REEL

Regional Electrified Logistics

Charging infrastructure for trucks
2024:02

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 70 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

2024-02-29

Frontpage: GLC Göteborg. Image: CLOSER.

The content of this report is based on an interview study executed during the autumn of 2023 with nine logistic actors. The data presented in this report reflects the current status related to for example costs, utilization, and policies.

The interviews have been performed by CLOSER at Lindholmen Science Park in a semi-structured manner.

The interview study including the questions was designed by CLOSER.

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

Images: Volvo Trucks, Scania

The REEL consortium consists of 45 organizations

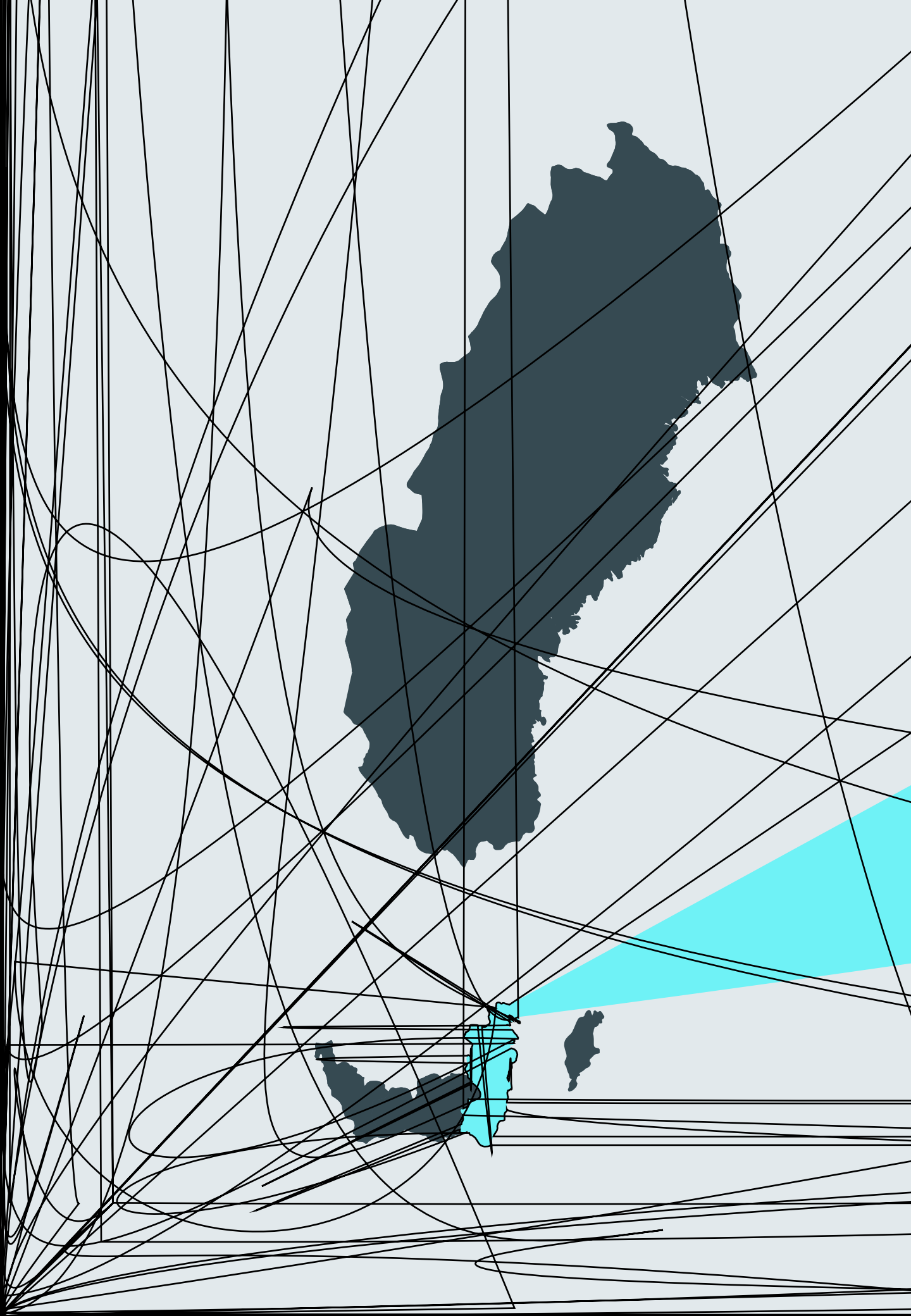
The REEL project targets the over-all mission to significantly reduce CO_2, noise, particulate and gaseous emissions through electrification of regional road transport. It is centred upon performing demonstrations of regional electrified logistics systems. By developing and operating these demonstrations, 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
BOLIDEN
BÖRJE JÖNSSON ÅKERI AB
DAGAB
DANIA CONNECT
Derome
DFDS
DHL
elis
einride
e·on
Eriksons Åkeri Tomtilla
FALKENKLEV LOGISTIK
FLYGFRAKT
FORIA
GLC GÖTEBORGS LASTBILCENTRAL
GTS Gods Transport Service
Höganäs
ICA
JULA LOGISTICS
LBC frakt
martin&servera
M-Lab
Nordisk Återvinning
postnord
Polfärskt MILJÖSMART SAMDISTRIBUTION
Renova
RAGN-SELLS
SCA
SCANIA
SWEROCK
Söderenergi
UME ASSISTANCE
VATTENFALL
VGT i Göteborg AB
VOLVO
WIBAX
Region Halland
REGION SKÅNE
VÄSTRA GÖTALANDSREGIONEN
CHALMERS
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



1,2 Rifil Malmö. 3 Laddbolaget Bråtebäcken.

Images: CLOSER.

