REEL

Regional Electrified Logistics

A review of research projects, academic publications and perspectives of the industry on business models

2023:01

LINKÖPING UNIVERSITY

CONTENTS

REEL is a national initiative where leading Swedish players have joined forces to accelerate the transition to electrified emission-free regional heavy road transport

Within the REEL initiative, the parties establish, operate and evaluate around 60 different regional logistics flows for various types of transport assignments. REEL gathers transport buyers, freight forwarders and distributors, hauliers, terminal operators, charging point operators, grid network companies as well as suppliers of trucks, charging equipment, energy and management systems. In addition, regions, national authorities and universities participate in the initiative.

REEL receives co-funding from the Strategic Vehicle Research and Innovation program (FFI) through Vinnova, the Swedish Energy Agency and the Swedish Transport Administration.

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The REEL consortium consists of 45 organizations

The REEL project targets the over-all mission to significantly reduce CO_2, noise, particulate and gaseous emissions through electrification of regional road transport. It is centred upon performing demonstrations of regional electrified logistics systems. By developing and operating these demonstrations, insights are obtained on how different system concepts and architectures perform, need to be dimensioned considering the electric truck performance, requirement on charging, and iteratively need to be revised, in order to meet the logistics needs in a cost effective and energy efficient way.

Participating actors

ALLTRANSPORT
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BÖRJE JÖNSSON ÅKERI AB
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DHL
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Eriksons Åkeri Tomelilla
Falkenklev Logistik
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GLC Göteborgs Lastbilcentral
GTS Gods Transport Service
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VINNOVA Sweden's Innovation Agency

This review is part of the Swedish research and innovation project REEL and the work package on *Business and Financing Models*. Is is authored by Assistant professor Henrik Gillström at Linköping University (LiU). In the work package LiU collaborate with CLOSER, Einride, E.ON, Jula Logistics, Region Skåne, Scania, Vattenfall, and Volvo Group.

This review on business models consists of three separate parts; i) Review of research projects, ii) Review of academic publications, and iii) Challenges and trends from the perspective of the industry.

Image: Scania, Volvo Trucks

1 Background

This review is part of the Swedish research project Regional Electrified Logistics (REEL) and the work package 1.2: Business models and financing models.

Electrification of freight sector is a fast-developing area and viewed as an important step in reducing the sector's climate impact. However, there are several limiting factors that hinder large-scale transition. The REEL project, which focuses on regional electric deliveries, strives to build knowledge together with the industry and academia to overcome barriers surrounding the area. REEL is a national initiative and is led by CLOSER and is financed by the program strategic vehicle research and innovation (FFI). Well-thought-out business models and financing models are vital for any organization to secure long-term viability. Business models can be described as a plan for how organizations make business and with who, and include the value offered to the customers, who the partners are, and the cost structure. In the case of electrification of freight transport, business models have an important role since it addresses many of the uncertainties associated with the transition. For example, understanding the cost structure with higher investment costs, what type of value can be offered to the customers, and what role will new actors take in the transport system.
This review consists of three separate parts:

- Review of research projects
- Review of academic publications
- Challenges and trends from the perspective of the industry

The review addresses research projects that are similar to REEL, to investigate their focus and results. The review of academic publications is a structured literature review that aims to describe how business models have been considered for electrification of freight transport. The last section, challenges and trends from the perspective of the industry, addresses aspects that representatives from partner companies within REEL have highlighted.

1.1 Methodology

As presented in the last section, this review focus on the electrification of freight transport and business models. This means that the methodical approach is based around it and largely influences inclusion criteria of research projects and publications during the review.

Research Projects

The search for research projects was performed by using different national and international databases. The international databases used were TRID (from the transport research board) and the European commission's database over projects. The national databases were from financiers of research projects in Sweden: Vinnova, Energimyndigheten, and TripleF (fossil-free freight). As a complement, a workshop was held with representatives from partner companies within REEL to discuss the search strategy and to identify relevant research projects that they were aware of.

The project description was read for all identified research projects and an inclusion process was carried out to include projects that targeted business models to some degree. The projects did not have to solely focus on business models, but it had to be involved to some degree.

