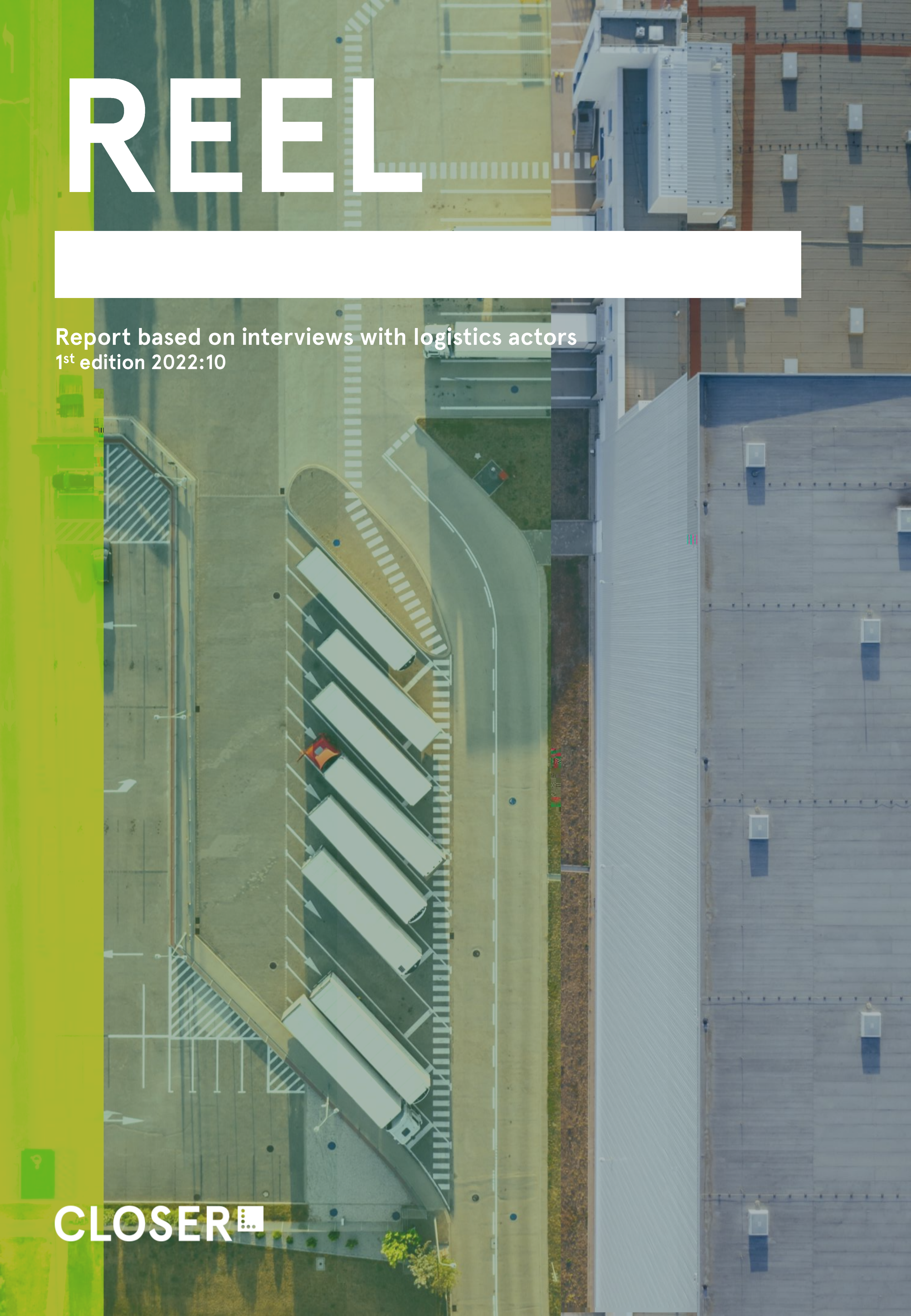
REEL

Report based on interviews with logistics actors

1st edition 2022:10



CLOSER

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.

www.closer.lindholmen.se/reel

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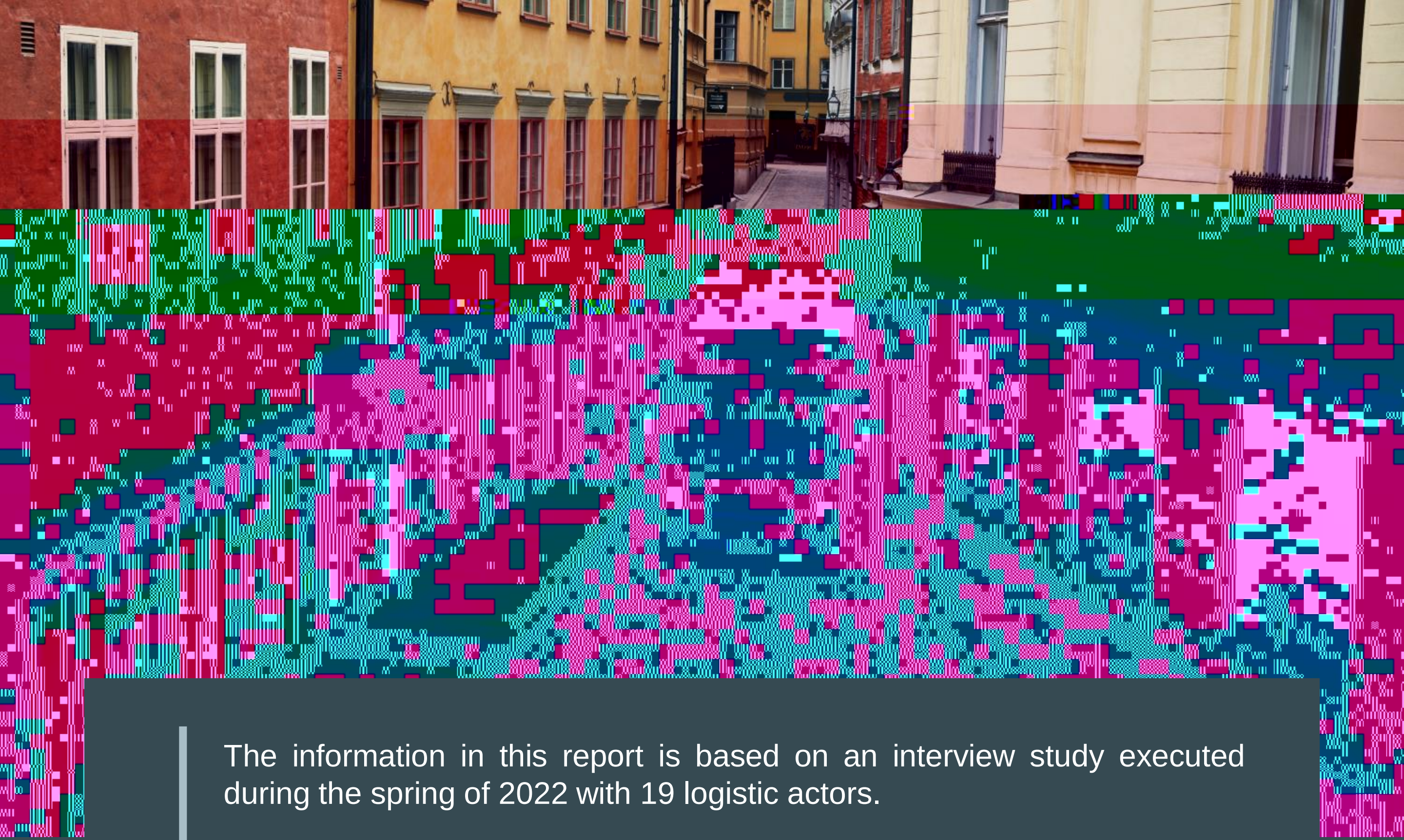


The information in this report is based on an interview study executed during the spring of 2022 with 19 logistic actors.

The interviews have been performed by CLOSER at Lindholmen Science Park in a semi-structured manner covering the following aspects: general organizational info, logistic & operational set-up, hard- and software specifications, policy, business models, working environment, system architecture, and scale-up potential.

The 175 interview questions were designed in collaboration between CLOSER and the academic partners participating in REEL i.e. Chalmers, Linköping University, and Lund University.

Business critical information obtained in interviews has been aggregated and filtered.

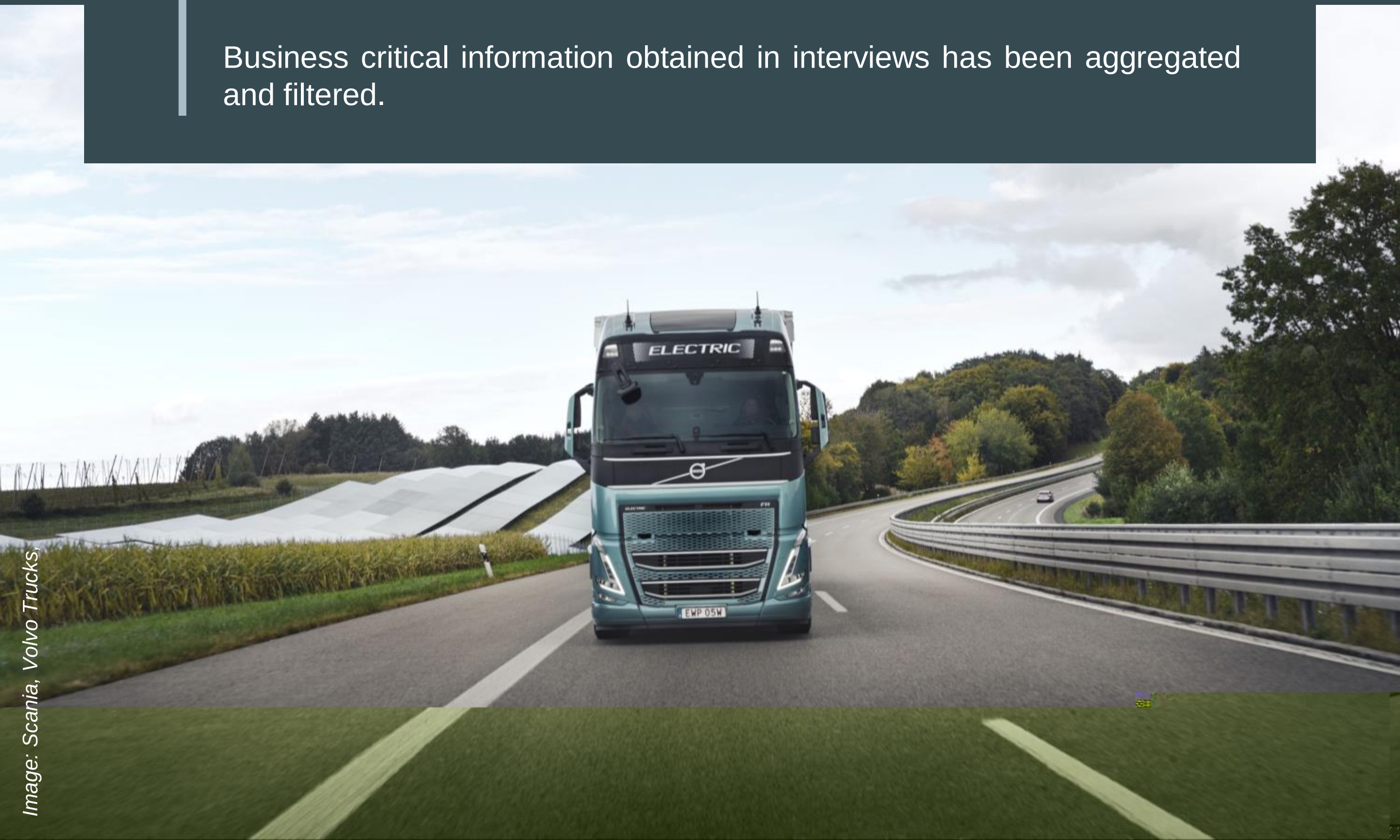


Image: Scania, Volvo Trucks.

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
NEW BOLIDEN
BÖRJE JÖNSSON ÅKERI AB
DAGAB
Derome
DFDS
DHL
elis
einride
e.on
Erikssons Åkeri Tomelilla
FALKENKLEV LOGISTIK
FLYGFRAKT
FORIA
GDL
GLC GÖTEBORGS LASTBILCENTRAL
GTS Gods Transport Service
Höganäs
ICA
JULA LOGISTICS
LBC frakt
martin&servera
M-Lab
NÅ Nordisk Återvinning
postnord
Polfärskt MILJÖSMART SAMDISTRIBUTION
Renova
RAGN-SELLS
SCANIA
SWEROCK
Söderenergi
UME ASSISTANCE
VATTENFALL
VGT Göteborg AB
VOLVO
WIBAX
Region Halland
REGION SKÅNE
VÄSTRA GÖTALANDSREGIONEN
CHALMERS
LiU LINKÖPINGS UNIVERSITET
LTH LUNDS TEKNISKA HÖGSKOLA
Swedish Electromobility Centre
CLOSER

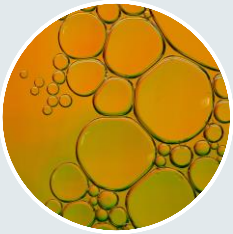
Public co-financing

FFI Fordonsstrategisk Forskning och Innovation
Energimyndigheten
TRAFIKVERKET SWEDISH TRANSPORT ADMINISTRATION
VINNOVA Sweden's Innovation Agency

The logistic solutions in REEL are designed for various types of goods

Ash
see Ragnsells and Foria p. 27

Building material
see LBC Frakt p. 21, GTS p. 17



Chemicals
see Wibax p. 30

Concrete
Will be covered in next edition of this report

Containers
see Alltransport p. 7, Jula Logistics p. 19

Excavated material
Will be covered in next edition of this report

Food
see Dagab p. 8-10, Erikssons Åkeri i Tomelilla p. 15, GLC p. 16, ICA p. 18, Martin & Servera p. 22, Polfärskt p. 24

Iron ore
Will be covered in next edition of this report

Pallets and parcels
see DFDS p. 11, DHL p. 12-13, GLC p. 16, GTS p. 17, Postnord p. 25-26

Textiles and laundry
see ELIS p. 14

Timber
Will be covered in next edition of this report

Waste and recyclables
see Nordisk Återvinning p. 23, Renova p. 28

Image: Unsplash

The transport flows in REEL are spread across Sweden

In the REEL project the parties establish, operate and evaluate around 60 different regional logistics flows in various types of transport assignments. In this edition of the report we cover 41 of the flows. The geographical location of these flows are presented in the map.

