

Defining ERSO: The Electric Road System Operator

Stefan Tongur¹, Håkan Sundelin

¹*Stefan Tongur, RISE, Box 1151, SE-164 26 Kista, Sweden, stefan.tongur@ri.se*

Summary

Electric road systems (ERS) are road transportation systems based on technologies that support electric power transfer from roads to vehicles in motion. Surprisingly, there has been very little attention to how users will pay for using ERS. An implemented ERS could require an operator that handles the relationship between users and suppliers of ERS. We term this operator role as ERSO (Electric Road System Operator) and define it as the role that connects the users with energy supply of the electric road. The paper presents an architecture that describes the ERSO interfaces, relationships between stakeholders, and discusses the role of ERSO in two different deployment scenarios. The paper concludes that the role of ERSO will not be homogenous but will depend on how closed or open ERS will be. Thereby, policy makers should enhance possibilities for develop the role of ERSO to enable a platform for innovative business models and an open ERS market.

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 urgent policy 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. Compared with other alternative technologies, ERS reduces the need for batteries, relies on well-established electricity infrastructure, and could preserve flexibility in the freight sector [1]. Demonstration projects are currently under construction in various parts of the world to determine whether ERS should be implemented on a wider scale to achieve sustainable transportation. However, ERS is entering the valley of death, were many innovations fail to attract the substantial investments needed for commercial operations [2].

Since ERS changes the type of fuel, from liquid (fossil) fuel to electric (renewable) energy, and how the fuel is consumed, from statically standing still to dynamically on the move, it causes major implications for users and the business models of today [3, 4]. Surprisingly, there has been very little attention to how users will pay for using ERS. In fact, an implemented ERS could require an operator that handles the relationship between users and suppliers of ERS. We term this operator role as ERSO (Electric Road System Operator) and define it as the role that connects the users with energy supply of the electric road. The purpose of this article is to describe how ERSO could be described and analysed in different phases of a potential transition to ERS. Accordingly, it addresses the following three research questions:

1. How can the architecture and interfaces of ERSO be described?
2. How could ERSOs role be analysed in a small-scale deployment of ERS?
3. How could ERSOs role be analysed in a large-scale deployment of ERS?

2 Methodology

The paper is based on a several different methodologies used to address the research questions. First, it is based on a longitudinal case study of ERS development in Sweden (2010 – 2019), Los Angeles in the U.S. (2014), and in Germany. (2018 – 2019). The research has included interviews, observations, and project

management of ERS projects. These activities have contributed to understanding of the socio-technical configuration of ERS and the role of business models in a potential transition. Furthermore, these activities have contributed to the development of how a transition to ERS could go through different scenarios (see fig. 1) from precommercial activities to commercial markets. This study focuses primarily on ERSOs role in two scenarios, niche markets and in mass markets [5].

Second, it based on interviews (autumn 2018) with potential users and buyers of ERS services, transport related trade associations, and electric energy and grid companies. These interviews have highlighted what opportunities and challenges there are for using ERS. It has also shed light on the viewpoints of potential users and energy suppliers when it comes to the role of ERSO.

Third, the interfaces of ERSO's architecture are described by using the Systems Modelling Language tool (SysML). By forming a visual description, a starting discussion could be enabled that discuss the role of ERSO in the transition towards ERS. Consequently, rather than arguing that the architecture of ERS will look like that, we acknowledge that it will change depending on the maturity level of ERS technologies, local contextual conditions, different regulations, and depending on the type of business case that is analysed.

3 Results

3.1 How can the architecture and interfaces of ERSO be described?

The architecture of ERSO and the interfaces it relates to are described in Figure 1. It shows that ERSO has two types of relationship, one with suppliers and one with users of ERS. On the suppliers' side, ERSO operates the Electric Road which consists of many Electric Road segments. The Local power grid then provides electricity to each segment individually. ERSO then contracts electricity from the energy provider. On the user side, ERSO is the handler of the subscription for the Electric Road and is responsible for contracting them to the Transported goods owner or the Haulage contractor.