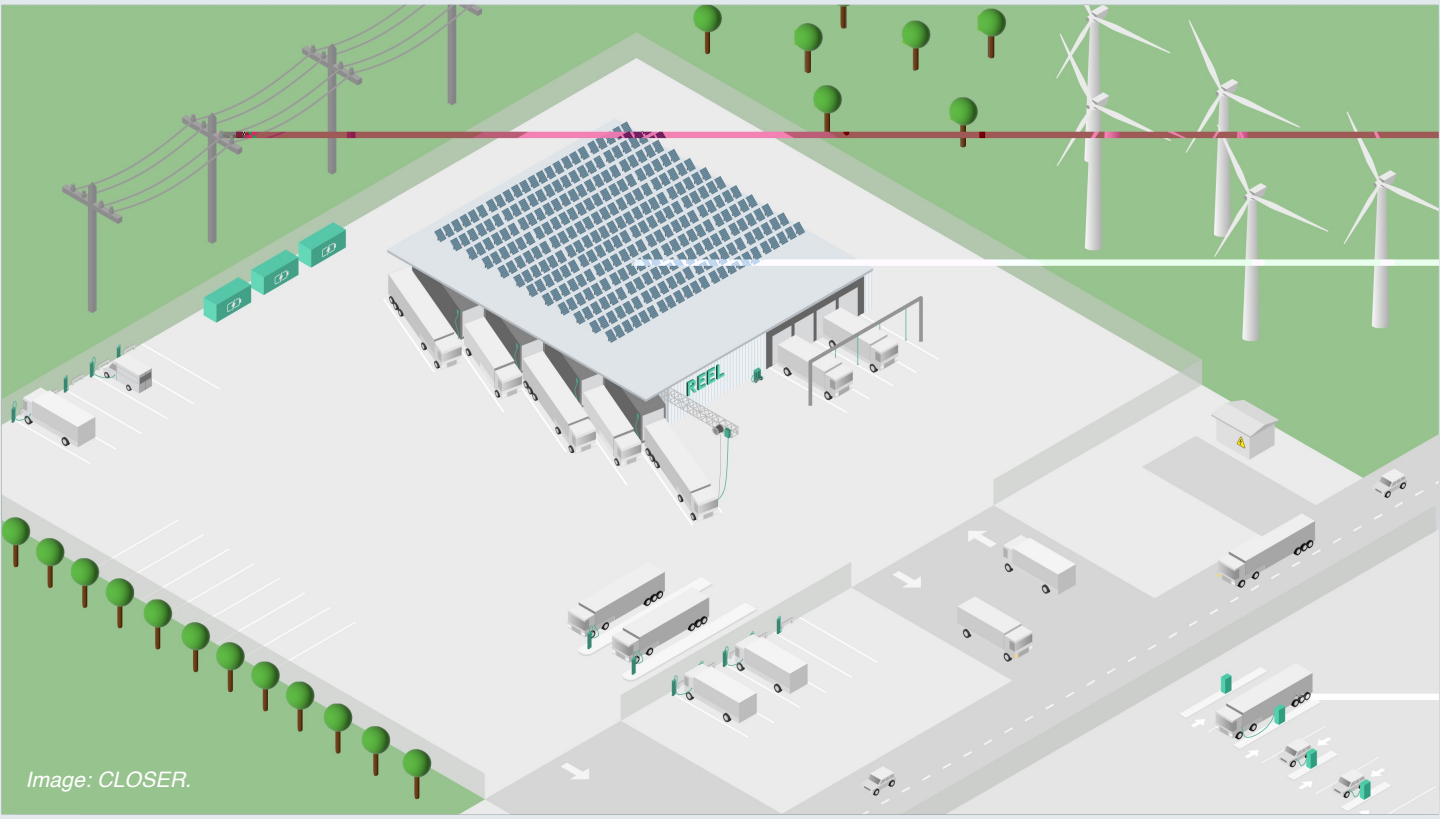


Image: CLOSER.

As many transport companies in REEL have stated during the project's lifespan: We are used to buy trucks, but charging infrastructure is completely new to us.

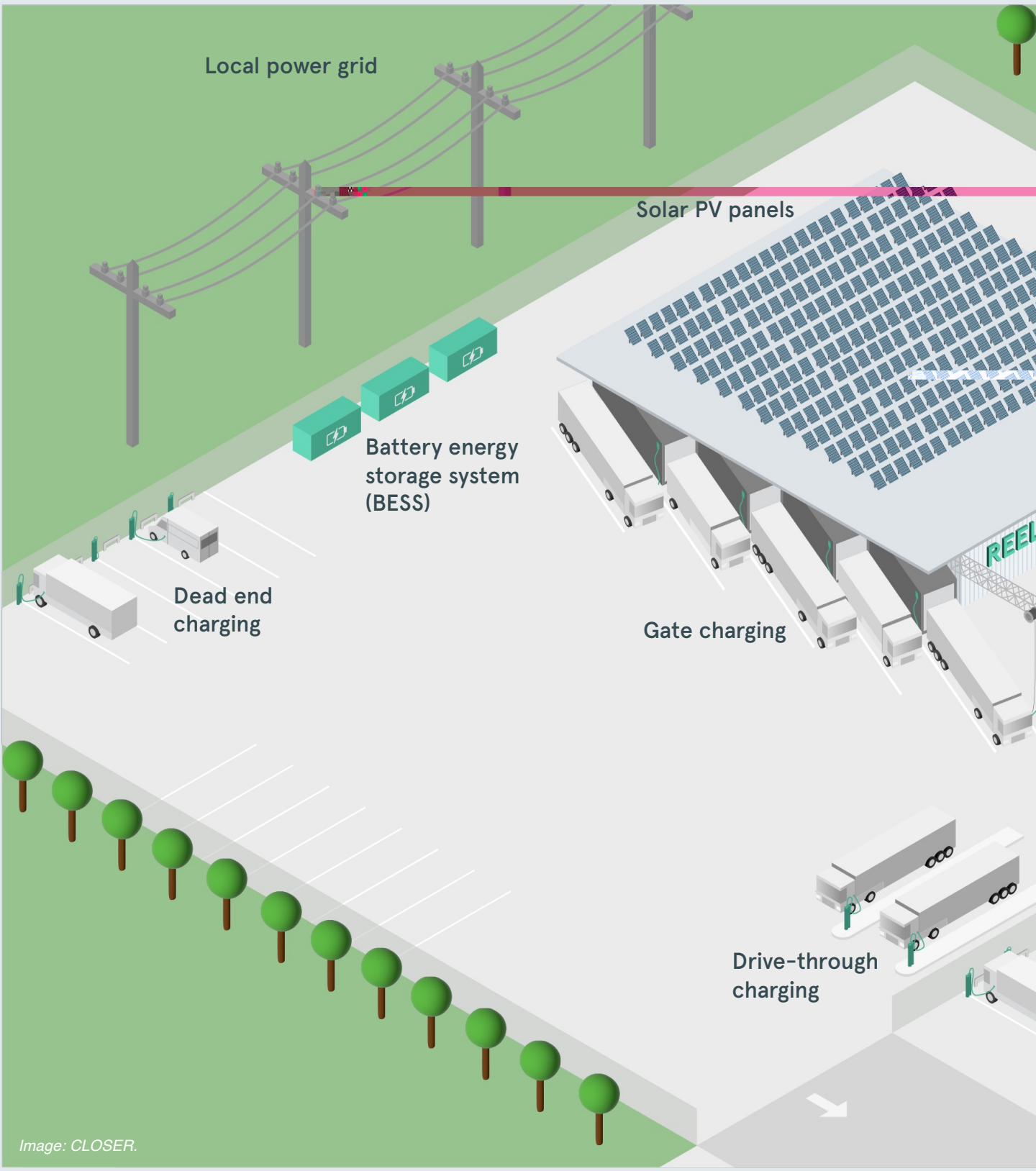
With deployment of electric trucks, transport and logistics companies face the challenge of designing, acquiring and installing necessary charging infrastructure. As the number of electric trucks operating from the same logistics terminal or depot increases, so does the scale of the charging infrastructure. Charging impacts the operational cycle of the electric trucks which is why there are many trade-offs to consider when designing a charging solution to balance e.g., downtime of the trucks versus charging related costs, and size of the batteries versus loading capacity.

There are different prerequisites in terms of physical space on each site which impact the choice of certain charging infrastructure design, and layout.