Image: Scania, Volvo Trucks, Einride

AL[redacted]SPORT

Vehicle	SCANIA P230 BEV 4x2, 300 kWh
[redacted]	Tractor
Total weight	**29 t**
Type of goods	**Containers with consumer goods**
Charging	**At home depot** (**33 kW**)
Localization	**Norrköping**

Image: Scania

DAGAB

DAGAB delivers to supermarkets around Sweden. Two demonstrators are performed in the project: one in Greater Stockholm and one in Västra Götaland County.

Greater Stockholm Demonstration

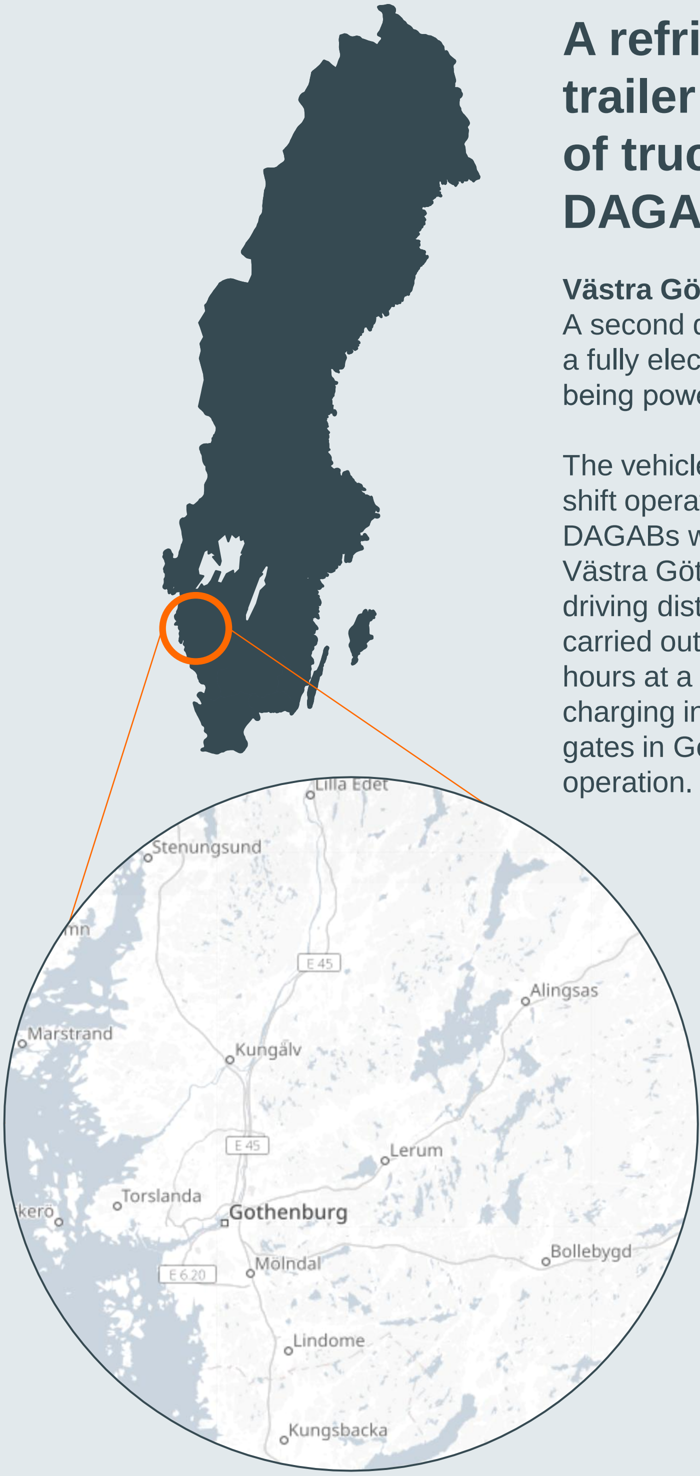
When designing this demonstration, DAGAB wanted to explore ways to utilize the trucks as much as possible to reduce the cost per km. In order to achieve that, the possibility of providing additional charging during unloading and/or reloading were seen as a possibility. Two trucks were put into operation, a plug-in hybrid (PHEV) and an all-electric truck (BEV, rigid, 6x2 * 4, 28 tonnes, 300 kWh). The trucks deliver chilled and frozen food, thus the total energy demand of the vehicles consists propulsion of the truck and operation of cooling units.

A 175 kW high-power charger was installed between two loading gates at DAGAB's warehouse in Jordbro, where both trucks return several times a day for reloading. In addition, two night-chargers of 22 kW each were installed at the parking lot at the warehouse premises where the vehicles are parked from around 22:00 to 05:30. By charging during reloading for about 30-45 minutes logistics losses were minimized while total daily mileage was increased. It also enabled two-shift operation with 2-3 rounds per shift, with a total daily mileage of around 350 km per vehicle. The charging station at the loading gates was also dimensioned to be able to meet future needs from external hauliers, with electrified transports, also serving the DAGAB warehouse. Prior to the installation of the charger, the insurance company of the warehouse facility demanded additional measures with regards to fire safety. The insurance company required some adaptation of the gate to minimize the consequences in the event of a fire while charging the truck. The following adaptions therefore had to be made: fire-resistant surface on the gate and absence of fire-sensitive construction closer than 10 meters from the charger, fire alarm with smoke detectors and sprinkler system in the gates, and emergency exit to prevent drivers being trapped in the gate in case of fire and fire blinds to prevent the fire from spreading.

The actual consumption for the BEV is about 1.25 kWh/km and the truck has a range of about 180 km on a single charge. For the PHEV, the combustion engine's fuel consumption was reduced by about 30% by using electric power as a complement to HVO and RME during the distribution round in the city and by being able to utilize braking energy to charge the batteries during operation. Apart from plugging in and out the charger the operation has been carried out in the same way as with a conventional vehicle.

Image: Scania

A refrigerated rigid truck and trailer is the most common type of truck being operated by DAGAB around Sweden.



Västra Götaland County Demonstration
A second demonstration by DAGAB and Scania will test a fully electrified rigid truck and trailer with cooling units being powered by the vehicle's and trailer's batteries.

The vehicle is planned to be operated in two to three shift operation each day performing distribution from DAGABs warehouse in Gothenburg to grocery stores in Västra Götaland, starting Q3 2022. The daily estimated driving distance is 250-300 km. Charging is going to be carried out during on- and offloading, for around 1.5 hours at a time as well as between the shifts. The charging infrastructure will be installed at the warehouse gates in Gothenburg prior to the start of vehicle operation.

Vehicle	SCANIA 6x2 (Prototype)
Body	**Refrigerated rigid truck and trailer**
Total weight9	

DFDS

The aim of the demonstrator is to study electrified "just in time" transports, between logistics terminals and factories.

In the demonstrator a repetitive "hub to hub" transport is performed between Hisings Backa and Tuve in Gothenburg. The truck runs 4 to 6 laps per day and the total daily mileage sums up to 180-250 km. As a next step, a second shift in the evening with more varied and longer flows will be added.

Between shifts, DFDS plans to charge the vehicle with DC at high power. Based on available battery capacity, the energy consumption for two shifts, downtime, etc., a charging concept was designed consisting of a 350 kW charger at DFDS´s terminal in Arendal. The high charging power was chosen to be able to quickly charge several future vehicles in sequence between shifts to get a high degree of utilization of the vehicles.

The charging station is designed to meet DFDS's requirements of being placed at a suitable distance from buildings to minimize the risk of possible collisions etc., while being able to charge two vehicles simultaneously. The vehicle combination consists of a two-axle Volvo FM tractor and a standard 3-axle semi-trailer. Nominal battery capacity is 540 kWh and maximum charging power is 250 kW DC. The service weight of the vehicle is slightly heavier than that of the corresponding diesel truck. However, the higher total weight is not a constraint for this particular transport assignment.

Image: Volvo Trucks

Image: Volvo Trucks

DHL

The goal of DHL's demonstration is to study heavier transports over slightly longer distances between logistics terminals in different regions, so called line-haul.

In Sweden, this type of driving is most often performed with a flatbed truck and trailer. The line-haul route in this demonstration between Gothenburg-Jönköping is just over 150 km one-way and is relatively challenging regarding topography. The route is mainly on motorway, and since it is a truck with a trailer, 80 km/h applies. The return journey from Jönköping begins with a continuous climb of about 130 meters, which makes it possible to test the vehicle's propulsion under high load on the driveline.

A normal day starts with the truck departing from Gothenburg at approximately 19:30 and arriving in Jönköping at 22:00. After that, the vehicle is charged and loaded, departing from Jönköping around midnight and ending the shift in Gothenburg shortly after 03:00, when charging is initiated. To increase the utilization rate of the truck, it also runs a second shift during the day with bulk goods for DHL Express. On this route the truck is used without a trailer starting just after 06:00 when the truck is driven up to Landvetter for loading. Unloading of the goods is done in the Gothenburg region at various customers. The mileage varies but is normally just over 100 km. This shift ends at 15:00.

The two shifts result in a daily driving distance of over 400 km. Based on available battery capacity, the energy need for the two shifts, downtime etc., a charging concept was designed consisting of a 175 kW charger at Volvo Truck Center in Bäckebol (right next to DHL's terminal in Gothenburg) and a 350 kW charger at DHL's terminal in Jönköping. The available time for charging between the two shifts is slightly longer than in the middle of the night shift, hence the different power levels for the chargers. The high charging power in Jönköping was chosen to minimize downtime.

The charging stations are designed to be spacious enough to charge the vehicle with a trailer coupled and at a suitable distance from buildings to minimize the risk of potential accidents. The vehicle combination consists of a three-axle Volvo FH straight loader and a standard 4-axle trailer. The truck is equipped with a swap body, i.e. the cabinet can easily be mounted on and off the flatbed. This is used during loading and charging, the cabinet is loaded at the terminal gate at the same time as the vehicle is parked by the charger.

Nominal battery capacity is 510 kWh and maximum charging power is 350 kW. The service weight of the vehicle is slightly heavier than that of a corresponding diesel truck. As this logistics flow is limited by volume and not weight, the increased service weight has not affected the capacity to transport goods.

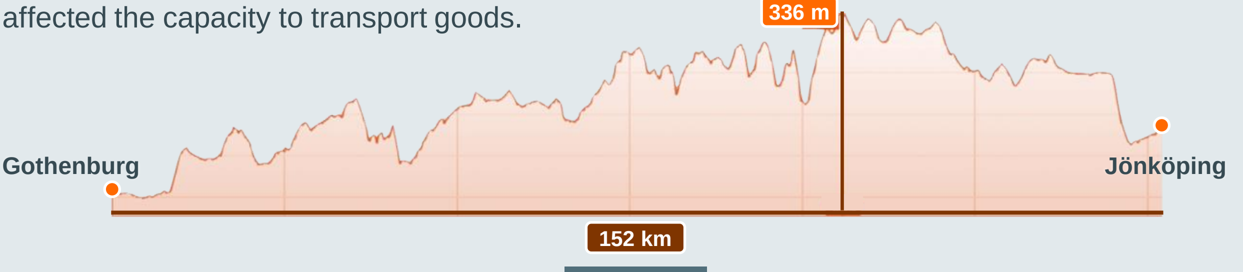


Image: Volvo Trucks

ELIS

ELIS performs transport of textiles and laundry in roll-cages to healthcare providers, hotels, and restaurants.

ELIS's business model is based on renting out textiles to businesses such as healthcare units, hotels, and restaurants. About four years ago, they chose to insource most of their transports to enable a better customer experience by having their own drivers meeting the customers. The shift also provided greater opportunities to choose vehicle type. This gives ELIS a better ability to reach its goal of having climate neutral transports by 2030, with the transition to an electric vehicle fleet being an important factor.

ELIS has a fleet of approx. 225 trucks where the majority are LDVs. In REEL they operate three HDVs from their sites in Helsingborg, Huddinge, and Stockholm. The goods are transported in roll cages where each truck can carry 36 cages. All trucks operate in one shift in designated routes over a week's time. The total daily mileage for each electric truck adds up to 150-200 km with an average energy consumption varying between 1.1-1.4 kWh/km, depending on the route, vehicle body, and time of the year.

The trucks are charged during evenings and nights at ELIS's home depots. They charge with 22 kW, and this is sufficient to reach a full battery before the shift starts in the morning.

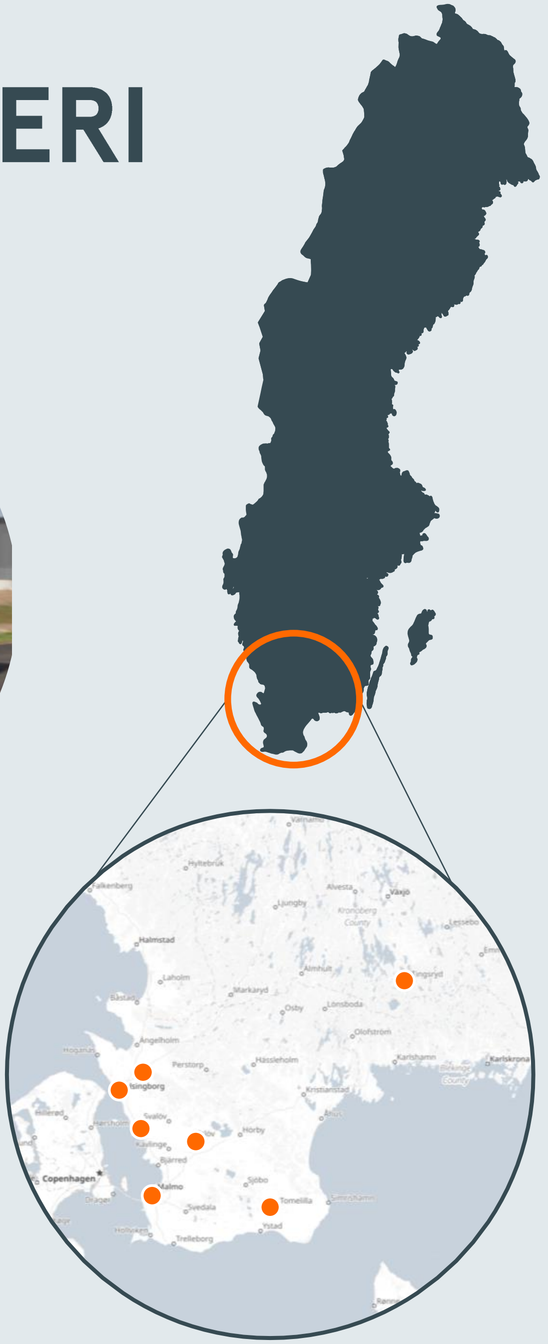
The truck in Stockholm operates for the City of Stockholm in an assignment where emission free transport was required when transports of laundry to healthcare units were tendered in a public procurement.

