected to significantly affect transport demand, as electricity is a small part of the costs of owning or operating an electric car.

Introduction

In the last seven years, Norway has experienced a formidable growth in sales of plug-in electric vehicles (PEVs); both battery-electric electric vehicles (BEVs) and plug-in hybrid vehicles (PHEVs). Norway has the highest national BEV density in the world in 2020.

Electrification of the car fleet makes the electricity market and the transport system more intertwined. Norway is set to become one of the first countries in the world where this is becoming a real issue, and the experiences from this could provide valuable insight to other countries that want to reduce emissions from their transport sector to the lowest possible social cost.

Models

We analyze the increased interconnection between the transport and the electricity market through various model scenarios. We draw on three families of models:

1. The BIG model[1]: The projected changes in the car fleet from this model feed into the scenarios to run the other models
2. Transport models: The National Transport Model (NTM) and the Regional Transport Models (RTMs) are used in this project. New developments have been added to the models in order to model a transport system with a significant share of car owners with BEVS and PHEVS.
3. The energy market model LIBEMOD: LIBEMOD is a numerical equilibrium model for the energy markets. The model includes the 30 European countries as endogenous. In addition, 6 other countries / regions that are important for the European energy markets are modeled with simpler behavior. Furthermore, the model is adapted to this analysis by dividing Norway into 5 regions.

[1] The acronym is derived from "bilgenerasjonsmodell", meaning "car cohort model".

We aim to use each of the models according to their relative strengths. LIBEMOD has a detailed modeling of the energy markets and endogenous determination of equilibrium prices and quantity traded. On the other hand, it has a simple modeling of energy demand from the transport sector that depends on income level, and on the prices of the energy carriers used for transport (oil / petrol / diesel, biofuels and electricity). The transport models have exogenous prices for these energy carriers, but in return have a detailed modeling of the demand for transport services.

The structure of the model interlinkage is shown in Figure S1. All exogenous assumptions such as initial values for energy prices, quantity and income level are coordinated between the models. The models are then run iteratively in that the energy model returns prices to the transport model, which then delivers the requested quantity back to the energy model.

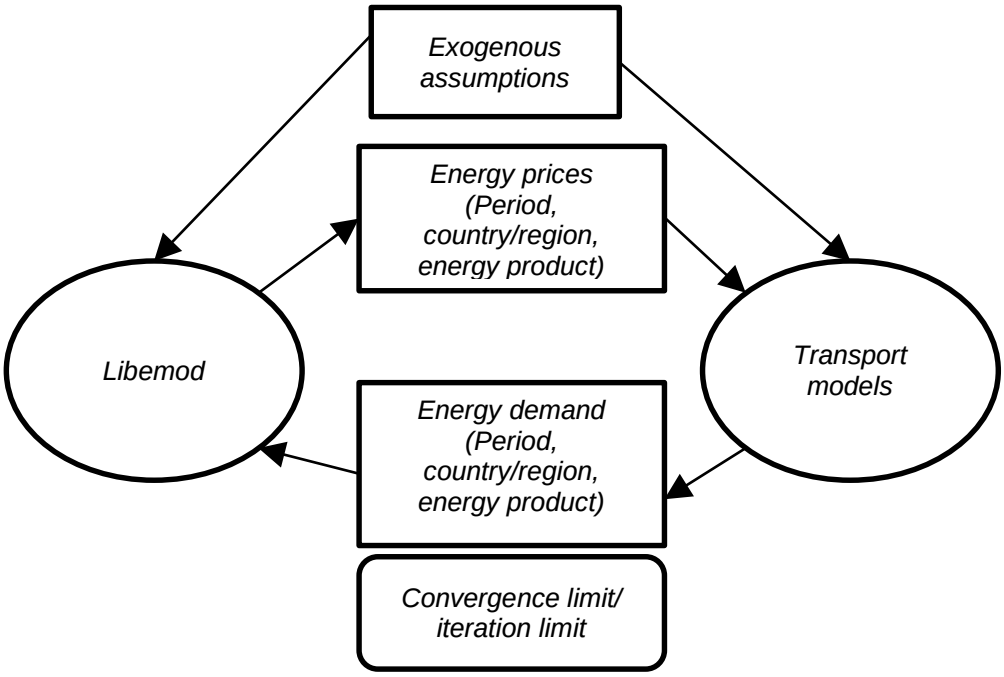

Figure S1: Coordinated running of the energy market model and national and regional transport models.

Results for 2030 scenarios

- **NB19**: In these 2030-scenarios, PEVs will in have an average share of 3,6 % of electricity consumption nationally, with a somewhat higher share in Eastern Norway and lower share in Northern Norway. In practice, it does not affect prices significantly.
- **NTP-EU:** PEV charging will make up an average share of electricity consumption of between 2.1 % and 5.8 % in the different regional electric markets, with a national average of 4.2 %. The increased share of demand from PEV charging is also due to the fact that total consumption has declined somewhat in all regional markets. The extra demand that charging represents, on the other hand, is not reflected in visible price changes.
- **Stress test – cold and dry in 2030**: We get a price increase of 6-7 % in the Norwegian electricity market, which is mainly due to the loss of approx. 25 TWh of hydropower and an increase in heating demand of 6 TWh. The demand increase from PEV charging is only 0.8 TWh in this model run.

- **Night time charging**: We find 11.5 % higher prices for concentrated charging on winter evenings compared to uniform charging throughout the day. The price effects of evening charging in the summer are small. If the charging is shifted to night time charging, there is a much smaller effect, with less than a 0.5 % price increase.

Conclusions

The Norwegian electricity market is, as a whole, fairly robust to the challenges that Norwegian PEV charging entails. There is sufficient capacity in Norwegian power generation, international transmission and transmission between Norwegian price zones so that the demand for electricity for charging can be satisfied without major price effects. The price of power also does not significantly affect transport demand, as electricity is a small part of the costs of owning or operating an electric car. Even in a dry and cold year, the need for charging will not have a large effect on prices or the desired capacity. It is the loss of hydropower production and an increase in heating needs that will have by far the greatest impact.

The time profile of the PEV charging, on the other hand, can be important. If charging is concentrated in the evening hours after many people come home from work, electricity consumption from PEVs will come on top of a power need that is already dimensioning for the electricity market. The price effect in the spot market can then be significant. If the charging can be shifted to night time, it will not come in a period with peak demand and power prices will hardly be affected. Nor will it trigger a need to strengthen the power capacity in transmission or power generation.