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The market dilemma

Implications of an introduction of Electric Road Systems on markets and possible business models

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Summary

This paper gives insight in the progress of business model development for ERS within the CollERS project. It focuses on interactions between supply and demand in a provided market model and on the relations between different sub-markets relevant to ERS. Key findings are that in contrast to (petrol) station based solutions, ERS is a system-based approach based on dynamic charging. Consequently the introduction of ERS requires changes in existing markets. These fundamental changes take place on the infrastructure market, but not necessarily on the transport market. A policy push is needed to create market demand for this technology.

1 Research Questions

Electric road systems (ERS) are road transportation systems based on technologies that support electric power transfer from roads to vehicles in motion. In recent years, ERS has emerged as a potential way to achieve CO2 reduction-goals related to the long-haul freight sector, which is one of the most difficult sectors to decarbonize, and projected to grow drastically in coming years. So far, the development of ERS has primarily been driven by societal and ecological needs rather than market demand, and most pre-commercial ERS activities have been initiated, supported, and subsidized by public funding.

While the purpose of these actions is to prepare ERS for commercial take-off, leading to a more sustainable transportation system, such technologies that contest the established technological paradigm often fail at market deployment. One of the reasons for a possible failure of ERS is that ERS requires large investments in developing and commercializing technology (e.g., electric road trucks) as well as capital investments in a new physical infrastructure (e.g., electrified roads and power grid extensions) at a time when uncertainty is high and rewards difficult to predict. Moreover, ERS is probably not compatible with the established station-based infrastructure (petrol stations) and business models of incumbent industries. Adding new features to roads like ERS could also contest established funding and ownership models of public infrastructure.

Accordingly, the purpose of this paper is to identify the main variables of promising business models for ERS. Therefore, market structures are analysed, relations between actors clarified, and individual interests described. A universal market approach that covers the primary market for goods and services on the one hand and the primary markets for infrastructure and energy on the other hand is presented here. By using this approach, the market can, for example, be interpreted from a logistics or from an ERS perspective, leading to different implications for successful market deployment of ERS. Furthermore, based on theoretical considerations from market theory and current findings on ERS pilots in Sweden and Germany, a demand-pull approach to market penetration, based on transportation efficiency and costs, is compared with an

environmental policy-driven, “policy push” approach, based on CO2 savings. It is discussed, how these could be aligned for successful deployment of ERS.

2 Methodology

This paper is theoretically based on market theory. In particular, it focuses on interactions between supply and demand on a sub-market level, and on the relations between different sub-markets. This approach is known from (institutional) micro-economics and co-evolutionary approaches. Below we settle on theoretical adaptions and combinations of existing market and relationship models [1] - [5] that are adapted to the specific context of ERS. Mixed elements of microeconomic market theory, industrial economics and institutional economics are used to describe and evaluate the different actors’ behaviour on the relevant sub-markets, and the consequences for market changes and development.

In particular, this paper addresses the following research questions:

- market organisation in the context of ERS
- the market dilemma
- ways out of the dilemma
- conclusions for deployment of ERS in a market context

The paper is an outcome of the German-Swedish research collaboration on ERS [6]. It is mainly based on three theoretical workshops being held in Sweden and Germany during 2018-19. The paper gives insight into the state of our work, and current findings.

3 Results

Positioning ERS in a market model requires an understanding of the relevant market environment. Therefore, the relevant sub-markets have to be identified and described through supply and demand. Road freight operations are best to be described on the basis of the primary market for goods and logistics services, whereas the necessary technical facilities can be found on the primary markets for infrastructure and energy. By combining these two categories, five sub-markets for the configuration of ERS are given. *Figure 1* shows these sub-markets, the main interdependencies between them, and how external parameters such as environmental or capacity needs affect each sub-segment.