Vehicles	3 Volvo FL 4x2 265 kWh
Body	**Rigid**
Total weight	**16 t**
Type of goods	**Textiles and laundry**
Charging	**At home depot** (**22 kW**)
Localization	**Helsingborg, Huddinge and Stockholm**

Image: Elis, Volvo Trucks

ERIKSSONS ÅKERI I TOMELILLA

Image: Einride



One of the first electrified logistics flows in Sweden.

Since October 2020, the Skåne-based carrier Erikssons Åkeri i Tomelilla (EÅ) has operated 4 electric tractors from EMOSS, provided by Einride. Thus, the carrier is one of the most experienced within electrified road transportation in the country.

The vehicles are distributing oat-based dairy products from the producer; Oatly. The products are being transported from Oatly's production facility in Landskrona to warehouses Iin Helsingborg and Åstorp. Chargers are available in Landskrona, Helsingborg as well as the home base in Tomelilla. During end of 2022, the 2-axles electric tractors from EMOSS will be exchanged to 3-axles tractors (from e.g., Scania) which will allow for heavier loads.

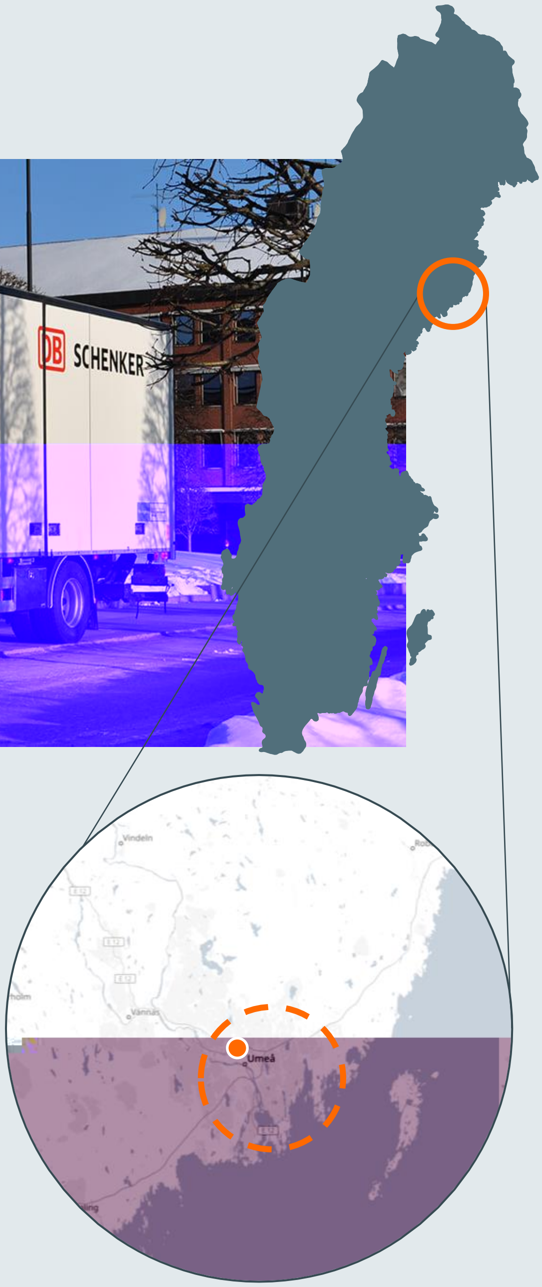
EÅ will also extend its electric truck fleet further later this year with a Volvo FH tractor, which will be the first series-produced electric FH truck by Volvo. The vehicle will be partly operated for the food producer Solina, but also for other customers on various routes. EÅ is the one of the carriers within REEL operating electric trucks from several manufacturers.

** the chargers can deliver 300 kW but the charging power is currently limited to what the vehicles can handle*

Vehicles	**4 EMOSS Tractor 4x2 280 kWh 1 Volvo FH 4x2 540 kWh**
Body	**Tractor / Tractor**
Total weight	**44 t / 44 t**
Type of goods	**Temperature-controlled (dairy) / Food products**
Charging	**Helsingborg* (140 kW) Landskrona (44 kW) Tomelilla* (140 kW)**
Localization	**Skåne and Småland Counties**

GÖTEBORGS LASTBILSCENTRAL

GODSTRANSPORTSERVICE I UMEÅ (GTS)



The first local distribution truck in northern Sweden.

GTS is a local logistics company based in the city of Umeå. The company is a transportation supplier for DB Schenker.

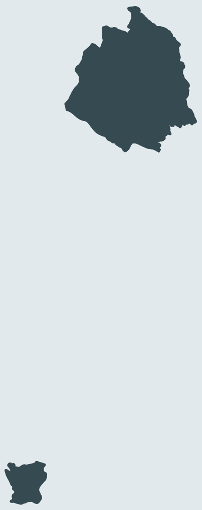
The vehicle is operating on weekdays during an 8-hour shift. One of the transport assignments is distribution of building materials for renovation and extension of the University Hospital of Umeå. Most of the material bound for the site is being consolidated onto this electric truck, reducing the number of vehicles distributing to the site significantly. The consolidation has been set up through a project between GTS and Region Västerbotten, the public actor responsible for healthcare. The other assignments is distribution of parcels and pallets in Umeå and its surrounding areas within the DB Schenker transport network.

The vehicle's performance during the long and tough winters, which northern Sweden is known for, will be an important result for the REEL project.

Vehicle	SCANIA 25P 4x2 300 kWh
Body	**Rigid truck**
Total weight	**18 t**
Type of goods	**Building materials, pallets and parcels**
Charging	**At home depot (76 kW)**
Localization	**Umeå**

Image: Tidningen Proffs

ICA



Vehicles	3 Volvo FE 6x2 265 kWh
Body	**Rigid**
Total weight	**27 t**
Type of goods	**Temperature-controlled food products**
Charging	**At home depot (22 kW)** **At VTC Bäckebol (150 kW)**
Localization	**Gothenburg, Stockholm**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FÖR EN GOD MORGONDAG
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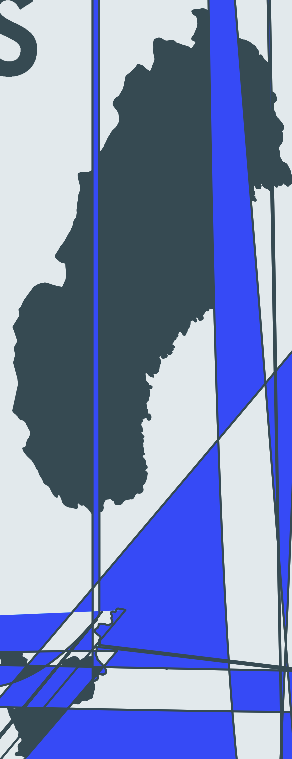


[illegible]ce 2013 [illegible]ula Logistics operates [illegible] [illegible]ermodal [illegible]erminal in Falköping co[illegible] [illegible] Port of G[illegible]thenburg by railway.

[illegible]a Logistics is [illegible] part of Jula, one of Sweden's larg[illegible] [illegible]ourself (DIY) r[illegible]tailers. The main warehouse of Ju[illegible] [illegible]ich is also the [illegible]argest logistics warehouse in Swed[illegible] [illegible]ated in Skara. [illegible]ach day, containers are being [illegible]nsported betw[illegible]en the railway terminal in Falköping a[illegible] [illegible]la's main wareh[illegible]use, a distance of 30 km, as well as t[illegible] [illegible]d from other cu[illegible]omers in a radius of up to 200 km from [illegible]e railway termin[illegible]. The transports are performed by a [illegible]rrier working in [illegible] close relationship with Jula Logistics.

[illegible]e p[illegible] [illegible]ec[illegible] [illegible] to deploy electric heavy [illegible] [illegible]hic[illegible] [illegible]ra[illegible] [illegible]al transport [illegible] [illegible]ust[illegible] [illegible]ctric tractor was [illegible] [illegible]n Ju[illegible] [illegible]cle is permitted to [illegible] [illegible]nati[illegible] [illegible]wo 40ft containers [illegible] [illegible]f 33 [illegible] [illegible]e already plans to [illegible] [illegible]ectric[illegible]

Currently, up to 35 trucks belonging to the carrier are serving the intermodal terminal. The transport assignments are geographically limited to the region with several reoccurring customers. The two most reoccurring nodes are controlled by Jula Logistics which ensures 24/7 access to the facilities for on- and off-loading and the charging infrastructure. There are around 20-25 locations with similar logistics setup around Sweden. If the outcome is successful, Jula Logistics and the carrier are planning to replace the current fleet of 35 diesel tractors in a matter of a few years.

LBC [illegible]

	[illegible]ania 2[illegible] [illegible] Sca[illegible]
Body[illegible]	Rigid
[illegible]tal wei[illegible]	[illegible]t
Typ[illegible]	[illegible]rials
Charging	At home depot (150 kW)
Localization	[illegible] County

MARTIN & SERVERA

Martin & Servera delivers food to both privately owned and public restaurants and cafeterias around Sweden. In the demonstrator, deliveries from Enköping, Malmö and Stockholm are performed.

Martin & Servera (M&S) has 22 cross-dock hubs and four main warehouses in Sweden. For the transports, the company has an internal fleet of approximately 100 trucks, and an additional external fleet of 300-400 trucks. In general, the trucks operate 200 km daily in one-shift. M&S's strategy for transitioning its fleet is to replace two diesel trucks with one electric truck and also adding a night shift. The company has managed to do this with several private and public customers and has also been provided permits to deliver during night in the cities of Malmö, Stockholm and Västerås. This implies that M&S in the long run can improve the inventory turnover rate, reschedule warehouse personnel from night to daytime and achieve a more efficient distribution in the cities during night by avoiding peak traffic .

In total, the company currently operates four electric trucks. Each vehicle has a cooling unit that is powered by the vehicle's batteries. The dayshift runs between 08:00-15:00, and the nightshift between 01:00-08:00. Each shift consists of 2-3 rounds and 10-12 stops per round. When the trucks return to the terminal for reloading, they are also charged simultaneously for about 45 minutes. Chargers with a capacity of 44 kW are installed at the terminal gates. During the longer breaks, they utilize a wall-box charger of 22 kW placed in the parking area.

Vehicles	3 Volvo FE 265 kWh / 1 Scania P230 165 kWh
Body	**Rigid**
Total weight	**27 t / 29 t**
Type of goods	**Temperature-controlled food products**
Charging	**At terminal gates (44 kW) At terminal parking (22 kW)**
Localization	**Enköping, Malmö, Stockholm**

Image: Martin & Servera

NORDISK ÅTERVINNING

Nordisk Återvinning is responsible for collecting waste and recyclables from households in South-West Gothenburg on behalf of the City of Gothenburg.

Vehicles	4 Volvo FE 6x2 260 kWh / 1 Volvo FL 4x2 200 kWh
Body	**Rigid**
Total weight	**27 t / 17 t**
Type of goods	**Waste and recyclables**
Charging	**At home depot (22 kW) At VTC Mölndal (150 kW)**
Localization	**Gothenburg area**

Nordisk Återvinning (NÅ) currently operate five electric trucks, four of which (Volvo FE) have a split body rear loader for waste and the fifth one (Volvo FL) being a box unit truck for collection of recyclables. The trucks operate on fixed weekly schedules with a daily mileage of about 100 km. The operation starts around 06:30 and finishes around 15:00 and includes a lunch break. Remaining time the vehicles are parked at the home depot and are charged with 22 kW.

In wintertime and at some other occasions, the vehicles also utilize a public charger at Volvo Truck Center Mölndal in order to manage a full day's tasks. The energy consumption varies between routes and time of the year. Further on, the super-structure is powered by the vehicles' batteries and influences the range. For the Volvo FE trucks, the bodies require much energy which put a strain on the operation. NÅ has observed energy consumption varying between 2 - 2.5 kWh/km.