Academic publications

Scopus was used for the database for identifying academic publications. To capture the larger area of electrification, three different groups of search terms were used. Group one included search terms such as electric or synonyms, group two included search terms such as logistics or transport, and group three included search terms such as freight. To further specify the search, a fourth group was used to capture the area of business models.

The analysis of the academic publications was performed in two steps. The first analysis can be described as a descriptive analysis and focused on quantitative data such as the year of publication. This analysis was based on the larger area (i.e. the first three groups of search terms) and included 1025 publications. The second analysis can be described as content analysis and targeted electrification and business models. An exclusion process was carried out to remove publications that were not relevant. Similar to the inclusion process for research projects, the publications needed to address business models to some degree.

Challenges and trends in the industry

To capture the perspective of the industry, a workshop was held with representatives from partner companies within REEL. The workshop was based around certain themes and the discussions were guided by the involved researchers. The industry perspective was complemented with information from presentations of companies held within REEL.

Image: Volvo Trucks

2 Review of research projects

As a first step in the review of existing knowledge concerning electrification of freight transport and business models, it is of relevance to review similar research projects as REEL. The identification and analysis of similar projects shed light on aspects that have been studied before, important results and important areas that need to be addressed to accelerate the transition towards increased use of electric trucks. The area of business models for the electrification of freight transport is diverse and can be addressed from a multitude of different perspectives and angles, hence the importance to create an overview.

The review of research projects includes where and when the projects were conducted, the main actor in focus, and the main results and research questions. Furthermore, both national (Sweden) and international databases were used to identify research projects which led to most of the projects identified being performed in Sweden.

2.1 Identified projects

In total, 10 research projects were identified that targeted electrification and business models. The projects ranged in scope, type of transport system, and actors in focus. Table 1 presents the list of projects and table 2 shows the projects in relation to several aspects.

Table 1. List of research projects

Project name	Project number
Affärsmodeller för öppen plattform för delad laddinfrastruktur	P1
Affärsmodeller för framtidens hållbara logistiksystem	P2
Drive Sweden Business Model Lab	P3
Integrated Modelling Program and TCO Calculator for Battery-Electric Medium- and Heavy-Duty Truck Deployment in Regional Freight Use-Cases	P4
Assessment of Requirements, Costs, and Benefits of Providing Battery Charging for Battery Electric Heavy-duty Trucks at Safety Roadside Rest Areas Facilities	P5
Elektrifiering av tunga lastbilar genom smart samverkan i energisystemet	P6
Mobility Environmentally-friendly, Integrated and economically Sustainable Through innovative Electromobility Recharging infrastructure and new business models	P7
Öppen plattform för delad laddinfrastruktur	P8
A Comprehensive Cost-based Comparative Analysis of Different Last-mile Strategies for E-commerce Delivery	P9
Transportsystemets omställning och finansiering	P10

Table 2. List of projects with additional information

Project	Carried out	Main country	Project leader	Actors studied	Main focus
P1	2022-2023	Sweden	Chalmers	E.g. LSP*, energy companies, property owner	Shared charging infrastructure
P2	2020-2023	Sweden	Linköping University	Truck manufacturer, LSP*	Interplay between business models
P3	2019-2023	Sweden	KTH/ITRL	Unspecified	Shared and automated mobility
P4	2021-2022	USA	Georgia Institute of Technology	LSP*	Route optimization and TCO
P5	2021-2022	USA	University of California	LSP*	Charging infrastructure
P6	2021-2022	Sweden	Ecoloop	LSP* and goods owner	Local energy storage
P7	2018-2022	Spain	ETRA	Unspecified	Sustainable urban transport
P8	2020-2021	Sweden	Chalmers	IT company and goods owner	Shared infrastructure
P9	2019-2020	USA	University of California	LSP*	Optimization models
P10	20xx	Sweden	Göteborgs University	Unspecified	Financing models

** LSP = logistics service providers*

2.2 The identified projects: content and results

As shown in Table 2, the projects have different focuses and different actors in focus. A summary of each of the projects presented with their research questions and results, when available, is presented below.