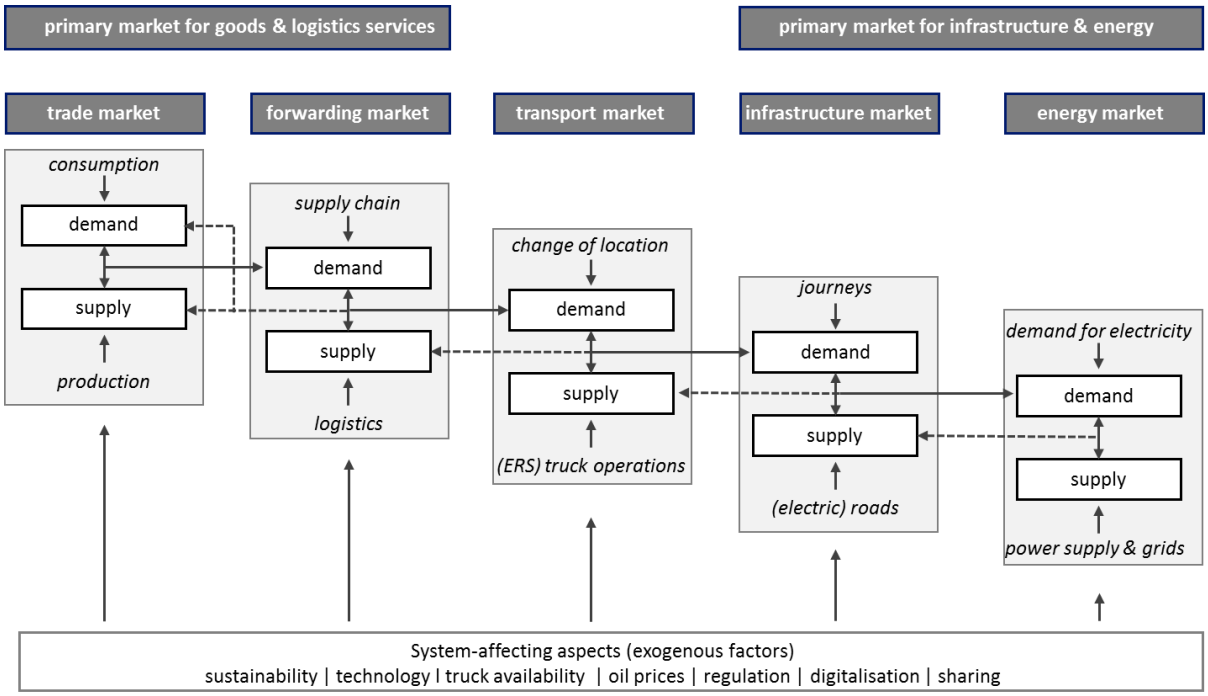

Figure 1: The market model of ERS

In each sub-segment of the market model relationships, represented by a combination of contracts, form a demand pressure affecting other sub-segments. For example, trade generates a demand for supply chains on the forwarding market. Meeting this demand requires supply of ERS trucks and services on the transport market, which in turn is dependent on the infrastructure market's supply. Operating electric roads creates a demand for energy on the energy market.

In order to outline changes from a petrol station-based diesel energy supply infrastructure ("filling up" at petrol stations) to a system-based ERS infrastructure (dynamic energy charging), it is important to take the perspective of the actors on the respective sub-markets. For example, for stakeholders on the transport market (shippers, forwarders, etc.), value creation and market perception are based on their primary market, i.e. on profitability and cost efficiency in transport. Consequently, it is fundamentally different compared to more regulated markets such as the infrastructure and energy markets.

The actors on the primary market for goods and logistics services ask for low prices on the transport market. Thus, according to *figure 2*, price competition in the transport market is quite high. Stakeholders in the transport market demand that new vehicle technologies have to be cost-efficient, since the low margins in this sub-segment of the market reduce the willingness to take higher risks or investments. Carriers will adapt to new technologies that bring the best short-term cost efficiency in their particular situation. A good example for technologies that are expected to be quite well received by carriers are those related to autonomous driving, as one of the biggest cost factors lies in the availability and the wages of drivers. There is a market pull for such technologies, i.e. a demand generated from the market is waiting for the right supply, which could potentially necessitate the infrastructure investment required to enable such technologies.

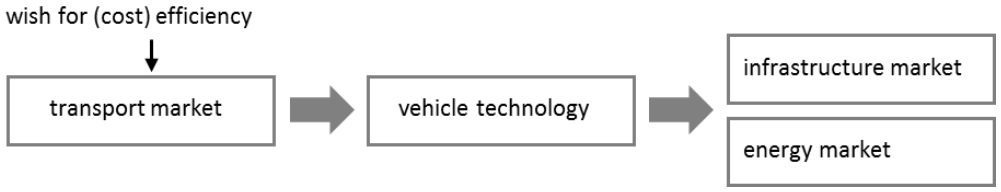

Figure 2: Market pull

On the other hand, as outlined in *figure 3*, the model can also be used to describe and analyse the interdependencies between different sub-segments of the market by starting at the energy market. The political wish for CO2 reduction in transport can create a "policy push" to the development of ERS as a solution, which is "pushed on" the supply side of the infrastructure and energy market in hope to create ERS operations on the transport market.