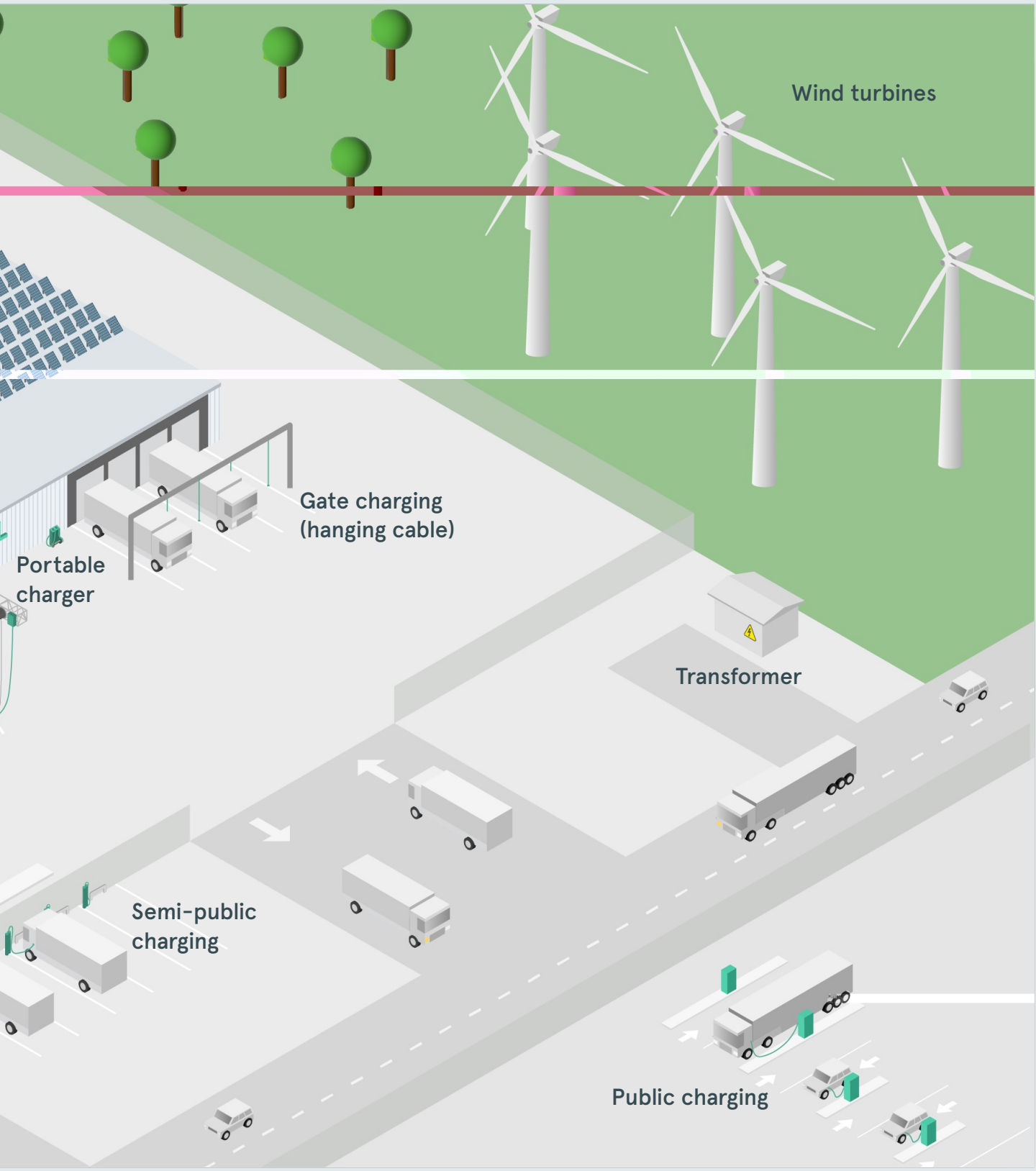
In this report, several solutions chosen by partners in the REEL project are presented.

Being some of the earliest adopters of electric trucks in Sweden, several logistics companies soon found themselves formulating expansion plans for their electric fleets and consequently the charging infrastructure. Since charging is a new phenomenon for the trucking industry, a lot of effort has been put into designing these solutions while simultaneously navigating in the new emerging landscape of suppliers including e.g., charging hardware manufacturers, energy companies, and grid operators.

Charging infrastructure impacts the overall energy and power system in the logistics terminals and depots. Therefore, local energy production and energy storage solutions may become important to keep energy and power costs down while maintaining a higher level of system resilience.



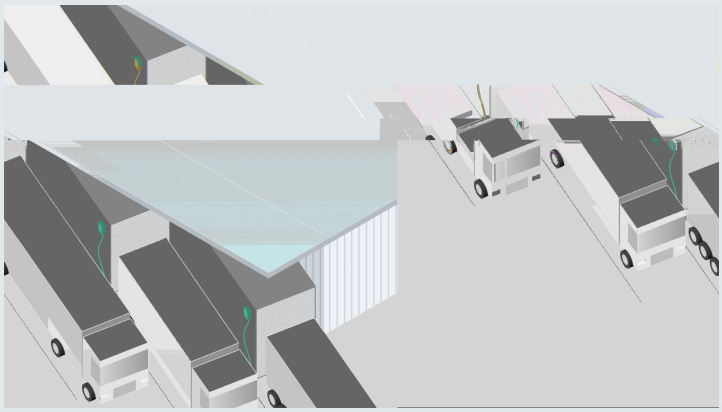
The illustration offers a conceptualized view of the modern logistics terminal predominately served by electric trucks. Apart from various charging designs, it also showcases a simplified view of the adjacent energy and power system.



With electrification of the trucks new competitive factors emerge. Hauliers, distributors, as well as transport buyers need to develop new capabilities including skills related to e.g., charging infrastructure, local energy production, and power supply to ensure access to green energy, sufficient power levels, and competitive prices.

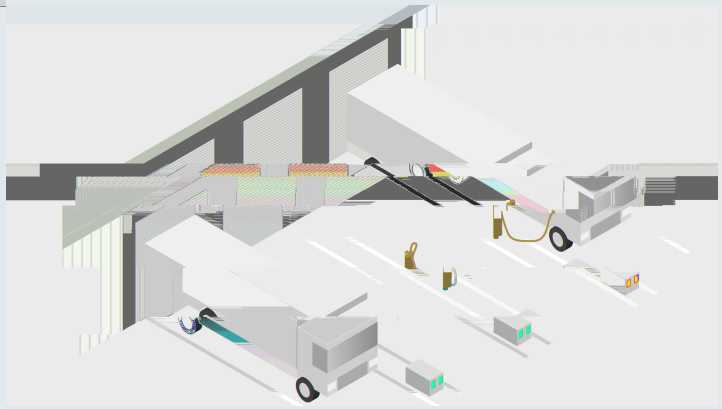
Charging solutions at terminal gates

This section presents some of the observed charging solutions at terminal gates in the REEL project and in general. These solutions allow for charging while on- and offloading the vehicles.



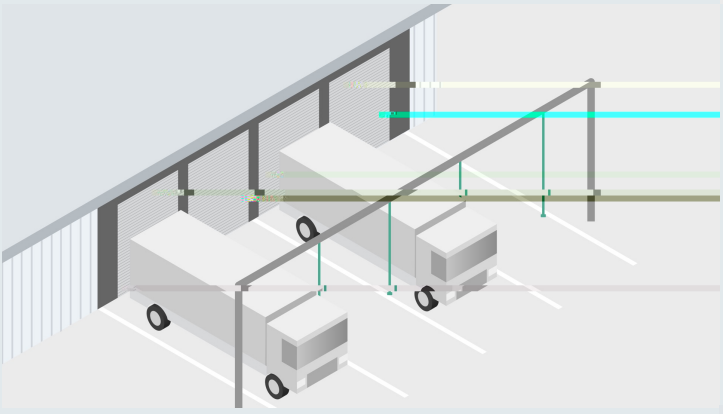
Angled gate charging

Charging points are located on the wall of the adjacent terminal gate.
See for example Martin & Servera, page 36.