P1 address one of the main limiting factors to large-scale implementation of electric freight trucks, namely the charging infrastructure. Extended use of electric trucks will pressure the energy systems and its infrastructure. Therefore, the project address how available infrastructure and future infrastructure for charging can be shared between users. Shared charging infrastructure, according to the project description, eases the planning of charging, can reduce cost, and increase the overall availability of chargers. Furthermore, the project strives to develop how business models can be formulated for shared infrastructure and consider actors such as LSP, energy companies, and property owners. (Chalmers, 2022a)

P2 is focusing on logistics business models and strives to create an understanding of how these models affect the current business models of truck manufacturers and LSPs. Furthermore, this project does not only focus on the business models of one company or actor but also on how business models of different actors can function together. The results from the project are expected to provide potential enablers on how to design future business models. (LiU, 2022)

The third identified project, P3, focuses on shared and automated electric vehicles and how this can affect business models. The idea is that new types of transport systems challenge existing systems where new actors and new roles of actors may lead to new or adjusted business models for organizations. Electrification also put new types of expectation on the transport system and combining it with shared and automated vehicles further push for the new transport system. The research project also functions as an incubator in the development of the different areas. (Drive Sweden, 2022)

P4 is the first identified project that does not have its lead organization in Sweden, since the project is led by researchers from Georgia Institute of Technology in USA. The project targets heavy transport in short and regional transport systems and especially focuses on the optimization of transport systems in terms of cost and vehicle emissions. (NCST, 2022b)

P5 is also a project led by researchers in USA but from the University of California. The business case in this project target roadside rest areas and how they need to be designed to meet future demands with e.g. chargers. The project target both how different locations are feasible for LSPs to use, but also the viability of using these stops for drivers. Some of the results from the project show that using trucks with a longer range (i.e. 600 miles, approximate 965 kilometres) is not feasible when it comes to fitting the battery in the truck while using a battery with a lower range (300 miles) is possible if the batteries can be charged at rest areas. If charging stations along highways are used, the results point to that the cost of operating charging facilities can be relatively low and that the whole TCO for a 300 miles range trucks can be cheaper than diesel trucks. (NCST, 2022a)

The sixth identified research project, P6, tested cases with electrified trucks and calculate the environmental impact, as well as, energy consumption. In their cases, they used local energy storage to charge the trucks to ease the usage of the power system, and to create scalable solutions. (Energicentrum Gotland, 2022)

P7 was primarily executed in Spain and targeted both electric personal vehicles and electric freight trucks in urban areas. The project strived to create a platform (including the design of business models) for sustainable urban mobility. To investigate the feasibility of mobility solutions, business cases such as low emissions hubs, E-car sharing, and smart charging were used. (MEISTER, 2022)

P8 also highlight the lack of charging infrastructure and focus on how shared infrastructure of charging can be an important enabler for the large-scale transition to electrified freight transport. Within the project, an ICT platform was developed which connects the owner of goods and LSPs to create a more open system with data shared among actors. The platform could enable cost sharing and increased efficiency of the transport which could enable optimal utilization of infrastructure for charging. (Chalmers, 2022b)

P9 targets sustainable urban freight from the perspective of LSPs, where electrification is one potential solution among others. Cost calculations are used together with sustainability outcomes to mathematically compare different strategies. The main objective is to create an optimization models that can be used to evaluate different strategies. (NCST, 2022c)

The last identified research project, P10, takes a more financially oriented perspective and targets how investment, such as the electrification of freight, can be financed in the transport system. It is highlighted that even if many uncertainties exist when it comes to investment, the system must handle costs and risks. The project aims to understand the challenges and identify opportunities for financing in the transport system. (GU, 2022)

2.3 Summary of the reviewed research projects

With only ten projects identified, it is difficult to identify trends between the projects, however, it is worth noting that logistics companies (or LSP) is the actor that is most reoccurring as the main actor. Furthermore, charging infrastructure, and especially how the infrastructure can be shared has gained much interest. Most of the projects have their project leader in Sweden, which is not that surprising since most databases used for the search are indexing Swedish projects. It is interesting to note that there a lack of publicly available documentation related to the different projects. This is likely due to results ending up in academic journals or conference proceedings, instead of reports that summarize the results. Even if most projects have one or more actors in focus, there is a need to expand the research and include multiple actors in the research. The freight transport system consists of multiple actors and when transitioning to electric trucks new actors such as grid companies and energy companies are included in the system. Hence the need to take a system perspective to understand the relations between actors and how they affect each other. This is vital to design business models since the current models are expected to change.