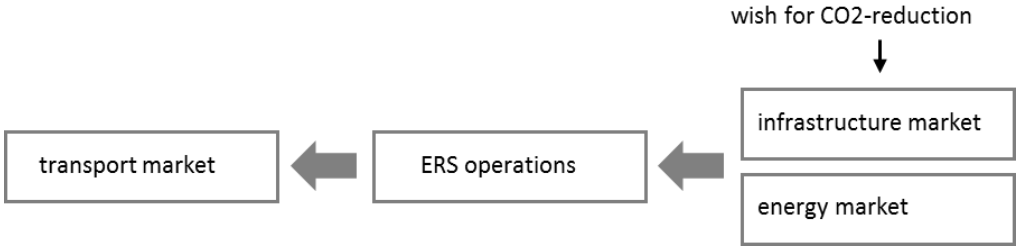

Figure 3: Policy push

By using the market model, the main differences between the perspective of carriers (cost efficiency), and the ERS perspective (saving CO2) becomes obvious. The consequence of this "market dilemma" is that the implementation of ERS must be supported and pushed by moderating actions, balancing the two perspectives.

As shown in *figure 4*, a policy push on the transport market has impact on all primary markets. Towards the forwarding and trade market, initial incentives can cut down the costs of using ERS. These incentives should be monetary, e.g. subsidies or grants for investing in electric trucks and using ERS, as long as the introduction of ERS does not result in any major structural market changes on the primary market for goods and services. This is due to the fact, that ERS does not have a direct impact on the supply and demand relations in the trade market and the forwarding market.

Considering the (more) regulated infrastructure and energy markets, changes are primarily driven by new market opportunities in the energy sector, which have higher expected operational profit margins compared

to the transport market. This implies radical changes on those primary markets as these new technical facilities for roads are being developed and implemented with a couple of new possible business models for energy distribution, sales and storage. Subsequently, through ERS the infrastructure market might become market for a new kind of owners and road operators.

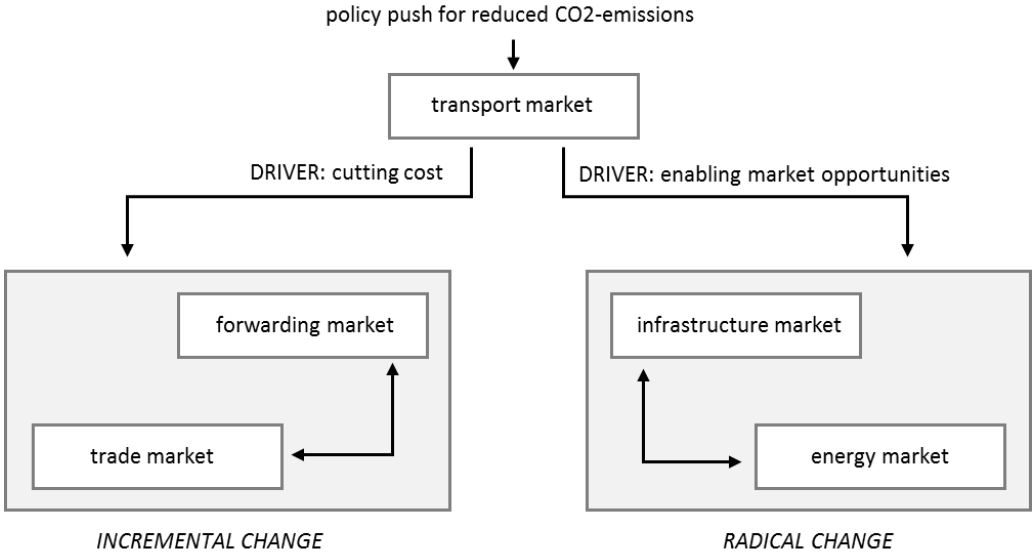

Figure 4: Drivers for an introduction of ERS

Out of these market-based considerations, different implications of a potential ERS (market) deployment can be drawn:

- The development of ERS will have a major impact on the infrastructure market, but not necessarily on the transport market. The transport market is based on prices and service levels set in the market. Even if the implementation of ERS will result in obvious changes of road transport, ERS will not completely change the industry. Main drivers for change of the transport market are rather new technologies like autonomous vehicles, digitalisation and economies of scale realized by global transportation companies.
- While ERS are a system-based approach based on dynamic charging, most alternative technologies like fuel cells or static electric charging rely on a station-based energy supply system, just as today's diesel fuel supply. Consequently, the introduction of ERS requires changes in existing market structures which might result in the creation of a monopoly on roadside-electricity. In comparison, an introduction of a hydrogen drive system would not necessarily require such changes in the market structure, as it is a station-based system.
- ERS may open up innovative business opportunities. For example, truck operators that are running electric trucks might become part of the energy supply system through offering capacity for decentral energy storage. Infrastructure companies could be interested in operating or financing electric roads. Companies providing billing solutions will be interested in billing electricity for ERS trucks, for instance.

A market model perspective reveals how the various sub-markets are affected in different ways through the introduction of ERS. This enhances our understanding of how new business and financing models could be introduced that could support ERS deployment. If ERS as part of a political strategy wants to be successful political actors have to focus the market out of different perspectives. Consequently, the role of the operators of ERS, either in the public or private sector, is becoming more important, as they are moderating between different primary markets.

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