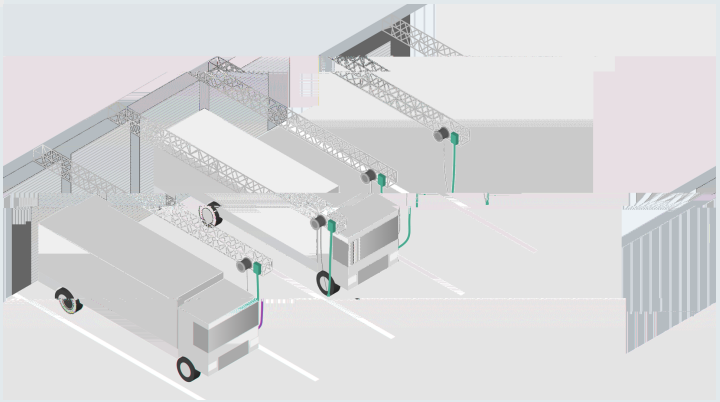
Gate charging (ground)

Charging points are located on the ground between terminal gates. The satellites are protected by concrete blocks to prevent collisions. See for example Dagab, page 13.



Gate charging (overhead arc)

The charging cables hang down from an overhead arc in proximity to trucks cabins.



Gate charging (overhead)

The charging points and cables are located above each terminal gate. They are held above ground level and retrieved with the help of a steel wire.

Images: CLOSER

1 Martin &Servera Stockholm. 2 Dagab Stockholm.

Images: CLOSER, Scania

Charging hardware

In the cases covered in this report charging hardware from three manufacturers are utilized, each briefly described here using the manufacturers' own nomenclature.

ABB

ABB is the supplier of charging hardware to Ragn-Sells' two charging locations described further on pages 40-43. On their semi-public site the model HVC 160 is installed and for the public site the model Terra HP 350 is used. Both Terra HP and HVC have a modular set-up of charge posts and separate AC/DC converter power cabinets.

Alpitronic

Alpitronic is the supplier of charging hardware to Wibax described further on pages 45-46. The model used is Hypercharger with two power stacks and AC/DC conversion. It has a maximum total DC output power of 150 kW.

Kempower

Kempower's hardware has been installed by e.g., Dagab and GLC. Both have chosen a solution with power units and satelites. Kempower's power unit is a modularly scalable AC/DC converter cabinet solution including power modules. Each power module is 50 kW and the modular design allows for 1-12 (600 kW) modules in a cabinet. Up to 8 distributed charging points, i.e. satellites, can be connected and supplied by a single power unit.

Images: Göteborg Energi, Wibax, CLOSER

DAGAB

Dagab delivers food products to Axfood's supermarkets around Sweden.

The company started its electrification journey by acquiring one battery-electric and one plug-in hybrid truck for deliveries from Dagab's warehouse in Jordbro, outside Stockholm, in 2021. A 175 kW charger was installed between two loading gates at the warehouse, to which both trucks return several times a day for reloading. In addition, two night chargers of 22 kW each were installed at the parking lot nearby.

Electrifying the Gothenburg fleet was the next step with delivery of an electric 64-tonne Scania truck in 2022. Charging infrastructure was installed to provide energy for both the truck and the trailer containing a battery for electric propulsion of the cooling unit. The charging in Gothenburg is the focus of this article.

Dagab's warehouse in Hisings Backa, Gothenburg consists of several buildings each containing many terminal gates. The company decided to continue pursuing their charging strategy of recharging the vehicles during on- and offloading to keep logistics losses down and the mileage of the vehicles up. The site is rather compact and under expansion. Available space for a charging hub is scarce, which was another factor in the decision making.

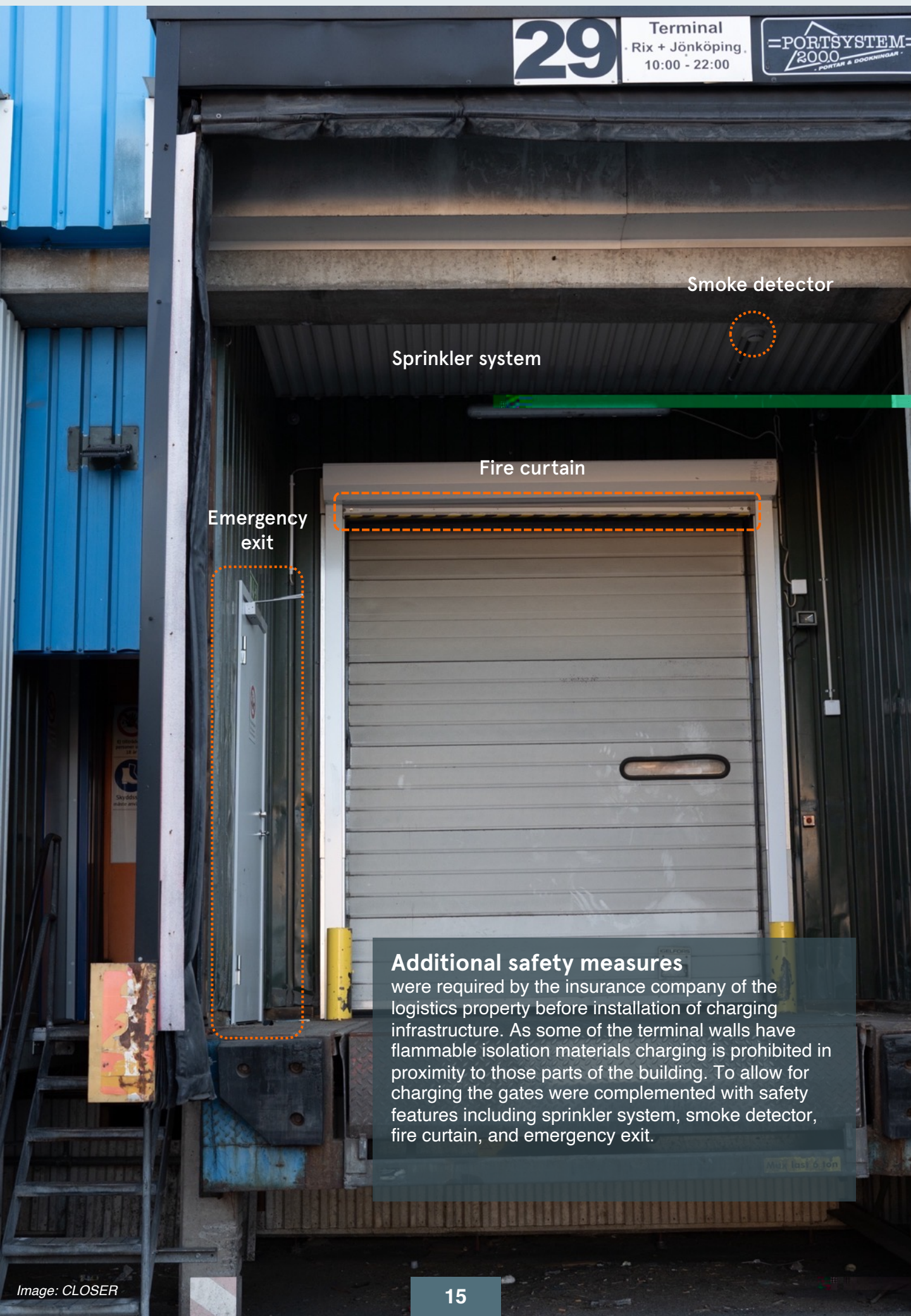
C	
# charging outlets	4
Total power to charging station	350
Type of charging	
Access	-

Images: Scania

The charging solution in Gothenburg. Chargers have been placed between the terminal gates. As the space is rather narrow, a satellite solution was chosen. Four satellites with one charging outlet each and a power unit was installed.

A closer look at one of the charging satellites. Additional safety features were installed in the terminal gates. In comparison, the left gate has additional features while the one on the right does not. Read more on next page.