3 Review of academic publications

Electrification of freight transport is an area that has also risen on the research agenda, especially due to the fast technology development. When new technologies become more technology ready, it is important to also consider the system readiness. System readiness include aspects such as the design of functioning logistics systems and business models. Adopting business models, for example, is a vital part of system readiness, i.e. having parts that work together to create a functioning system. This review of academic publications targets electrification of freight in combination with business models since it is important to understand what has been published within the area and in turn provide insights on system readiness.

The two upcoming sections present a descriptive analysis and a content analysis. The descriptive analysis considers a wider search of electrification and freight (business models was not a criteria). This analysis focus on more quantitative measures, such as the number of publications per year and publications per university. This section also presents an analysis where the electrification of freight is combined with a logistics perspective to shed light on aspects that are of relevance.

The content analysis is a more in-depth analysis of the content in the identified articles that target electrification and business models. In this case, the selection of articles includes business models (and synonyms) as search terms.

3.1 Descriptive analysis

The search results show that the area of electrification of freight transport is growing fast. In total, 1025 articles were identified, where 45% were published in the last 5 years and 70% during the last 10 years, and this is illustrated in Figure 1 below. This is no surprise, however, since authors such as Macharis et al. (2013) and Figenbaum and Kolbenstvedt (2016) early pinpointed electrification of freight as an important step in reducing the sector's climate impact. As the development of vehicles and batteries moves forward, more and more attention is directed to electrification as a real competitor to today's conventional freight vehicles. This means that the number of publications is expected to continue to rise.

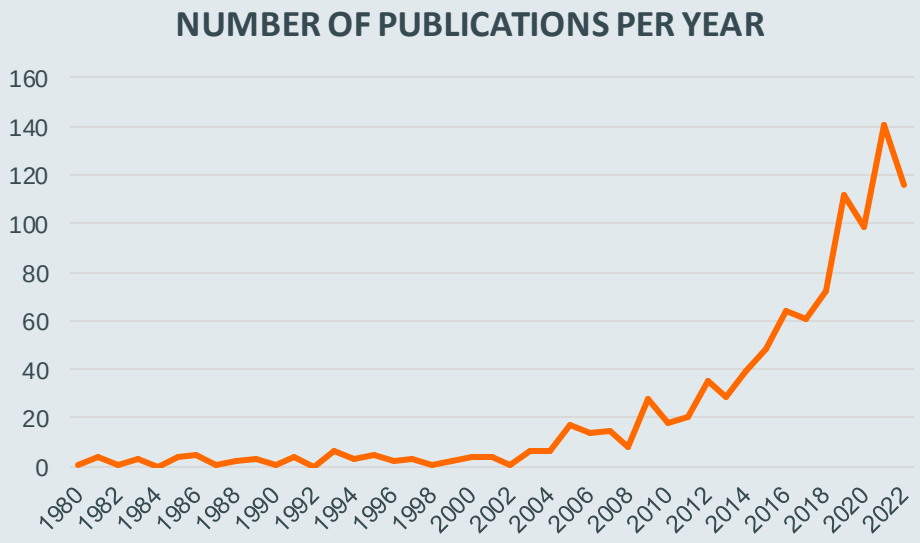

Figure 1. Number of publications per year

When it comes to the origin of the lead author, Figure 2 below shows that large countries are responsible for a large share of the publications with the United States, Italy and Germany at the top.