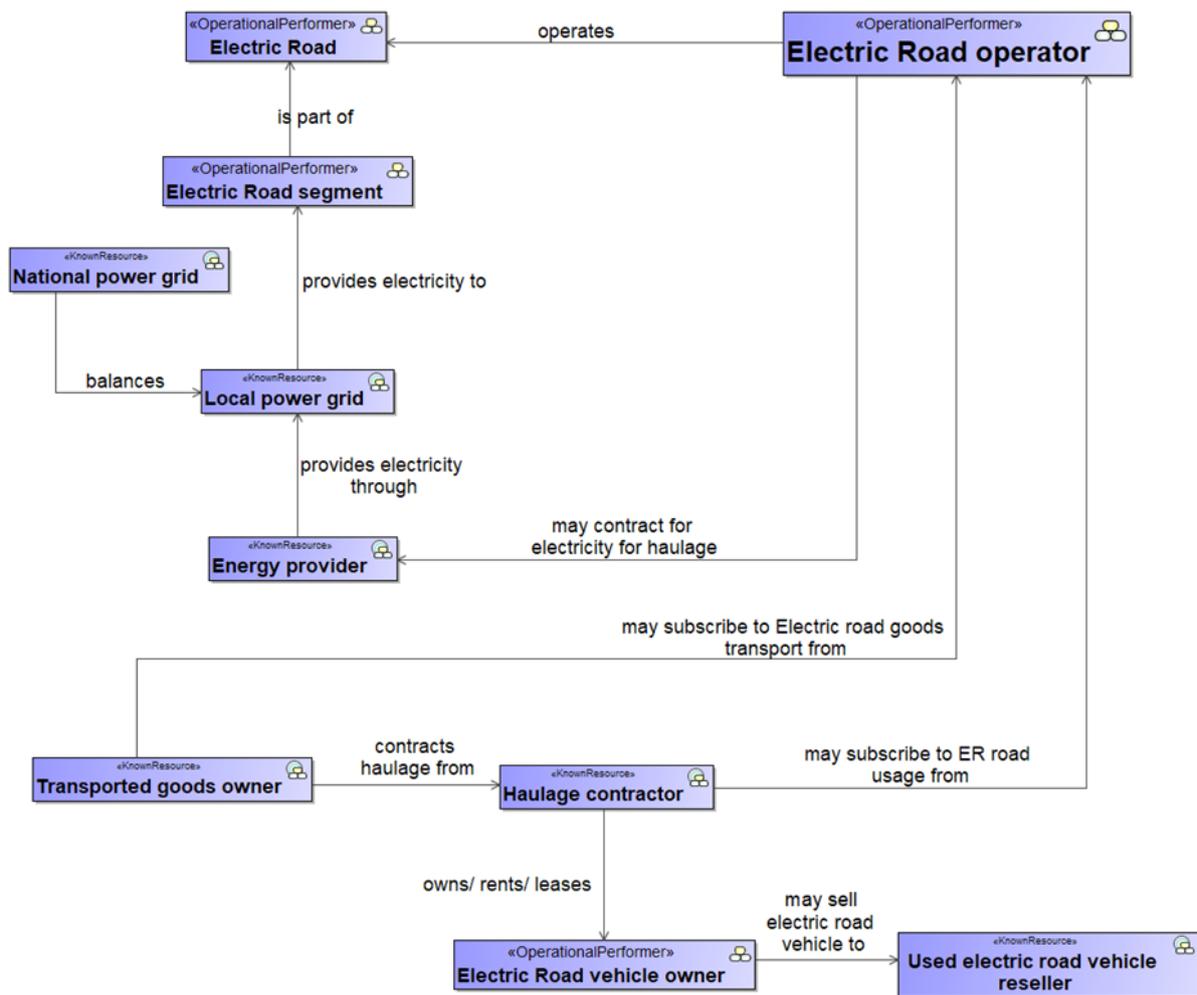


Figure 1. Relationship between logical elements and the operator.

Since the potential transition to ERS could be depicted through different phases, each with different types of user cases, the role of ERSO will change over time. The following two sections will analyse a small-scale deployment and a large-scale deployment of ERS from an ERSO perspective. We will do this by addressing the following questions:

1. Who is ERSO?
2. What is ERSOs relationship with users (transport goods owners and haulier companies)?
3. What is ERSOs relationship with suppliers (Electric road owner and energy provider)?

3.2 How could ERSOs role be analysed in a small-scale deployment of ERS?

A small-scale deployment of ERS could be resembled with several of the pilot projects that are explored in Sweden, a permanent ERS deployment with at least 20-30 km situated in local area with high traffic flows (cf. the closed system description in [5]). A typical example is ERS deployed near a harbour and industries with high level of fossil fuel diesel trucks traveling in between (See Figure 2).