Images: CLOSER



Additional safety measures

were required by the insurance company of the logistics property before installation of charging infrastructure. As some of the terminal walls have flammable isolation materials charging is prohibited in proximity to those parts of the building. To allow for charging the gates were complemented with safety features including sprinkler system, smoke detector, fire curtain, and emergency exit.

Image: CLOSER

Investment in charging at terminal gates in Gothenburg

Grid connection, extension, and transformer

Existing grid connection to the terminal was sufficient to supply the charging infrastructure.

Ground works, installation, safety measures, & PM

Includes indoor and outdoor installations of the charging hardware. Safety measures were required by the insurance company (fire curtains, smoke detectors, emergency exits, sprinkler system and additional wall insulation).

Hardware

Four charging satellites with one charging outlet each and one power unit. A product warranty is included. Some of the installation costs were included in the hardware cost.

The charging infrastructure has been co-financed by Klimatklivet (read more on page 51).

Initially the charging infrastructure was utilized for the 64-tonne Scania truck. As Dagab's electric fleet is continuously expanding the utilization of the charging infrastructure increases. Further on, Dagab also allows its transport suppliers to charge their electric trucks at the facility during on- and offloading.

In retrospect, Dagab states that the chosen charging solution is not as collision proofed as initially expected. The combination of narrow space between charging gates, placement of the satellites and reversing truck configurations of up to 25 meters has already caused a few collisions with the charging satellites. The company is searching for a new solution in terms of placement of the charging infrastructure to avoid collisions and charger downtime.

Want to learn more?

Scan the QR-code to watch a film about Dagab's electrification journey.

Image: Scania

FALKE V LOGISTIK

One of the biggest charging station for heavy-duty trucks to date

Since October 2022, this charging station is available to the public in the city of Malmö. Kempower was chosen as the charging hardware supplier, primarily due to the modular flexibility provided by the satellite and power unit solution. The power units (1) and the charging outlet (2) are separated allowing for narrow charging islands and thus an efficient space utilization. The 22 charging outlets can provide over 100 kW of power each which is supplied from five power units. 1.7 MW of power is available from the grid which can be expanded up to 2.5 MW by temporarily utilizing power from neighboring facilities. Although the charging site in Malmö has a sufficient grid connection, Rifil strives to keep its power levels and thereby power fees as low as possible.

Keeping the power levels down can also be achieved by utilizing the battery energy storage system (BESS) (3) and a software allowing to plan the charging of the Falkenklev trucks. Currently, BESS is primarily participating in ancillary grid services procured by the Swedish transmission system operator (TSO) through an aggregator. These ancillary services provide high profitability for batteries which significantly shorten the payback time of the BESS. The BESS is owned by Soltech and Rifil receives a percentage of the income from participation in ancillary grid services. Read more about ancillary services on next page.

Rifil has also ambitions to become an energy producer. In Perstorp, located in another part of Skåne county, the company is currently building a solar PV panel park to produce electricity for its upcoming charging network. The company's ambition is to become energy self-sufficient.

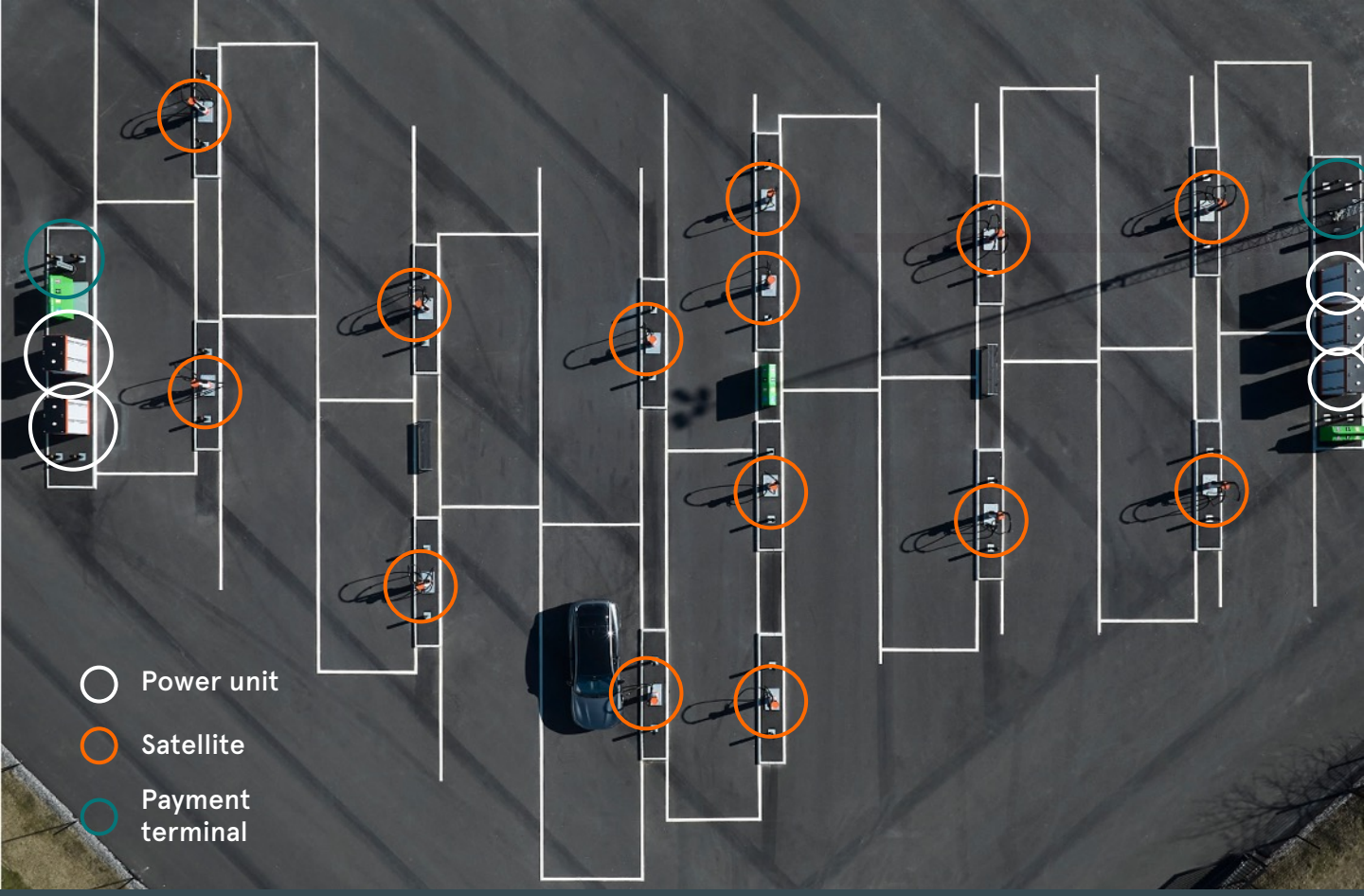
Image: CLOSER

Ancillary services

To balance and manage disturbances in the power system the Swedish TSO, Svenska Kraftnät, has access to ancillary services. Their role is crucial, ensuring that the grid is in balance i.e., maintaining a frequency of 50 Hz. The ancillary services are complementary to the future and hourly spot market where the bulk of the electrical energy is traded. There are several different ancillary grid services for which batteries can be utilized as they provide fast response times and sufficient endurance.

The owners of BESS can participate as a flexibility resource through an aggregator which puts bids for participation in the different ancillary grid service markets. These markets are created and administrated by Svenska Kraftnät.

