Electric Road Pilot E20 Hallsberg–Örebro

The Conditions and Potential for an Electric Road Pilot in One of Sweden's Leading Logistics Regions

Authors: Emma Alenbrand, Simon Jäderberg, Karin Wallin

31 August 2020 Doc. no.: 19RS1405

Region Örebro län

Abstract

Region Örebro County has been tasked by Trafikverket, the Swedish Transport Administration (STA) to produce this report, looking at the conditions for testing a large-scale electric road pilot on the E20 European Highway between Hallsberg and Örebro in central Sweden. The work has been done alongside a network of players from the business community in Örebro County, the directly affected municipalities of Hallsberg, Kumla and Örebro, regional cooperative organizations and Örebro University, with support from Trafikverket.

The data for the report was produced with the assistance of the network members, who had an opportunity to give their views on electric roads, and what they need to be incentivized to use the electric road. An interview study was conducted with the County's largest transport purchasers; the study highlights their needs, their desire to pay for the electric road, transport and charging infrastructure, their views on risks, and the opportunities they can see with an electric road pilot and electric roads as a concept. An interview was also conducted with Örebro University, which is conducting research into sustainable business models focusing on transport and logistics, and is a main player in the project.

A study into the benefit of running shuttle services on an electric road between Hallsberg and Örebro, and the potential environmental and cost savings that can be made by switching to electric vehicles, was conducted by the consultancy firm Novoleap. The analysis shows that electric operation is far more profitable compared to fossil-fuelled vehicles, both in terms of operation and maintenance, and that the electric road is necessary: partly to reduce costs when purchasing vehicles, since a large part of the cost is the battery itself, and partly because the electric road removes the restriction on how many journeys on a route a battery-only vehicle can drive, since the battery charges as the vehicle rolls towards its destination.

The report shows that it is a good idea to conduct a pilot trial for electric roads on the E20 in Örebro County. There is a consensus on the initiative among the politicians in Region Örebro County and the municipalities affected, as well as a strong political desire to invest in sustainable transport in Örebro County. There are sufficient transport flows to make the electric road viable, the capacity in the electricity grid is there, and there is far-reaching commitment and drive among the business community. There are opportunities for added values in multimodal transportation solutions. Above all there is the possibility to test a broader transition in the transport system that not only relates to electric roads, but also to other vehicle types and changes in business logistics processes.

Contents

Why an electric road between Hallsberg and Örebro? **4**

About the assignment **5**

Description of Örebro County **5**

Region Örebro County's work with logistics and transport **8**

Projects and collaborations 10

International 10

National 11

Interregional collaboration – Council for the Stockholm Mälar Region 11

Conditions for an electric road pilot **13**

Municipal planning work 13

Electricity grid infrastructure 15

Transport infrastructure E20 Hallsberg–Örebro 15

Traffic flows on the E20 15

Trafikverket survey of goods flows 16

Conditions for using electric vehicles in shuttle traffic **17**

Results from the report on shuttle traffic and electric vehicles 17

Interview study with transport purchasers **19**

Interview study with Örebro University **22**

Implement an electric road pilot between Hallsberg and Örebro – a location with the right conditions **24**

Glossary **27**

Why an electric road between Hallsberg and Örebro?

Why is the E20 between Hallsberg and Örebro the place in Sweden where Trafikverket, the Swedish Transport Administration (STA) should test a large-scale electric road pilot?

Year after year, the Örebro Region is ranked highly among logistics locations thanks to its geographically and demographically favourable position in Sweden. The County's conditions have enabled the Örebro Region to become an important node, both in Sweden and internationally. There is a *consensus between Region Örebro County, municipalities, Örebro University and the business community that logistics and transports are the areas to focus on, even though they are already the County's great strength. Örebro County wants to lead developments, look forward and develop its strengths. Örebro County is good at logistics and transport because it wants to be.

Common focus on sustainability

Based on Agenda 2030, progressive environmental goals have been set for Örebro County in the regional development strategy. Within the framework of these goals, the County will develop with a focus on innovation related to sustainable transports and energy efficiency. The County's business community, meanwhile, has its own goal to actively strive to achieve the challenges of the Paris Agreement. There could be no better circumstances for an electric road pilot.

A broad, committed business community

The business community in Örebro County enjoys a close cooperation with Region Örebro County, municipalities and Örebro University, but above all among itself. In Business Region Örebro businesses meet and discuss topical issues, and this network has also enabled the business community to get involved in the work on the electric road pilot. A great many players have been involved and interested in what an electric road can bring to their particular business. Transport providers would like to have electrically powered vehicles, and transport purchasers are prepared to pay more for transports initially to support this. Örebro University feels that electric roads are just what is needed, and is also interested in testing and researching other transport solutions in combination with electric roads.

A solid foundation for thorough testing

The members of the *En Bättre Sits* transport-policy collaboration agree that investing in electric roads is the way forward to achieve a sustainable transport system. There are many haulage companies here, and the municipalities are planning for new areas of operation to keep up with demand for available land. The volumes of goods and transports that players in Örebro County can use for testing an electric road pilot are already large enough to enable Trafikverket to collect data over time as a basis for an electric road pilot, even if it does not subsequently evolve into a national electric road system (ERS). The E20 European Highway in Örebro County is a good option for testing a large-scale electric road pilot.

About the assignment

Trafikverket is working nationally on the development of the transport infrastructure and has a remit to collect data for current and future transport requirements, which are to be adapted to existing climate goals and the available transport infrastructure. Trafikverket's Programme for Electrification creates a knowledge base on electric roads by trialling different electric road technologies and studying the various fields that come under the concept of 'electric road', such as technology, environmental impact, power supply, operation, maintenance and regulation. Organization and funding of an electrified infrastructure system, along with the impact on the transport sector and its various individual players, are areas that are highlighted in Trafikverket's analyses.

In order to test different aspects of electric roads simultaneously, Trafikverket has been tasked to perform at least one pilot trial to increase the body of data for how an ERS can work in reality. In June 2019, Trafikverket announced that the Hallsberg–Örebro section of the E20 and Västerhaninge–Nynäshamn on National Road (NR) 73 had been selected for further investigation, with the ultimate aim of building a pilot section.

This work is comprised of several aspects:

1. Trafikverket continues to look into a business model, organization and funding issues related to electrification of heavy transport nationwide.
2. Trafikverket conducts road planning, looking into the preconditions on each road for providing an electric road.
3. Trafikverket assesses traffic flows, traffic volumes, and how the sections can be used by the regional transport providers.
4. Region Örebro County and Region Stockholm each write a report on the opportunities and risks of an electric road pilot, concept, willingness to invest and pay, along with driving forces and incentives among transport purchasers to use an electric road.

Region Örebro County's work to chart the conditions for electric roads in Örebro County started back in 2017. Since then a network of various transport purchasers, transport providers, Örebro University, municipal authorities, the Mälardalen Chamber of Commerce and other partnerships have been developed. The network is presided over by Region Örebro County, supported by Trafikverket and several major private players with experience of electric roads. The network formulated a joint response to the RFI (Request For Information) in early 2019, along with a letter of intent on using a potential electric road. This was signed by several major players in the County. In June of the same year, the E20 section was selected for a study into its conditions for becoming a potential pilot section. This entailed a commitment for Region Örebro County to contribute the knowledge base to Trafikverket as presented in this report.

During autumn 2019 and spring/summer 2020, Region Örebro County's work has consisted, in association with different players, in disseminating knowledge about electric roads, discussing their benefits, and gathering information about the preconditions, incentives and driving forces that exist among the County's players, through a range of different activities. One area of focus has been talking to transport-intensive goods owners and transport providers in the business community. In order to respond to questions and supplement Trafikverket's work, a consultant has looked into shuttle traffic on an electric road in the Örebro Region, see Appendix 3.

This report brings together the knowledge that has been amassed, and aims to explain why the first electric road pilot should be built on the E20 European highway between Hallsberg and Örebro.

Description of Örebro County

Örebro County comprises 12 municipalities with just over 300,000 inhabitants, and this figure is expected to increase by 30,000 by the year 2030. The County encompasses the municipalities of Askersund, Degerfors, Hallsberg, Hällefors, Karlskoga, Kumla, Laxå, Lekeberg, Lindesberg, Ljusnarsberg, Nora and Örebro.

FIGURE 1: Örebro County from a broader geographical perspective.

Historically speaking, Örebro County has been an important area for both road and rail transport. The County includes the railway hub Hallsberg, which has Sweden's biggest marshalling yard and also provides a combi terminal. The proposed pilot section for an electric road starts at interchange 106 Brändåsen, which is close to the Hallsberg combi terminal, which is where NR 50 links to the E20. There is a further combi terminal in Frövi. The railways Västra stambanan, Mälarbanan, Godsstråket genom Bergslagen, Bergslagsbanan and Värmlandsbanan run through the County, and are important railway routes for trains between the north and south, as well as east and west. Most of the freight being transported between northern and southern Sweden passes through Örebro County. Goods flows by lorry in the region are expected to increase by 46% up to 2040, with an annual growth rate of 1.1% up to 2040 and 0.8% in 2040–2065, according to the Trafikverket's national basic forecast for freight transport[1].

1. Swedish Transport Administration basic prognosis 2020 (in Swedish), https://www.trafikverket.se/for-dig-i-branschen/Planera-och-utreda/Planerings--och-analysmetoder/Samhallsekonomisk-analys-och-trafikanalys/Kort-om-trafikprognoser/

As well as the above-mentioned sections of the rail network, the E18 and E20 European Highways and NR 50 also run through the County. These roads are significant to a large percentage of the country's goods flows and they all run through Örebro, which is popularly known as Sweden's biggest junction. NR 49 and NR 51 also have extensive flows of heavy goods traffic. NR 51 has flows to and from the entire region, and is being improved by measures funded by the the regional plan for infrastructure *(Länsplan för regional transportinfrastruktur)*, which bolsters the connection with Norrköping, which has expanding port operations. The County is also home to Sweden's fourth largest airport for cargo.

To take advantage of the historically and strategically important hub for transport in Örebro County, Region Örebro County, the County's municipalities and Örebro University are actively working on logistical issues. Region Örebro County is responsible for regional development planning, and has a vision of connecting the County and facilitating its development. The strongest trade and industry sectors are manufacturing and mineral extraction, along with warehouse management and logistics. Most exports go to the EU and other Nordic countries[2]. Region Örebro County would therefore like to invest in better transport and continue promoting new and extended establishment in the County, in order to achieve better connectivity both nationally and internationally.

The Örebro Region has become a hub for logistics establishments, largely thanks to its central demographic location in Sweden. Trade and industry is mainly concentrated around the city of Örebro, and logistics companies primarily set up business in what is locally known as *tillväxtbananen* (literally 'the growth banana'). This is the area between Brändåsen and Örebro Airport, where there are larger and more accessible land areas, and which attracts companies to establish logistics centres outside of the Stockholm Region. The result is that several companies have located national and international central warehouses and logistics centres in the region. Örebro was also rated joint first as Sweden's best city for logistics by *Intelligent Logistik* magazine, and the best inland logistics location.

2. Export/import companies by country area 2018 (in Swedish), www.regionfakta.com/globalassets/upload/naringsliv_1800/n22n_1800.pdf

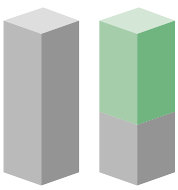
Region Örebro County's work with logistics and transport

In Örebro County, transport and logistics are a principal area for trade and industry, and therefore a natural focus area for the County's public sector. Region Örebro County works with the transport system internationally and cross-regionally, and also sets regional goals for the County. The municipalities work with developments within their own boundaries, but collaborate on all things inter-municipal. What they all have in common is an interest in laying creating the best possible foundation for Örebro to be attractive to trade and industry, while they also take shared responsibility for achieving regional and national sustainability goals.

The regional development strategy 2018–2030, entitled *Tillväxt och hållbar utveckling i Örebro län* (Growth and Sustainable Development in Örebro County) is the region's guiding document, and expresses Örebro County's joint ambition. It serves as a starting point for work on sustainable regional growth and development in the years to come, and provides guidance for the physical planning. The regional structural images are one form this guidance takes, acting as an introduction for the County plan for transport infrastructure and traffic sourcing programme prepared by Örebro County as tasked by the government.

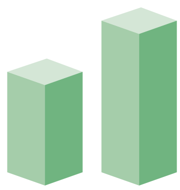
The regional development strategy contains three overall goals, which are complemented by effect goals and indicators which clearly describe where the focus for regional development in Örebro County lies. One aim is to increase attractiveness so as to attract both national and international companies, while also increasing production and exports. This will take place within the framework of the goals set for high, equal quality of life, and of the climate goals outlined in the regional Energy and Climate Programme.

The climate goals in the regional Energy and Climate Programme have been set in order to achieve the goals of the Paris Agreement.



In Örebro County, by 2030 there should be **60%** less greenhouse gases than in 2005.

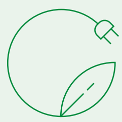
At least **80%** of the energy use in Örebro County should be renewable energy by 2030.



Energy use in Örebro County in 2030 should be **50%** more efficient than in 2005.

In order to achieve the goals, the County will focus on three investment areas in the transition.

REDUCED EMISSIONS OF GREENHOUSE GASES



RENEWABLE ENERGY

ENERGY EFFICIENCY

Transport and infrastructure is one of the prioritized areas in the regional development strategy. The significance of stronger links with Oslo and Gothenburg is highlighted, since Örebro County is already an integral part of the Stockholm Mälar Region. Because Sweden's largest rail and road transport routes pass through the County, the County's transport infrastructure has the primary function of interlinking Sweden's transport in both a north-south and an east-west direction. Its geographically strategic location makes the County a transport node, and as such there is good reason to invest in logistics operations – and by extension an even greater incentive to invest in sustainable transport.

The vision is that in 2030, Örebro County attracts company establishment and investment, and Örebro has consolidated its position as one of the three best logistics locations in Sweden. To achieve this, players in the County must work together to create a sustainable transport system according to the structural images in the regional development strategy, and to develop Örebro County as a node along national and international transport routes.

The structural image shows the routes of highest priority for trade and industry in the Örebro Region. The map also shows important nodes for freight transport, along with connections to nodes outside of our region. The routes and nodes are also crucial in achieving efficient transport links both nationally and internationally.

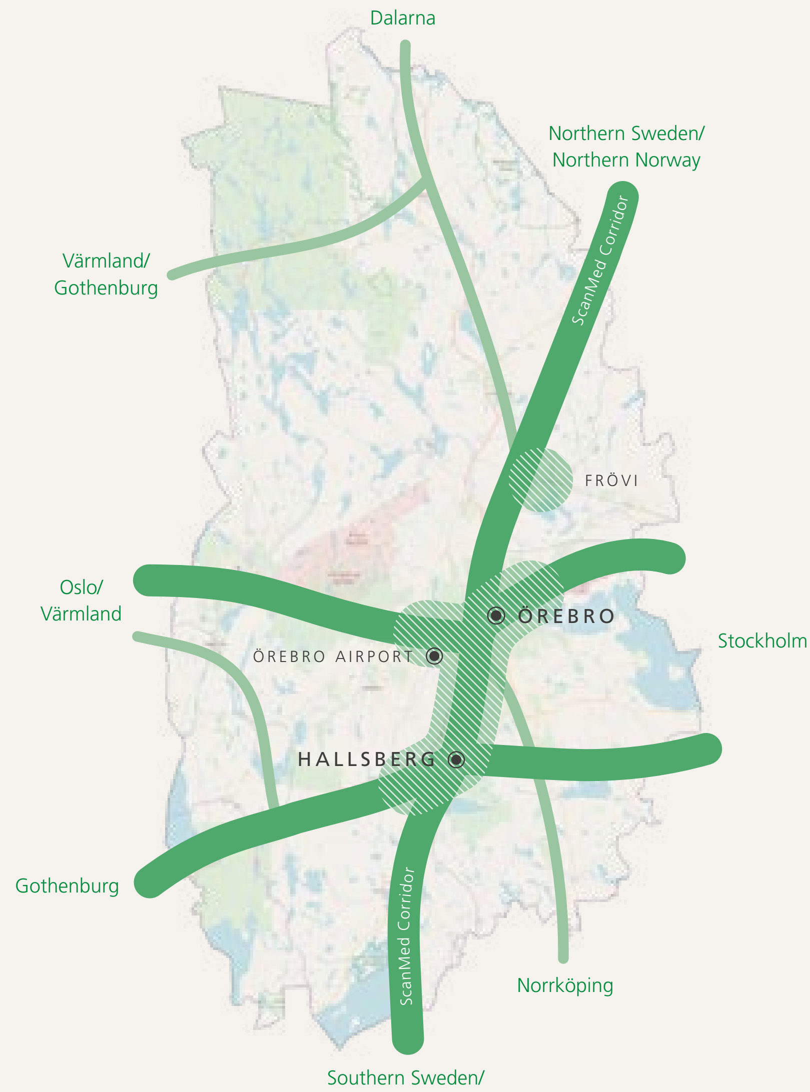


FIGURE 2: Structural image for freight transport and logistics in the regional development strategy for Örebro County, 2018.