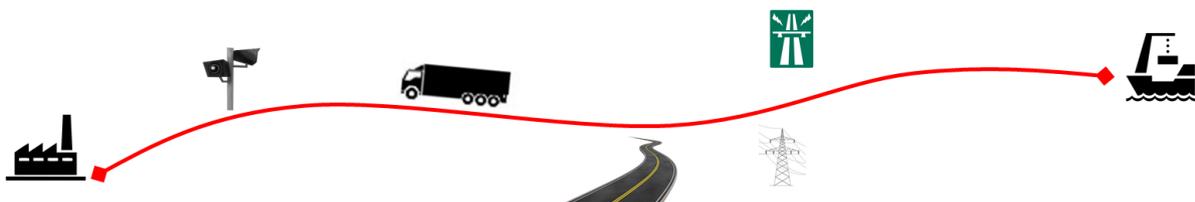


Figure 2. Description of a small-scale deployment of ERS.

Who is ERSO?

In this case, the role of ERSO could be assumed by one of the ERS suppliers. This could reduce the number of actors involved in the ERS market which could initially help to reduce technical risks and increase incentives for actors to integrate forward and to develop new business models. For example, ERSO could be one of the following actors;

- supplier of power transfer technology (e.g. Siemens, Alstom or Electreon),
- vehicle OEMs with a vehicle as a service offer to users (e.g. Scania or Volvo),
- energy suppliers that offer subscriptions to users and possibly also pick-ups (e.g. Vattenfall, Eon, Elevio, EnBW)

What is ERSOs relationship with users (transport goods owners and haulier companies)?

The relationship between ERSO and transport goods owners will be very important in a small-scale deployment of ERS. Goods owners that have rather fixed transportation e.g. from a factory to a railyard or harbour, could decide to support investment in an ERS if it allows them to decrease their transportation cost and their environmental impact. Thereby they could collaborate with haulage companies, by writing longer transport contracts and by sharing some of the higher costs in ERS trucks. Thereby the risks for establishing an ERS is reduced. The metering and billing could be done through deposition for the single electric road and be contracted with haulage company, which in turn has a contract with the transport goods owner.

What is ERSOs relationship with suppliers (Electric road owner and energy provider)?

The relationship between ERSO and ERS suppliers is rather simple here. Since the electric road network is limited, there will be one electric road provider and probably one (or maybe two) energy providers. This decreases the number of suppliers that ERSO must collaborate with and simplifies access control and metering.

3.3 How could ERSOs role be analysed in a large-scale deployment of ERS?

A large-scale deployment could be illustrated by a potential ERS corridor from Sweden to Germany (Figure 3), which has been elaborated on in the Swedish-German ERS research collaboration (CollERS). This involves ERS over three different countries and jurisdiction.

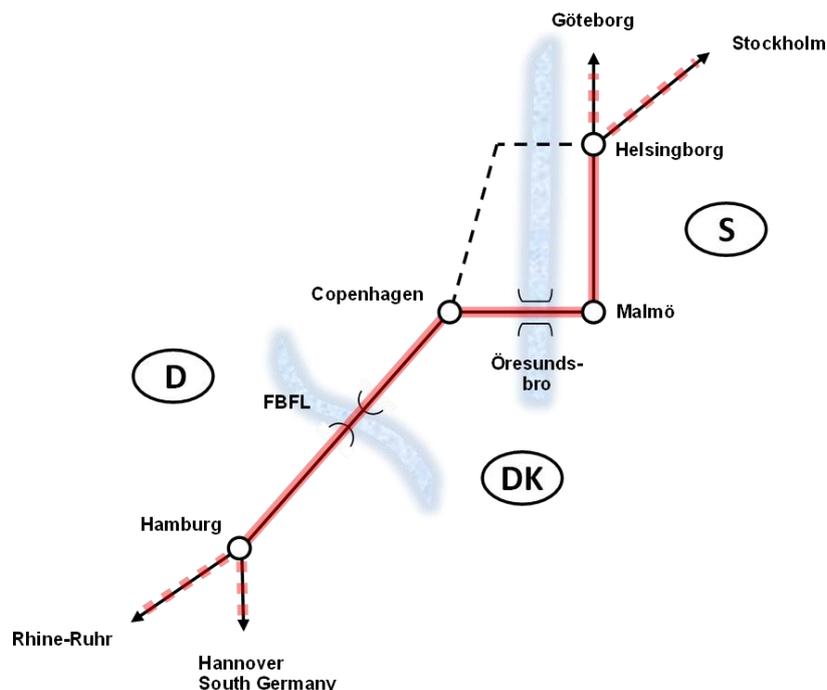


Figure 3. Description of a large-scale deployment of ERS.