Rifil Malmö.
Image: CLOSER



The chosen layout of the station enables vehicles to approach the charging outlets from both sides. This design can easily accommodate vehicles of various lengths, providing easy access regardless of the location of the charging inlet in the vehicle. The ability to drive through the parking spaces is especially important for the heavy-duty vehicles of up to 34.5 meters in length which have been recently allowed in Sweden.

Payment for charging can be done via a web-page by using a QR-code, located on every charging satellite. In addition, there are two card payment terminals present on opposite ends of the station allowing for charging without registering in advance. The payment solution is managed by Rifil.

E
The hauiler is frequently using the Malmö station during transport assignments of their 9 Volvo FH Electric trucks matching charging with drivers' breaks.

Images: Rifil, CLOSER

Investment in charging infrastructure at Rifil Malmö

Grid connection, extension, and transformer

High voltage grid connection including upgrading the local grid and installing a new transformer.

Ground works, installation, safety measures, & PM

Extensive ground works were required due to the nature of terrain. Installation of the hardware and safety measures are included in the groundwork. In addition, the cost for a self-service kiosk, lighting, water connection to the WC and signs are included.

Hardware

14 charging satellites and 5 power units. (The BESS is not included since it is owned by Soltech)

The charging infrastructure has been co-financed by Klimatklivet (read more on page 51).

Want to learn more?

Scan the QR-code to watch a film about Falkenklev's electrification journey.

Images: CLOSER

1,2 GLC Göteborg

Images: CLOSER

Total power to charging statio	1
Type of charging	
Acce	-

The charging hub is located along the outer fence next to parking spaces. The trucks are being parked nose front. Large concrete blocks protect charging equipment from collision. Power units and satellites are placed in front of the parking spaces.

The satellites are equipped with either one or two charging outlets. Some of the satellites are reserved for regular customers. The payment terminal is used to initiate every charging session together with TapNet, an app developed for TRB.

1 MW grid connection
8 satellites
15 charging outlets
4 power units

- Power unit
- Satellite
- Payment terminal

Images: CLOSER

GLC: Charging sequence

1. The truck returns to the depot at the end of the shift.

2. After offloading, the truck is parked next to a charger.

3. The driver logs onto TapNet.

4. GLCs charging hub in Gårdsten is selected in the app.

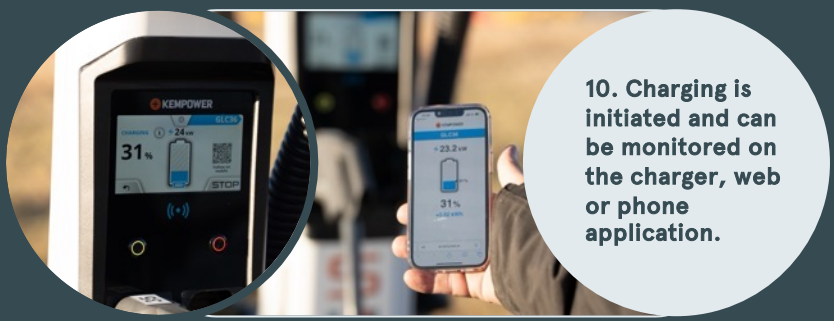
5. The specific charging outlet is selected.

6. Vehicle ID is inserted on the payment terminal.

7. The specific charging outlet is selected in the terminal.

8. Charging sequence is initiated in the terminal.

9. Charging cable is plugged into the vehicle.



10. Charging is initiated and can be monitored on the charger, web or phone application.

Images: CLOSER

The charging hub has been primarily designed for fast charging during the shifts and night charging. Chargers were placed on the parking lot as GLC did not want to lock charging to the terminal gates at this initial stage. Both GLC's own vehicles and some external companies are currently utilizing the hub. Most of the charging takes place during the evenings and night. Roughly 40% of the total energy is charged by external companies.

The insurance company did not require any safety measures as the chargers are located away from the warehouse building.

A new night charging hub is underway. After that, charging at terminal gates is planned as opportunity charging will be required during on- and offloading in the future. Additional charging will be challenging to establish as no additional capacity is available in the local grid today.

Another ambition is to establish public charging stations for trucks around Gothenburg. Acquiring necessary land plots will be of major importance.

Investment in charging infrastructure at GLC's terminal

Grid connection, extension, and transformer

Existing grid capacity was rather high hence the low grid connection cost.

Ground works, installation, safety measures, & PM

The area was already paved, and the cost relates only to minimal cable routing. Groundwork has been done by GLC themselves.

Hardware

8 satellites with 15 charging outlets in total and 4 power units.

The charging infrastructure has been co-financed by Klimatklivet (read more on page 51).

Image: CLOSER

Jula Logistics railway terminal in Falköping

Image: CLOSER

JULA LOGISTICS

Jula Logistics has invested in a public charging station for trucks next to its railway terminal in Falköping.

Jula Logistics is a part of Jula, one of Sweden's largest Do-It-Yourself (DIY) retailers. The main warehouse of Jula, which is also the largest logistics warehouse in Sweden, is located in Skara. Each day, containers are transported between the railway terminal in Falköping and Jula's main warehouse, a one-way trip of 30 km, as well as to and from other customers in a radius of up to 200 km from the railway terminal. The transports are performed by a carrier working in a close relationship with Jula Logistics.

The parties have so far deployed two electric heavy-duty trucks for these transports in a total fleet of 30 trucks. The electric tractors are permitted to haul a two-trailer combination allowing for two 40-foot containers with a total length of 33 meters.

Jula Logistics is planning to increase the number of electric trucks utilized for transports to and from the railway terminal. Building necessary charging infrastructure has thus been an important step. Previously, Jula Logistics has installed charging infrastructure at its main warehouse in Skara. To better serve logistics flows to other customers to and from the railway terminal, and to achieve more flexibility, the company invested in additional charging in Falköping. As the company was able to match timing for a new Swedish incentive program for public charging Regionala Elektrifieringspiloter, (read more on page 51), the station will also serve trucks from other hauliers.

C	
# charging outlets	**6**
Total power to charging station	**2**
Type of charging	**D** -
Access	

Image: CLOSER

Public charging station designed for longer vehicles.

The railway terminal in Falköping is a key location for Jula Logistics due to the significant volume of imported and exported goods on rail. Apart from Jula's goods, inbound and outbound freight trains are loaded with goods from various companies in the region, generating significant truck traffic.

Jula Logistics has been one of the pioneers when it comes to testing HCT (High-Capacity Transport) truck configurations of up to 33 meters in length. Since December 2023, a part of the Swedish road network has been opened for truck configurations of up to 34.5 meters. Jula Logistics plans to continue utilizing HCT, especially between Falköping and the warehouse in Skara since this flow represents most of the goods volume.

Long truck combinations have been given a lot of attention during the design phase of the charging station in Falköping. The greatest challenge was to be able to accommodate 35-meter-long trucks in a rather small area while enabling the trucks to drive through the charging station and thereby also avoiding reversing and risk of collision. Turning circles of various truck configurations were studied before adopting the current design. The drive through design also allows for trucks to charge before or after on- and offloading, minimizing additional coupling and uncoupling of trailers. Placing the satellites on the outer edge of the paved surface also provides greater flexibility of the land use in the future.

The charging station consists of six satellites and three power units from Kempower, with a max output of 350 kW per charging outlet.