Projects and collaborations

Örebro County is an important node for transport, and the strategic line is to focus on the development of logistics and transport. Region Örebro County is therefore working continuously to develop the transport system with innovation as the focus. There are projects and collaborations under way both nationally and internationally, which makes Region Örebro County a good platform for disseminating experiences from a pilot. Below is a selection of projects and collaborations in which Region Örebro County is involved.

International

The Bothnian Corridor

Region Örebro County is working with Region Gävleborg, Region Jämtland–Härjedalen, Region Norrbotten, Region Västerbotten and Region Västernorrland to strengthen the transport infrastructure and improve links between northern Sweden and the rest of Europe. Part of the collaboration entails working to make the Bothnian Corridor including the Freight Line through Bergslagen a part of the European TEN-T ScanMed Corridor.

CPMR (Conference of Peripheral and Maritime Regions)

The CPMR is Europe's biggest lobby organization, comprising six geographical commissions and a total of 160 member regions. The network conducts advocacy work in a range of areas such as transport, maritime issues, cohesion policy and climate. Region Örebro County is a member of both the North Sea and the Baltic Sea Commissions' transport groups, which include efforts to make Oslo–Stockholm and the Bothnian Corridor (including the Freight Line through Bergslagen) a part of the TEN-T ScanMed Corridor.

Baltic Loop

Project Baltic Loop focuses on identifying bottlenecks in the transport system for passenger and freight transport between the Norwegian border and St. Petersburg, via Finland and the Baltic States. The aim is to find non-technical solutions (WP 1 and 2) that can optimize transport across and within the borders, and minimize travel and transport times, thus making transport here more attractive. Region Örebro County's part lies in mapping which non-technical solutions are available, and where they can be implemented in Sweden. The method will then be applied to the other countries collaborating in the project.

Scandria Alliance

This network primarily aims to develop eco-friendly, sustainable multimodal transportation and travel opportunities along the route. This will take place partly by the network acting as a platform for dialogue and bringing together the business community, academic research, municipalities and regions for joint strategies, projects and activities.

COMBINE

The COMBINE project is about developing multimodal transportation solutions in the Baltic Sea Region. The project aims to contribute to an exchange of best practice and experience as regards innovations and smart technical solutions between EU Member States in the areas of Combined Transports, High Capacity Transports (HCT – longer and/or heavier goods vehicles), platooning and associated activities for the handling of goods at terminals.
COMBINE aims to be a flagship project in the Baltic Sea Region/EUSBSR. The project comprises around 15 partners, headed up by Port of Hamburg.

Region Örebro County is working on the project alongside CLOSER (a Swedish platform for collaboration), and a partnership with a major freight transporter is in the pipeline. The freight transporter carries some 5,000 containers a year to Hallsberg, and the aim is to carry out a pilot study focusing on 'the last mile', and look into conditions for implementing longer and/or heavier special vehicles to and from terminals in our region. The intended section for ultimately testing special vehicles is the same as the one being considered for an electric road pilot between Hallsberg and Örebro.

Previous projects

Scandria2Act and TENTacle were two flagship projects aiming to support multimodal transportation and the modal shift of goods from road to railway, and to thereby make Hallsberg the natural destination for freight arriving by rail from Central Europe. Scandria2Act focused on clean fuels, and TENTacle on establishing a long-term collaboration strategy with players north of Örebro.

SmartLog was an Interreg Central Baltic project aiming to improve transportation times in the two TEN-T Corridors – ScandMed and North Sea Baltic – by enabling better data sharing using IoT (Internet of Things) and Blockchain technology. With the project, Region Örebro County wanted to enable companies in the Örebro region to test new technical solutions.

National

CLOSER

CLOSER is a national Swedish platform for collaboration, knowledge node and project workshop for greater transport efficiency. Several of the CLOSER focus areas relate to electric roads, particularly Energy Supply & Logistics and Multimodal Solutions. Region Örebro County, Örebro Municipality and Örebro University are all active parties in the CLOSER project. Region Örebro County is represented on the CLOSER board.

Cross-regional collaboration – Council for the Stockholm Mälar Region

Mälardalsrådet, the Council for the Stockholm Mälar Region, is a unique platform that brings together politicians and decision-makers across block boundaries in the Stockholm Mälar Region. The region has almost 4 million inhabitants in cities, towns and rural areas, who jointly contribute 49% of Sweden's GDP.

The Council's remit is to serve as a forum for cross-regional collaborations on strategic issues, and to thereby promote the development of the Stockholm Mälar Region – which is growing and remains a knowledge-intensive region. In order to promote development over the decades to come, the Council works in four focus areas: Transport & Infrastructure, Knowledge & Skills Development, Maritime Collaboration, and International Learning & Benchmarking.

Transport & Infrastructure – *En Bättre Sits*

En Bättre Sits (literally 'A Better Seat') is the name of the Council for the Stockholm Mälar Region's cross-regional collaboration in the field of infrastructure & transport. *En Bättre Sits* is a broad transport-policy collaboration between stakeholders in the seven regions of Stockholm, Uppsala, Västmanland, Örebro, Södermanland, Östergötland and Gotland. Regions and municipalities are working together for a cohesive, sustainable region with infrastructure and public transport that help make people's everyday lives easier. With the right national investments, the aim is to develop the infrastructure of the Stockholm Mälar Region, enable the construction of more homes and lay a better foundation for transportation and travel in Sweden. The aim is to create a transport system in which:

- the region's and the nation's international competitiveness can develop and enhance the attractiveness of the participating counties in Eastern Central Sweden.
- developments are sustainable in the long term – economically, socially and environmentally.
- collaboration, a holistic approach and the use of all four modes of transport lead to efficiency.
- polycentrism and an expanded labour market promote regional development.

Within the framework of the collaboration, a cross-regional system analysis and freight strategy are being drafted based on the regions' shared priority areas, the aim being to influence development of the transport infrastructure in the Stockholm Mälar Region and Sweden.

Cross-regional system analysis

The *En Bättre Sits* system analysis starts from and focuses on cross-regional connections, challenges, needs, shortcomings and priorities. The focus is thus on the shared prioritizations in infrastructure planning in the Stockholm Mälar Region.
There are also associated county-specific conditions, which are dealt with in those counties' regional plans and strategies.

The cross-regional system analysis presents the shared needs and prioritizations of the municipalities and regions, as well as how the Stockholm Mälar Region can contribute to a better level of service and a climate-smart transition.

In the system analysis for 2020, the E20 between Gothenburg and Stockholm is one of the passenger and heavy goods transport routes that have been highlighted. Among other things, the system analysis supports the claim that the pilot sections should primarily be extended in connection with expansion of a national Swedish ERS.

Cross-regional freight strategy

The cross-regional freight strategy indicates that the Stockholm Mälar Region is facing several challenges related to climate, the environment, safety and level of service. These include:

- a significant increase in freight transport that will increase the burden on the infrastructure.
- these increases will be greatest on already heavily burdened routes.
- competition on the railways is tough.
- increased shipping is necessary.

Every year some 150 million tonnes of freight come to, from or through the Stockholm Mälar Region. Much of this freight is transported into the region, intended for Sweden's largest consumer market. Other goods originate from the region's goods production. Further freight transportation belongs to the transit flows that cross the region and branch out into the European transport network. Smoothly functioning freight transportation is fundamental to a vibrant, attractive Stockholm Mälar Region. To meet the challenges and secure the level of service in freight transport, collaboration and consensus are needed in the Stockholm Mälar Region on the needs and challenges of freight transport. The cross-regional freight strategy also encompasses a better-developed collaboration and system approach, so as to improve preparedness for future measures in the transport system in the Stockholm Mälar Region.

During 2020, the cross-regional system analysis and freight strategy will be adopted by formalized resolutions in the seven regions, and on the Council for the Stockholm Mälar Region board.

Conditions for an electric road pilot

This section looks briefly at the conditions that exist for an electric road pilot in Örebro County, with regard to transport and electrical infrastructure, and traffic flows on the road section in question. Both the electrical and the transport infrastructure offer good conditions for an electric road pilot, and the outlined transport flows are large and tend to grow with time.

Municipal planning work

In the structural images of the regional development strategy (see page 9), the area between Hallsberg and Örebro is highlighted as a development area for logistics operations. Hallsberg, Kumla and Örebro are the municipalities that are directly affected by the electric road. The municipalities also utilize their geographically strategic locations, with direct or nearby connections with the E18 and E20 European Highways, National Roads (NR) 50, 51 and 52, and Örebro Airport.

Kvarntorp and Brändåsen are where Kumla Municipality has its principal plans for development of commercial areas. The Kvarntorp area is currently home to several large commercial operations, for instance Epiroc has a branch here just 15 minutes from the E20 via NR 52.

Adjacent to NR 50 and the E20 at Brändåsen, there are development plans for both Hallsberg and Kumla Municipalities to make use of the nearby marshalling yard, with connections to the combi terminal in Hallsberg. In Hallsberg alone, local plans are under way for 300,000 square metres of commercial land at the combi terminal. At the Rala area in Hallsberg, a national maintenance centre for railway operations is being built in an area of 100 hectares, and capacity for electricity is also being expanded at the terminal in Hallsberg.

Örebro Municipality is planning for four new areas for commercial establishment in Palmbohult, Norra Marieberg, Bettorp and Törsjö. All are directly adjacent or nearby the proposed pilot section. New operations are already under development in existing commercial areas, including several new central warehouses: Lidl, XXL, Dollarstore and Närkefrakt's new terminal. There are also plans for new commercial areas at Örebro Airport.

All in all, future establishment will generate significant volumes of transport and attract even more transport-intensive companies to the region – companies that can see the benefits of Örebro County's strategic location and the clear strategic focus on warehousing and logistics that exists on both the regional and municipal level.

Electricity grid infrastructure

The assessment from E.ON is that the capacity exists to connect an electric road expansion in conjunction with an electric road pilot between Hallsberg and Örebro. The assessment was conducted in May 2020 and was based on indications from grid owners Ellevio, Vattenfall and Svenska Kraftnät. To secure the required output for an electric road pilot, reservation agreements are required: this entails regional grid owners and Svenska Kraftnät looking into the capacity situation and reserving the required capacity. Fees are charged for this. In addition to reservation agreements, a grid investigation is needed at E.ON to select the best technical solution, and to clarify the situation with regard to permits and lead times; this will involve project planning charges. The grid investigation would be carried out in consultation with the ordering client once the commercial conditions have been established.

Transport infrastructure E20 Hallsberg–Örebro

The section being considered for an electric road runs along the E20, starting at interchange 106 Brändåsen and ending at interchange 110 Adolfsberg (see map below). Either end of the section, at Hallsberg combi terminal and Truckstop, offers opportunities for loading, unloading and charging vehicles. Hallsberg combi terminal has capacity for half a million trucks per annum and Truckstop is the Nordic region's largest professional drivers' facility for rest and services, in close proximity to major commercial areas in Örebro and Örebro Airport.

The entire section is motorway and is a total of 21 kilometres in length. The surroundings mainly comprise open areas such as agricultural land and a wind farm located between Kumla and Örebro. In parts there are trees along the road, but not directly adjacent to the roadside. Any height differences are primarily ramp structures for the interchanges along the section.

A more detailed description of conditions along the section can be found (in Swedish) in the consultation report for the road plan[3] relating to the section.

FIGURE 4: Örebro County with the electric road pilot section of the E20 highlighted.

3. https://www.trafikverket.se/nara-dig/projekt-i-flera-lan/pilotprojekt-elvagar-nynashamn-eller-orebro/e20-hallsbergorebro/dokument-for-e20-hallsberg-orebro/

Traffic flows on the E20

In Örebro County in 2020, 18,773,000 tonnes of goods were loaded onto lorries, with 65% of transportation taking place within the County and 35% to other counties[4]. The road section in question has annual average daily traffic (AADT) of almost 20,000 to 44,000 vehicles, of which almost 20% are heavy vehicles.

The cross-regional freight strategy (2020) mentions, for example, that freight in the Stockholm Mälar Region is expected to increase by 65% up to 2040, with the largest increase on roads, especially European Highways, and the smallest increase on railways. The reason for the smallest increase being on railways is that the railway network has very limited capacity, and extending new main lines and upgrading existing railways is proceeding slowly. There is a sincere ambition to transfer freight from fossil-fuelled vehicles to electrified ones, and an extended ERS would be a crucial aspect in changing the vehicle fleet more quickly and achieving the climate goals.

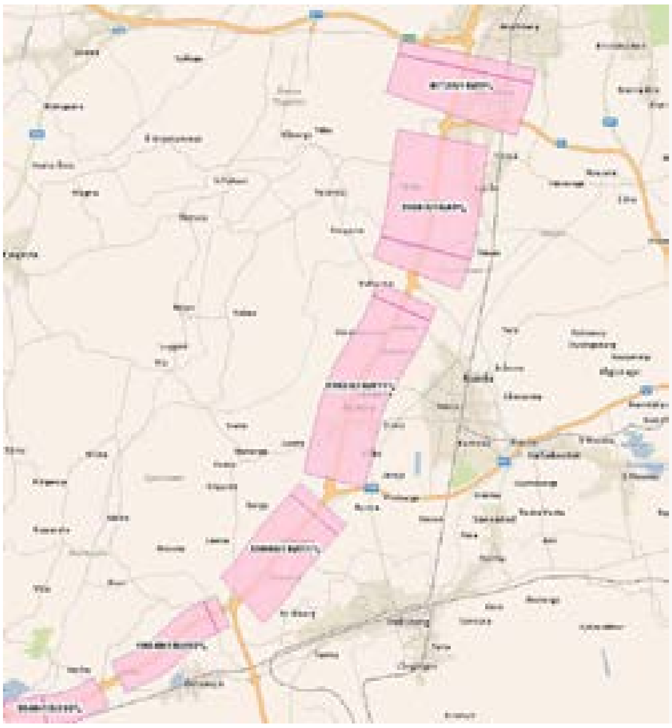


FIGURE 5: Total AADT E20 Hallsberg–Örebro.
Source: STA road traffic flow map, vtf.trafikverket.se

FIGURE 6: AADT heavy traffic E20 Hallsberg–Örebro.
Source: STA road traffic flow map, vtf.trafikverket.se

4. Freight transported by lorry, Regionfakta 2020, http://www.regionfakta.com/orebro-lan/infrastruktur/lastat-gods-pa-lastbil-samt-destination/

STA survey of goods flows

The STA, Trafikverket, has commissioned SWECO to conduct a transport survey among regional haulage companies and goods owners with transportation under their own auspices. The respondents were a selection of players with which Trafikverket had contact when working on the electric road pilots in Örebro County and Stockholm County.

The percentage of respondents from Örebro County was higher, and some players operated in both counties. The report presents a compilation of the flows which the respondents claimed to work with.

The responding transport providers' vehicles account for almost 4% of Sweden's heavy vehicles, the largest proportion being vehicles between 16 and 31 tonnes, and a clear majority over 16 tonnes. 20% of the players' 2,409 vehicles over 16 tonnes operate on the pilot sections in questions, regardless of their starting point or destination. Of these vehicles, roughly 40% drive 300 kilometres or more on a typical Wednesday. The transport providers primarily carry general goods and food, and operate largely on the considered electric road sections, and 87% of the respondents have transport on the sections intended for electric road pilots.

The report states that a shuttle-like transport pattern would be most efficient for transport on an ERS, since this entails fewer diversions from the route. Of the respondents' transports, the most common distance driven is 51–100 kilometres on a typical Wednesday, with 79% of vehicles stopping once or more for at least 45 minutes and returning to the depot/terminal/home after the completed shift. This means that a large proportion of the overall traffic operates in shuttle transport, and 144 vehicles (30%) is driven in shuttle traffic on the indicated sections already today. 78% of respondents are interested in driving one or more vehicles on the electric road pilot if it was in their area, and they were generally of the opinion that electric roads and electrified heavy vehicles is the way forward, for example in order to achieve the environmental goals.

Conditions for using electric vehicles in shuttle traffic

At the information meeting in February, it was made clear that transport providers needed to know how far they would need to go outside of the ERS section in order to plan their journeys. To ensure the correct design of the ERS, knowledge is needed on how far the vehicles must drive outside of the ERS. In order to create a model for journey planning and increase the understanding of the costs, benefits and potentials of an electric road between Hallsberg and Örebro, Region Örebro County commissioned consultancy firm Novoleap to conduct a study. The aim was to increase knowledge about how electrification of the Örebro–Hallsberg section could influence a national ERS. Also to understand the relationship between costs, benefits and potentials, in order to show the advantages of an electric road between Hallsberg and Örebro. Particular focus was placed on shuttle traffic in the Örebro Region.