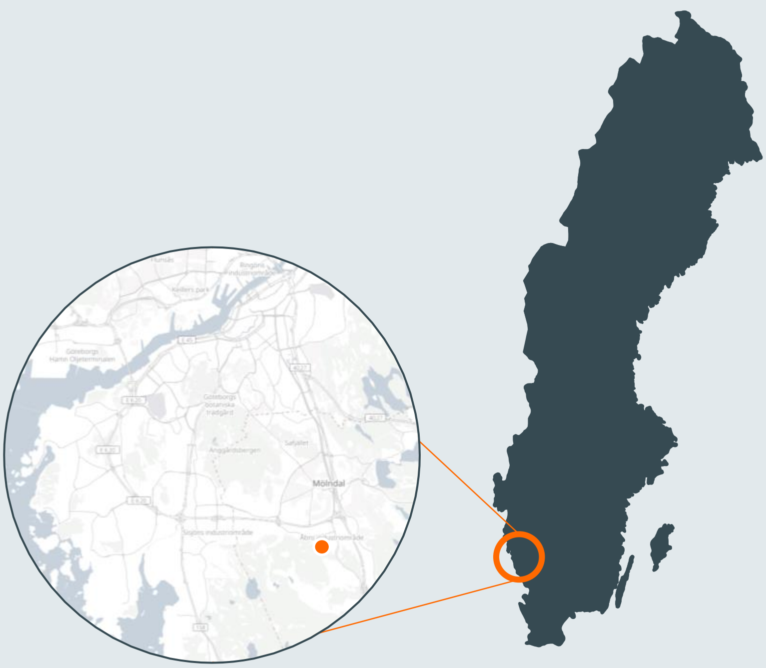
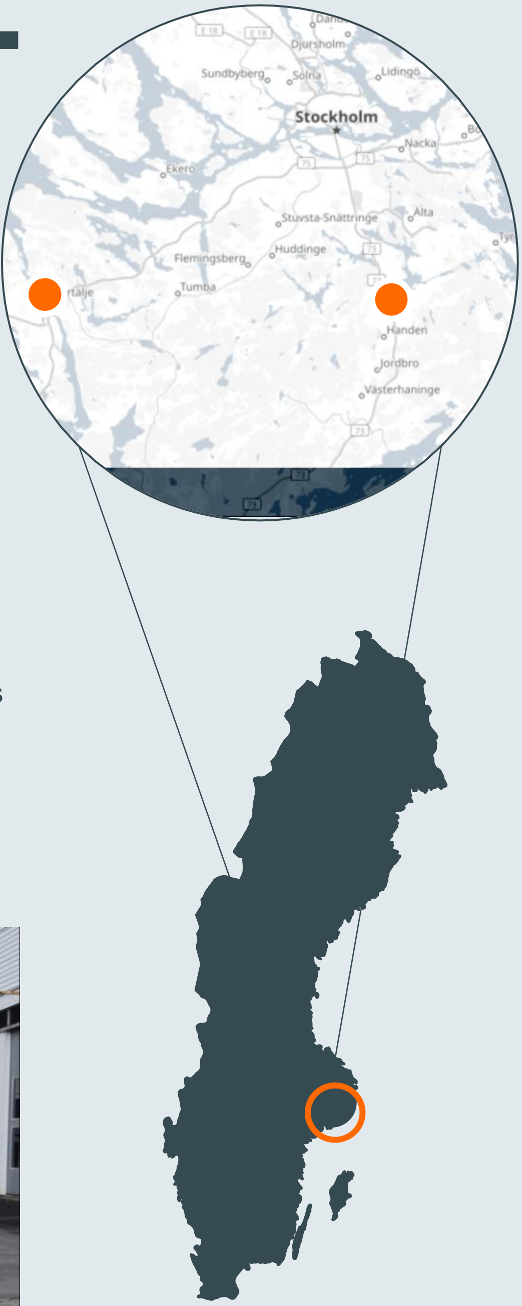


Image: Volvo Trucks

POLFÄRSKT

Polfärskt is one of the major suppliers of bread products in Sweden.



Polfärskt is responsible for distributing products from brands such as Polarbröd, Skogaholm, and Fazer.

Their Volvo FL vehicle is operated 6 days per week, delivering between 06:00 and 15:00, serving six stores in the Southern Stockholm area. The vehicle is charged during the evening and night. While charging, the truck's cargo haul is being preheated, as the bread arriving to Polfärskt's terminal is frozen. The products are being defrosted during the night and while being distributed by the Volvo-truck during the day. Thus, the products arrive to the stores in perfect condition. The drivers of Polfärskt's vehicles are also merchandizers, delivering the products all the way to the store shelf. The vehicle might stand still for several hours at the stores, as the driver is also responsible for organizing the bread shelves in the store. By utilizing this stand-still time for charging the scope of routes could be expanded, although not yet utilized.

Vehicle	Volvo FL 4x2 200 kWh
Body	**Rigid truck**
Total weight	**16 t**
Type of goods	**Food (bread products)**
Charging	**At home depot (22 kW)**
Localization	**Southern Stockholm**

Image: Volvo Trucks

POSTNORD

One of the largest logistics companies in Sweden is testing two types of vehicles for two different applications in The Stockholm Metropolitan Area.

One of the cases is based at PostNord's terminal in Årsta in Southern Stockholm. The transport assignment is carried out for Apotek Hjärtat, a pharmacy retailer in Sweden. The vehicle distributes pharmaceuticals around Stockholm and Södertälje during two daytime shifts. A third shift, which is conducted during night, is based on distribution of parcels to various parcel collection points around Stockholm.

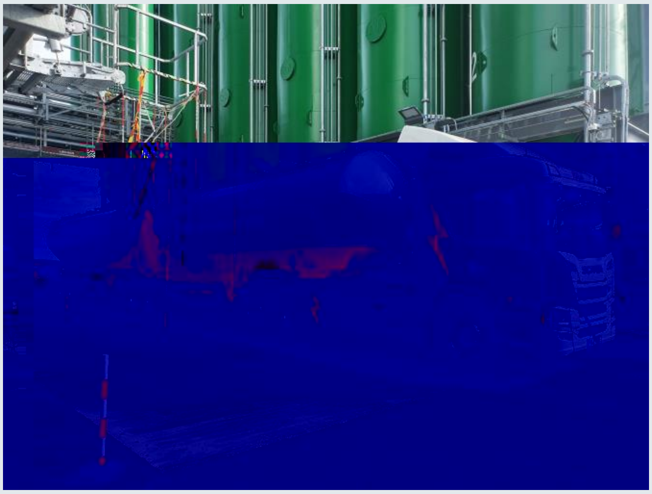
Since the vehicle is on the road for most of the day, there is very little time for charging. Fast charging is therefore conducted between the shifts at the terminal in order to avoid logistics losses. The vehicle is being operated by haulier Tempcon, a large group consisting of various transport companies specialized in temperature-controlled goods.

Vehicle	Scania P230 6x2 300 kWh
Body	**Rigid truck**
Total weight	**28 t**
Type of goods	**Pharmaceuticals, pallets and parcels**
Charging	**At terminal (150 kW)**
Localization	**Stockholm**

Image: Scania


postnord

RAGN-SELLS & FORIA



Two companies combine their strengths to prove that electrification of regional heavy-load logistics flows is possible.

Ragn-Sells is a privately held corporate group involved in waste management, environmental services and recycling. Ragn-Sells will be responsible for providing cargo volumes and Foria will be operating the truck. Foria is a publicly traded transport operator, and the truck will be the first battery electric heavy duty vehicle of Foria's 1200 vehicle fleet.

The upcoming Scania truck will transport primarily fly ash from, among others, an energy plant operated by Söderenergi in Södertälje, to Ragn-Sells plant outside Bro, where recovery of valuable raw materials from the fly ash will take place. When flue gas from waste incineration is scrubbed and filtered, fly ash is formed. The Ash2Salt method makes it possible to extract salts out of the ash. Usage for the salts includes e.g., road salt, potassium fertiliser, plastics, glass, paper and building materials.

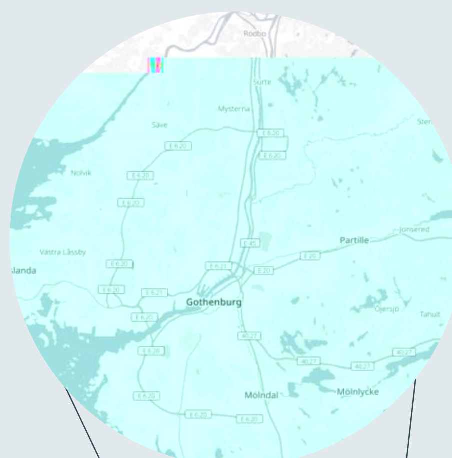
The Scania truck is allowed for a total weight of 75 tonnes. A one-way trip from Södertälje to Bro will be around 80 km. The vehicle is planned to be operated during two shifts each day to maximise the use of the truck. Therefore, the charging will take place during the night (8 hours) and the opportunity to charge at 150 kW during on- and offloading. This particular Scania truck is a prototype. A key factor when choosing charging equipment was that it would be safe and adapted to the industrial environment at the plant.

Vehicle	Scania 300 kWh (Prototype)
Body	**Tractor**
Total weight	**75 t**
Type of goods	**Primarily fly-ash**
Charging	**During on- and offloading (150 kW)**
Localization	**Stockholm County**

Image: Foria, Ragn-Sells


FORIA

RENOVA



Rödbo
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Mysterna
Säve
Nolvik
Västra Lässby
Gothenburg
Partille
Jonsered
Öjersjö
Tahult
Mölndal
Mölnlycke

Image: Scania

WIBAX

Vehicle	Scania 25P 6xX 300 kWh (Prototype)
Body	**Tractor**
Total weight	**64 t**
Type of goods	**Chemicals**
Charging	**During on- and offload[illegible] (150+ [illegible]W)**
Localization	**[illegible]rth-East [illegible]**

Case summary – 1/4

	Alltransport	DAGAB Stockholm	DAGAB Gothenburg	DFDS	DHL
Truck	Scania P230 4x2	Scania P230 6x2	Scania Prototype 6x2	Volvo FH 4x2	Volvo FH 6x2
Body	Tractor (and container)	Rigid refrigerated	Rigid & trailer, both refrigerated	Tractor (and semi-trailer)	Rigid swap-body and trailer
Battery size	300 kWh	300 kWh	300 kWh	540 kWh	510 kWh
Gross weight	29 t	28 t	64 t	44 t	64 t
Type of goods	Containers with consumer goods	Food (Refrigerated)	Food (Refrigerated)	Industrial comp.	Pallets and parcels
Logistic flow	Port-to-Hub	Urban & Suburban Distribution	Regional Distribution	Hub-to-Hub	Line-haul & Suburban Distribution
Daily milage	200 km	350 km	300 km	250 km	450 km
Shifts per day	1	2	3	1	2
Charging up to 49 kW (%)	100%	40%	0%	TBD	0%
Charging between 49 149 kW (%)	0%	60%	100%	TBD	0%
Charging from 150 kW (%)	0%	0%	0%	TBD	100%
Public charging (%)	0%	0%	0%	0%	65%
Charging at customer (%)	0%	0%	0%	0%	0%
Charging at own premises (%)	100%	100%	100%	100%	35%

Refrigerated goods

Image: Volvo Trucks

Case summary – 2/4

	ELIS	EÅ	EÅ	GLC	GLC	GTS
Truck	3 Volvo FL 4x2	EMOSS (Einride) 6x2	Volvo FH 4x2	2 Volvo FL 4x2	2 Scania 25P 4x2	Scania 25P 4x2
Body	Rigid	Tractor (and semi-trailer)	Tractor (and semi-trailer)	Rigid refrigerated	Rigid	Rigid
Battery size	265 kWh	280 KWh	540 kWh	300 kWh	165 kWh /300 kWh	300 kWh
Gross weight	16 t	44 t	44 t	18 t	26 t	18 t
Type of goods	Textiles and laundry	❄ Dairy	❄ Food	❄ Food	Industrial comp.	Pallets and parcels
Logistic flow	Urban & Suburban Distribution	Hub-to-Hub	Hub-to-Hub	Urban & Suburban Distribution	Local & Regional Distribution	Urban & Suburban Distribution
Daily milage	150 - 200 km	150 km	TBD	200 km	120 km	110 km
Shifts per day	1	2	TBD	1	1	1
Charging up to 49 kW (%)	100%	85%	TBD	80%	100%	100%
Charging between 49 149 kW (%)	0%	15%	TBD	0%	0%	0%
Charging from 150 kW (%)	0%	0%	TBD	20%	0%	0%
Public charging (%)	0%	0%	TBD	20%	0%	0%
Charging at customer (%)	0%	100%	TBD	0%	100%	0%
Charging at own premises (%)	100%	0%	TBD	80%	0%	100%

❄ *Refrigerated goods*

Image: Erikssons Åkeri

Case summary – 3/4

	ICA	Jula Logistics	LBC Frakt	Martin & Servera	Martin & Servera	Nordisk Återvinning
Truck	3 Volvo FE 6X2	Scania P230 6x4 Prototype	Scania 25P 4x2	3 Volvo FE 6x2	Scania P230 6X2	Volvo 4 FE 6x2 1 FL 4x2
Body	Rigid refrigerated	Tractor (and double container)	Rigid	Rigid refrigerated	Rigid refrigerated	Split body rear loader for waste / Rigid
Battery size	265 kWh	300 kWh	300 kWh	265 kWh	165 kWh	260 kWh / 200 kWh
Gross weight	27 t	64 t	19 t	27 t	29 t	27 t / 17 t
Type of goods	❄ Food	Containers with consumer goods	Building material	❄ Food	❄ Food	Refuse
Logistic flow	Urban & Suburban Distribution	Dry port-to-Hub	Regional Distribution	Urban & Suburban Distribution	Urban & Suburban Distribution	Urban & Suburban Waste collection
Daily milage	150 km	300 – 400 km	200-300 km	200 km	200 km	100 km
Shifts per day	1	2	1	2	2	1
Charging up to 49 kW (%)	95%	50%	70%	100%	100%	90%
Charging between 49 149 kW (%)	0%	0%	0%	0%	0%	0%
Charging from 150 kW (%)	5%	50%	30%	0%	0%	10%
Public charging (%)	5%	0%	0%	0%	0%	10%
Charging at customer (%)	0%	0%	0%	0%	0%	0%
Charging at own premises (%)	95%	100%	100%	100%	100%	90%

❄ *Refrigerated goods*

Image: CLOSER

Case summary – 4/4

	Polfärskt	Postnord	Postnord	Ragn-Sells / Foria	Renova	Wibax
Truck	Volvo FL 4x2	Scania P230 6X2	Scania 25P 4x2	Scania Prototype	Scania 25P 6x2	Scania 25P 6xX Prototype
Body	Rigid	Rigid refrigerated	Tractor (and semi-trailer)	Tractor (and open container)	Tractor (with hook-lift for container)	Tractor (and chemical bulk trailer)
Battery size	200 kWh	300 kW	300 kWh	300 kWh	300 kWh	300 kWh
Gross weight	16t	28t	19t	64t	30 t	64t
Type of goods	Food	❄ Pharmaceuticals	Pallets and parcels	Fly and bottom ash, wood chips	Refuse	Chemicals
Logistic flow	Urban & Suburban Distribution	Urban & Suburban Distribution	Hub-to-Hub	Hub-to-Hub	Hub-to-Hub	Urban & Regional Distribution
Daily milage	100 km	200 km	140 km	400-600 km	80 km	300 km
Shifts per day	1	3	1	2	1	2
Charging up to 49 kW (%)	100%	0%	0%	0%	100%	0%
Charging between 49 149 kW (%)	0%	0%	0%	0%	0%	0%
Charging from 150 kW (%)	0%	100%	100%	100%	0%	100%
Public charging (%)	0%	0%	0%	0%	0%	0%
Charging at customer (%)	0%	0%	0%	0%	0%	0%
Charging at own premises (%)	100%	100%	100%	100%	100%	100%

❄ *Refrigerated goods*

Image: CLOSER

Focus areas

System Architecture

Introduction of new technology and new players creates a need to supplement and revise existing logistics systems' and sub-systems' architectures and interfaces. Examples and learnings from the participating actors are presented on page 38, covering e.g.:

- What hardware installations have been made in the demonstrations and how are they utilized?
- What needs do the actors see for further development in the various sub-systems?