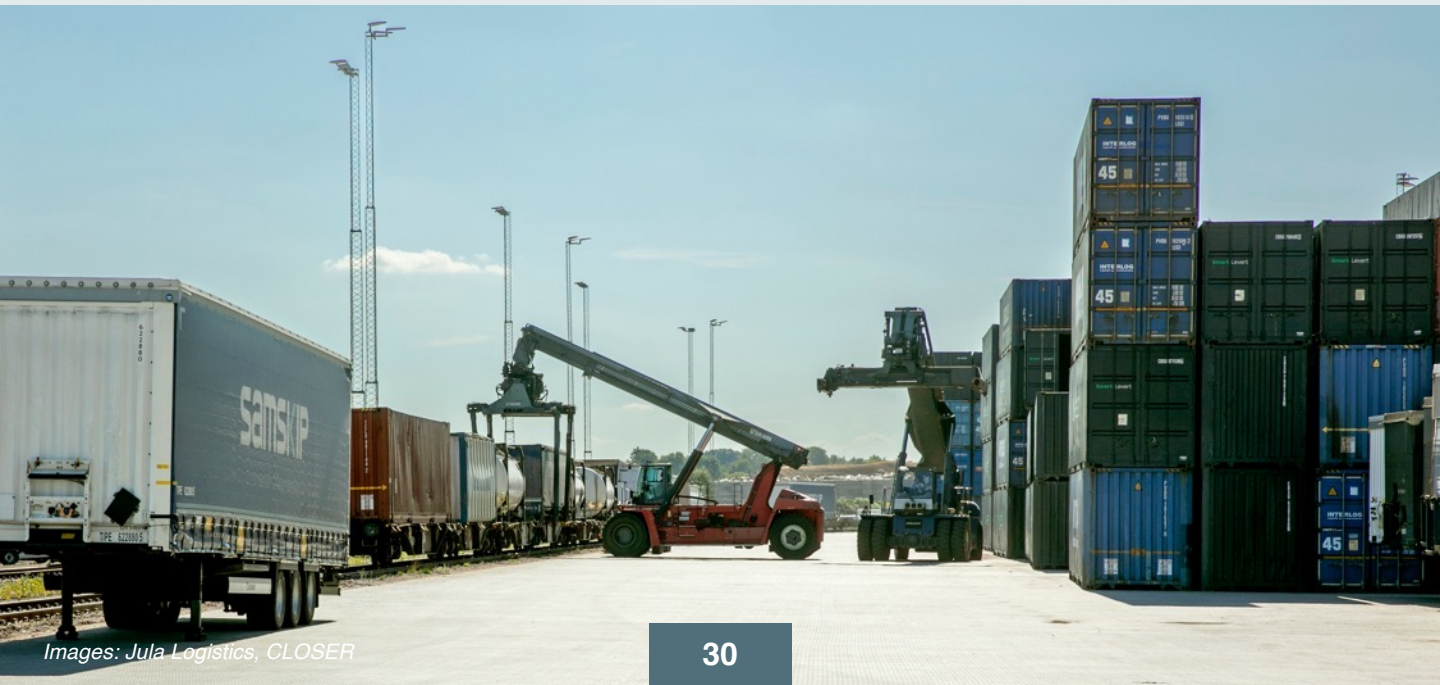
Image: CLOSER

Around 30 diesel trucks are being operated in partnership between Jula Logistics and the carrier. Two electric tractors are in operation and the ambition is to replace the diesel trucks as soon as possible. The charging station in Falköping is a prerequisite for the transition.

The railway terminal can be seen behind the charging station. An expansion of the railway terminal and construction of a new warehouse is underway which is expected to increase the goods volume.

The new warehouse will be equipped with solar PV panels on the roof which will supply the charging station with electricity.

The charging satellites are kept at ground level due to accessibility requirements stated in the terms of the incentive scheme. The requirements also state that the site needs to be accessible for the public. Instead of asphalt, concrete tiles are used for surface since asphalt tend to deform faster from the weight of the trucks when exposed to sunlight.



Images: Jula Logistics, CLOSER

Investment in charging at railway terminal

Grid connection, extension, and transformer

A high voltage connection was previously established for the railway terminal. In relation to the charging station, the investment includes a refurbished transformer.

Ground works, installation, safety measures, & PM

Consists of ground works, building permit and hardware installation.

Hardware

6 satellites with one charging outlet each and 3 power units.

All the investment costs have been covered by the Regionala Elektrifieringspiloter incentive (see more on page 51).

LBC FRAKT

A transport company with 220 trucks and 12 charging sites.

LBC Frakt is based in Värmland County and consists of 50 small and individual carriers that co-own LBC Frakt together, i.e. a haulier network organization. The company's vehicles mostly operate within Värmland transporting general cargo, bulk products, refuse, and concrete. Currently, their fleet includes 50 construction machines and 220 trucks whereof four are battery electric trucks (BETs). The four BETs operate in various assignments. The first electric truck delivered to LBC Frakt operates for the wholesale- and trading company Bevego, distributing sheet metal and other materials related to roofs. The second electric truck operates for Stora Enso, at their paper production facility, transporting refuse in specialized containers. The two other trucks transport excavated material between the construction site of a new hospital in Karlstad and LBC Frakt's rock quarry in Bråtebäcken.

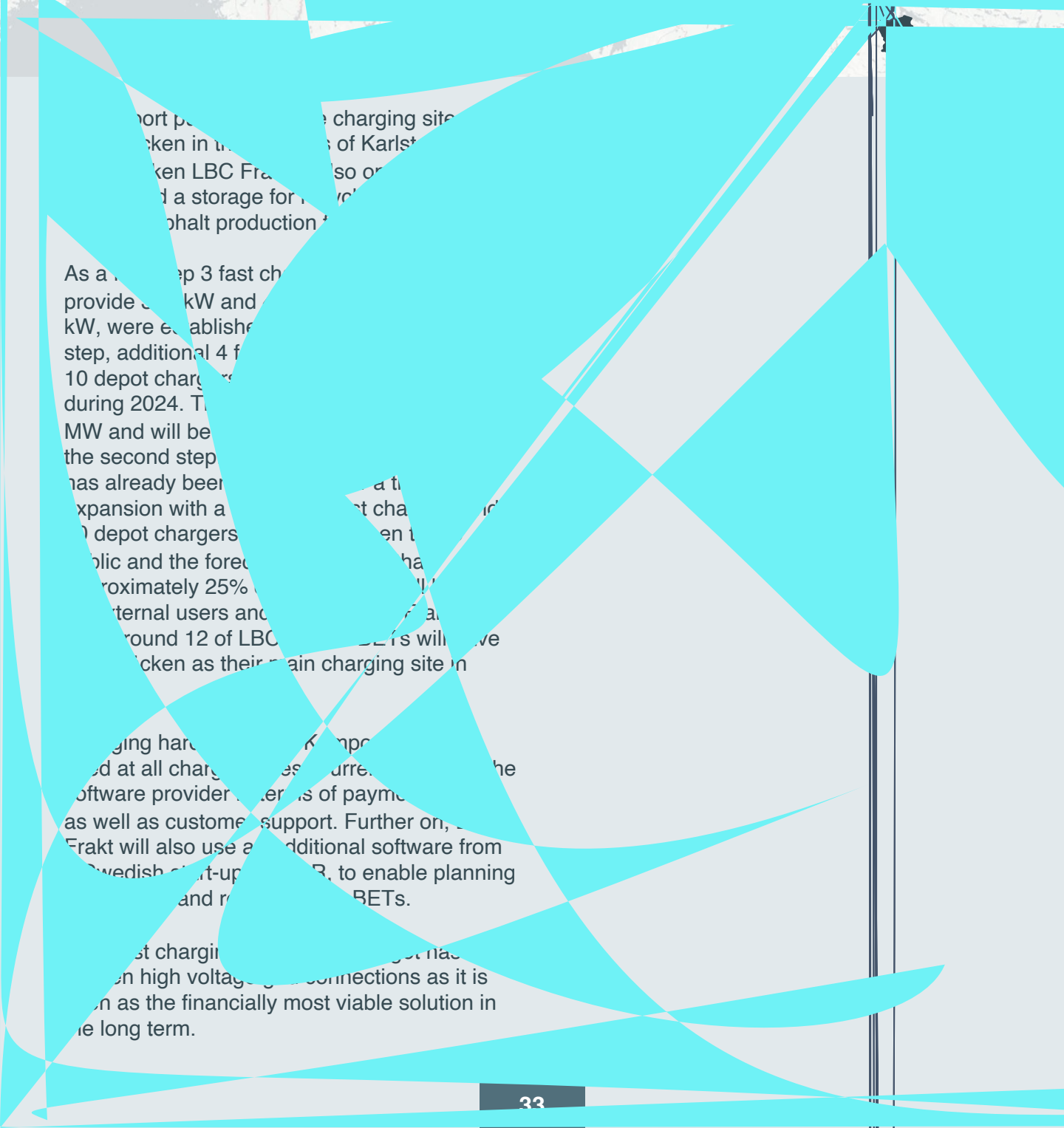
In 2024 another 20 BETs will be added to LBC Frakt's fleet including e.g., wood chip trucks of 70 tons, long-haul 64 tons trucks, asphalt, and refuse trucks. The roll-out will continue with a goal of having 50 BETs in operation by the end of 2025, and 150 BETs by 2030.