Since Trafikverket itself works with issues such as technology, installation, operation and maintenance, the consultancy firm did not focus on those areas, and has made no calculations based on any particular technology. Nor has it looked at the costs for infrastructure around the electric road, but has instead focused on the cost of batteries and the vehicles' progress on the road. The study analyzed journeys for 300 vehicles, or 15% of the heavy transports on the section on average today, and the focus is only on shuttle traffic for regional transport. The remaining 85% of the traffic flows are defined as through transport, which could also benefit from an ERS. The consultancy firm's benchmark vehicle is a semi-trailer truck, which is not the most common type in Sweden but the type that has come the farthest in technological development for running on an ERS. The report can be read in its entirety in Appendix 3.

Results from the report on shuttle traffic and electric vehicles

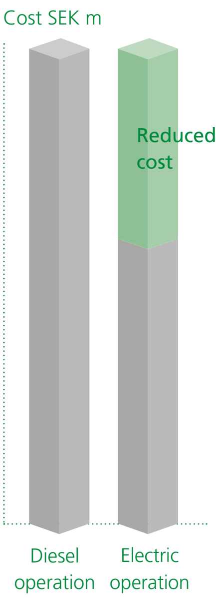
With only one battery in the vehicle, the haulier is limited by the battery's capacity and reliance on charging points, for example on loading/unloading, and can only complete a certain number of journeys before the battery needs charging. If an electric road is added along the route, the haulage company can reduce the size of the battery in the vehicle on purchase, and can still manage the same number of journeys as with a large battery, but without being limited by the battery in the same way. Access to an electric road creates major benefits as the need for large batteries is reduced, thus boosting each vehicle's overall efficiency.

The report differentiates between the nature of incoming and outgoing vehicles: essentially, a vehicle uses the electric road to a different extent depending on its starting point and destination. This is because incoming vehicles have a lower battery charge than outgoing vehicles, as the latter set off with a full or almost full battery on entering the electric road. Consequently, incoming transport utilizes the power on the electric road to a higher degree than outgoing transport. The power on the electric road and the size of the battery in the vehicle influence the degree of utilization, which means that a balance between battery and power output should be sought to maximize the number of runs on the routes.

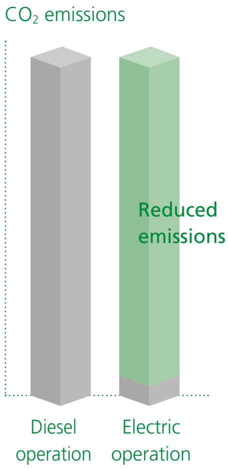
A high output on the electric road reduces charge times, and thus also the utilization of the electric road. The opposite also applies, i.e. a low power output on the electric road increases charge times, but also increases utilization of the electric road. Dynamic charging effects could correct this imbalance. With a power output of 200 kW, the electric road has a greater impact on incoming than outgoing transport on routes of 50–100 kilometres. If the output of the electric road is raised from 200 to 400 kW on these routes, vehicles in the outgoing flow can manage more journeys than vehicles in the incoming flow over the same distance. For transportation further than 100 kilometres on battery only, some kind of backup charging is required to complete the journey, such as an electric road or recharging points. An electric road is preferable as it does not have a negative impact on time taken for the journey, and increases the number of runs that can be completed during the working period.

Increasing the number of journeys on an electric road and access to recharging on loading/unloading entails a cost saving, since this makes electric running time-neutral. Smaller batteries and higher vehicle efficiency is positive for a business model, since much of the cost of a battery-powered vehicle is the battery. A smaller in-vehicle battery size makes it possible to simultaneously raise the efficiency of charging in the incoming flows for shorter distances. For the outgoing flow the efficiency remains unchanged, but the battery can be reduced from 400 to 200 kWh. This means a lower investment cost in both the electric road and the vehicles, while environmental impact also decreases in the production of electrical infrastructure and vehicles.

EXAMPLE:
A reduced battery size of 200 kWh rather than 400 kWh on 75 vehicles in shuttle traffic on routes of 50–100 km would prevent having to invest in a further 15,000 kWh. This entails an investment cost that is SEK 67 million lower (complete battery pack mounted on a tractor unit with trailer) as well as 1,815 tonnes less of CO_2.



The average cost for a 40-tonne vehicle running on electricity is SEK 26.5 per 10 km, and for running on diesel it is SEK 43.0 per 10 km. The 300 journeys analyzed by Novoleap encompass 41,250 km driven per day, which equates to about 15 million km a year; on transition to electrical operation this would constitute a saving of SEK 24 million a year in fuel costs.



The Novoleap report also shows a simplified analysis of environmental impact, based on 300 shuttle traffic journeys of varying distance. Running on diesel emissions amount to 32 tonnes of CO_2 per day, and on electricity to 2 tonnes of CO_2 per day. This means that a total of approximately 30 tonnes of CO_2 emissions could be cut per day with electrical operation on these 300 journeys alone, and would bring it closer to zero. Moreover, engine noise and other exhaust emissions would also decrease.

Since the cost of electricity compared to diesel as a fuel is so low, and the cost of buying the vehicles so high, there is every incentive for haulage companies to increase the utilization of the vehicles. To achieve this, work on electric roads needs to lead to altered behaviours in transport providers and logistical processes among transport purchasers, if using electric vehicles is to be profitable. If this is not done electrical operation will be very expensive, but if it is done, then there are huge gains to be made compared to the current system. Novoleap has not calculated exactly how great a financial effect increased utilization would bring, as this is very much a company-specific consideration.

Companies with transporter within the area of the studied vehicle flows for shuttle traffic ought to be willing to cover part of the cost for investing in an electric road, vehicles and charging infrastructure, bearing in mind the cost savings that electric vehicles can bring compared to existing diesel vehicles.

With a sufficient balance between distance, power output and battery size, a lorry powered by electricity could theoretically run for 24 hours a day in shuttle traffic, which entails huge financial benefits for businesses, particularly if things start developing towards autonomous vehicles.

Shuttle transport both locally and regionally will be able to derive benefit from an electric road pilot. An electric road of 200 kW is fully adequate for the flows analyzed, although 400 kW may be needed to support through traffic in the longer term. Further investigation is needed into the breaking points for willingness among transport providers and haulage companies to pay, if the government were to introduce a national ERS.

Interview study with transport purchasers

To investigate the preconditions for an electric road pilot in Örebro County, interviews were conducted with several goods owners/transport purchasers regarding their interest in an electric road, incentives for using an electric road on the Hallsberg–Örebro section, their willingness to pay for using an electric road, and so on. There is great interest among transport purchasers in the electric road pilot and work on sustainability, but it does depend on related financial aspects. The primary focus is on the company's continued survival, but if there is room for environmental investments within the company's financial limitations, the players involved are perfectly prepared to invest in sustainable transportation. The transport purchasers need to know more about the system as a whole to make any useful financial calculations, and would like guarantee from Trafikverket on the continued expansion of an ERS on routes relevant to them, or some other form of support, to ensure their investments are not wasted.

Interest in electric roads

The respondents generally indicate a high level of interest in electric roads, primarily on the basis that they can reduce their environmental and climate impact by using electric roads. It is noted that sustainability and environmental profiling can lead to positive effects or 'bonuses' for the profit-making operation. Some respondents are more interested generally in different potential solutions for contributing to achieving climate goals and regard an electric road between Hallsberg and Örebro as a good starting section, but emphasize that the more long-term effects of larger-scale development are of more interest. Others stress that the Hallsberg–Örebro section is of particular interest for achieving a longer chain of fossil-free transport in combination with railway transport to and from the combi terminal in Hallsberg.

Gains and benefits of using an electric road

None of the respondents believe that using an electric road would bring any financial gains in the short term, but would be part of their efforts to contribute to a transition to fossil freedom and sustainability. They also see an opportunity in using the electric road as a path to offering their customers more sustainable alternatives, and thus achieving business gains in the long term. A few respondents do, however, stress that to date they have not been able to make financial calculations based on the use of the electric road, as there is as yet no clarity around the costs and terms.

Opportunities and risks of an electric road pilot

The main opportunities highlighted are the possibility of fossil freedom/sustainability that can strengthen the company's brand, and that the use of an electric road could thus lead to more and/or larger contracts. In the long run, the respondents also see the potential to reduce transport costs, if the cost of using the electric road is lower than other fuel prices.

In the very short term, one respondent mentions the risk of disruptions to their transports during the construction phase. They say that their daily running costs could be affected if they are forced to receive incoming deliveries outside of regular opening hours.

Other short-term risks are linked to investment requirements in both infrastructure and vehicles, the concern being that no player will be willing to assume investment costs. Several respondents note that there is a chance that the haulage companies (vehicle owners) will not want to risk investing in vehicles while there is such a limited section of electric road. To counter this risk, guarantees are needed either on the continued expansion of electric roads on sections relevant to the haulage companies, or on other types of support to mitigate the adverse effects should it prove to be an unsound investment.

Risks linked to the technical solutions are also highlighted. For instance, aspects such as the choice of technology for the electric road has not yet been finalized, which makes it hard for goods owners and hauliers alike to plan for use of the ERS. Another risk and difficulty mentioned is the fact that several solutions for fossil freedom are under development simultaneously, which can lead to uncertainty as to which one to choose – even though there is an understanding that a combination of solutions will be needed to achieve a sustainable transport system.

“Hauliers can get confused as they’re not sure what to invest in”

It is also pointed out that vehicles need to be able to use different sections of electric road also beyond Sweden’s borders. One respondent clearly advocates that the same technology should be used across Europe to enable transnational transport. In terms of vehicles, one respondent mentions the risk of there not being a technical solution for the kind of rig used for their transport. They would also like Trafikverket to ensure that the chosen technical solution can also be used by 24-metre rigs, and not just tractor units with trailers. Close cooperation is likely to be needed here between Trafikverket, electric road users and vehicle manufacturers *(ed.)*.

Willingness to invest

When it comes to the willingness to invest (such as co-funding in infrastructure or vehicles) to make an electric road between Hallsberg and Örebro possible, there was no broad consensus among the respondents. Several did, however, say that it is hard to comment on their willingness to invest since there are no concrete proposals on the table. A couple said that sustainability should not involve higher costs than at present, but rather cost the same or be cheaper if companies are to be convinced. The majority did however say they were possibly prepared to accept some initial costs for the sake of longer-term profitability. The aspects highlighted here again were environment, climate, and the potential to strengthen the company’s brand by using an electric road.

As for willingness to invest in measures to adapt company facilities to an electric road, such as stationary charging points, several respondents had looked into, planned for or already had stationary charging points at their facilities. Generally speaking, attitudes were positive towards investing to meet that kind of need. Respondents also commented that the transition was already under way as smaller vehicles, cars and vans are already being increasingly electrified, and they request charging points. One respondent was however doubtful as to the benefit of charging points at their facility, as vehicles were only there for the limited time it took to load them. The person did however observe that it depends on the technical opportunities for charging the vehicles sufficiently during the short time they were being loaded. Another respondent was also doubtful about the benefit of stationary charging; due the weight of their freight, they are uncertain whether current battery-powered vehicles would be able to pull their loads.

Willingness to pay

When it comes to willingness to pay more for transportation using vehicles that use the electric road, here too respondents say that it depends on several factors. One is what the actual cost of transport would be; a slightly higher transport cost initially is understandable, but it would eventually need to become the same or cheaper than transportation by fossil-fuelled vehicles. They also say that a marginally higher cost for more sustainable transport could be acceptable, as the company would gain in terms of business, but it depends on the end customer’s willingness to pay for the transport.

Demand from customers

Respondents commented that demand among customers for sustainable transportation does exist, but to different degrees and in different ways depending on the type of customer. Only one respondent mentioned demand directly from private individuals, saying that customers buying products online more often reflect on the means of transport than people buying in a shop. That company already offers private customers the option to choose electrified transport at a slightly higher shipping cost (a surcharge of SEK 5).

Several respondents also said that smaller companies demand sustainable transport less frequently than larger ones. This was thought perhaps to be because smaller companies have smaller margins and are therefore more price sensitive. Larger companies more frequently ask about the environmental impact of transportation, and it is more important for them when doing business than it is for smaller companies. The respondents more often see demands on sustainable transportation being placed in major procurements and contracts that come under the Swedish Public Procurement Act.

A couple of respondents mentioned that they had taken initiatives to make their operations and transport more sustainable, in order to strengthen their brand and their products. This means that they can offer customers sustainable solutions before they even ask, but also that transport purchasers now compete not mainly on price, but can win contracts based on other aspects and values.

Internal environmental requirements and networks

All the respondents have internal environmental requirements which mean that they actively strive to reduce the environmental and climate impact of their companies' transportation. Several also said it was a pure question of survival, since in the long term it will not be economically sustainable to not be fossil free. The respondents' companies have different levels of ambition in their internal environmental requirements. Some talk about climate positivity with a desire also to have an impact outside of their own operations, while others work mainly to influence the transport providers through the agreements they sign, and/or to optimize their own transports.

Interview study with Örebro University

An interview study was conducted with Frans Prenkert, professor in business administration at Örebro University School of Business and head of logistics research at the CSB – Center for Sustainable Business. The CSB conducts research and development in the areas of circular economy, business ethics, sustainable value chains, and transparency in sustainability reporting and sustainability communication. The CSB works across disciplines with the business community to increase knowledge of sustainable solutions for corporations, business life and economics so as to achieve lower environmental impact, improved working conditions and quality of life.

Interest in an electric road pilot

According to Frans Prenkert, the electric road pilot is a tool in achieving the 2030 climate goals, and is of particular interest as there is nothing similar in this format. The pilot is an initiative that is fully in line with two important areas of research at Örebro University: sustainability and infrastructure.

1. The CSB proves that the university is investing in research and knowledge development in sustainable economy, sustainable enterprise and sustainable infrastructure.
2. The university's strategic profiling and the pilot are in line with the regional development strategy and its focus on transport and logistics. They are both direct and indirect reasons for the university to support the pilot.

There are obvious benefits with the sustainability aspect and in converting the transport system to an electrified one. Just electrifying the Gothenburg–Stockholm section via the E20 would have major positive effects on the climate footprint, even though goods volumes are increasing. It is important that the CO_2 emission curve must match the higher volumes of goods. In the near term, one of the most important things we can do is to maintain focus on making transportation more sustainable, not just with electricity but also other necessary components such as biofuels and hydrogen.

Opportunities and risks of an electric road pilot

Sweden has the possibility to be a pioneer nation for electric roads. The management and business culture enjoys a good reputation, and cooperation between different types of player at different levels is already a well-established practice. The ability to lead and talk about complex challenges, and then to take action and capitalize on them, already exists, and this is what can make the electric road pilot a successful case for many players in Sweden. It is also important to show what cannot be achieved.

Pertaining to risks, Frans Prenkert says that there is a risk with the electric road pilot that some players do not understand the dynamics of responsibility and benefits. This could lead to a situation in which certain players with particular resources wave the baton.

FRANS PRENKERT,
Professor and Researcher at Örebro University

The major infrastructure giants could hold especially large sway over the transport system if a particular technology is chosen, and it is crucial that other players balance out the roles. It is important that the players not holding the baton are not forced into a system where they have to adapt, as that is not sustainable in the long run. An unnecessary distribution of power or dominance is bad for the market and the whole system, as the imbalance could lead to a loss of innovative power.

The electric road pilot is a typical infrastructure model in which a major initial cost is paid off over a long period. For the players that choose to join, the most important question is over how long the pilot will be paid for. For small companies, anything over five years is barely of interest, but the larger corporations may look further ahead than that. Generally speaking, it is necessary that a lot of parties gain something from the system, rather than a few making a big profit. There is huge business potential, but it calls for capital, and responsibility from the players that choose to hold the baton.

There is a risk that the players decide the initiative is too small in scope to bother investing, and that the continuation after the pilot is too uncertain. This could be an argument for the state to inject more funds initially. If players drop out the project will lose momentum, which will further slow the process of achieving the climate goals by 2030.

A large-scale pilot is an opportunity to position the region as a pioneer in the field, which benefits the university indirectly. The university can see that there is some interesting research linked to the area and has employed a doctoral candidate over two years to conduct research into electric roads generally, and this pilot specifically. Frans Prenkert believes that there are spin-off effects and side effects that are hard to discern in advance, and the university is focusing on this field as it believes in electric roads as a concept. The goal is to generate unique knowledge, communicate with the wider world and contribute to actual work on the pilot, whereby the university can see and manage bottlenecks in the pilot. How the knowledge is used will be absolutely crucial in how the players adopt it themselves.

Implement an electric road pilot between Hallsberg and Örebro – a location with the right conditions

The report notes several reasons why the E20 European Highway between Hallsberg and Örebro is a good section on which to test an electric road pilot on a large scale. The location itself is strategically suitable in terms of infrastructure and the concentration of transport-intensive businesses, and it also enables added values in the shape of multimodal transportation. The public sector players have a common foundation, partly in the interregional system analysis and the regional development strategy. They also look positively on innovations in transport and logistics, especially if they can help the County to achieve the Agenda 2030 goals, while strengthening the County and boosting its competitiveness.

