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Socioeconomic Analysis of Electric Road Systems

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Summary

The implementation of Electric Road Systems at national and international levels will be associated with large investments and it is therefore important to study the economic impact and benefits for the society. The present work describes a framework for conducting socioeconomic analysis on electrification of an existing road infrastructure.

1 Research Questions

An operational full-scale Electric Road System (ERS) will be a system-of-system consisting of power transfer systems, electrified vehicles, logistics system, energy system, as well as systems for safety, control and management. The implementation of ERS at national and international levels will thus be associated with large investments and it is therefore important to study the economic impact and benefits for the society [1], [2], [3].

Electrification of roads can take place either as a separate deployment to existing road infrastructure, or in connection with a major infrastructure development. Socioeconomic analyses are widely used in transport planning, especially when investigating large investment projects. The presented work is based on the situation where the investment is made as an electrification of an existing road and not infrastructure development in general.

2 Methodology

The question of socioeconomic surplus is largely the same as the question for a private investor would be: How large are the gains in terms of cost savings compared with the cost of investing in new infrastructure and new vehicles? However, a socioeconomic analysis will follow a slightly different structure and include some more elements [4]. The main differences are:

- **Break-even vs. net benefits:** When considering private profitability, the question is often whether the investment *is* profitable or not (break-even), and not *how* profitable or unprofitable (net benefit). Sensitivity analyses are based on changing one prerequisite (e.g. number of vehicles) and showing how much another prerequisite (e.g. the proportion of driving on the ERS) must change in order for the electric road to be profitable. In socioeconomic analysis, it is more common to change one assumption at a time and show how much profitability changes.
- **Net present value:** In socioeconomic analyses, a present value of net benefits is calculated from a discounting and summation of all future benefits and future costs. In the study of business models, one has instead used the annuity method, which gives the cost per year throughout the lifetime. Both methods are based on discounting, and it is easy to calculate the net present value from annuity costs.
- **Taxes and fees:** In a socioeconomic analysis, taxes and fees do not constitute a net cost to society, only a transfer from private individuals or firms to the government. However, it is customary to

include taxes and fees in the calculations in order to show how the benefit of the measure is distributed between the public and other groups (e.g. road users).
- **External impact:** A socioeconomic analysis should include the cost of greenhouse gas emissions, local pollution, noise and accidents. It is uncertain whether an ERS investment will affect the two latter outcomes, but this must be investigated.
- **Demand effect:** In a socioeconomic analysis, it should be taken into account whether the saved transport costs make it more profitable to increase the transport volume. (It may also be considered profitable to distribute the transport on several and possibly smaller vehicles.) In practice, demand is often considered fixed, for simplicity.

There are not necessarily major differences between business and socioeconomic analyses, at least not in the case of a closed transportation systems, e.g. bus loops or mining transportation applications where the routes are predictable and relatively easy to service and maintain. However, open systems, e.g. along a highway, are more interesting as it is easier to achieve large traffic volumes and there is a clearer role for the public sector.

Compared to other types of infrastructure projects, analysing open ERS cases involve some specific challenges for traffic modelling:

- Railways are used by only one type of vehicle, and the capacity utilization is regulated by the government.
- Conventional roads are used by several types of vehicles (including private electric vehicles) and access to the road is open, but the infrastructure does not affect the choice of vehicle.
- For an open ERS case, the project will affect whether private business invest in electric trucks that can operate on the ERS, which again is crucial for the socioeconomic impact.

Moreover, private profitability and economic benefits will also depend on the existing ERS network. An electrified road link that is not profitable by itself could be profitable if it is close to an existing ERS network, because (i) trucks that use the existing network can now drive an even longer distance on electricity and (ii) using electric trucks now become profitable on distances that previously were served by conventional trucks.

3 Results

For an analysis of a public investment in an ERS system, the following data are needed for both a reference case and the ERS development case:

- Costs of road construction.
- Cost for deployment of ERS infrastructure.
- Cost of maintenance.
- Amount of traffic with heavy vehicles, electrical (development case) and conventional, distributed along the road network. This should preferably be based on a suitable demand model.
- Distance-dependent driving costs for heavy vehicles of both types.
- Non-distance-dependent capital costs (investment and maintenance) for vehicles of both types.
- Local emissions (and possibly noise) costs from heavy vehicles of both types, segmented by geographical area.
- Costs of greenhouse gas emissions from heavy vehicles.
- Other external costs, if applicable.

The analyses should be structured such that it is shown how the different costs are divided between different actors. This implies that taxes and fees are included as an expense for private actors and as an income for the public sector.

As to how many transports will be transferred to electric vehicles, the assumption should be that the companies choose electrification as long as the saved driving costs outweigh the additional costs of such vehicles (difference in purchase price and possibly maintenance costs). The decisive factor here is the proportion of transport distances that take place along the electric road. A simplified procedure would be to assume that this percentage is fixed. A more sophisticated approach will be to also take into account that the consolidation pattern changes so that a greater extent utilizes the ERS (such as for rail). This requires a logistics model.

If the ERS route is built on an existing route without great gains in terms of driving time savings, it is in our view not necessary to analyse wider economic impacts of the investment. If electrification occurs in

combination with a project that also involves substantial transport time savings, one should also assess these effects. In all cases, one should follow developments in this field within transport economics.

In addition, the following general prerequisites are required:

- Analysis period and life of the investment. The analysis period should preferably be equal to the lifetime of the electric road, but one may possibly operate with a calculative residual value of the investment.
- Discount rate.

The recommendations above are quite general. They must be adapted to the specific case that is subject to a socioeconomic analysis. This particularly concerns the simplifications that can be made in the analysis as to which transports are affected and how the companies adapt. For cases where a single operator or a type of transport dominates heavily, a socioeconomic analysis will require less resources.

The Swedish Transport Administration has recently procured a tool to be used for socioeconomic calculations of ERS deployments. The presented for socioeconomic analysis presented in this work is intended to complement and inspire the use of the calculation tool.

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