SHIFT TO ELECTRIC VEHICLES: LONG-TERM EFFECTS

Andrey Kolpakov
Institute of Economic Forecasting of Russian Academy of Sciences (IEF RAS)
+79165497401, ankolp@gmail.com

Overview

The shift to electric vehicles (EV) is one of the probable trajectories of the road transport development. The economic efficiency of EVs has reached acceptable levels and its improving continues. Global EVs stock is still less than 1% of the world cars stock, but it is growing dynamically. Research is devoted to the analysis of potential long-term effects (both energy and macroeconomic) from the shift to EVs. In addition, we indicate some questions that arise while constructing the possible scenario for the large-scale use of electric vehicles.

The obvious consequence of the EVs use is the decrease of oil consumption. However, in addition to local energy effects, a number of macroeconomic consequences can be noted.

In the global level the shift to EVs may be considered as a part of energy used unification process. Moreover, this scenario correlates to the current global electrification trend which means the increasing share of electricity in the energy consumption structure. Gradually the technological bundle "Electricity – Electric accumulator" achieves acceptable economic characteristics, and the scope of their application is expanding. This means that the use of electricity for transportation may only be a particular case. We should analyze the possible directions of the technological replicating and look for another consumption areas, where the energy supply can be transferred to the electricity.

The shift to EVs is favorable for the world economy. This creates new technological chains and sub-sectors, generating new value added, making the world economy structure more complex and increasing the world GDP, which creates positive signals for the markets.

We will obtain much more serious consequences for oil demand and macro-structural changes in the world economy in case of the end of individual car ownership and the transition to the transport-as-a-service (TaaS) model dominance, especially if it will be based on autonomous EVs use.

Methods

The main goal of the research is to estimate the world oil consumption in different scenarios of motor transport development, as well as to analyze possible macroeconomic consequences. We use our own techno-economic bottom-up model of Institute of Economic Forecasting of Russian Academy of Sciences (IEF RAS). In this model the world is divided into 50 aggregates: 43 countries + EU + 6 geographical groups of other countries. Nomenclature of energy resources includes oil, coal, natural gas, nuclear energy, hydropower, solar energy, wind energy, other renewable energy sources, electricity, heat, petroleum products (gasoline, diesel fuel, kerosene, fuel oil, naphtha and LPG, other products). Nomenclature of consumption sectors includes industry, transport (road, aviation, railway, other), energy sector (electricity and heat production), residential sector, commercial and public services, non-energy use. For macroeconomic estimations we use own system of input-output models of IEF RAS.

Results

According to our estimates, even in rather optimistic scenarios (global EV stock is more than 500 mln by 2045 which is about 25% of the world cars stock) the shift to EVs is 3 times less significant factor of oil demand reduction than the increase in fuel efficiency. The use of electric vehicles leads to 8.1 mbd decrease of world oil consumption, and fuel economy improvement saves 25.7 mbd by 2045.

However, in the scenario of TaaS model dominance with autonomous EVs use the situation changes more dramaticly. The main effect from the autonomous EVs spread is that due to the significantly higher operating intensity and the reduction in downtime, the same transportation work can be performed with a multiple reduction in the fleet of cars. Thus one autonomous EV may replace several traditional ICE cars, which will accelerate the escape

from oil. So, if the stock of TaaS autonomous EVs amounts to at least 200 mln by 2045 (less than 10% of the car fleet to be necessary for the world population), oil demand will drop by another 12.5 mbd. World consumption of petroleum products, which now amounts to 4.23 bln toe, in this scenario will reach a peak at 4.87 bln toe in 2030-2035 and then will drop to 4.70 bln toe by 2045 decreasing by 0.4% per year.

One also shoud expect significant changes in the structure of petroleum products consumption. Today gasoline and diesel fuel account for 56%, but by 2045 their share will decrease to 49%. At the same time the share of gasoline will decrease from 24% to 16%, while the share of products for mainly chemical use (naphtha, LPG) will increase from 19% to 22%. Thus, a raw product (naphtha) may become more in-demand than the next stage of its processing (gasoline). It makes one to rethink the expedient structure of the petroleum products output and the directions of the world oil refining development.

The possible development and spread of self-driving cars will lead to dramatic consequences for the entire autotransport industry, right up to its transformation from commercial to infrastructure segment. If vehicle users switch their behavior model from car ownership to autonomous TaaS cars using, the complicated and diverse structure of car business with a large number of producers and models will become inexpedient. In the long term it may be replaced by a bundle of an infrastructure operator and several large suppliers of standardized self-driving taxis, possibly having different comfort packages for different consumers groups. Obviously, this scenario leads to fundamental macrostructural changes in the world economy.

The important question that doesn’t have a clear answer is whether the electric car provides fundamentally new opportunities for the consumer. Yes, with a certain combination of prices for different energy sources, the full cycle cost of electric car (how much we will pay for all the time of car owning) may be comparable or even lower than one for traditional car, but the price of electric car (how much we have to pay today) remains significantly higher. This is often a determinative factor in choosing a car, especially in developing countries. Yes, the electric car is characterized by zero emissions at the operating stage. But taking into account the full cycle, the cumulative effect will depend strongly on the structure of electricity generation, which is characterized by the hydrocarbon fuels dominance for the most countries. In addition, according to sociological surveys, the environmental factor is determinative one in choosing an electric car for only for 25-30% (in average) of the respondents. Yes, the electric car has two pedals, but the automatic transmission in the ICE cars also provides two pedals. Yes, electric cars have an autopilot technology, but BMW, Volvo, Infinity and other producers offer similar solutions in ICE cars. Although the electric car is a more technically convenient option for self-driving technologies.

One more possible effect. Today many countries offer subsidies for consumers to purchase the electric cars. However, petroleum sector provides a significant share of budget revenues in many countries, and the share of taxes in the price of gasoline can exceed 50%. If in the long term EVs replace ICE cars and oil becomes an undesired energy resource, how will countries fill the budget? An obvious option is additional electricity taxation. This will generate a significant negative impact not only on the economic efficiency of electric cars, but also on the overall macroeconomic indicators of all countries since the electricity is consumed ubiquitously.

Conclusions

The expansion of personal electric cars use leads to a drop in oil demand. However, in the coming decades this factor will not be determinative since fuel economy improvement is 3 times more significant.

If vehicle users switch their behavior model from car ownership to autonomous TaaS cars using, the macrostructure of world economy will dramatically change. If autonomous cars are electric, this will lead to significant acceleration of escape from oil.

In rather tough scenarios world oil consumption may peak in 2030-2035.

One may consider the shift to electric vehicles as a part of the global process of unifying energy use and moving to the "Electricity – Electric Accumulator" bundle.

If in the long term EVs replace ICE cars many countries may use additional electricity taxation to compensate decreasing budget oil revenues. This will generate a significant negative impact not only on the economic efficiency of electric cars, but also on the overall macroeconomic indicators of all countries since the electricity is consumed ubiquitously.