The business community in the County has a positive attitude towards electric roads, and is involved in the electric road project regionally. They already collaborate on shared platforms and in their own initiatives, and they have enough transportation themselves to make an electric road viable. Transport providers and transport purchasers alike are considered to have the courage and the willingness to invest in an electric road pilot, and they say themselves that they can incur additional costs initially if this leads to a more cost-effective operation a few years down the line – especially if they can achieve added values from getting involved in innovation projects that benefit the environment, and can profile themselves as sustainable companies. Many players, however, require some kind of assurances from the state if they are to be willing to take the risk and be part of the pilot project.

The Örebro Region is a transportation hub

Several national trunk roads and national roads meet in and close to Örebro. The Örebro Region's geographical location gives it the function of connecting Sweden in all directions, which naturally brings high transport flows. This means that the transport system in Örebro County is and will remain a crucial place for transport, and thus a logical place to test whether new solutions work. The section in question on the E20 is an important route for heavy transportation, the most important one between Sweden's two largest cities, it is of motorway standard and has few points of conflict along the way. This facilitates construction, and the electricity grid is deemed to have sufficient capacity for an electric road. The physical preconditions speak in favour of the E20 between Hallsberg and Örebro. If it does not work here, it is unlikely to work anywhere else.

Development of commercial areas

The section being considered for an electric road pilot is in the middle of what is known as *tillväxtbananen* ('the growth banana') in Örebro County – the area between Brändåsen and Örebro Airport via the E20 and E18. Here, Region Örebro County, the municipalities and the business community all want to invest in areas of commerce that are transport-intensive. Central warehouses have been established here for Lidl and XXL, PostNord has built a parcel centre, and there is land available for further development. More land is planned for commercial purposes in the future, each project larger than the one before. An electric road could draw more transport-intensive operations to the region, as the infrastructure is already attractive to companies with extensive transport needs. This means the roads will have more traffic and ever-increasing emissions, but this in turn will lead to a larger customer base and more electric road users.

Potential for a multimodal shift

Proximity to the railway is one of the biggest benefits of the Örebro Region. Several railways pass through the County in all directions, and most of them come together in Hallsberg at the largest marshalling yard in the Nordic region. Increased freight transportation will heighten the burden on the infrastructure, with the biggest increases on already heavily burdened routes. At the same time, more and more players are seeing the benefits of transporting long-distance goods by railway, with only the first and last sections taken by lorry. Railways will be heavily burdened even after completion of the new main lines, and will not be able to cope with the increased need for transportation in either the short or long term. An electric road pilot has the potential to genuinely influence the choice of future investments in national infrastructure. Testing shuttle traffic on the electric road between Hallsberg combi terminal and the logistics zones in Örebro and Kumla will create a knowledge base in the field of reloading and new transport solutions. For example, Lidl transports its goods by electric road in Germany. They are then reloaded onto a train which goes as far as Hallsberg. There it is reloaded onto another lorry and taken to the new central warehouse in Örebro. The freight is taken the whole way fossil-free – apart from between Hallsberg and Örebro. Just like many other players, they would like to use fossil-free transport the whole way and to test new ways of conveying their goods.

The common desire

The cross-regional system analysis, prepared by the members of the *En Bättre Sits* collaboration, recommends building electric roads and beginning with the sections currently being considered. According to the regional development strategy, the County overall should increase its attractiveness to businesses, while production and exports should also increase. This should take place within the framework of the climate goals by focusing on reduced emissions of greenhouse gases, renewable energy and energy efficiency. Particular focus has been placed on innovative solutions for sustainable transport; Region Örebro County is involved in several international projects with other partners and works alongside Örebro University.

In January, politicians from Region Örebro County and the directly affected municipalities jointly wrote a debate article (see Appendix 2). The article explained that an electric road is just the right area to invest in, and that we must jointly take responsibility and try out new solutions that lead to a reduced use of fossil fuels, so as to achieve set national and international environmental goals.

Business community involvement

The business community in Örebro County is committed, and wants to be involved when we change the world. Private sector players have been involved since work on an electric road pilot began in 2017, and have not only helped to share knowledge for the report, but have also shared knowledge among themselves and with others. The transport purchasers say that interest is great and that they want to change the transport system in the long term. They are simply waiting for the government to take a firm stand and let them know which solution to invest in and things will start happening. The players are deemed to be willing to pay for higher transport costs initially (15–20%), and for charging infrastructure; some companies have already begun. They do see great long-term potential and would like to get started as soon as possible. However, they stress the importance during the construction phase of investing in mobility management measures, to ensure as little disruption as possible to their business activities.

Potentials and benefits

The investigation into shuttle traffic shows that the studied flows already make an electric road in the Örebro Region viable. Shuttle traffic between the combi terminal in Hallsberg and businesses in Örebro and Kumla municipalities will be able to benefit from the electric road pilot, even if there was no national electric road network moving forward. The number of journeys that can be made during the course of a working day is an important parameter, since the purchase price of a suitable vehicle is many times that of a fossil-fuelled one. Novoleap deems that the benefit of an electric road between Hallsberg and Örebro would be so big, that the players in the flows studied ought to be willing to pay to establish an electric road, as it would lead to major cost savings in the future. An electric road would make it possible to shift the logistical flows and make the vehicles work more efficiently.

One clearly defined aim of electric roads is to contribute to the electrification of transportation, while other developments are also under way in the transport system. The COMBINE project aims to conduct a pilot study focusing on the last miles with HCT (High Capacity Transport) between Hallsberg and Örebro, and to test vehicles up to 90 tonnes. An electric road between Hallsberg and Örebro needs to be dimensioned to cope with rigs with higher total vehicle weight than the current bearing capacity class BK4 and vehicle lengths of up to 34 metres.

Region Örebro County and Örebro University also believe that the combi terminal in Hallsberg could be a site for testing autonomous vehicles and thus also testing autonomous reloads to HCT vehicles that run on electricity. This would enable a whole chain of pilot projects to jointly test the theory of vehicles working 24 hours a day, in practice. Along with other projects in the County, longer, heavier and therefore also fewer vehicles between Hallsberg and Örebro would create the potential to test the effect of higher efficiency in transport company vehicles, as well as modified logistical processes.

A holistic approach

In order to meet the climate goals an effective shift in the transport system is needed. If the transition is to go smoothly for users, a holistic approach is required from public and private sector players alike, and testing vehicles and business models for electric roads is not the only consideration. The major potential lies in testing a new transport system on a small scale. For transport providers and transport purchasers, the great potential lies in altering the flows and utilizing the vehicles more efficiently over time. The potential for the public sector lies in exploiting the test as much as possible and trying out different combined solutions, and also in conducting further research into a new, more efficient, climate-friendly transport system. This requires public sector players, along with transport purchasers and transport providers, to jointly take responsibility for the change that needs to happen, and that everyone will profit from over time.

Politically speaking, there is broad support for investing in sustainable transportation in Örebro County, and there is a good, close, dedicated cooperation with the private sector. The business community has transport-intensive operations, with transports that can run in shuttle traffic between the combi terminal in Hallsberg and Örebro, so as to make the electric road pilot viable. The location, the players involved and the flows involved in the Örebro Region provide the potential to achieve added values by supporting through-transportation, multimodal transportation, and further research at Örebro University. An electric road pilot in Örebro County provides an excellent opportunity, not just for an electric road pilot but for testing the transition of the entire transport system.

Glossary

Agenda 2030 – includes the UN's 17 global Sustainable Development Goals (SDGs), adopted in 2015.

Charging point – a stationary point for charging an electric vehicle, such as a service station.

Electric road – a road on which vehicles can charge their batteries and be powered along by connecting to a receiver that provides electricity using some kind of technology.

Pilot – a test or trial, as in a pilot study.

Shuttle traffic – frequent traffic between two endpoints.

Power (output) – refers to energy conversion, measured in Watts.

Transport purchaser – a goods owner that buys transport services from companies.

Transport provider – provides transportation services for other companies.

Charging infrastructure – various forms of charging for electric vehicles, such as charging points and stationary charging.

Activities

Below is a description of the activities carried out since summer 2019, following confirmation that the Hallsberg–Örebro section was one of two candidates for an electric road pilot. Unfortunately, several activities during the spring had to be cancelled due to the COVID-19 pandemic, but some could be carried out digitally.

Start-up meeting

Date: 14 October 2019
Venue: City Konferenscenter, Örebro + digitally

FIGURE 1: Photo from the start-up meeting in Örebro, 14 October 2019. Photo: Region Örebro County

In October, Region Örebro County and the Swedish Transport Administration (STA), Trafikverket, held a joint start-up meeting in Örebro. There was a total of 54 participants, as well as several media representatives at the joint press conference, including national public broadcaster SVT and regional newspaper *Nerikes Allehanda*.

The aim of the start-up meeting was to give players who were already involved an opportunity to come together once again, to run through their joint response to Trafikverket's Request for Information (RFI), and to use this as a starting point for the process moving forward. Representatives from the Trafikverket's Electric Road Programme (now the Electrification Programme) were in attendance and explained why the Hallsberg–Örebro section had been shortlisted as one of two options, and talked about their national work on electric roads. A press conference was held in the middle of the event, after which the regional players had an opportunity to ask questions.

These questions related, among things, to which technology would be used, business aspects such as depreciation periods for hauliers, state support for buying lorries, and taxation. Other matters raised included the link between electric roads and vehicle automation, how other vehicles could use the electric road, and connections to the airport.

Information meeting 1

Date: 2 December 2019
Venue: Örebro University + digitally

Between the start-up meeting and the December information meeting, the working form and allocation of questions between Trafikverket and Region Örebro County were discussed. The meeting itself included a proposal for role allocation and information about the work moving forward, so as to give the regional players an idea of how involved they would ideally need to be. Since many of the questions at the first meeting were about the choice of technology, Magnus Lindgren of Trafikverket gave a presentation on which technologies are available and which are being considered. Örebro University, which hosted the meeting, gave a presentation on their interest in electric roads and talked about their work in the fields of innovation, logistics and sustainable enterprise. The County Administrative Board also talked about what kind of business support is available for companies, for instance relating to vehicle purchases and charging infrastructure.

Information meeting 2

Date: 11 February 2020
Venue: Närkefrakt + digitally

The second information meeting was held at the new premises of regional transport/logistics company Närkefrakt in Berglunda, Örebro. A total of 27 people attended, and the meeting was more like a workshop than the previous ones. Between the first and second information meeting, changes had been made to which questions would be answered in this report.

The CEO of Närkefrakt gave a welcome speech and presented Närkefrakt's business. Region Örebro County then briefly talked about how much progress they had made, after which Trafikverket reported on its work on the road plan, which is now under way. After the break, Trafikverket talked about the business model it is using for electric roads, and this was then discussed in small groups.

The discussions highlighted questions about the combination of electric roads, charging stations and batteries. Trafikverket then said that it is looking at various system options, and that the section in Örebro could be part of a system test. Other matters that arose included:

- How quick roll-out would be and the long-term scope of the technology will affect who and how many will use electric vehicles.

FIGURE 2: Photo from the workshop at Närkefrakt.
Photo: Region Örebro County

- Special vehicles will be a tough issue. For instance, how to charge a crane lorry.
- The electrification of transportation will redraw the map of where vehicles can drive in e.g. urban environments. Even if there are no longer any drivers, a lot will change due to a change in cost patterns.
- Too much remains uncertain at present to be able to make any predictions as regards business and finances.
- If the one or two pilot sections end up being the only ERS sections, the players will completely lose interest. The earlier the long-term plans for electrification of roads is communicated, the better.
- It is crucial to the project that the major transport purchasers are involved. They must be willing to pay the haulage companies more for carrying freight more in a more climate-friendly way, unless the hauliers receive state support to balance their finances if they are obliged to make the transition. The process is too slow amongst transport purchasers. For instance one major transport purchaser has put 20 haulage companies out of business, while they want low expenditure and claim publicly that they will be fossil-free.
- What happens when we (transport providers) have to compete with other companies that have fossil-fuelled vehicles and are cheaper? When will the electricity become profitable? The transport purchasers have and must assume more responsibility! We (the transport providers) have little responsibility on the issue as we have not previously charged more when driving eco-friendly. Customers expect us to take the cost.
- Why are no eco-lorry premiums payable?
- Things are stalled right now. The haulage companies want to operate more eco-smart but diesel is wrong and there are not that many alternatives that are fossil-free, which means either postponing the purchase or buying a diesel-fuelled vehicle. Quickly developing an electric hybrid could be a first measure.
- As soon as diesel is SEK 0.25 cheaper than HVO, transport providers use diesel. Transport purchasers don't want to pay more, even though the hauliers want to operate fossil-free as afar as possible. The transport companies work with far too small margins.
- More but smaller vehicles would call for driverless vehicles to reduce the costs for the transport provider. They already watch every penny to try to stay in the black and have two shifts with drivers in the evenings and mornings, but don't believe it will be attractive for e.g. shops to receive deliveries during the night. The big vehicles are construction vehicles and bin lorries. Using a vehicle in two shifts entails far higher personnel costs, and some warehouses only receive goods 7 hours out of 24.
- It's important to bear in mind that there's no precedent for this, and it's a very difficult thing to deal with.
- The potential for operating on electricity rather than fossil-free is barely negligible. It requires moving towards driverless vehicles.
- It will cost money to be first and hold the baton, but everyone still wants to be involved. There are significant risks in being first. E.g. if the a company buys lorries, electric road etc. only for the government to decide it's a bad idea and invest in another technology instead. The government will have to manage that risk, as the companies will not be able to take the full risk themselves. No haulier will want to invest money when the risks are that big. If the government promises to buy back the vehicles afterwards, that could be a form of security.
- Närkefrakt offered to help draw up a model for mapping vehicle journeys.

Information meeting 3

Date: 12 March 2020
Venue: Region Örebro County + digitally

A lot of people dropped out of the March meeting due to COVID-19, but there were still 21 participants either in person or online. On this occasion, Region Örebro County reported on how regional work was progressing, after which the RFI response the regional players had prepared just over a year earlier was discussed. The aim of the discussion was to explore how to further bolster the response ahead of this report.

Cancelled activities

Information meetings 4 and 5 unfortunately had to be cancelled. In April, input from the discussion in March would have led to a proposal on the form of report preparation, and business cases. While we realized we would barely have time to do everything we had planned, due to the COVID-19 pandemic Trafikverket extended the deadline to 31 August rather than 30 June, which was very welcome. Rather than carrying out stages four and five separately, we decided to write the actual report and send it out for checking and approval in July, to the players that had been involved in preparing the report or involved in some other way.

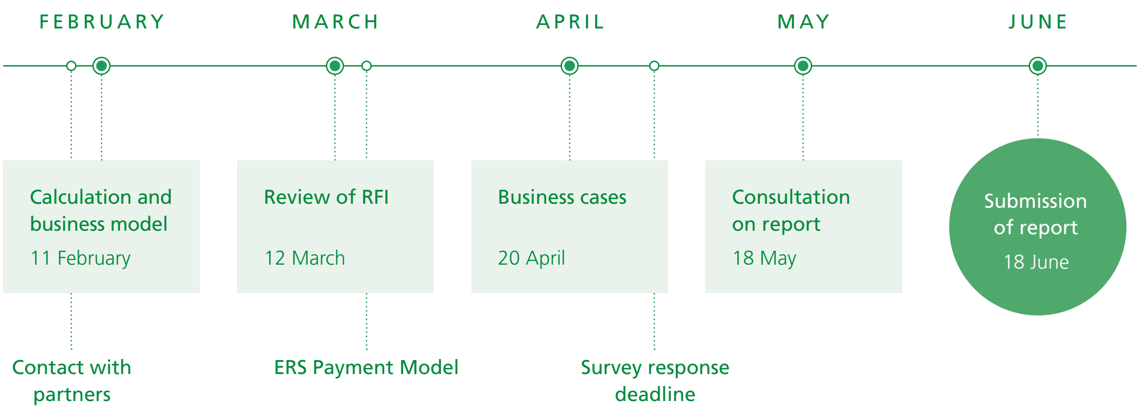


FIGURE 3: Project plan for Region Örebro County, spring 2020.

Electric road – the right way forward

Region Örebro County, together with Hallsberg, Kumla and Örebro Municipalities, would like to explain why we would like to see an electric road pilot on the E20 European Highway between the Brändåsen and Adolfsberg interchanges. We have received communications regarding the electric road pilot during the autumn, and it is evident that the project is unclear to outside parties. We would like to deal with any questions and be transparent as the electric road pilot affects a lot of companies in the County, particularly in the transport sector.

The selected section – greatest potential in Sweden

"If an electric road pilot is to be tested in Sweden, then it should be here."

An electric road on the E20 with high traffic flows, close to the largest marshalling yard in the Nordic region, has all the right conditions to be a good electric road pilot facility, according to the STA. We would go further and say that if an electric road pilot is to be tested in Sweden, then it should be here. The goods flows that arrive in Hallsberg by rail are distributed onwards by lorry to goods owners in the region and nationally, primarily via Örebro.