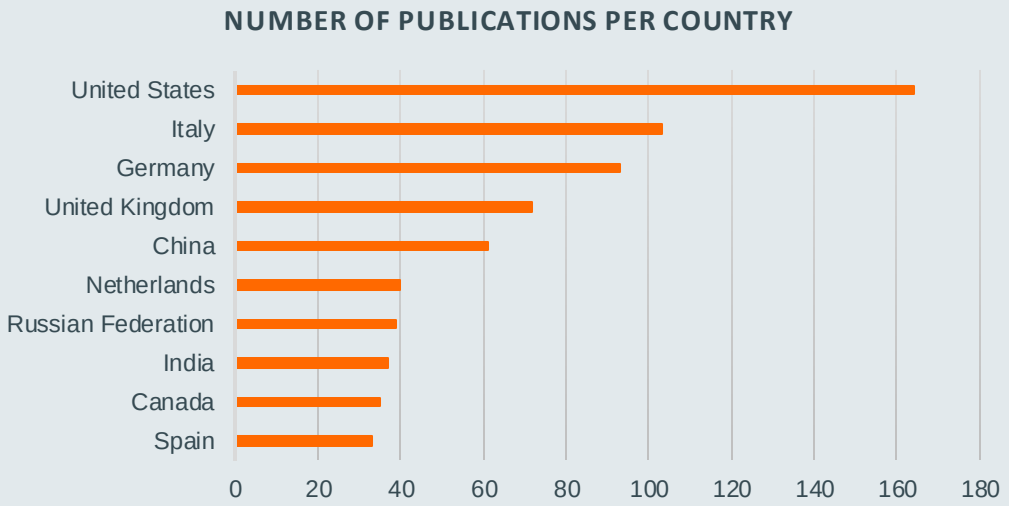

Figure 2. Number of publications per country (only the top 10 countries are shown)

However, regarding publications from individual universities, which often indicated specific research groups, Figure 3 below shows several universities in Belgium as prominent within this area.

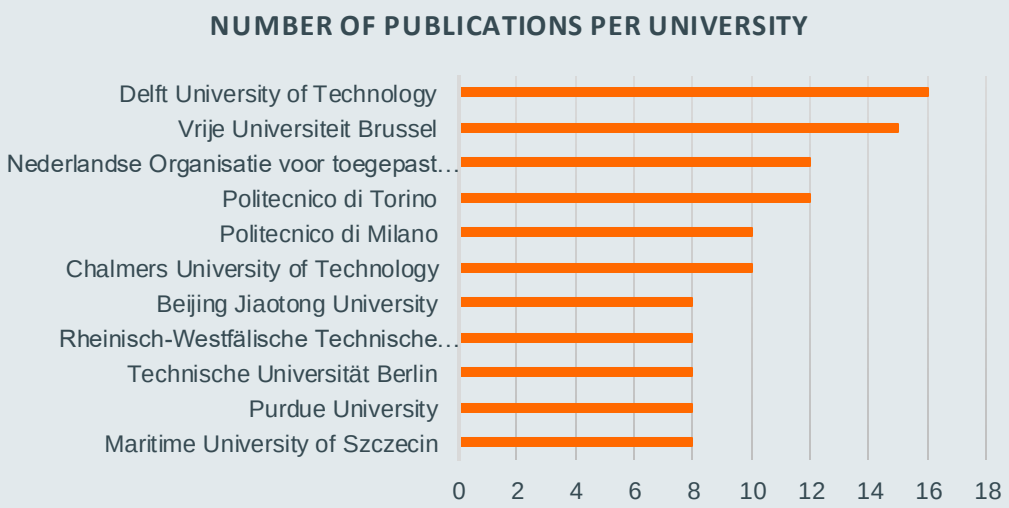

Figure 3. Number of publications per university (only the top 10 universities are shown)

Different transport systems

Based on an analysis of the abstracts of the search results, the results point to a large focus being on urban transport systems and light freight vehicles (below 3,5 tonnes). More than 50% of the articles focus on urban transport. This can be explained by the technology for electric vehicles operating in urban areas being more developed compared to regional or long-haul deliveries. The investment cost for smaller electric trucks is also closer to similar-sized conventional trucks (Dong et al., 2018), whereas the investment cost for electric heavy trucks is often highlighted as a large barrier (Samet et al., 2021; Schiffer et al., 2021). Furthermore, the limited range of electric vehicles is not as large of an issue for urban deliveries since delivery routes are usually relatively short compared to longer delivery routes (Hovi et al., 2019). Worth noting is also that in many cases is it not clear based on the abstract what type of transport system is in focus, i.e. the remaining articles do not solely focus on regional and long-haul transport.