Who is ERSO?

In this case it is likely that ERS technologies has been standardized and that the ERS market has moved into efficiency and new business models that enable value creating services for users. This could pave the way for establishment of new operators from similar markets, e.g. from telecom, energy industry or petroleum companies. Furthermore, there will probably be multiple of ERSO actors on the market, possibly different operators in different region. These ERSOs could develop unique business models to compete on the ERS market.

What is ERSOs relationship with users (transport goods owners and haulier companies)?

In a large-scale deployment, goods transport owners could choose and calculate on using a large ERS network. ERSOs relationship will thus be stronger with the forwarding market, rather than single haulier companies and good owners, since they control international logistic chains with high volumes. Furthermore, given that the forwarding market consist of multimodal transportation, e.g. using train, shipping and road transportation, ERSO might play an important role in facilitating future improvements of the logistic chains. One example is that ERSO could integrate autonomous technology with ERS and thereby facilitate efficient and sustainable logistic chains over international markets.

What is ERSOs relationship with suppliers (Electric road owner and energy provider)?

In this market scenario, ERSO must be able to handle multiple ERS suppliers and owners. Thereby they must have a standardized contracts and metering systems that could enable roaming e.g. supplying and billing energy to ERS users over different regions and from different suppliers. Furthermore, there could also be different ERS technologies (that co-exist) and thereby different types of ERS trucks (with different pick-ups). Hence, ERSO must be able to facilitate interoperability between different transportation modes and ERS alternatives.

4 Conclusions

This paper has defined ERSO and presented an architecture that describes the ERSO interfaces, relationships between stakeholders, and discussed ERSO in two deployment scenarios. The conclusion is that the role of ERSO will not be homogenous but will depend on how closed or open the system will be with regards to e.g. relationship with haulier companies and transport buyer, the number of applications and vehicle types, and different jurisdictions. While ERSO could be connected to suppliers and users in different ways, this paper has established a technology neutral architecture which could enable commercialization of ERS. Thereby, we argue that policy makers should enhance possibilities for develop the role of ERSO to enable a platform for innovative business models and an open ERS market.

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References

- [1] IFEU (2018): Roadmap OH-Lkw: Kurzfristig realisierbare Potenziale für den wirtschaftlichen Betrieb von OH-Lkw
- [2] Tongur, S., *Preparing for takeoff – analyzing the development of electric road system from a business model perspective*, Doctoral thesis, KTH Royal Institute of Technology, 2018
- [3] M.G.H. Gustavsson, C. Börjesson, H. Kenani Dahlgren Ericsson, L. Moberg RISE och J. Petersson Trafikverket. *Förstudie om betalssystem för elvägar (prestudy on payment systems for electric road systems)*. RISE Viktoria 2015.
- [4] Trafikverket, [National roadmap for electric road systems](#), 2017.
- [5] Tongur, S. and Sundelin, H., *The electric road system transition from a system to a system-of-systems*, 2016 *Asian Conference on Energy, Power and Transportation Electrification (ACEPT)*. IEEE, 2016.

Authors



Stefan Tongur is Senior Researcher at RISE Viktoria and is interested in socio-technical transitions and business models. He defined the concept of electric road systems (ERS) in 2010 and has continued to study the development of ERS since then. He is published in e.g. *Technovation*, *Environmental innovation and societal transition*, and *IEEE conference on Energy, power, and transportation*. In 2018, Stefan defended his PhD thesis entitled “Preparing for takeoff – Analyzing the development of electric road system from a business model perspective” at KTH Royal Institute of Technology.



Dr. Håkan Sundelin is a senior researcher in electromobility projects at RISE. He is currently the project leader of the Research and Innovation Platform for Electric Roads in Sweden and the Swedish project leader of the Swedish -German collaboration on Electric Roads. He has a long industrial background from Scania where he has been evaluating and testing the concept of electric roads using both inductive and conductive power transfer in many different research projects. During his work at Scania he led the inductive part of the Swedish research project Slide-in. He was also the project leader of a joint project together with Siemens where overhead line technology was tested. He has taken part in the investigation of the electric roads made in UK by TRL and was responsible for the Scania part in the EU project FABRIC.