Electric road – not like a railway

The function of an electric road is to power vehicles during their journey, and to load batteries so the vehicles can run on electricity beyond the charging section. Current batteries do not have the capacity to power a heavy lorry for long distances, and they are heavy and expensive. The solution that is closest in time would involve a hybrid vehicle that is powered by batteries which can be charged along charging sections, along with e.g. biogas or hydrogen. The capacity of the electricity grid will be studied at a later stage.

"We must take responsibility together in the transition to a sustainable transport system."

Electric road – one way towards a sustainable transport system

To achieve national and international environmental goals, we must try out new solutions. We must reduce the use of fossil fuels, even while goods transport is constantly increasing. At present the transport sector takes great responsibility for emissions, and we must take responsibility together in the transition to a sustainable transport system. Our electric road pilot could be the first piece of the puzzle in a longer, national electric road system (ERS).

Electric road pilot does not affect other projects

Neither the region's not the municipalities' other projects would be affected by the electric road pilot. The STA will finance 50% of the electric road pilot, max. SEK 300 million, the remaining 50% to be arranged through other financiers and paid for via user fees.

An electric road pilot strengthens the County

The electric road pilot exudes forward thinking, collaboration and innovation, with the region, municipalities, the business community and Örebro University jointly showing the way forward – and the ultimate goal of establishing the world's longest commercial electric road. It will attract visitors from around the world to our County, and we obviously want to showcase what we have to offer.

An electric road would increase competitiveness both nationally and internationally, and would consolidate Örebro County as a logistics hub, thus increasing its attractiveness for business establishment. We can see opportunities, we want to develop our County according to its strengths, and we have an ambition to be a Swedish leader in transport and logistics.

Nina Höijer (Soc. Dem.), Regional Councillor, Region Örebro County

Ullis Sandberg (Soc. Dem.), Municipal Councillor, Örebro Municipality

Magnus Andersson (Soc. Dem.), Chairman of the Municipal Board, Hallsberg Municipality

Katarina Hansson (Soc. Dem.), Chairman of the Municipal Board, Kumla Municipality

NOVOLEAP
SUSTAINABLE LOGISTICS

Report electric road Region Örebro County
2020-06-05

Av: Henrik Wallström
Anders Lundgren och Jonas Winther

1. Background

The Region Örebro County is preparing for a pilot of an electric road between Hallsberg and Örebro. The electric road pilot includes three areas:

● Distribution (locally Örebro – Hallsberg)

● Shuttle traffic (between Hallsberg – Örebro)

● Passage trail (traffic passing on the way to other destinations).

A key aim in this report is to highlight the advantages of this specific route by presenting grounds for decision, a business case, and provide substantiated figures for the Region Örebro County´s electric road pilot. The study focuses on highlighting the benefits of electrification through an electric road between Hallsberg and Örebro.

2. Purpose and goal

2.1 Purpose

The primary purpose is to increase understanding of cost, benefit and potential for an electric road between Örebro and Hallsberg, but also to increase understanding of how electrification along the route can become an important part of a national system.

2.2 Objectives

The goal is a to provide support for a decision that:

● increases the chances of being assigned the Governmental supported pilot on the route

● highlight the benefits of electrifying the shuttle traffic and build an overall business case in the aspect of output power, battery sizes and type of vehicles

An argumentation is also presented how an electrification of shuttle traffic and the customer base contributes to a national electric road system.

2.3 Delimitations

● The report focuses on shuttle traffic, excluding transit transportation and local distribution.

● Only different output power from an electric road is included in the analysis, i.e not type of technology used to transfer/transmit energy, for example inductive or conductive.

● Neither are costs for an electric road, installation, financing/depreciation etc. included in the report, nor operational and maintenance costs.

3. Defined deliverables

Costs and environmental impact of electrification, two scenarios:

1. Electrification with battery operation and charging in the flow

2. Electrification with electric road (dynamic charging)

For the two scenarios, advantages and disadvantages are analyzed, as well as possible short and long term risks for each scenario.

4. Argumentation and reflections on the electric road between Hallsberg and Örebro

As part of this report*, we will argue in terms of more “soft” parameters connected to the electric road route. The argumentation is based on the assumptions and analysis carried out in the study. The assignment includes argumentation about the following effects:

● Benefits and potential effects of an electric road on the route Hallsberg – Örebro.

● How electrification of shuttle traffic contributes to a national system (transit route), as well as customer base and potential distribution of costs.

● Why Hallsberg – Örebro is suitable for an electric road pilot from a logistics perspective. Output power required for shuttle service vs. a national system and future vehicle combinations.

* *presented in Chapter 10*

5. Approach and method

5.1 Assumptions

To answer the questions from the Region Örebro County, different scenarios have been created. These scenarios are based on a number of assumptions validated in consultation with the Region Örebro County, responsible for data collection from product owners and forwarding companies in the region.

5.2 Assumption 1: Number of passages per day

The route along E20 between Hallsberg and Örebro connects the Hallsberg terminal with many logistic centers and central warehouses located in Örebro. The route is also an important passage for north- and southbound transports from south of Sweden conversely north of Sweden.

According to Trafikverket, the Swedish Transport Administration Authority, freight volume by truck is estimated to increase by 47–68% by 2040. (Source: Proposal for Pilot Route, Region Örebro County).

Statistics from Trafikverket, see Figure 1, show that approximately 1.900 trucks pass in each direction every day, which constitutes approximately 20% of the total traffic volume.

The assumption is that **300 passages in each direction take place every day** in some form of shuttle traffic within a 200 km radius from the planned electric road route.

This corresponds to approximately 15% of all passages with heavy vehicles per day. This assumption has been validated with the Region Örebro County, that in previous analysis and data collection has identified a corresponding need for transports within the region.

TRAFIKVERKET

Avsnitt: 9530054 Län: T Vägnummer: 20

Årsmedeldygnstrafik

Avsnitt	Fr o m	Till	Mätkod	Mätår	Mätriktning	ÅDT(OS) Samtliga fordon	ÅDT(OS) Lastbilar	ÅDT(OS) Axelpar
9530054	1994-01-01	1998-01-01	2	1993	0	11450	1470	13790
9530054	1994-01-01	1998-01-01	2	1993	1	6160±(16%)	760±(26%)	7380±(16%)
9530054	1994-01-01	1998-01-01	2	1993	2	5290±(14%)	710±(14%)	6410±(10%)
9530054	1998-01-01	2001-01-01	2	1998	1	6210±(8%)	1080±(8%)	7920±(8%)
9530054	1998-01-01	2001-01-01	2	1998	2	6070±(8%)	1030±(8%)	7680±(8%)
9530054	2001-01-01	2010-01-01	2	2001	1	6750±(7%)	1150±(9%)	8560±(7%)
9530054	2001-01-01	2010-01-01	2	2001	2	6400±(14%)	1140±(13%)	8190±(14%)
9530054	2010-01-01	2014-01-01	2	2010	1	8320±(13%)	1540±(11%)	10530±(13%)
9530054	2010-01-01	2014-01-01	2	2010	2	7470±(10%)	1430±(9%)	9580±(10%)
9530054	2014-01-01	2016-01-01	3	2014	1	8580	1560	10810
9530054	2014-01-01	2016-01-01	3	2014	2	8620	1640	10860
9530054	2016-01-01	2018-01-01	2	2016	1	9330±(11%)	1880±(9%)	11890±(11%)
9530054	2016-01-01	2018-01-01	2	2016	2	9620±(11%)	1960±(9%)	12160±(11%)
9530054	2018-01-01	9999-12-31	2	2018	1	9700±(8%)	1860±(7%)	12130±(8%)
9530054	2018-01-01	9999-12-31	2	2018	2	10100±(11%)	1950±(9%)	12740±(11%)

Image 1 – Trafikverket, the Swedish Transport Administration Authority´s data on number of passages; annual average daily traffic (ÅDT)

The assumption of 300 passages per day in each direction are distributed over 4 routes: 50, 100, 150 and 200 km, which will be described in the next chapter.

5.3 Assumption 2: Routes and driving distances

The analysis is based on four (4) different routes, see Image 2. The routes are divided into distances (roundtrips) from the time the vehicle leaves the planned electric road section along the E20.

The routes 50, 100, 150 and 200 km were chosen based on data provided by the Region Örebro County. The purpose of analyzing a rather long radius was:

● to capture transports using the Hallsberg terminal as part of its import and/or export flow, even if it involves an up to 200 km “last-mile” transportation (roundtrip)

● to give a better overview on how an electric road can be used for dynamic charging in a fixed flow – and to some extent replace fixed charging in each part of a flow

The transportation in the route is carried out by 1 x truck + trailer, with the assumption that the vehicle makes a delivery and then drives back with an empty load carrier (trailer/container). The energy consumption is lower after the vehicle has unloaded its delivery, given the tare weight is lower on its way back.

Each completed transport represents a trip. The number of trips that can be executed per day depends on the Time Cycle in each route, and how many hours per day each vehicle can be assumed to operate.

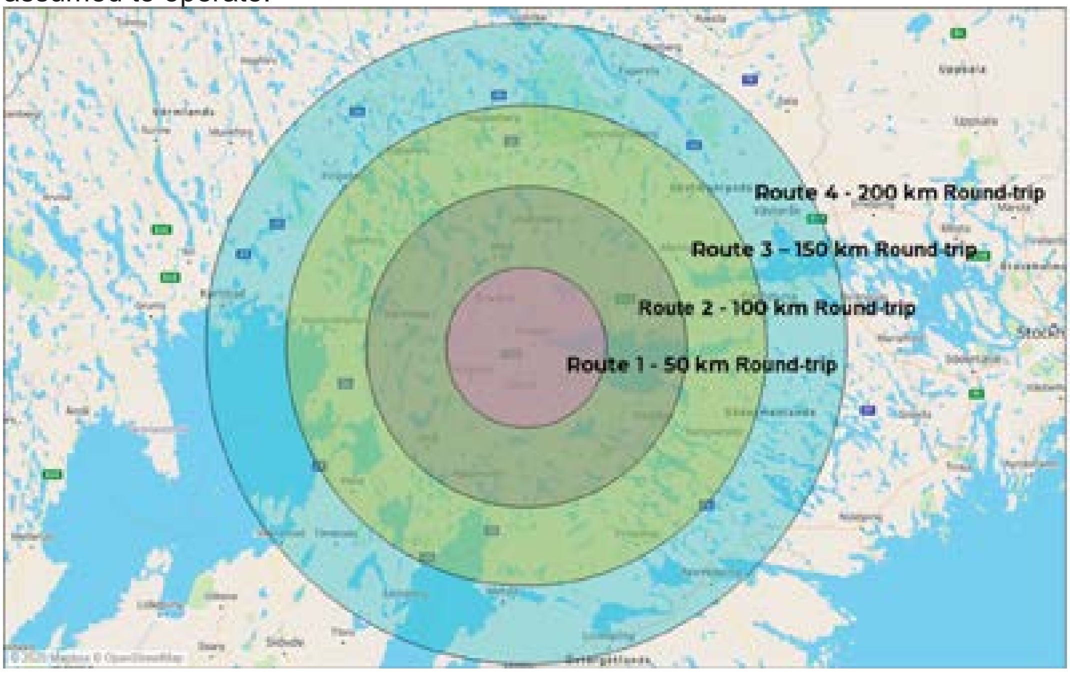


Image 2: Four different routes between 50–200 km assumed in the analysis

5.4 Assumption 3: Transport flows and distances

The electric road between Hallsberg and Örebro is analyzed based on two perspectives:

● Outbound transports

● Inbound transports

The distance for out- vs. inbound transports is the same, however charging takes place at different positions/sections of the electric road.

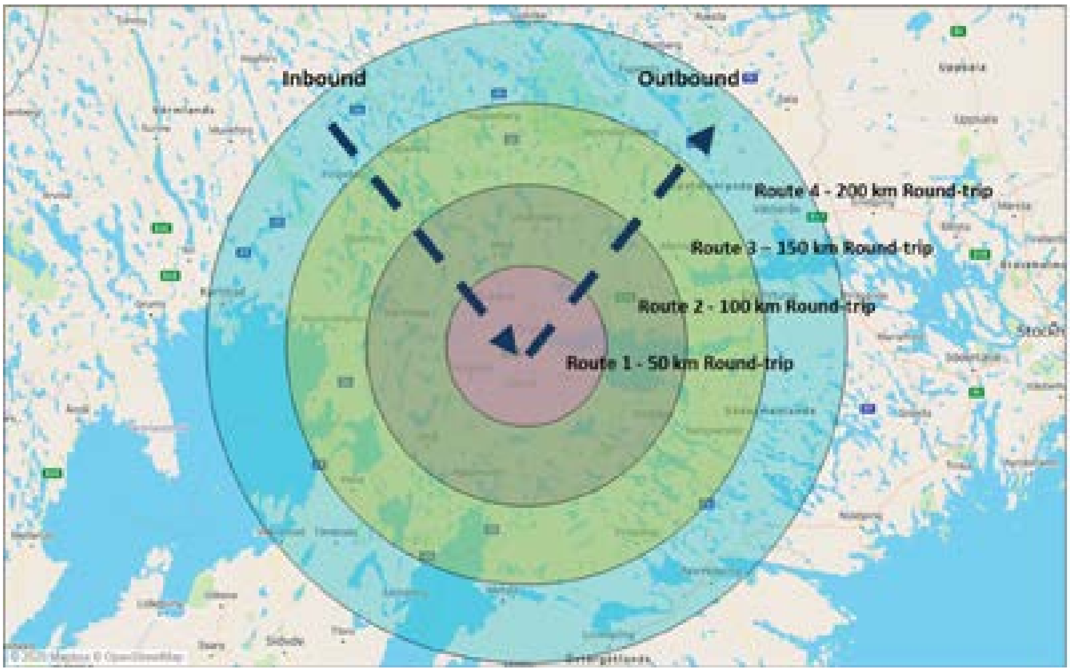


Image 3: The analysis is done for in-, vs. outbound transports

1. Outbound transports

Goods arriving at the terminal in Hallsberg and transported further into the region are defined as outbound flow.

A flow consists of all goods arriving at the Hallsberg terminal for further transportation in the region. This also means goods transported by shuttle traffic/repetitive flows on the route Hallsberg – Örebro, including nearby towns (such as Kumla etc).

The route begins in Örebro after the vehicle has left the electric road.

Image 4 below illustrates an example of this flow and how the battery is affected by the distance.

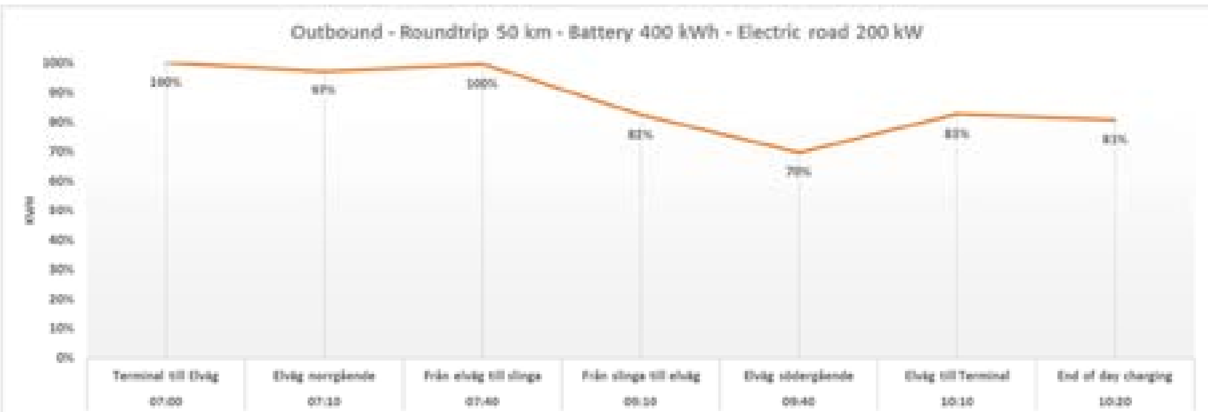


Image 4: Example of battery charging for an imaginary outbound route

2. Inbound transports

Inbound flow, conversely. Goods in transportation from the outer edge of the operating radius to the Hallsberg terminal

In each route, the transport is assumed to take place with a maximum distance within each route (50, 100, 150 and 200 km).

For example, in Route 1 – Inbound transports, the goods are transported 25 km from the place of origin to the electric road and then on the electric road to Hallsberg in order to then return to the place of origin (25 km).

Image 5 below illustrates an example of this flow and how the battery is affected by the distance.