Logistics perspective

Applying a logistics management perspective (logistics management can be described as performing activities in a supply chain effective and efficient in a cost-effective manner, CSCMP, 2022) is of great relevance in the freight industry and concerns most of the actors. Logistics aspects such as performance in terms of delivery reliability and lead times are often viewed as competitive advantages in the industry. Hence, understanding how electrification of trucks affects logistics management is important for companies since it can have large effects on the design of their business models and financing models. Gillström et al. (2022) performed a systematic literature review where terms such as electrification, freight, and logistics were used for the search. The paper aimed to map the area, identify what has been published, what has been the focus of the articles, and identify gaps in the literature.

The descriptive results from the article (Gillström et al., 2022) show similar tendencies as presented above; many of the articles have been published during the last decade and a large focus on urban transport systems. Other interesting results from the include that 79% of the identified articles used transport data (e.g. driven kilometres) as the primary data source and the second most common method for data collection was data from reports and papers. This is interesting to note since only 17 out of 62 articles used primary data for the data collection. This means that the vast majority of the publications based their analysis on second-hand information, i.e. information potentially collected with another purpose. One reason for this can be explained by the method used for the analysis, where the most common method was mathematical modelling. Mathematical modelling is based on quantitative data where the data is often from previous work. Even so, it is of interest to note that very little focus has been on more qualitative data collection methods and analyses. This is also evident when it comes to the type of actor that is targeted in the articles reviewed. The most reoccurring answer was that "no actor" was studied which further highlights the lack of actor perspective.

3.2 Content analysis – Business models and electrification

The content analysis is based on publications that targeted a combination of electrification, freight, and business models. This analysis was expected to pinpoint the gaps and highlight existing knowledge. However, the review showed that very few articles have been published within this area. After the inclusion and exclusion process, only 13 articles remained (out of 1025). This is far too little of a sample to make any useful generalizations of the area or any identification of trends or sub-areas. Furthermore, out of the few identified articles, there was little focus on explicitly studying and analyzing how to design business models or how existing business models are affected when transition to electrified freight. Due to the low number of publications identified, the content analysis highlights a few examples that focused more extensively on business models, and those are presented below.

Lind and Melander (2021) targeted business models for truck manufacturers from a network perspective. Contrary to most identified articles, this one used interviews and workshops as the main sources for data collection. They used a framework to classify business models into stable, established, and emerging models. The authors noted that truck manufacturer strives to move from stable to established ones since it can lead to improved relationships with customers and collection of data through a more connected network. For emerging network business models (which could include automation and electrification), the authors highlight big data and data sharing as important resources and activities.

The second article, Teoh (2022), targets how different charging strategies affect logistics companies' business models. The author lists several aspects that need to be considered when addressing charging strategies and the effect on business models: location of battery during charging, the motion of the vehicle during charging, charging interface, charging power, and charging modes. The four charging strategies studied were downtime charging strategy, opportunity charging strategy, intrusive charging strategy, and emergency charging strategy. The main results concerning business models are how different strategies affect logistics companies' business models. For example, how do companies value cost versus logistics performance since it can heavily affect charging behaviour and in turn the need for charging.

Monios and Bergqvist (2020) present a conceptual framework for smart network business models, and they focus on electric autonomous vehicles and mobility as a service. The authors highlight three types of business models: The traditional ownership model, network operator emerges, and smart network. One large difference between the models is that the ownerships of the vehicle shift between actors, i.e. from transport providers in the traditional arrangement to the network operator. Another large difference is the use of data and how it is shared. The authors argue that traditional logistics companies might "be squeezed out of the market" and instead be replaced by network operators, which can be a new actor or a previous actor taking on a new role in the system.

3.3 Summary of the state-of-the-art

The To summarize, instead of identifying major trends and making a generalization based on the sample, it is very evident that business models have not been considered for electric freight and this is a huge gap. Design functioning business model is vital for most organizations (Osterwalder et al., 2005) and this is especially true in a transition since organization need to see that the whole system work.

In Gillström et al. (2022), a research agenda is presented. Even if the article focuses on electrification from a logistics perspective, similar gaps can be identified in electrification and business models. The proposed research agenda can therefore also be of relevance from a business model perspective. The full research agenda is presented below but more information on the areas can be found in Gillström et al. (2022).