Policy & Regulation

Properly designed policies and incentives can help increase the speed of the transition to electrified logistics. In the section starting at page 42, views from the actors in the project are presented covering e.g. :

- What type of incentives are the actors benefitting from, and what can be improved in today's processes?
- What regulatory development should be prioritized with regards to e.g. off-peak deliveries, zero emission zones, conditions for expansion of electricity network capacity, and working time regulations?

Business & Financing Models

The transformation to electrified road logistics creates a need for and opportunities to change existing business models. New actors and roles will be introduced. On page 47 the project actors' views are presented:

- What models will be used when establishing charging infrastructure and how are the costs distributed?
- How will contracts between transport buyers and hauliers be affected in terms of duration and transport prices?
- What financing models will be used for trucks during the transition?

Working Environment

The introduction of electrified logistics will affect the people in the system. The work environment for drivers, traffic planners and service personnel, among others, will be affected and the need for behavioural changes, skills development and new professions will be created, see more on page 58.

- How is the work environment affected for the system users, such as the driver environment, maintenance personnel, traffic planning?
- What behavioural changes are required and/or desirable for the actors involved in operating the system?

Image: Unsplash, CLOSER

System Architecture

Image: Unsplash

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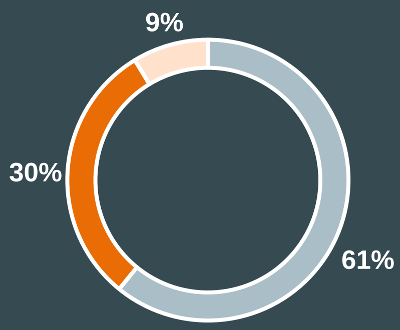
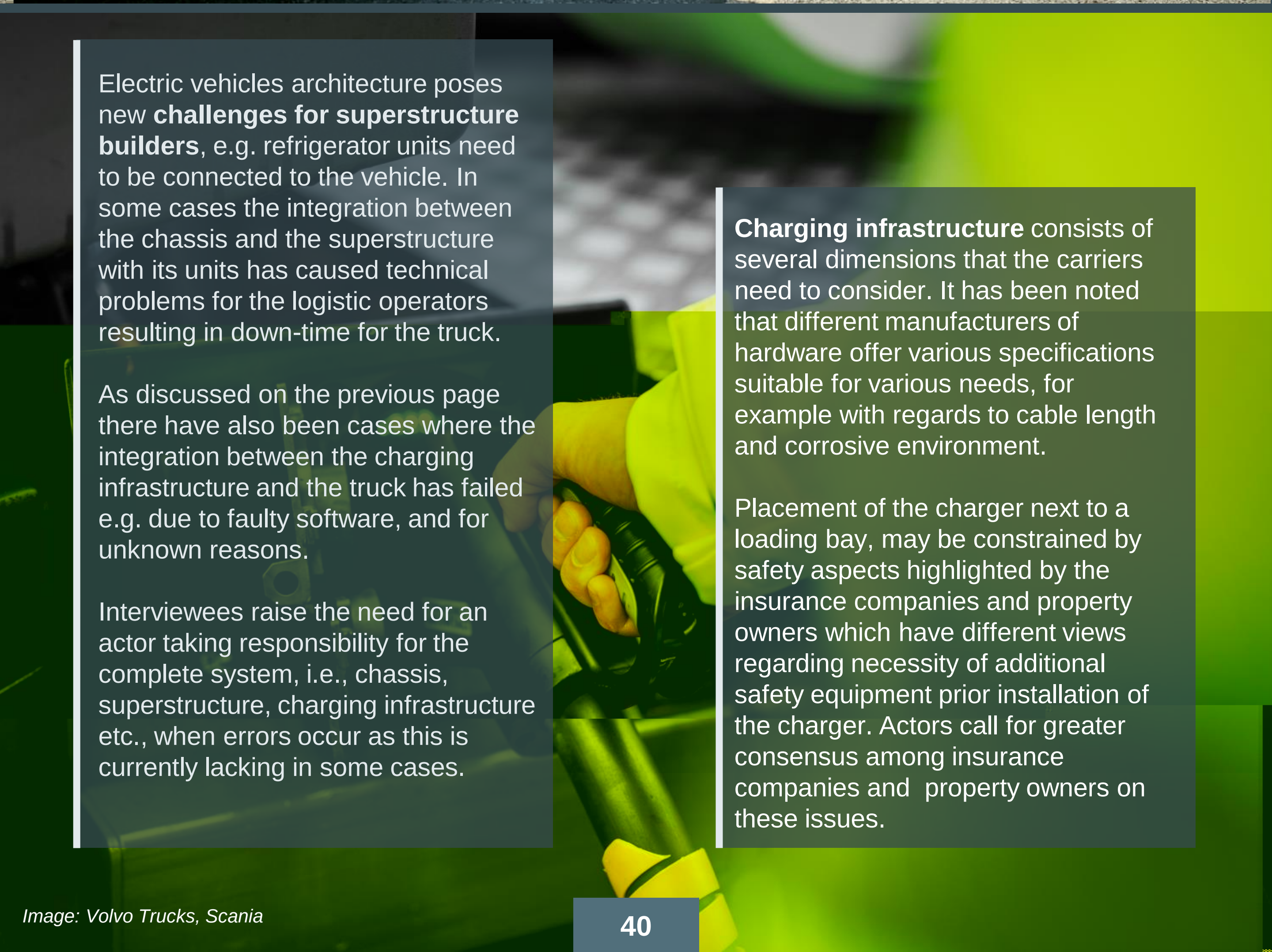

9%
30%
61%

System architecture: Other findings

In some cases, **logistics losses** occur in comparison with the operation of the same logistics flow with conventional trucks. Due to increased weight of the vehicle as a consequence of addition of batteries, the maximum allowed load weight is lower for some vehicles and applications. It may be a consequence of fewer axles or allowed load weight, according to the so called brake certification for the vehicle. In a few cases the additional time for charging also poses extra down-time for the operation.

Additional advantages from operation of electrified vehicles are seen when distributing to loading bays in closed environments e.g. in under-ground garages. A few actors also saves time by not having to refuel with diesel.



Electric vehicles architecture poses new **challenges for superstructure builders**, e.g. refrigerator units need to be connected to the vehicle. In some cases the integration between the chassis and the superstructure with its units has caused technical problems for the logistic operators resulting in down-time for the truck.

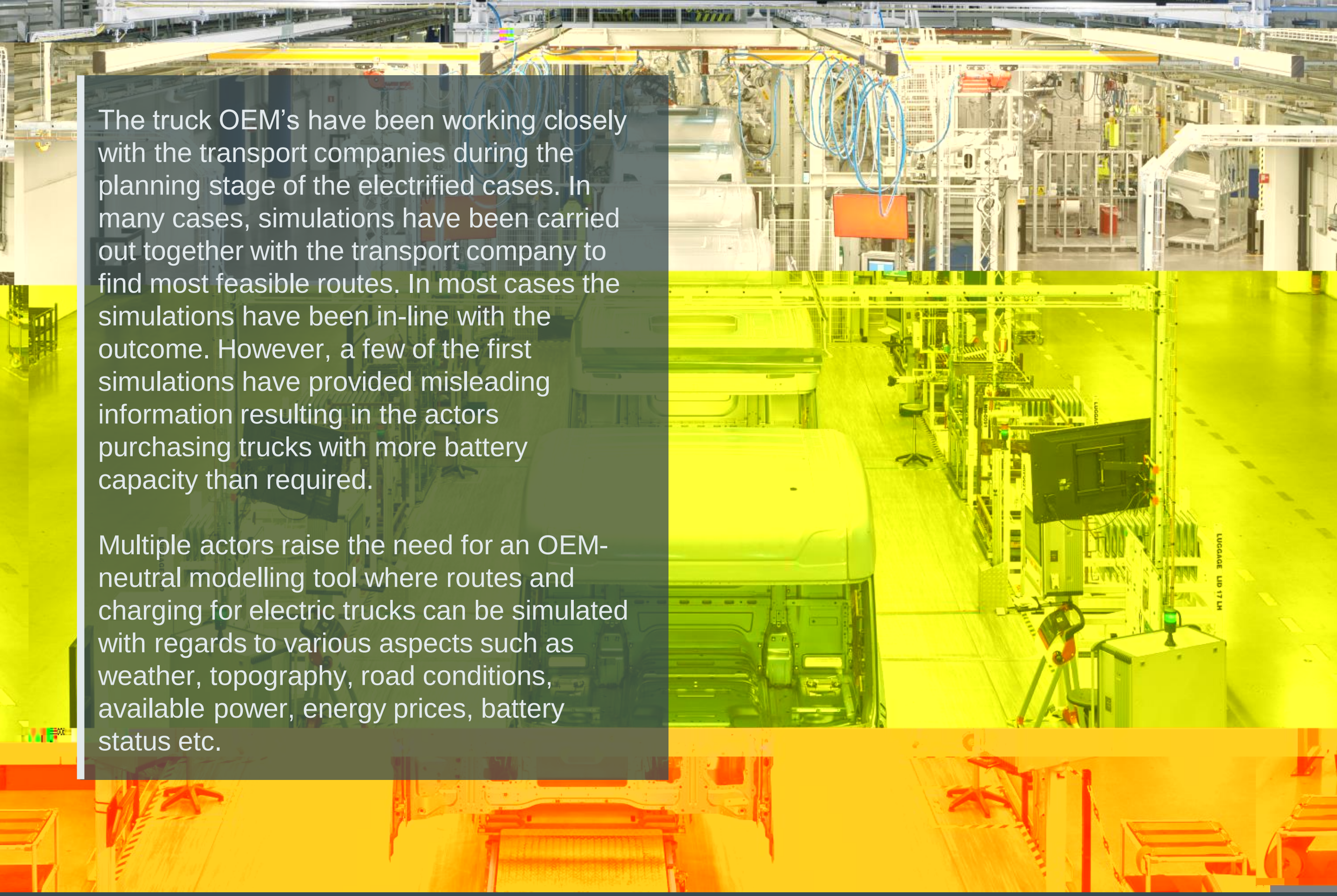
As discussed on the previous page there have also been cases where the integration between the charging infrastructure and the truck has failed e.g. due to faulty software, and for unknown reasons.

Interviewees raise the need for an actor taking responsibility for the complete system, i.e., chassis, superstructure, charging infrastructure etc., when errors occur as this is currently lacking in some cases.

Charging infrastructure consists of several dimensions that the carriers need to consider. It has been noted that different manufacturers of hardware offer various specifications suitable for various needs, for example with regards to cable length and corrosive environment.

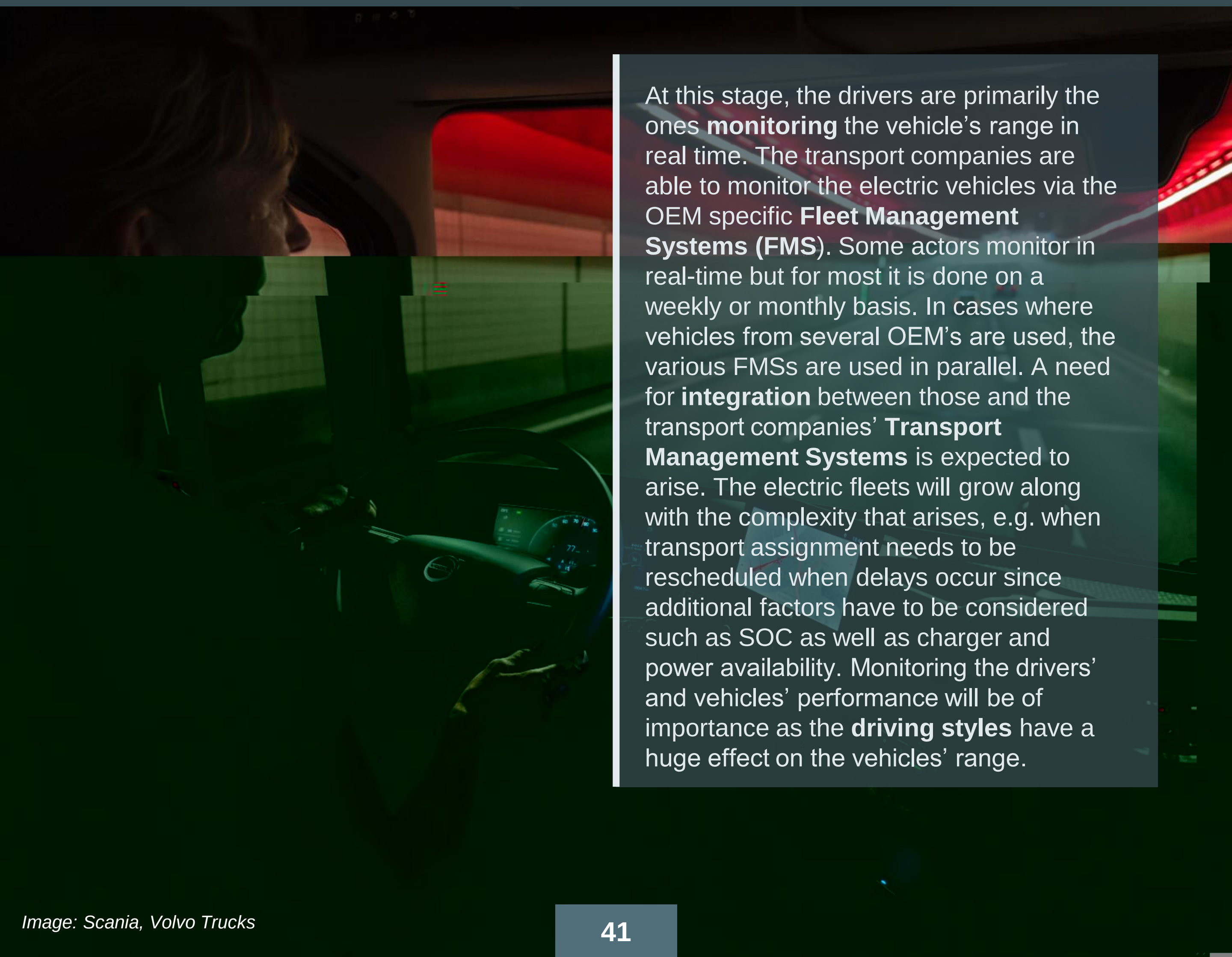
Placement of the charger next to a loading bay, may be constrained by safety aspects highlighted by the insurance companies and property owners which have different views regarding necessity of additional safety equipment prior installation of the charger. Actors call for greater consensus among insurance companies and property owners on these issues.