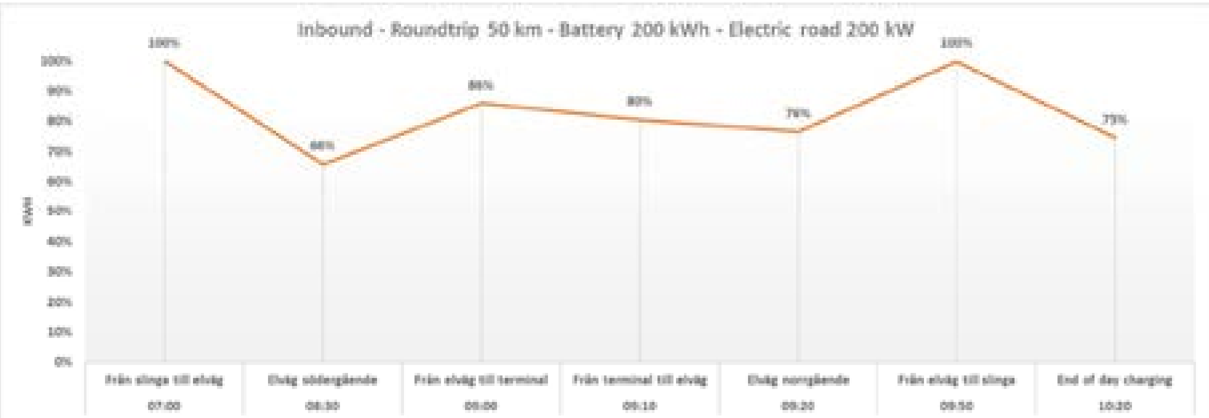


Image 5: Example of battery charging for an imaginary incoming route

Route	Total distance	Time Cycle (roundtrip)	Max trips a day	Max trips by 9h driving
50 km	100 km	3h 20 min	7	2
100 km	150 km	4h 20 min	5	2
150 km	200 km	5h 20 min	4	1
200 km	250 km	6h 20 min	3	1

Each route is linked to a Total distance, Time Cycle, and a Maximum number of trips per day.

Total distance means the total distance for a roundtrip, i.e from starting point to its delivery point and back, in three sections:

Total distance in each scenario consists of 3 parts (see Image 6):

● *The transit* – distance to and from the electric road from the Hallsberg terminal. (a distance of 4 km one way)

● *The electric road* – along the E20. Total distance 21 km in each direction

NOVOLEAP SUSTAINABLE LOGISTICS

● *The route* – the distance the vehicle travels after leaving the electric road. (Varies pending on scenario; (50 km, 100 km, 150 km and 200 km)

Image 6: Different type of distances included in the analysis

Time Cycle on the various routes includes driving time as well as loading and unloading in each route. Assuming the vehicle is running full load (2x20 foot container or 1x40 foot container) with one stop, at which the vehicle then turns and drives back. The difference in Time Cycle between the routes is thus related to the distance, where the assumption is that the vehicle has a speed of 50 km per hour after leaving the electric road to complete its route.

One of the analyzed scenarios is when charging takes place in the flow, for example at customer's location, and included in the Time Cycle (charging is assumed to take place in connection with loading or unloading).

Number of trips per day represents how many trips a vehicle can execute during one day. The analysis is based on two scenarios:

1) Time for driving and rests or breaks is not taken into account, using all hours of the day (24 hours)

2) Considering the maximum number of hours a driver is allowed to drive per day (9 hours).

The number of trips is rounded downwards. Which means that a trip that takes 3 hours and 20 minutes can only be completed twice a day (instead of 2.7 rounds per day, i.e 9h/3h 20min). Thus, a vehicle cannot perform a subset of a trip.

Example: In image 7, the vehicle ends its trip with 81% charge of battery left, which means that this specific trip has consumed 19% battery. This means that the vehicle can perform 5 such

rounds per day. If the vehicle is operating 24/7, extra time for charging needs to be set aside before the next day can begin.
(We have chosen to ignore this in our analysis as the assignment does not include giving recommendations for optimizing the vehicle fleet).

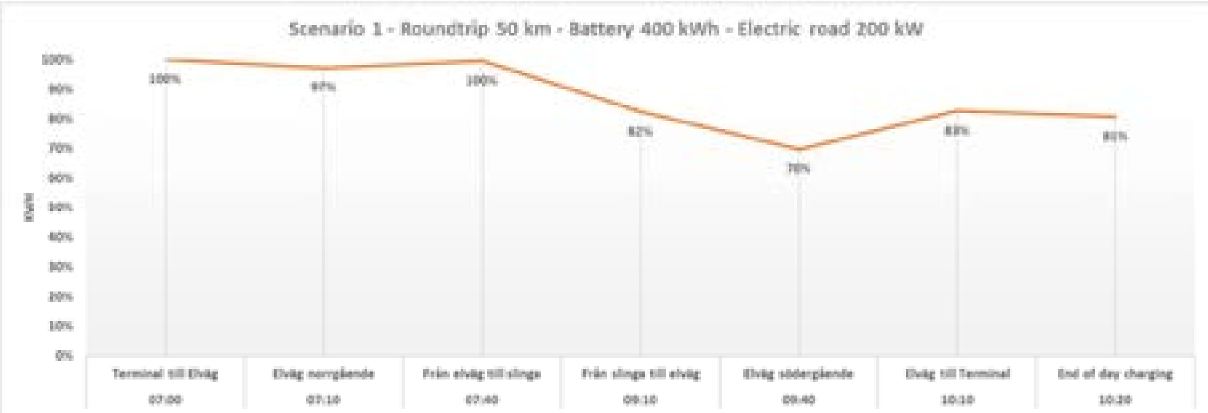


Image 7: Example of battery charging seen over a trip.

5.5 Assumption 4: Distribution of passages per route

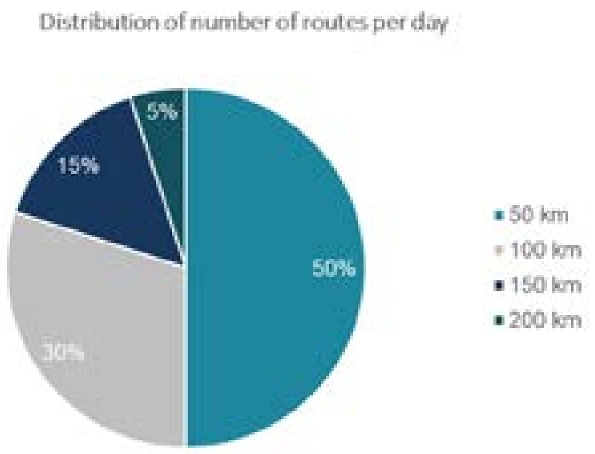
The assumption is 300 trips a day (300 passages in each direction) and in consultation with the Region Örebro County, the following allocation has been approximated:

● A large part is transportation to existing central warehouses and logistics centers in Örebro. About 50% of the 300 trips are estimated to enter this route.

● There is also a considerable amount of recipients and senders within a 100 km radius from Örebro, this equals 30% of the trips

● 150 km and 200 km are expected to account for 15% and 5% of the trips, respectively. Within this radius places with a large manufacturing industry, such as Köping, are situated.

Route	Allocation (%)	Number of routes a day (total)
50 km	50%	150
100 km	30%	90
150 km	15%	45
200 km	5%	15



6. Scenarios

The analysis is based on 80 different combinations of routes, propulsion and battery sizes.

Route	Battery size	Propulsion
50 km	200 kWh	Battery without charging in the flow
100 km	300 kWh	Battery with charging in the flow
150 km	400 kWh	Electric road 200 kW
200 km	800 kWh	Electric road 400 kW
		Electric road 800 kW

6.1 Battery and energy consumption

Today, the market for electric trailer trucks is in a start-up phase in Sweden. Outside of Sweden, these kinds of vehicles have been operating for a few years now. Several with a battery size just over 400 kWh.

Some manufacturers have announced there will be a launch of electric trailer trucks with a battery capacity reaching close to 1 MWh.

In this analysis battery sizes 200, 300, 400 and 800 kWh are included. The purpose is to identify the relationship between electric road power and battery size in the interval of 200–400 kWh, and give an indication where a possible breaking point may be, i.e when the electric road enables smaller battery sizes in vehicles.

The assumption is that **all batteries are compatible with the selected electric road loads**. For batteries, where charging sometimes come to 4xC* (200 kWh battery on an 800 kW electric road), different battery technology will be required compared to the most common batteries for electric trucks today (NMC and LFP).

In the batteries found in heavy electric trucks today, the charging power is about 70% to 100% of the battery size (0.7 C – 1 C).

(The analysis excludes “battery stress" due to high charging loads. Incorrect type of battery together with high charging loads (high "C" – normally referred to as charging power 0.7 -> 1C), reduces battery life and thus resulting in higher costs and higher environmental impact.)*

* *https://en.wikipedia.org/wiki/Electric_charge*

In the analysis we have set **a limit for battery charge of minimum 15%** to ensure the life of the batteries and thus give the trucks the same range of reach over time. This means that a battery of 200 kWh has only 170 kWh available capacity (-15%) in our planning assumptions.

In the analysis, **an average of the energy consumption has been used**. For example, a fully loaded vehicle has a 30% higher energy consumption than a vehicle returning with an empty load carrier.

It has also been assumed **that battery size has no impact on other factors than the vehicle's range of reach**, such as reduced load capacity or energy consumption due to heavier or lower total weight. In a deeper analysis, with specific customer flows, this aspect should be considered. However, in this analysis this aspect has been excluded due to complexity and time schedule.

6.2 Propulsion

The study defines propulsion as how the vehicle gets its energy, which is in two primary ways:

1) Charging in the flow (Static charging with cable in connection while loading and unloading)

The static charging is defined as "Charging in the flow" in the analysis and simulates a charging carried out by loading and unloading. The charging output power is 150 kW and the charging time is under 30 minutes, which will charge the battery with 75 kWh.

2) Electric road (Dynamic charging while driving)

The dynamic charging takes place through an electric road, in the analysis assumed to have three different capacities: 200 kW, 400 kW and 800 kW. The charging time is 25 minutes on each passage of the electric road (2 times per route).

6.3 Number of vehicles in the flow

Based on the two different scenarios we have used the following calculations:

- “Full day 24h”: required number of vehicles 57
- “Working day 9h”: required number of vehicles 180

The weighted average for the number of trips per vehicle and day is:
- 5.75 for "Full day 24h"
- 1.8 for "Working day 9h"

At the present, 180 vehicles are needed to complete 300 trips per day, in turn generating 300 passages in each direction, based on our basic data. Due to Time Cycle for completing a trip, the utilization rate will be lower. Ex: "50 km route" takes 3 hours and 20 minutes to complete and the number of trips per day will be 7.2 at ("24h") and 2.7 at ("9h").

(All figures are rounded down to represent "full" trips. The result is lower utilization rate per vehicle, as actual time allows 2.7 trips, however only "full" trips is possible).

Max trips a day (24h)	**Vehicles a day (24h)**	**Max trips a day (9h)**	**Vehicles a day (9h)**
7	22	2	75
5	18	2	45
4	12	1	45
3	5	1	15
	57		**180**

7. Analysis

The focus of the analysis is to describe outcomes of different configuration of battery size and type of charging. We have analyzed the result by looking at the *number of trips* that can be completed in each flow.

The analysis is divided into 3 sections:

1) Analysis of outbound transports

2) Analysis of inbound transports

3) Analysis and comparisons of outbound and inbound flows

7.2 Analysis 1: Outbound transports

In an outbound transport, charging from the electric road takes place at the beginning and at the end of the flow, see image 8. When a battery is fully charged, or almost fully charged, the charging is slower than when the battery has a lower charge level. This means the electric road is not in maximum use at the beginning of the route. The advantage, however, is that you could have a fully charged battery by the start.

Image 8: Where in the flow charging takes place.

7.2 Number of trips – Outbound

The overall conclusions from the analysis of battery and energy consumption are as follows:

● To be able to operate routes of 150 and 200 km, large battery packs (+400 kWh) are required. This is because charging from the electric road takes place relatively early in the flow and therefore cannot be fully utilized.

● Another conclusion is that already at 200 kWh, the electric road shows great potential compared to charging in the flow or pure battery operation with shorter routes. The improvement is primarily due to the vehicle completing each trip with a higher battery level and thus are able to complete a larger number trips. For example: The number of trips can be doubled using a 200-kW electric road compared to charging in the flow (except from a battery size of 800 kWh).

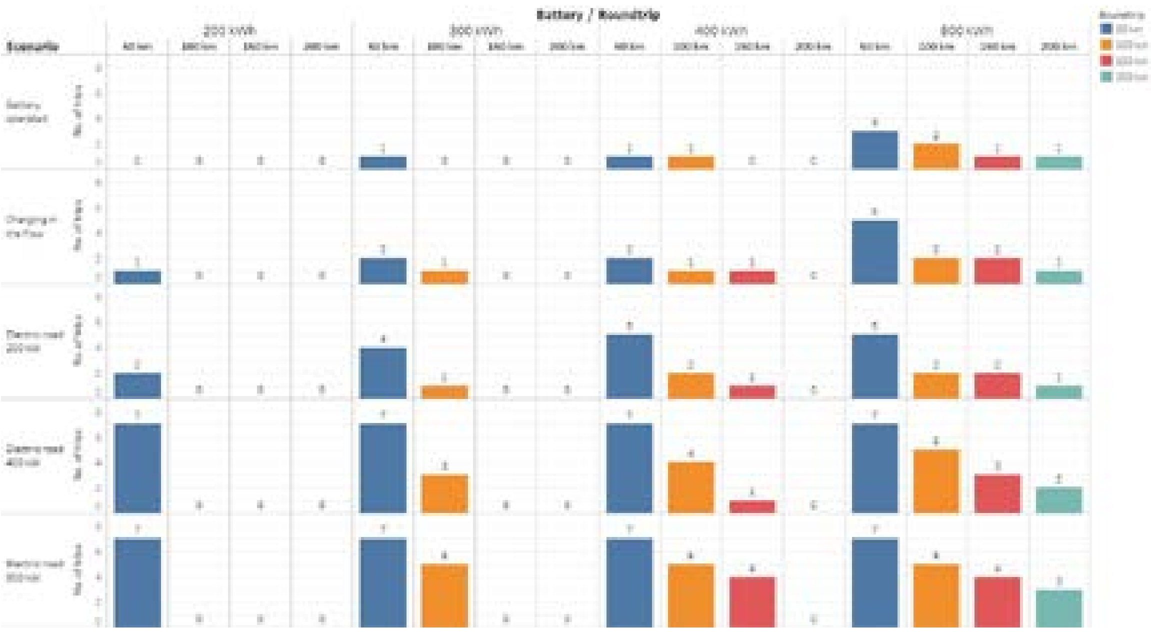


Table 1 shows how many trips that can be performed in each scenario.

7.3 Analysis 2: Inbound transports

In an inbound flow, charging takes place in the middle of each trip, meaning a higher utilization of the electric road compared to outbound transports, as the batteries can absorb more charge. However, this means you need to drive a longer distance before the first charging can be carried out, which stipulates a risk the vehicle would run out of battery on the way back after the last charging from the electric road.

Figure 9: Shows how the distances are distributed over the inbound flow

7.4 Number of trips – Inbound

As the nature of each trip varies, due to better utilization of the electric road, a 200-kWh battery pack can be used to operate the 100 km route.

The same effect can be seen with a 300-kWh battery as the electric road potentiate traffic on the 150 km and the 200 km route, provided that the electric road has an output power of at least 400 kW.

The outcome is that the electric road brings both opportunities to operate the shorter distances with a smaller amount of batteries, and that the number of trips can be increased.

Table 2 shows possible number of trips in each scenario

7.5 Analysis 3: Comparison of Outbound vs. Inbound flows

7.5.1 Number of trips – Combined

When comparing how an electric road affects inbound and outbound flows, it can be stated that an electric road of 200 kW has a greater impact on the inbound flow at 50- and 100-km routes. Mainly because more trips per day can be completed. This will change when the power from the electric road is at least 400 kW, as the number of trips in the outbound flow exceeds the trips in the inbound flow.

Overall, an electric road provides great advantages, both when it comes to reducing the need of battery, and a potential for better utilization of each vehicle as the number of trips per day can be increased.

The output power from the electric road has some significance for the result, but the main difference will be between charging in the flow and an electric road of 200 kW. A stronger output power from the electric road (+400 kW) enables a larger number of trips in the distances 150–200 km to be carried out.

The conclusion is, depending on where the receiver and the sender are in the flow, an electric road will affect the need of battery size and number of trips in different ways by offering charging while driving.

Table 3 shows possible number of trips in each scenario

7.5.2 Charging time – Combined

Outbound and inbound flows are different in terms of logistics. Charging from the electric road on different occasions during the trips, affects the time of charging in each route.

In our analysis model, however, no difference is considered in energy consumption between different battery sizes, which means all battery sizes in each route and electric road output power have the same charging time.

A truck with an 800 kWh battery would probably have a higher energy consumption than the equivalent with a 200 kWh battery, given that the battery is four times heavier. However, the type of electric engine, driving behavior and the vehicle´s choice of route are also important parameters.

The energy consumption is about 30% higher when the vehicle is loaded, but in this analysis we have used the same energy consumption regardless of battery size.

To understand exactly how different battery weights etc. affect the total range / consumption, more accurate tests need to be done, although it has lower impact than, for example, driving behavior.