- Expand the scope of methodologies applied, especially to more qualitative ones;
- include primary data to a larger degree;
- include actor perspectives to a larger degree;
- include organisational aspects, such as collaboration and change of roles of actors;
- include logistical aspects in both empirical data and output;
- include change of payload capacity and its effects;
- include a larger focus on the positive effects of BEV and quantify them, and;
- expand the scope of studied transport systems and the size of vehicles.

Image: Scania

4 Challenges and trends from the perspective of the industry

The previous two chapters addressed reviews of research projects and reviews of academic publications. This chapter takes a more direct approach and presents challenges and trends based on industry representatives. All the representatives represent an organization that is a partner in REEL, and the organizations range from logistics companies, truck manufacturers, energy companies, municipalities, etc. The information presented below is a compilation of workshops and presentations held within REEL. Three separate areas are addressed: Charging infrastructure, actors and relationships between actors, and operative planning of the transport system.

4.1 Charging infrastructure

Instalment of chargers at logistics companies' facilities is viewed as a must to have the trucks fully charged before assignments. However, there is also a trend to having chargers installed at unloading ports at delivery locations. This enables the trucks to be charged during unloading and loading activities which can, at best, eliminate extra standstill times, even compared to diesel trucks. For a single logistics company, it is important to identify customers and routes that are very frequent to achieve a high use rate of the chargers. High utilization rate is important to achieve scale of economic. The utilization can also be increased if multiple logistics companies use the chargers. However, such arrangements require coordination and collaboration between both the receiver(s) and different logistics companies, especially if the investment cost of chargers is expected to be shared between actors.

Charging at receivers also has the potential downside that it can create uncertainties about how the energy price differs between locations at different receivers. To explain, at logistics companies' facilities, they or the property owner oversee contracts with electric suppliers, and they are aware of the price. This control is lost for chargers at other locations. The energy price can also differ greatly between different parts of the country, which can make it more complicated. Furthermore, the type of goods transported is also needed to take into consideration since the unloading times need to be long enough to charge the batteries sufficiently.

In the example above, the chargers are classified as private charging infrastructure since the chargers are placed at private properties. Public infrastructure is another type of charging solution, where the chargers can be used by any company, for example, a public charging station beside a highway. Such chargers could be used for longer delivery assignments where the trucks need to be charged during the assignment. Currently, there is a larger potential to receive financial support when building public charging stations compared to private ones. However, there exist uncertainties about how logistics companies choose charging strategies. Currently, many logistics companies lean towards the use of only private charging, especially for urban and regional deliveries since the standstill times can be kept low. When public chargers are used, logistics companies note that there is an evident risk for longer delivery times, especially if queueing for chargers is a factor. In other words, when planning routes to electrify there is a need to understand its characteristics and how the delivery performance is affected.

Another important choice for chargers is the use of fast or slow chargers. Fast chargers have the benefit of charging batteries faster but is often associated with higher investment cost and the risk of wearing out batteries faster. Destination charging (i.e. charging at logistics facilities) is more likely to use slow charging, compared to opportunity charging (e.g. at public charging stations). Thus, the ability to charge batteries fast does not always match the actual need to charge fast.

4.2 Actors and relation between actors

Actors and relations between actors are central parts of organizations' business models and electrification of freight can challenge current systems. One main difference, compared to conventional transport systems, is the inclusion of new actors such as grid operators and energy companies. Even if similar roles exist in conventional systems (e.g. fuel stations), the 'new' actors need to find their role in an industry that they have historically not been part of.

Another actor that has drawn much interest is the property owner of logistics facilities. Many representatives noted that the facilities need to be upgraded to also include charging stations. This mainly applies to facilities rented by logistics companies since the electric trucks need to be charged before driving assignments. It can also include the customers' (i.e. receivers of goods) facilities since having chargers available at unloading locations can reduce or eliminate time losses for logistics companies. A few challenges arise when chargers are installed at facilities. For example, the life expectancy of chargers is usually longer than the lease contracts which creates uncertainties about how the cost for chargers should be divided but it can also limit how the facility can be used in the future. On the other hand, offering chargers to new tenants can be a good selling point.