Image: Volvo Trucks, Scania



The truck OEM's have been working closely with the transport companies during the planning stage of the electrified cases. In many cases, simulations have been carried out together with the transport company to find most feasible routes. In most cases the simulations have been in-line with the outcome. However, a few of the first simulations have provided misleading information resulting in the actors purchasing trucks with more battery capacity than required.

Multiple actors raise the need for an OEM-neutral modelling tool where routes and charging for electric trucks can be simulated with regards to various aspects such as weather, topography, road conditions, available power, energy prices, battery status etc.



At this stage, the drivers are primarily the ones **monitoring** the vehicle's range in real time. The transport companies are able to monitor the electric vehicles via the OEM specific **Fleet Management Systems (FMS**). Some actors monitor in real-time but for most it is done on a weekly or monthly basis. In cases where vehicles from several OEM's are used, the various FMSs are used in parallel. A need for **integration** between those and the transport companies' **Transport Management Systems** is expected to arise. The electric fleets will grow along with the complexity that arises, e.g. when transport assignment needs to be rescheduled when delays occur since additional factors have to be considered such as SOC as well as charger and power availability. Monitoring the drivers' and vehicles' performance will be of importance as the **driving styles** have a huge effect on the vehicles' range.

Image: Scania, Volvo Trucks

Policy & Regulation

Public co-funding in Sweden

The logistic actors can apply for public co-funding when transitioning from conventional diesel powered trucks to trucks with electric power train. The co-funding can be received related to the procurement and installation of charging infrastructure as well as the truck. Below is a summary of the current incentive schemes. The actors' views and experiences of these schemes are presented in the following page.

Charging infrastructure

Klimatklivet for Non-public charging

- A maximum of 50% investment support, but for large enterprises the limit is 40%.
- Evaluates possible support for applicants in competition based on a cost-effective emission reduction.
- Usually 3-4 application periods per year, each open for approx. 14 days.
- Based on SFS no. 2015:517.

Klimatklivet for Public charging

- A maximum of 70% investment support of total cost.
- Support is awarded through a competitive tender procedure. Applications in the same geographical area compete.
- 2 application periods per year, each open for approx. 14 days.
- Based on Commission Regulation (EU) no 651/2014, and the new article 36a.

Regionala elektrifieringspiloter for Public charging (REP)

- A maximum of 100% investment support of total cost
- Support is awarded based on the strategic placement in relation to enable an accelerated transition to regional electrified heavy goods transport and feasibility.
- 1 application period conducted during spring 2022.
- Based on Commission Regulation (EU) no 651/2014, and the new article 36a, or Commission Regulation (EU) no 1407/2013.

Electric trucks

Klimatpremien for Trucks

- A maximum of 20% investment support of total cost which cannot exceed 40% of the additional cost compared to a similar conventional truck.
- Applicable for leasing i.e. the type of lease when the vehicle is taken over by the lessee at the end of the lease term.
- Open until further notice i.e. no specific application periods.
- Based on SFS no. 2020:750.

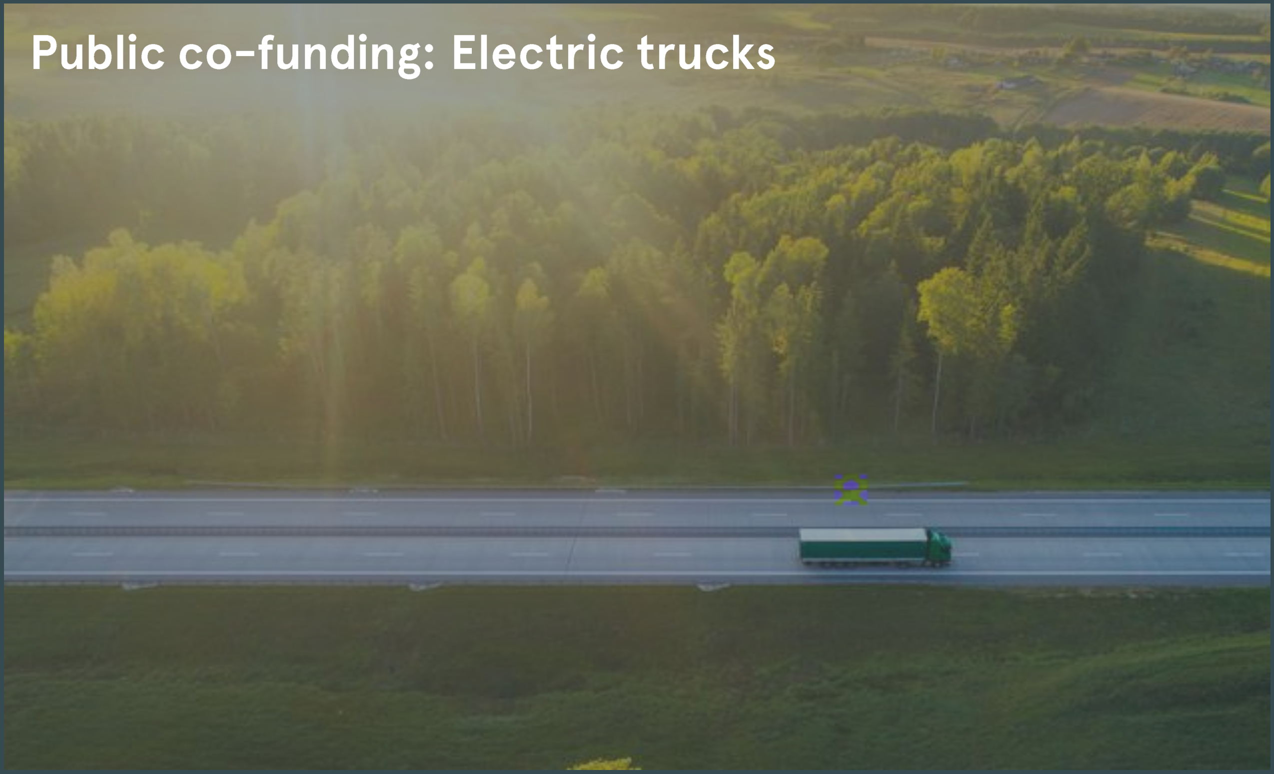
Klimatklivet for Trucks

- Funding 40% of the additional cost compared to a similar conventional truck. The level may be increased by 10% for medium-sized enterprises and by 20% for small enterprises.
- Evaluates possible support for applicants in competition based on a cost-effective emission reduction.
- The vehicle must be owned by the beneficiary.
- Usually 3-4 application periods per year, each open for approx. 14 days.
- Based on SFS no. 2015:517.

Prototype vehicles that are part of a demonstration in the REEL project have been co-funded by he Strategic Vehicle Research and Innovation (FFI) with 40% of the project related cost.

Public co-funding: Charging infrastructure

Public co-funding: Electric trucks



In the interview study the actors have expressed their opinions on what are the three most necessary, existing or non-existing, policy and regulatory measures

71% argue that one of the three most important policy measure is the **public co-funding for investment in trucks** in order to even out the TCO between electric and conventional trucks. In relation to this they also raise the importance of minimizing administration and to have a predictability and long-term perspective in the incentive schemes.

53% argue that one of the three most important policy measure is the **public co-funding for investment in non-public and/or semi-public charging infrastructure.** Actors find that today's incentive schemes are too much focused on public charging and would prefer a change of focus to enable more charging at own and/or goods senders'/receivers' premises.

41% argue that introduction of **emission free zones** is a crucial policy measure. This is considered to have the possibility to create a completely different demand for electric vehicles and competition on equal terms. When introducing zones, it must be communicated well in advance and with clarity, and to work as intended it requires support from law enforcement.

Image: CLOSER

Increase pressure on transport buyers (36%)
Actors argue that municipalities and authorities should have a regulated responsibility to demand emission-free transport in public procurement. Further on, both public and private transport buyers must be stimulated to offer longer contract periods.

Predictability and long-term perspective (29%)
Actors seek for increased clarity and long-term perspective for example with regards to public co-funding programs. Changes in previously made decisions e.g. the temporarily paused reduction obligation is raised as a factor that counteracts the transition. A good example raised is the 10 year tax exemption for biogas.

Allow off-peak transports (24%)
Better opportunities for off-peak deliveries in city centers with electric vehicles, by putting requirements on municipalities, property owners, and goods receivers to allow night-time deliveries would benefit the transition. Off-peak deliveries allow for better utilization of the vehicles and more efficient deliveries.

Change taxation for electric transports (18%)
To promote the transition, actors argue that taxation is an important factor. Firstly, taxation on electricity used by road logistic operators should be removed since it is absent for train operators. Secondly, electric vehicles should benefit from lower congestion taxes in cities compared to conventional vehicles. Thirdly, introduction of a km tax where electric vehicles benefit compared to conventional vehicles, is argued to be a measure that would promote the transition.

Harmonize pricing of electricity (18%)
Compared to diesel prices there is a major price difference for electric energy between the four Swedish electricity areas (SE1-4). Further, local grid owners' unique pricing models is regarded as a complicating factor. Actors (mainly in the southern parts of Sweden) argue for harmonized energy prices and pricing models to create a healthy competitive environment.

Establish a base of public charging infrastructure (18%)
Public charging will play a role in regional electrified logistics. Especially for energy-intensive applications, and for those vehicles not operating in repetitive flows where charging is available at customers' premises etc. It can also act as a risk minimizer to guarantee up-time of the vehicle if the standard charging solution is out of order.

Increase the maximum total weight for alternatively fuelled LDVs (18%)
Actors argue that adoption of EU Directive 2018/645, which allows alternatively fuelled vehicles with a maximum weight of 4250 kg (instead of 3500 kg) to be operated by drivers with a category B driving license, will drastically speed up the transition of LDVs, thus also promote transition of HDVs since charging can be shared etc.

Allow flexibility in driving time and rest periods (12%)
EU Regulation 561/2006, stipulates that the daily driving period shall not exceed 9 h, the weekly driving time shall not exceed 56 h, and breaks of at least 45 min (separable into 15 min followed by 30 min) should be taken after 4.5h at the latest. To allow and promote electrification, actors argue that these rules should be more flexible during a transition period until a sufficient charging network is established.

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Financing Models

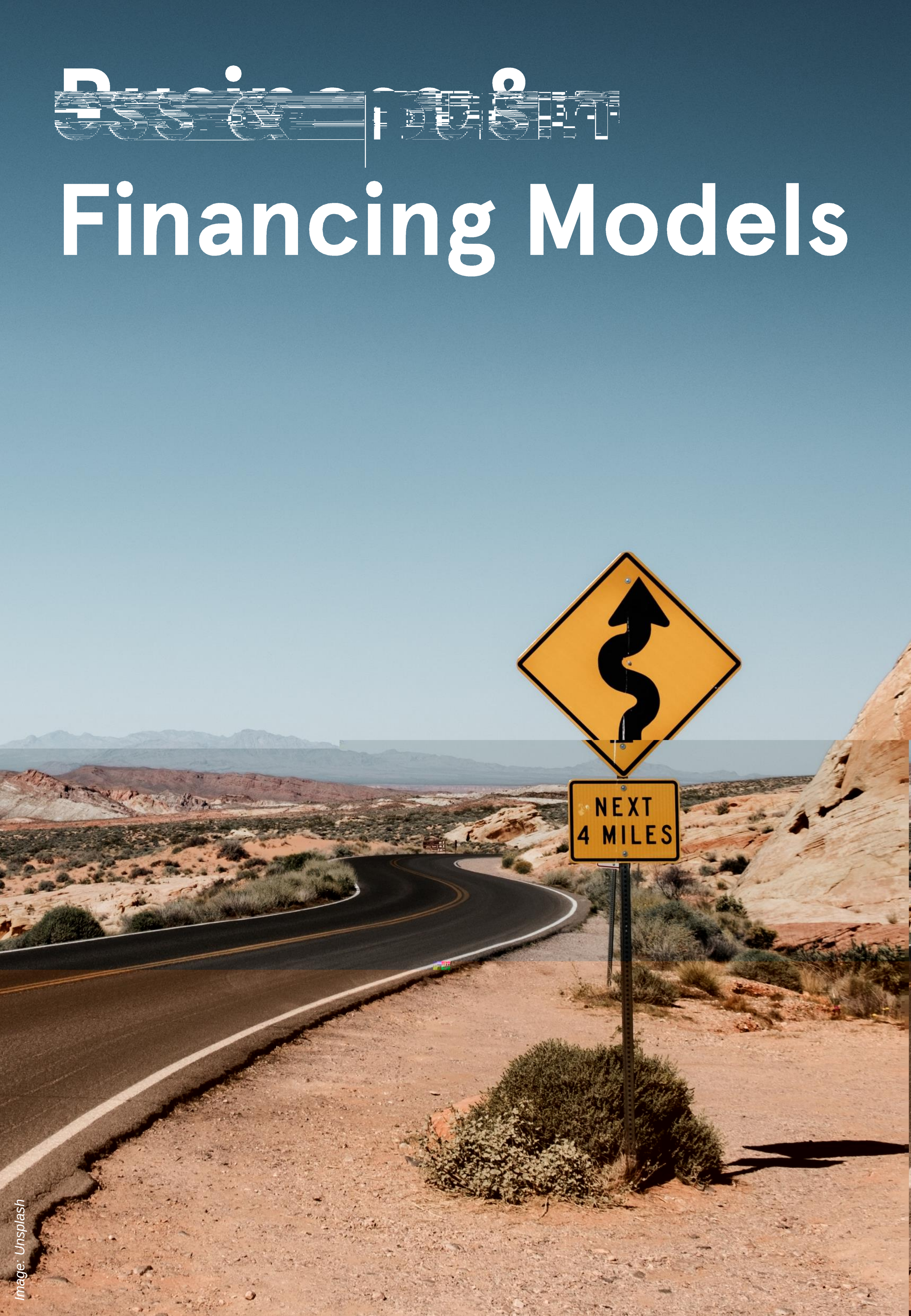
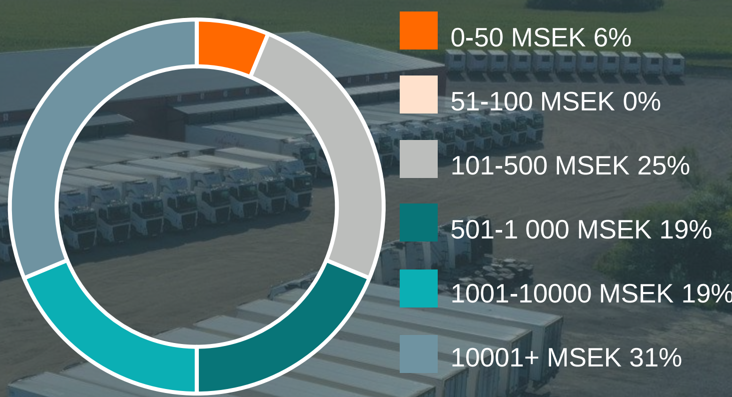