With higher electric road output power, charging times are shorter and the utilization of the electric road decreases. This does not automatically mean a disadvantage; by planning it is possible to regulate the output power from the electric road.

In the inbound scenario, with an electric road power of 400 kW, the charging time is 8 minutes northbound vs. 16 minutes southbound.

The analysis does not consider dynamic charging effects on the electric road, an area that should be analyzed more thoroughly in a next step. In this case the result would be that the output power can be reduced, so that the vehicle can be charged during the 25-minute drive, to reduce the load on the battery.

Another angle would be to investigate how the installed distance of the electric road can be reduced if the size of the batteries increases or if the output power from the electric road increases.

However, this is a risky conclusion, as higher charging effects can reduce the life of batteries, and probably result in a larger investment and higher operating cost for the vehicle fleet in total. It is therefore not possible, based only on this study, to conclude to shorten the electric road section. The cost for higher electric road output power needs to be set against wear and tear of batteries.

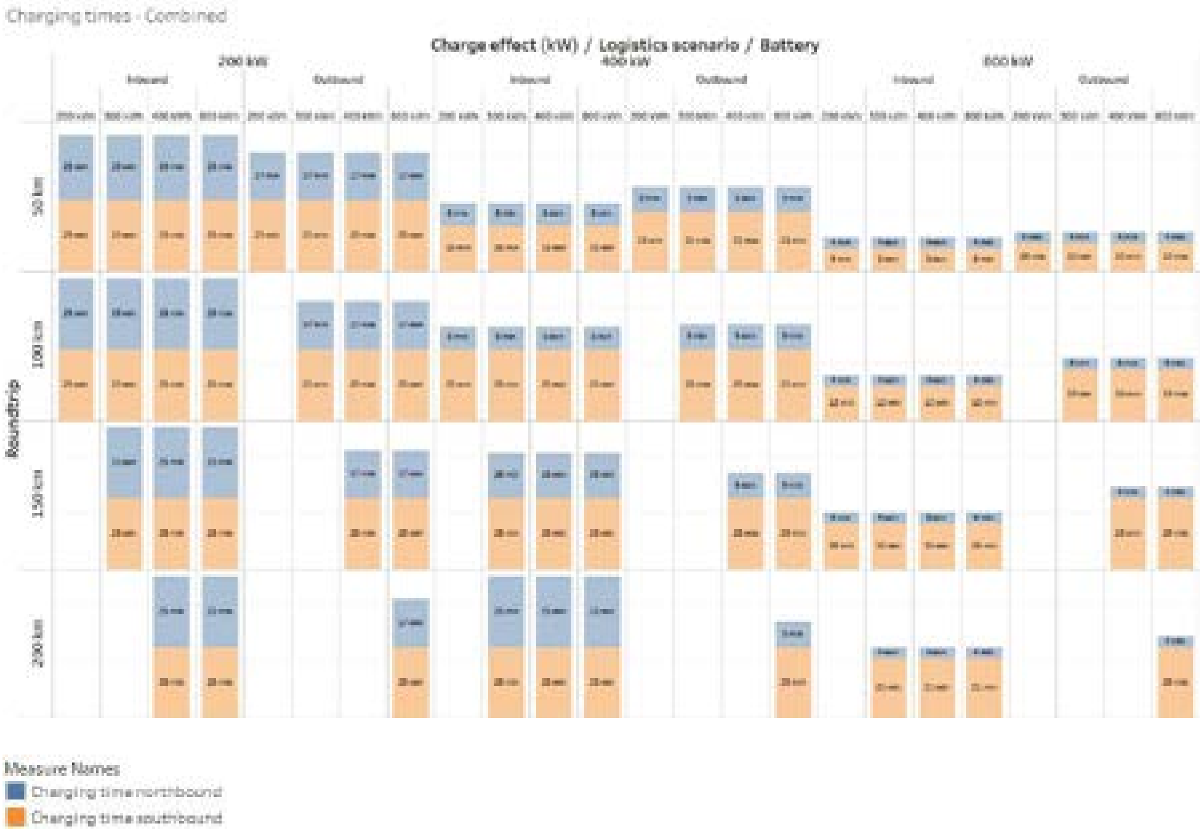


Table 4 shows charging times by different charging effects and battery sizes, per type of route

8. Environmental impact and costs

8.1 Environmental impact

One of the driving forces for electrification by an electric road is to accelerate transition to sustainable electric transports.

Diesel trucks are still the dominant means of transport in Sweden, even though there are different types of biofuel alternatives available.

The environmental impact shown in this analysis compares a diesel fleet with a fleet of electric vehicles. In our analysis, we compare electric vehicles powered by renewable electricity against diesel, meaning 2.54 kg CO2 / liter. (https://spbi.se/uppslagsverk/fakta/berakningsfaktorer/energiinnehall-densitet-och-koldioxidemission/).

The emissions from electric vehicles come from battery manufacturing, where we have used figures from IVL, the Swedish Environmental Research Institute, in our calculations. (https://www.ivl.se/download/18.14d7b12e16e3c5c36271070/1574923989017/C444.pdf).

Diesel vehicle:

Route	Distance (Roundtrip)	Consumption (liter per 100 km)	Kg C02 a trip
50	100 km	3,075	78.1
100	150 km	3,075	117.15
150	200 km	3,075	156.2
200	250 km	3,075	195.25

Table 5 shows diesel and kg CO2 consumption for each trip

Table 6 below shows estimated total emissions from all 300 trips, summing up to 32 tonnes by diesel operation a day, compared with 2 tonnes a day by electric operation. With a consumption of diesel just below 13m^3 a day.

If this data is annually aggregated, electric operation by the electric road means savings of 11.000 tonnes CO2 a year by reducing diesel consumption by 4.650 m^3 (22.300 barrels, 4.6 million liters).

Route	Number of trips a day	CO2 Diesel (kg)	CO2 Electric (kg)	Distance a day (10 km)	Liter diesel a day
50	150	11 715	726	1 500	4 630
100	90	10 544	653	1 350	4 167
150	45	7 029	436	900	2 778
200	15	2 929	182	375	1 158
Summa	300	32 216	1 997	4125	12 734

Table 6 shows total emissions per route and type of vehicle

In addition to the pure environmental savings electric operation entails, all other emissions from the exhaust pipes, such as NOx, are also eliminated. https://en.wikipedia.org/wiki/Nitrogen_oxide

Another valuable benefit is that the noise of engines is reduced in the flows where the vehicles are running, which is especially relevant in urban areas.

The environmental analysis is simplified. For example, impact of manufacturing of vehicles is not considered (only battery manufacture is included), neither are the environmental impact that the electric road itself entails.

8.2 Reduced investment cost through reduced battery size

By comparison, there is a clear breaking point between different scenarios when the electric road contributes to a reduction of battery size.

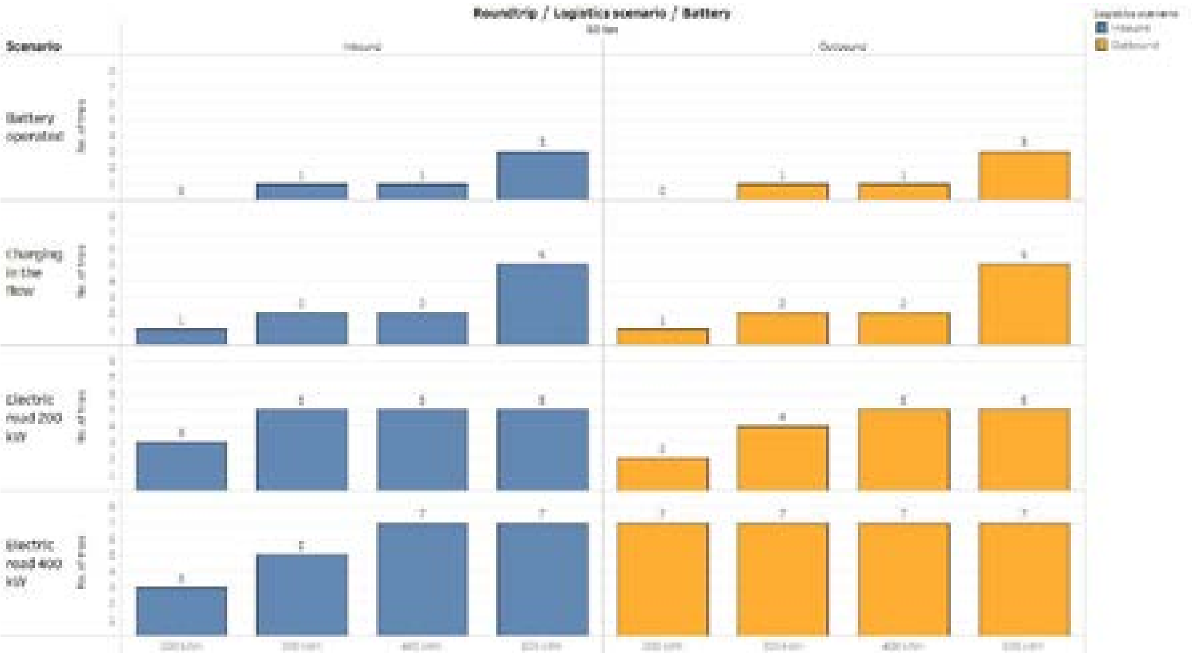


Table 7 shows how many trips can be compared in each scenario.

The table above shows, among other things, that:

- *the electric road in the 50-km route increases efficiency* while it is possible to *reduce battery size* from 400 kWh to 200 kWh in the inbound flow.
- *efficiency is unchanged*; however, battery size can be reduced from 400 kWh to 200 kWh in the outbound flow.

In comparison, with pure battery operation, an electric road enables a reduction of battery size from 800 kWh to 200 kWh without affecting the efficiency.

This means a **significant cost reduction and reduced environmental impact** as the vehicle fleet in this specific flow can be equipped with smaller batteries. By a normal 9 hours driving a day, 75 vehicles are needed to fully operate the flow (the 50-km route).

- A reduced battery size of 200 kWh in 75 vehicles means that an investment of additional 15.000 kWh battery capacity can be avoided.

- This means reduced investment costs of approximately 67 million SEK, in 2020 prices (with a complete battery pack mounted in the trucks)
- Reduced need of battery capacity by 15.000 kWh, equals 1.815 tonnes of CO_2

8.3 Cost savings due to increased number of trips

Counter arguments for electric vehicles are, for example: *"difficulty to plan charging in existing route planning"*, and *"the utilization rate of the vehicles decreases because of downtime needed for charging"*.

This can be partially avoided by charging during loading and unloading.

If loading and unloading time can be reduced by process improvements, time needs to be set aside for charging (downtime) if the vehicle cannot be charged from the electric road.

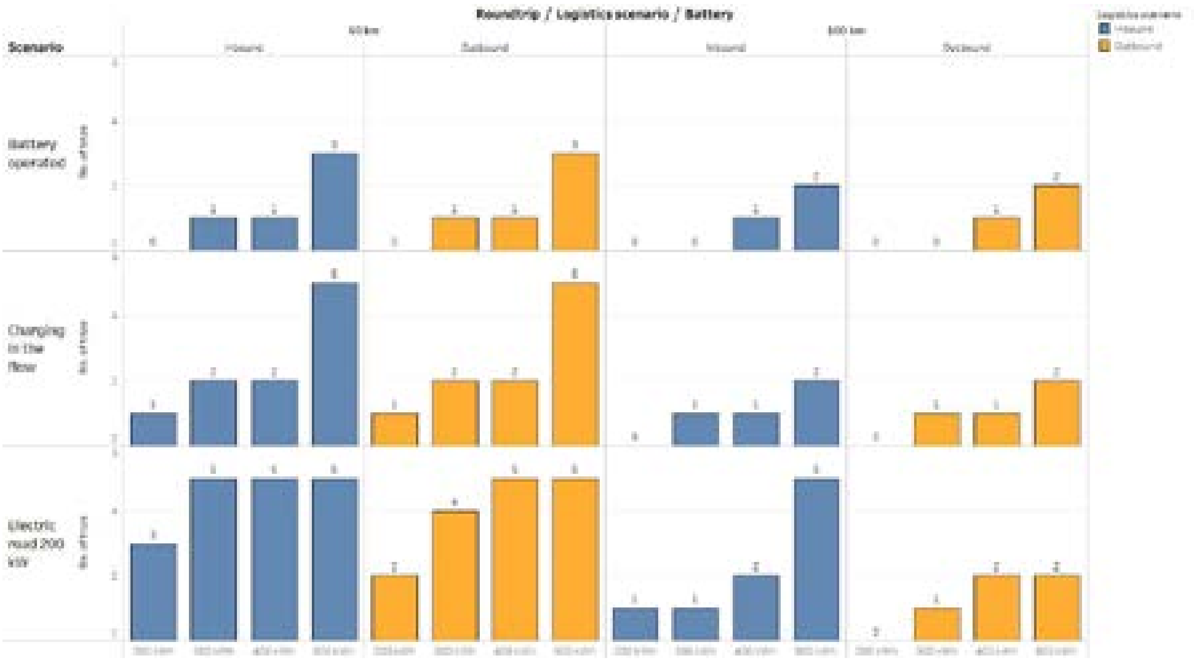
Table 9 shows the large difference between charging in the flow (at the customer location) and electric road charging in the aspect of increased utilization rate of the vehicle (more trips a day).

An electric road is a solution to reduce this impact and enables the vehicle to be used more hours without downtime while charging. However, it is difficult to quantify this effect and therefore needs to be examined for specific flows in more detail.

An electric road enables increased utilization and reduced battery investment costs as well as electric operation on a larger scale.

These factors combined makes it possible to present an appealing business case for electric operation.

Consideration also needs to be given to which transport flows the electric road intends to support and how it affects the vehicle fleet operating the different flows.



Tabell 9 shows the differences between stationary charging and electric road charging

8.4 Cost savings in electric operation

A major difference between electric vehicles and vehicles with internal combustion engines is the energy cost of propulsion. For a 40-tonne vehicle, in flows included in the analysis:

Electricity cost on average: 26.50 SEK /10 km

Diesel vehicles (average consumption 3.075 liters/10 km): 43.00 SEK /10 km

The 300 trips, covered in this analysis, results in a distance of 41.250 km per day, meaning an annual cost saving for electric operation of 24 million SEK, see Table 10.

Route	Number of trips a day	Distance a day (per 10 km)	Cost of electricity a day	Cost of diesel a day
50	150	1 500	39 750	64 500
100	90	1 350	35 775	58 050
150	45	900	23 850	38 700
200	15	375	9938	16 125
	300	**4125**	**109 312**	**177 375**

Table 10 shows electricity cost and diesel cost per day and route.

The largest positive gain in battery size from an electric road is on short distances (50–100 km). At 100 km, the electric road has a positive effect in the inbound flow, but no effect in the outbound compared to charging that takes place at the customer location in the flow.

In the longer routes, 150–200 km, the impact from the electric road has a certain effect on the number of trips, and in addition to some extent on the battery size. In the inbound flow in the 200-km route, an increase in power from 200 kW to 400 kW contributes to a reduction of the battery size from 800 kWh to 300 kWh, however the efficiency (number of trips) decreases from 2 to 1.

It is only at 800 kW output power that there is an impact on the number of trips.

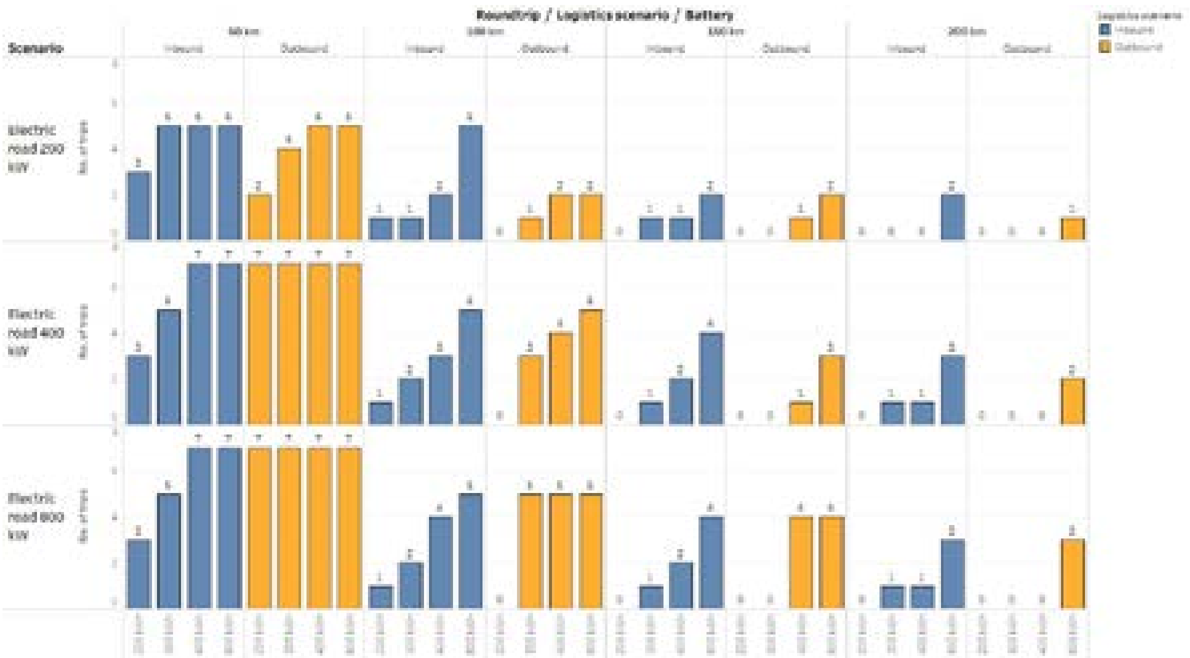


Table 11 shows the differences between different electric road effects

- Increased utilization rate (larger number of trips a day) is an important positive aspect of the electric road. Electric operation also is time neutral as charging takes place during transport.
- Increased output power, from 200 kWh to 800 kW, does not mean a significant increase in the number of trips. This is because the Time Cycle, and not charging, is limited already by 400 kW.
- Increased efficiency comes with an increase in charging power from 200 kW to 400 kW
    - For example: in the 100-km route, the number of trips increases from 1 trip a day to 3 trips a day in the outbound flow.