Another aspect that is evident from the companies that currently are operating electric trucks is that many of them describe the relationship with their customers more as a partnership. For example, the operator worked together with their customers to try to find delivery routes that fit electric trucks with their limitations.

4.3 Operative planning of transport system

A transition to electric trucks for distribution also challenges the operative planning of transport systems where, for example, limitation on battery capacity and the need for charging put different requirements on the system compared to a conventional system. The potential to install chargers at delivery locations was covered in previous section, and this can largely influence how routes are planned. Furthermore, the route planning is likely going to be based on the state of the battery. This can also be combined with cost parameters of energy since the cost of charging can change during the day. In other words, the route planning for electric trucks is far more complex and requires new calculation models, and this can lead to a paradigm shift in the logistics industry.

One way to handle the increased complexity of planning the daily operation of freight deliveries is to increase digitalization in the logistics industry. In other words, to use computers to make decisions. This in turn sets requirements for the availability of data and data sharing between companies. Data that need to be handled include, for example, available chargers, what charging effect can be expected at different locations, how the wind blow, uphill and downhill slopes. This is needed to both secure that the trucks can arrive at their locations in the most efficient matter and reduce costs as much as possible.

Another aspect is the uncertainties of different choices, including choice of vehicle technology and choice of charging strategies. The vehicle technology includes battery electric trucks with stationary charging, use of battery swapping (i.e. swapping out depleted batteries for fully charged ones), use of biofuels or use of fuel cells. The uncertainties lie in knowing what technology to invest in and investing in the 'right' technology for logistics companies. Furthermore, the investment cost for electric trucks is much higher, compared to conventional vehicles, which also put pressure on making the 'right' decision. Even if the investment cost is higher, electric trucks have the benefit of having lower operational costs, fewer maintenance costs, and an expected longer life span.

4.4 Summary

The sections above highlight some of the challenges that exist when transitioning to electric freight systems, but also how the area is developing. When using electric trucks, how and where to charge them is a central question. Having the opportunity to charge at delivery locations can be vital since it eases the planning of routes and can reduce the standstill time of the vehicles. On the other hand, this requires collaboration and understanding between different actors and how responsibilities and costs can be shared. Another important point is the need to create an understanding of how different types of routes fit to electrify. The examples above highlight different aspects, for example, the type of goods, the range between delivery locations, the complexity of planning, the price for charging, sharing of data etc. Multiple different aspects need to be taken into consideration and many of them include different actors, which further highlight the need for actors to cooperate to achieve efficient and cost-effective electric logistics systems.

5 Conclusions

This report addressed the electrification of freight trucks and business models in three different streams of information: research projects, academic publications, and insights from the industry. This is an area that is under fast development where the technology and industry are developing simultaneously as academic projects and studies. This is reflected since publications are lacking, with only 13 publications identified that combined business models and electrification of freight. In a wider context, publications on electrification have mainly targeted mathematical modelling and simulations based on quantitative transport data. This transport data has often been based on secondhand information from other studies and reports, as well as generic road data. This calls for more research and projects that apply more qualitative methods, such as interviews and workshops, on real transport systems with actual electric trucks operating. This is important to understand how different actors are affected, which can largely affect their willingness to work in electrified transport systems. The review of research projects shows that actors have been included to a larger degree compared to the publications, especially logistics companies. However, the report and results are often not publicly available. Even though logistics companies is the actor that has been targeted the most, there is a need to continue to study them, especially to use different approaches, and target how their operation is affected. Furthermore, it is evident from the industry perspective that different actors need to collaborate to find viable solutions, and this is heavily lacking in current academic publications. Therefore, researchers should not only target specific actors but also the relationships between actors, how they can collaborate, and build an understanding of how the larger system is affected.

The lack of focus on business models has been mentioned already, and this can also be addressed at different levels. For logistics companies, there is a need to construct models and identify which parts that are critical. From a system perspective, building similar models is important to create a mutual understanding of the systems, identify which parts are critical, build competence in how to handle complex parts, and target how actors can collaborate. Based on the review of projects and academic literature, these areas are lacking, and future research needs to target this, especially since having well-thought-out business models is vital for most organizations. Creating business models and models for the larger system can be important catalysts for the large-scale implementation of electric trucks.

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