Image: Unsplash

Companies in REEL

The turnover figures for the participating companies in REEL that have provided information to this report are presented to the right. As seen, there is a large spread when it comes to turnover. Some of the companies are traditional hauliers where transport accounts for the largest share of the turnover, while some are national distributors of e.g., food, and chemicals where transports only accounts for 10-15% of the total turnover.

Turnover in Sweden



The total size of the own owned fleet of HDVs for the companies are presented to the right. Companies with large fleets and multiple logistic flows emphasize that it has been easy to find assignments where electric trucks are well suited. Smaller actors have been able to handle this as well although becoming more dependent on longer contracts with the customers in order to manage the uncertainties.

# of HDVs in Sweden

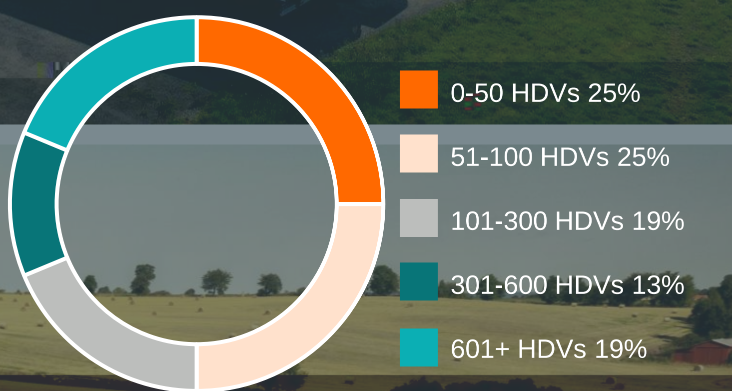


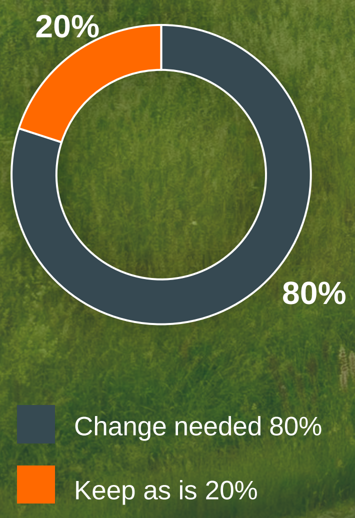
Image: Erikssons Åkeri i Tomelilla

How does the electrification of trucks affect the transport contracts?

The operation of the electric truck poses new ways of thinking in regard to the contracts between carriers and transport buyers. As utilization of the electric trucks is in its early days, there are some uncertainties. The residual value of the vehicles is hard to estimate as second-hand market doesn't exist for the electric trucks at this stage. The degradation of the batteries, which is expected to be the most important factors for the residual value of the vehicles, is yet to be examined as the electric trucks have been put into operation quite recently.

In order to cope with these uncertainties, most of the participating transport companies in REEL see a need to increase the length of the transport contracts with their customers in order to ensure the utilization of their electric vehicles. At this early stage, implementation and operation of an electric truck often requires thorough preparations with the customer, and a customer willing to explore the new technology together with the transport company. If the transport contract is short, it might take time before the next assignment for the truck is found, resulting in the truck standing still and thus becoming a financial burden. Historically, the participating companies have applied contract lengths spanning mostly from **12 to 36 months for conventional transports** (with some exceptions). Most companies see a need to increase the contract length to an interval between **36 to 60 months for electric transports**. Such contract lengths have been applied for REEL transport flows. For some transport segments even longer contracts lengths are desired.

The participating companies' intention to change their transport contracts



Contract length applied historically for conventional transport solutions and intended length for electrified solutions [years]

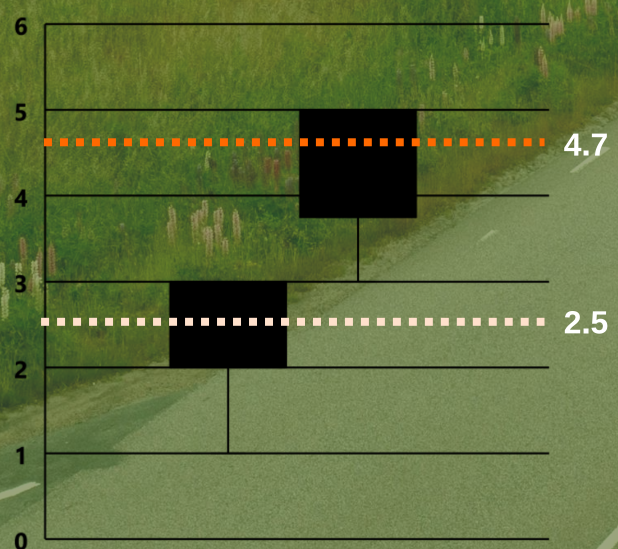


Image: CLOSER

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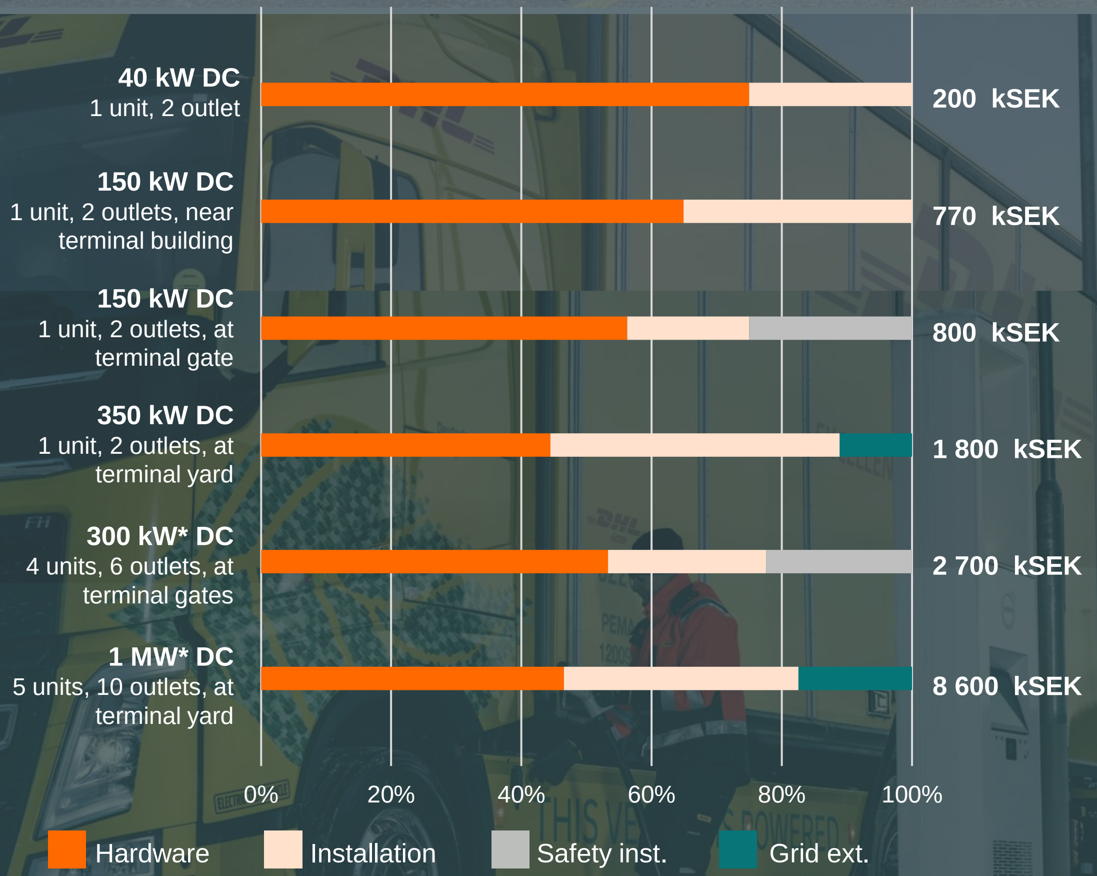
Charging infrastructure

In all cases, presented in this report, the investment in chargers and related infrastructure has been done by the participating companies i.e. no real-estate companies or CPOs have made the investments. The utilization rate of the installed chargers is 20-30% for high power chargers (>150 kW) and around 35-50% for low power chargers (<49 kW).

95% of the actors forecast that they will still own and operate their own infrastructure in 5-years from now, while 5% are investigating the possibility of transferring the ownership and operation to a third party and instead purchase charging as a service. All actors also state that they will be able to provide charging to other logistic actors that operate on their premisses. Notably, the haulier network organizations, freight forwarders, and food distributors consider charging as an important service for them to provide to their hauliers. Approximately 95% of all energy charged is assumed to be charged at either transport company's own or at customers' non-public chargers in the next five years. However, 4 out of 17 actors note that this is highly dependent on the development both with regards to maximum range of the vehicles and pricing for public charging. If electrified long-haul transports will be proven to be possible, the importance of public charging is expected to increase.

A majority of the actors believe that the local grid capabilities will be a limiting or a very limiting factor in the near future for many of their terminals and/or depots. It is regarded as one of the main risks for their strategies of replacing the fleets. In order to cope with this challenge, most actors are currently investigating solutions for local energy production and storage. Energy and power management are seen as key elements and will be new capabilities that the actors need to master.

The cost for charging infrastructure solutions varies a lot with the local pre-conditions with regards to current grid connection and need for upgrade of electrical components in the facilities. Below, some of the cases and their costs split are presented:



** total maximum power for all units*

Image: Scania, Volvo Trucks

Economic comparison between diesel and electric powered logistics solutions

The cost data for the following cases have been obtained through interviews with project participants and other stakeholders. For competitive reasons, not all specific costs can be reported broken down, revenues are not presented. As presented on page 49, the energy prices for electricity has fluctuated much during 2022, the same goes for diesel. In the table below the average price for each month excluding VAT is presented.

In the cost comparison calculations on the following pages the average price for MK1 Diesel (19,8 SEK/litre) is used, while for electricity the average price for the various areas is used in the different cases. For electricity grid transmission and monthly power tariff cost varies depending on geography, time, and subscription model, also electricity energy tax varies depending on geography and type of business sector. In the calculations costs for a high voltage subscription has been applied. Interest rate is set to 4%. The monthly salary is set to 32 000 SEK and collective agreement conditions applies. In the interviews no significant differences were observed for cost related to insurance, road tax, tires, service, and maintenance when comparing the electric and diesel solution.

Month 2022	SE 1 (öre/kWh)	SE 2 (öre/kWh)	SE 3 (öre/kWh)	SE 4 (öre/kWh)	MK1 Diesel (SEK/lit)	HVO100 (SEK/lit)
Jan	39,34	39,44	119,7	125,02	16,79	19,6
Feb	35,87	36,15	90,35	96,24	17,52	20,47
Mar	31,63	31,68	145,69	170,69	20,29	23,29
Apr	61,4	62,28	98,67	121,14	20,01	23,22
May	64,26	64,35	113,69	150,35	19,08	23,59
Jun	61,1	61,17	139,76	190,32	21,21	25,9
Jul	31,61	31,64	100,89	137,58	20,32	24,94
Aug	27,27	61,66	239,6	330,4	19,67	24,06
Sep	109,54	110,27	247,61	258,53	19,49	24,38
Average Jul-Sep	56,1	67,9	196,0	242,2	19,8	24,5

Source: Vattenfall, OKQ8

Image: Scania, Volvo

The first case, is based on one battery-electric rigid truck with a refrigerated superstructure and a total weight of 27-tons. The vehicle operates in urban areas delivering chilled and frozen food. It operates from 07:00-16:00 on weekdays, 250 days a year. The truck and its batteries are fully depreciated in 6 years. Installed battery capacity is 300 kWh and the total vehicle incl. refrigeration consumes 1.25 kWh/km, while the equivalent diesel vehicle consumes 0.27 l/km. The truck operates approximately 40 000 kilometres per year. In this case, the extra weight of the batteries has no impact on the operation, as the goods are rather limited on volume. The truck is charged during night and sometimes during lunch break if needed, using a 40 kW DC charger. In this and the following cases, no additional costs related to software have occurred or increased downtime for charging and/or continuous scheduling. The truck operates within electricity area SE 4.