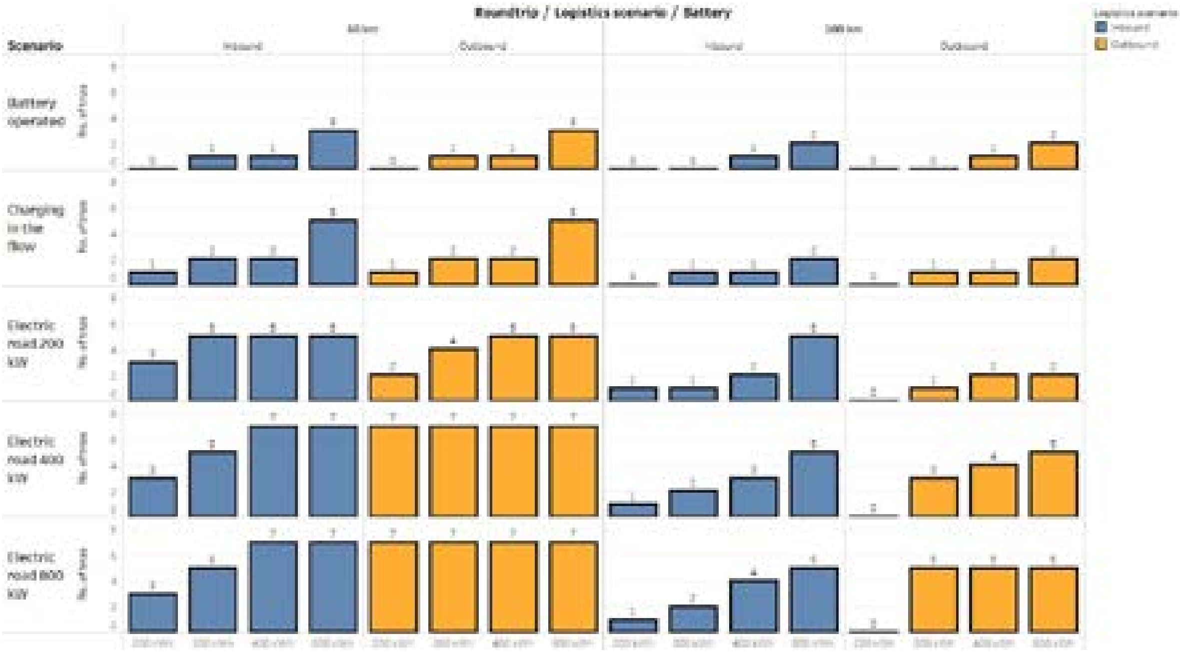


Table 12 shows the differences in the number of trips in different scenarios

The conclusion is, increased output power on the electric road (from 400–800 kW) has a certain impact on the number of trips that can be carried out per day, but do not affect the battery size.

8.5 Case study – Electric road 200 kW

In a comparison between battery operation with pure stationary charging and battery operation with supplementary dynamic charging on a 200-kW electric road, there is great potential when it comes to the possibility to reduce the need for large batteries on the vehicle.

The comparison should be seen in a perspective where a regional stakeholder takes responsibility for a centralized charging infrastructure to support the transition to electric transportation. The alternative is charging in the flow (at customer locations), but then additional investments in stationary charging infrastructure in the flow needs to be made.

In our calculations, the focus is not on the number of trips. With today's utilization rate it is unlikely that vehicles will operate 24/7. Still an electric road provides an increase in capacity (more trips with smaller batteries).

Due to high costs and environmental impact during production, you want to keep the battery size down. Therefore, 800 kW batteries are excluded in this example.

An electric road with 200-kW charging output power, and flows included in the 50-km and the 100-km route, show this result:

- the investment in vehicle fleet is reduced by up to 88 million SEK

- CO_2 emission from battery production can be reduced by approximately 2.300 tonnes

Route	50	100
Reduced battery size (kWh)	200	100
Number of vehicles	75	45
Costs (2020)	68 MSEK	20 MSEK
Environment (tonnes of CO2)	1.815	545

Table 13 shows reduced investment costs in batteries by an electric road

When comparing charging in the flow and an electric road of 200 km, cost savings will be the same as in the example above. Charging in the flow means that charging infrastructure needs to be installed at all customers´ in the flow, which is not an unreasonable assumption.

(Due to lack of data, there is no information on how many customers there are within the area of the 50-100 km routes. A complete cost calculation thus needs to include charging infrastructure at each customer, which have not been taken into account in this study).

Conclusion electric road:

- **Provides a large reduction of battery sizes**, compared to pure battery operation, as well as to if charging is added to the flow.
- The benefit of an electric road compared with charging in the flow is the increased number of trips per day. This is an important aspect to have in mind, as the investment in electric vehicles is initially larger.

9. Discussion, argumentation and reflections

9.1 Benefits and potential effects of an electric road between Hallsberg and Örebro.

- Contributes to a stronger business case for electric vehicles
  - Higher utilization rate (charging during operation)
  - Lower investment cost (smaller batteries)
  - Access to shared charging infrastructure (lower cost through higher utilization rate)
- Goods owners and forwarding companies within a radius of 200 km can use the electric road to electrify their transports to and from the Hallsberg terminal.
  - The electric road provides a centralized charging infrastructure that transporters in the region can use in their planning.

9.2 How electrification of shuttle traffic creates conditions for a national system (transit route), as well as customer data and potential cost distribution.

Electrification through an electric road for shuttle traffic as identified in this study, provides a basic ground for decision for a larger infrastructure investment on the route. Data are lacking to identify individual stakeholders, but the 300 trips analyzed in this study give an indication of the customer base and potential.

There is great potential in the electric road is reducing the investment cost for the electric vehicle fleet operating the shuttle traffic. With an active dialog with companies transporting goods in some form of shuttle traffic, a customer base can be established with a potential to bear part of the costs for the route.

The study shows that in a route of 50 km and 100 km, an electric road would potentially reduce the investment cost of batteries up to 87 million SEK, given today's battery prices (mounted in vehicles). There are clear financial incentives for companies with transport needs on this route to get involved in work connected to the electric road.

In the study, 15% of the heavy transports on the route were analyzed. The remaining 85% is defined as transit transports which can also benefit from an electric road. The total cost should not be borne by the 15% shuttle service transports. However, we judge that due to the conditions, companies within those 15% should be willing to bear part of the costs to get access to charging.

Trafikverket, the Swedish Transport Administration Authority, estimates the traffic is to increase by at least 48% towards 2040. This would most likely also create an increase in customer base.

An electric road could also stimulate the allocation of further logistics centers and central warehouses in the region, as existing infrastructure already attracts companies with large demand for transportation (domestic and export/import). This will probably affect the customer base and the number of users of an electric road for shuttle traffic.

9.3 Why Hallsberg – Örebro is suitable for an electric road pilot from a logistics point of view

The traffic volume within and through the region is large and, as previously mentioned, a further increase is expected. Data, validated in consultation with the Region Örebro County, shows the importance of existing freight volumes in shuttle traffic. A large part of these transports uses the short routes, 50 km and 100 km.

The route Hallsberg – Örebro is prepared to start already today with an electrification through battery operation with the support from batteries of 300 kWh and 400 kWh, with or without charging in a flow. A suggestion is to select a few specific flows and initiate a smaller fleet of electric vehicles for this purpose. This would provide valuable information on more accurate energy consumption, required adaptations in the logistic processes as well as on how charging via the electric road should best be performed. The vehicles could then later easily be converted to operate the electric road when installed.

There are no technical restrictions on starting electrification today, but the electric road will provide more profitable financial conditions for electrification. According to our experiences, an electrification through battery operation in corresponding flows will increase transportation costs with 10–20%. The additional cost is likely to decrease with an electric road installation as the degree of utilization (reduced with downtime due to charging), and the ability to drive longer routes without a need to upgrade the battery.

For example, table 14 shows that a vehicle with a 300-kWh battery can manage to drive the 50 km route and a vehicle with a 400-kWh battery the 50- and the 100-km route.

If charging infrastructure is activated, the utilization rate will increase considerably, from 1 trip per day to 5 trips per day with an electric road of 200 kW in a route of 50 km.

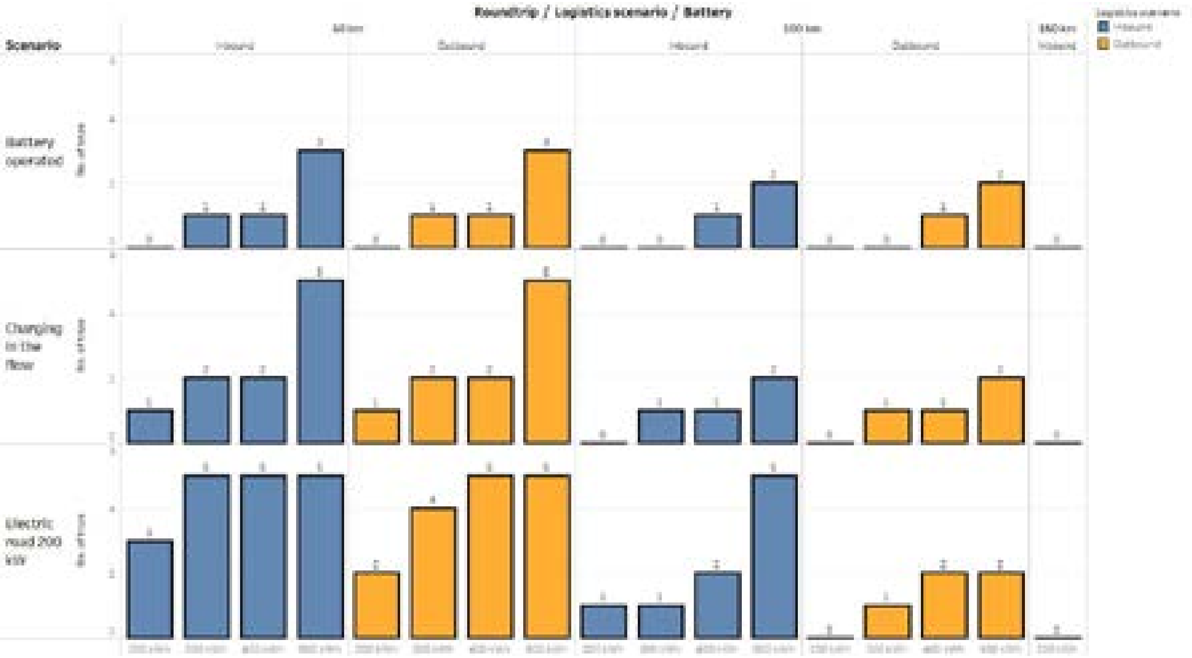


Table 14 shows certain transportation can be carried out with pure battery operation and then upgraded to an electric road.

9.4 Power consumption, need for shuttle traffic vs. a national system and future vehicle combinations

This study only focuses on shuttle traffic for regional transports.

An electric road between Hallsberg and Örebro can also be the first step towards electrifying larger parts of a national traffic infrastructure network. In Sweden, trucks and trailers with a total weight of 60 tonnes are dominant in long-distance transportation. There are a number of projects underway studying larger and heavier transports, i.e. High Capacity Transport, up to 90 tonnes (https://closer.lindholmen.se/closer-projekt/hct-demonstrationsprojekt). If heavier weights were allowed, in a shuttle flow it would mean for example, that two trailers could be connected giving a total weight of about 74 tonnes.

A clear goal with electric roads is also to contribute to the electrification of long-distance transportation. An electric road along the route Hallsberg – Örebro needs to be dimensioned for transport carrying a higher total weight.

Two factors need to be considered:

- what power is required to maintain the battery level?
- how far is the vehicle expected to travel after leaving the electric road?

In this analysis, we have defined fixed routes for vehicles in shuttle traffic, but we lack data to draw conclusions regarding long-distance transportation.

An example based on available data in the analysis shows a fully loaded 74 tonne vehicle consumes approximately 50% more energy than a fully loaded 40 tonne vehicle. This means that consumption is not linear and in longer heavy flows larger vehicles have advantages.

For a 40-ton vehicle, a charging of 120–150 kW is required to secure the battery not decreasing. The corresponding figure for a 74-tonne HCT vehicle is 220–250 kW. This means that the electric road charges a 74-ton HCT vehicle at all output power above 220 kW. An electric road of 250 kW is the minimum to guarantee that HCT vehicles can operate the distance.

The power probably needs to be significantly stronger, to be able to charge the batteries (not only keep them at the same level) and to compensate for eventual energy losses in the system.

In the analysis, distance up to 250 km has been analyzed (complete driving distance). A 74-tonne HCT vehicle requires a battery capacity of approximately 850 kWh to be able to complete the distance (fully loaded).

If the electric road between Hallsberg and Örebro should be able to charge a battery of this size on a distance of 21 km, an output power of approximately 2 mW is required during the 25 minutes when charging is possible.

The conclusion is that an extensive analysis of the logistics is necessary, as processes, flows, vehicles and electric roads all need to be included in planning.

One reflection, depending on the purpose of the electric road, it requires an output power from 200 kW up to 2 mW.

As the analysis above shows, an electric road with an output power of 200–300 kW has major positive effects for regional transportation in shuttle traffic. However, this might probably not be enough to support an electrification of long-distance transportation in Sweden.

Another conclusion is that the benefit for regional shuttle traffic transportation decreases at stronger output power (>800 kW), especially at distances up to 100 km. An interesting observation when discussing how a possible cost distribution should be conducted.

The system probably requires output power over 400 kW to support long-distance transportation, while regional transportation requires less output power.

Dynamic pricing and dynamic output power will therefore be required.

10. Conclusion and summary

An implementation of an electric road between Hallsberg and Örebro shows good potential and enables electrification of a large proportion of the shuttle traffic on which the analysis is based.

The greatest benefit of the electric road is the enablement of charging while driving, which increases the utilization rate of the electric trucks, while at the same time reducing the need for large batteries.

This effect is particularly evident in routes of up to 100 km from the electric road. In these routes, the analysis shows potentially reduced investment of up to **87 million SEK** for a vehicle fleet, and a reduced environmental impact of 2.300 tonnes CO2 due to smaller batteries.

If we look at the entire flow (all routes), an electrification will lead to annual reductions of:

Operating cost (derived from fuel)	**23 million SEK**
Reduced emissions of	**11.000 tonnes of CO2**

More thorough studies of the logistics are probably required to identify suitable flows in detail that can be electrified and connected to the electric road.

The Hallsberg – Örebro route can start electrification immediately and then be optimized with an electric road.

The cost structure for electric roads is not included in the analysis and should be considered when a total cost is to be calculated. Reasonably, there are additional costs for using the electric road. These costs must of course be included in the operational cost.

Service and maintenance of both the electric road and the vehicle fleet also have an impact on the total cost and can steer a business case in both a positive and a negative direction.

The assessment from our work with this analysis and report is that the route Hallsberg – Örebro would be a suitable pilot from a logistics and flow perspective. The customer base is large with suitable logistic flows within the geographical area that we have analyzed.

The conditions are good for electrification on this route, which can be established with existing technology.

As previously mentioned, this would certainly increase the attractiveness of the Region Örebro County as a logistics cluster and further expand a potential customer base for an electric road.

Postal address: Region Örebro län, Regionkansliet, Box 1613, SE-701 16 Örebro
Visiting address: Eklundavägen 2, Örebro **E-mail:** regionen@regionorebrolan.se
Phone: +46 (0)19-602 70 00 **Fax:** +46 (0)19-602 70 08 **Registered no:** 232100-0164.
www.regionorebrolan.se

CONTACTS:
Simon Jäderberg simon.jaderberg@regionorebrolan.se
Karin Wallin karin.wallin@regionorebrolan.se

Region Örebro län