Cost element	Electric excl. public funding (SEK/yr)	Electric incl. public funding (SEK/yr)	Diesel (SEK/yr)
Fixed logistics costs			
Trucks (incl. superstructure)	700 400	560 400	333 733
Charging infrastructure	33 333	20 000	N/A
Interest	88 048	69 648	40 048
Insurance, vehicle & road tax, wash, parking, etc.	70 447	70 447	70 447
Variable logistics costs			
Tires, service, maintenance	158 280	158 280	153 280
Energy	121 100	121 100	218 160
Grid transmission, power tariff, electricity tax	20 500	20 500	N/A
Staff			
Driver	647 420	647 420	647 420
Total cost	**1 839 528** (+26%)	**1 667 795** (+14%)	**1 463 088**

In the case presented the electric solution has a 26% higher TCO if no public co-funding is received and 14% higher if public co-funding is received, compared to diesel.

The comparison above do not include the additional time for preparatory work for the electric solution that the logistic operator needs to do with regards to discussions with e.g. transport buyers, hardware suppliers, grid companies as well as applying for public co-funding. In the project it has been observed to be around at least 300 man-hours for the first electrified cases.

Image: Scania, Volvo

The second case, is based on two battery-electric rigid trucks each with a refrigerated superstructure and a total weight of 27-tons. The vehicles operate in 2-shifts (06:00-22:00) on weekdays and 1-shift on Saturdays and Sundays. The trucks and their batteries are fully depreciated in 6 years. Installed battery capacity is 300 kWh and the total vehicle incl. refrigeration consumes 1.25 kWh/km, while the equivalent diesel vehicle consumes 0.27 l/km. The trucks each operates approximately 250 km on weekdays and 120 km on Saturdays and Sundays, 350 days a year (i.e. 74 500 km/yr). In this case, the extra weight of the batteries has no impact on the operation, as the goods are rather limited on volume. Two electric trucks depart from the same terminal and the charging infrastructure is positioned so that charging can take place at the same time as reloading at the terminal takes place without additional downtime. In addition both trucks are charged in a depot at night. The charger at the terminal has an output of 175 kW, each vehicle uses this charger for approximately 2 hours per day. The chargers used at night have an output of 25 kW and are used for approximately 6 hours. All chargers are fully depreciated after 6 years. A service agreement is paid for all chargers. The trucks operate within electricity area SE 3.

Cost element	Electric excl. public funding (SEK/yr)	Electric incl. public funding (SEK/yr)	Diesel (SEK/yr)
Fixed logistics costs			
Trucks (incl. superstructure)	1 400 800	1 120 800	667 467
Charging infrastructure	161 667	97 000	N/A
Interest	187 496	146 136	80 096
Insurance, vehicle & road tax, wash, parking, etc.	140 894	140 894	140 894
Variable logistics costs			
Tires, service, maintenance	354 508	354 508	341 508
Energy	365 050	365 050	817 625
Grid transmission, power tariff, electricity tax	78 877	78 877	N/A
Staff			
Driver	1 710 656	1 710 656	1 710 656
Total cost	**4 466 273** (+19%)	**4 080 246** (+9%)	**3 757 886**

In the case presented the electric solution has a 19% higher TCO if no public co-funding is received and 9% higher if public co-funding is received, compared to diesel. If the same case would operate within electricity area SE 1 the TCO for the electric solution would instead be 12% higher when co-funding is not received and 1% higher if funding was received, not taking into account any potential changes in energy consumption due to the in general colder climate in SE 1.

The comparison above do not include the additional time for preparatory work for the electric solution that the logistic operator needs to do with regards to discussions with e.g. transport buyers, hardware suppliers, grid companies as well as applying for public co-funding. In the project it has been observed to be around at least 300 man-hours for the first electrified cases.

Image: Scania, Einride

The third case, is based on one battery-electric tractor that operates in a repetitive hub-to-hub flow, transporting semi-trailers with consumer goods. The volume is the limiting factor, thus the increased weight of batteries has not affected the availability to transport goods. In the first scenario the vehicle operate in 1-shift (06:00-15:00) on weekdays. The distance between the hubs is approx. 29 km, and the loop is repeated three times resulting in a total mileage of 175 km on weekdays, 250 days a year (i.e. 43 750 km/yr). The truck and its batteries are fully depreciated in 6 years. Installed battery capacity is 300 kWh and the total vehicle consumes 1.2 kWh/km, the equivalent diesel vehicle consumes 0.35 l/km. The vehicle is charged during afternoons and nights at 33 kW, and operates in electricity area SE 2.

Cost element	Electric excl. public funding (SEK/yr)	Electric incl. public funding (SEK/yr)	Diesel (SEK/yr)
Fixed logistics costs			
Truck	581 133	464 467	197 800
Charging infrastructure	16 667	10 000	N/A
Interest	71 736	56 936	23 736
Insurance, vehicle & road tax, wash, parking, etc.	78 366	78 366	78 366
Variable logistics costs			
Tires, service, maintenance	180 469	180 469	166 469
Energy	35 648	35 648	309 269
Grid transmission, power tariff, electricity tax	16 590	16 590	N/A
Staff			
Driver	647 420	647 420	647 420
Total cost	**1 628 028** (+14%)	**1 489 895** (+5%)	**1 423 060**

In a second scenario the transport buyer extends the delivery window allowing a 2-shift operation (06:00-15:00 and 16:00-23:00) on weekdays. The same truck is used but instead a charger able to deliver 150 kWh is installed. This charger is used at breaks, between shifts and at nights. The trucks operate approximately 350 km on weekdays, 250 days a year (i.e. 87 500 km/yr).

Cost element	Electric excl. public funding (SEK/yr)	Electric incl. public funding (SEK/yr)	Diesel (SEK/yr)
Fixed logistics costs			
Truck	581 133	464 467	197 800
Charging infrastructure	128 333	77 000	N/A
Interest	85 136	64 976	23 736
Insurance, vehicle & road tax, wash, parking, etc.	78 366	78 366	78 366
Variable logistics costs			
Tires, service, maintenance	205 625	205 625	191 625
Energy	71 295	71 295	618 538
Grid transmission, power tariff, electricity tax	86 736	86 736	N/A
Staff			
Driver	1 234 221	1 234 221	1 234 221
Total cost	**2 470 846** (+5%)	**2 282 686** (-3%)	**2 344 286**

Image: Volvo, Scania

The fourth case, is based on one battery-electric rigid truck and trailer that operates in a line-haul operation between major terminals. The volume is the limiting factor, thus the increased weight of batteries has not affected the availability to transport goods. The vehicle operates in 2-shift (06:00-15:00 and 18:00-03:00), 350 days a year. The two shifts result in a daily driving distance of 600 km (i.e. 210 000 km/yr). The truck and its batteries are fully depreciated in 6 years. Installed battery capacity is 600 kWh and maximum GTW is 64 tonnes. The total vehicle consumes 2 kWh/km, the equivalent diesel vehicle consumes 0.43 l/km. The vehicle is charged during breaks and between shifts. Two charging cycles are performed at a 300 kW charger at the operator's terminal, however the peak charging is performed at 200 kW. Two shorter cycles of 45 minutes each are also performed at a service centre daily. Approximately 30% of the total energy is charged at the service centre. The cost for charging at the service centre consists of a monthly fee, a minute fee, and a kWh fee. The truck operates in electricity area SE 3.

Cost element	Electric excl. public funding (SEK/yr)	Electric incl. public funding (SEK/yr)	Diesel (SEK/yr)
Fixed logistics costs			
Truck (excl. trailer)	699 167	557 500	257 500
Charging infrastructure	266 667	160 000	N/A
Interest	115 900	86 100	30 900
Insurance, vehicle & road tax, wash, parking, etc.	132 421	132 421	132 421
Variable logistics costs			
Tires, service, maintenance	258 340	258 340	242 340
Energy (own premise)	576 240	576 240	N/A
Grid transmission, power tariff, electricity tax	208 125	208 125	N/A
Energy (service centre)	622 500	622 500	1 832 880
Staff			
Driver	2 089 822	2 089 822	2 089 822
Total cost	**4 969 181** (+8%)	**4 691 048** (+2%)	**4 585 863**

To summarize, the economic comparison shows that the TCO for the diesel powered solutions are lower than for the electric solutions but with more mileage per year the imbalance is evened out. An important factor is also geographic location, currently the energy cost in electricity area SE 4 is almost five times higher than in SE 1, further more the electricity energy tax is reduced for a majority of locations in SE 1 and SE 2. From a cost perspective it is therefore more beneficial for actors located in SE 1-2 to introduce electric solutions than for those located in SE 3-4.

The analysis also shows that public co-funding of both vehicles and charging infrastructure is crucial to even out the TCO. It must be noted that the TCO-calculations do not include the additional time for preparatory work for the electric solution that the logistic operator needs to do with regards to discussions with e.g. transport buyers, hardware suppliers, grid companies as well as applying for public co-funding.

The analysis also points out the need for transport contracts that are aligned with the time for depreciation of trucks to reduce risk for the hauliers. If a faster depreciation time needs to be applied, the competitiveness of the electrical solution is impaired. What also needs to be further examined is the cost effects when scaling up the system as this might cause extra costs related to grid upgrade as well as planning and steering of the operation.

Image: Volvo, Scania

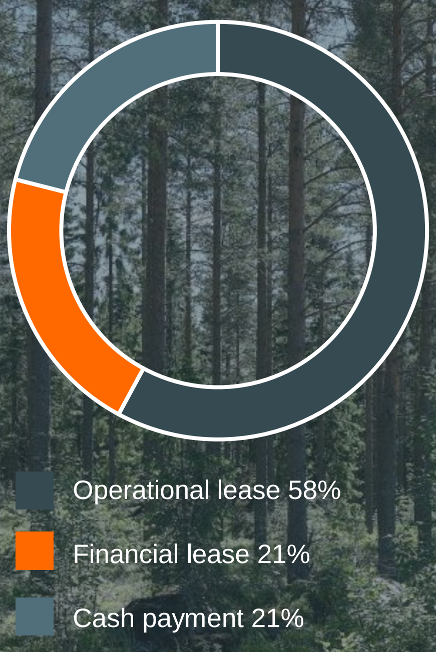
What financing models are used and will be used for electric trucks?

A majority of the actors have chosen to use operational leasing as the financing model for their first battery electric trucks. Actors are unsure of the performance of the first generation trucks for example with regards to battery degradation. Actors also believe that specifications for these trucks will be outdated in a few years time due to the rapid development in the field. Thus, operational leasing is used to minimize risk of low residual value. The actors who forecast that they will continue to use operational leasing in five years from now, believe that these arguments apply will be prevailing at that point in time.

However, a shift from operational leasing to cash payment is noted in a five years' time. Actors that prefer this model state that they benefit economically through either cash payment and/or financial leasing. They expect that the performance of vehicles will improve in the coming years and that battery electric trucks will have a longer lifecycle than conventional trucks. Therefore, actors would like to keep the vehicles as long as possible in their own operation, some state up to 12 years, succeeding by shifting routes and operation as the batteries degrade.

Multiple actors state that the financing of trucks will be a hurdle for small hauliers. A solution to this is that some of the larger actors and the haulier network organizations see is by them taking ownership of trucks and lease those to smaller hauliers.

Financing model used for trucks in REEL



Financing model used in 5 years

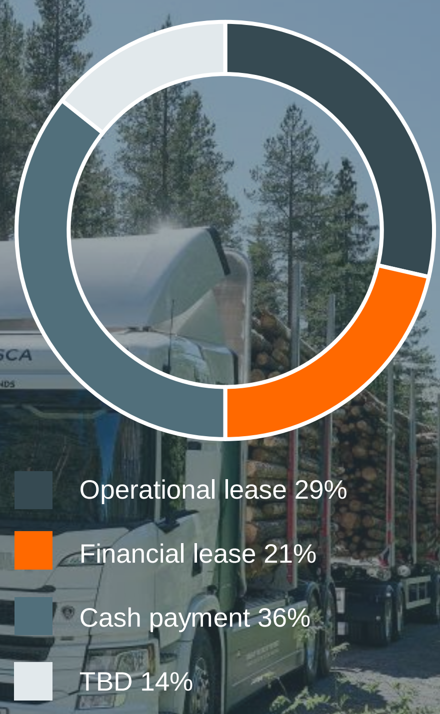


Image: Volvo Trucks, SCA Skog

Working Environment

Image: CLOSER

The driver

The most common change mentioned by the transport companies in regard to the driver is the improvement of the working conditions. Their workplace becomes much quieter, less stressful with less vibrations. Manoeuvrability, especially in city traffic is perceived as being much better since the truck is much more responsive. Range anxiety disappears rather quickly, as the driver gets to know the vehicle over time. Eco-Driving gains even more importance with electric trucks as the range is heavily influenced by the individual driving style.

As the vehicle becomes much more quiet, other noises become more noticeable, such as the sound from the cooling unit, often located behind the cabin. The absence of external noise from the vehicle results in pedestrians reacting to the oncoming truck much later, putting more responsibility on the driver.

Other professional groups

The working conditions for the warehouse staff and the vehicle maintenance personnel improves as well as the noise levels reduce drastically. Customers receiving an electric truck take pride in having their goods delivered with the help of new technology. Consequently, the driver of the electric truck obtains a renewed status among the customers as they are taking interest in their working tool which develops their relationship.

Maintenance and body-builder personnel poses new challenges. Electric vehicles create a need for re-certified personnel which has previously worked with completely different powertrains. New safety requirements are emerging, as the electric powertrain requires maintenance and superstructure builder staff working with much higher currents than previously. Education of personnel must not become a hurdle in the transition.

Re-education activities are also needed for the sales organization. Multiple actors raise that there are often discrepancies in what is communicated from OEMs' local sales compared to national sales organizations.

Transport management will have new constraints to consider when planning the operation of electric vehicles which creates requirement for new supporting management systems, able to take these new factors into account.

Image: Volvo Trucks, CLOSER

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