To enable the transition LBC Frakt joined forces with Karlstad Energi and OK Värmland and founded a joint venture; Laddbolaget.

By 2025 Laddbolaget will operate in total 12 charging sites around Värmland and its proximity. Four of the sites have received co-funding from Klimatklivet and the remaining have received co-funding from Regionala Elektrifieringspiloter (see more on page 51)

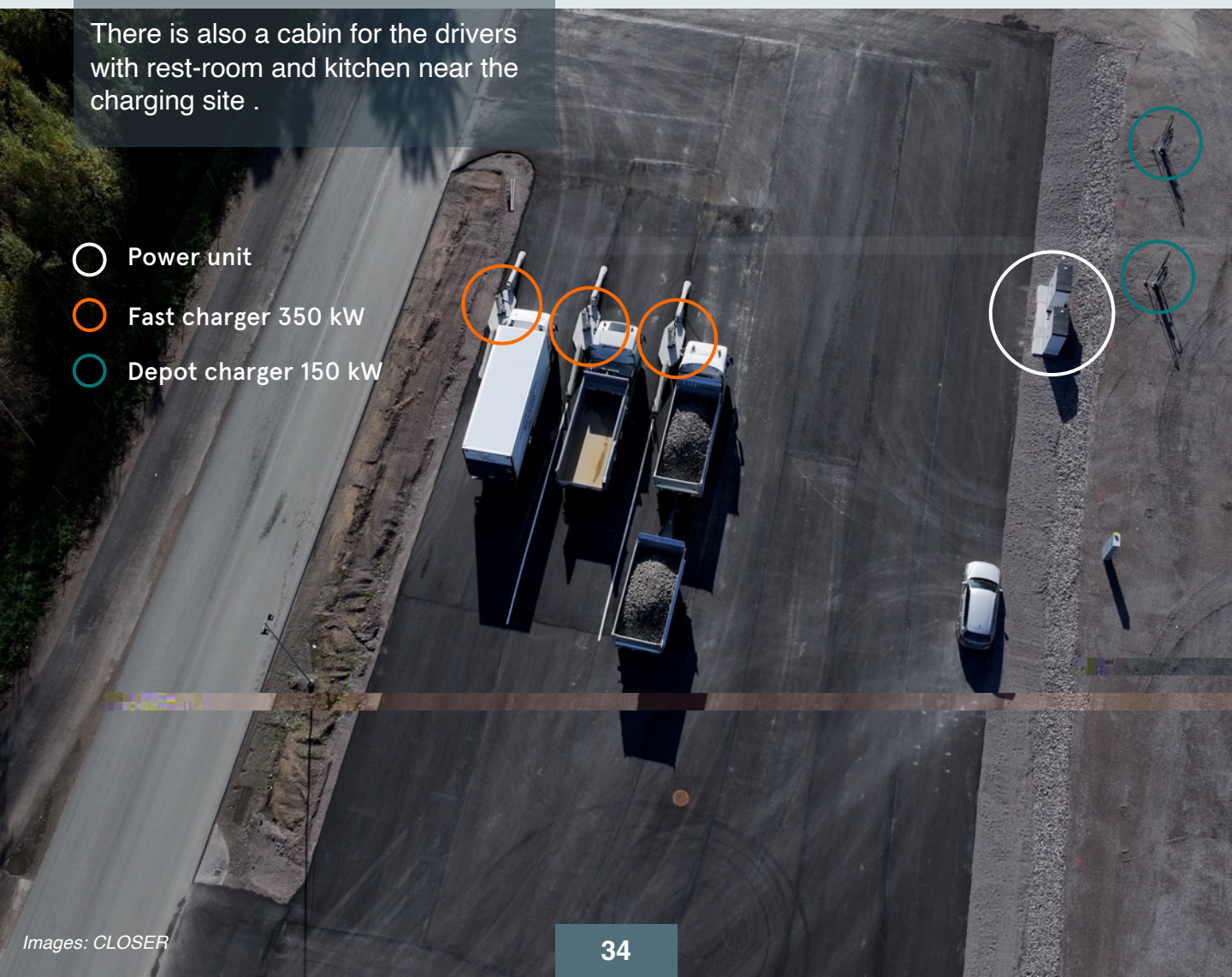
Images: LBC Frakt, CLOSER

LBC Frakt have invested in 12 charging sites in Värmland and its proximity, through its joint venture Laddbolaget. The charging network will enable its transition to a 70% electrified fleet in 2030.



When designing the charging sites, a self developed design model considering turning circles of 25.25- and 34-meter-long trucks was used. This model has been used for all 12 charging sites. For the fast charging points, a drive-through solution is used to minimize risk of damaging the infrastructure. For the depot charging the trucks will be parked.

There is also a cabin for the drivers with rest-room and kitchen near the charging site .



Images: CLOSER

Charging infrastructure at Bråtebäcken (Step 1: 7 charging outlets)

Grid connection, extension, and transformer

Including a high voltage grid connection and a new transformer to enable the construction of the site.

Ground works, installation, safety measures, & PM

The ground works were done by LBC Frakt, further on they also cast the concrete pylons themselves.

Hardware

Includes a power unit and seven charging outlets from Kempower, whereof three can provide 350 kW and four 150 kW.

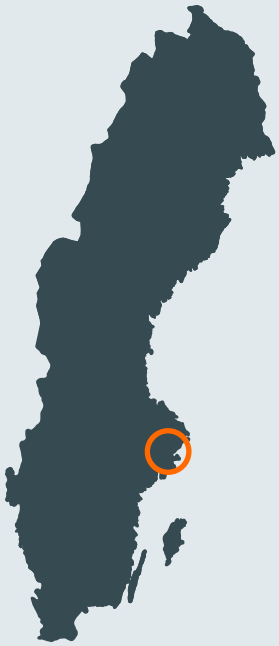
The charging infrastructure has been co-financed by Regionala Elektrifieringspiloter (read more on page 51).

Want to learn more?

Please view this film about electrified building and construction transports where LBC Frakt share their insights.

Images: CLOSER

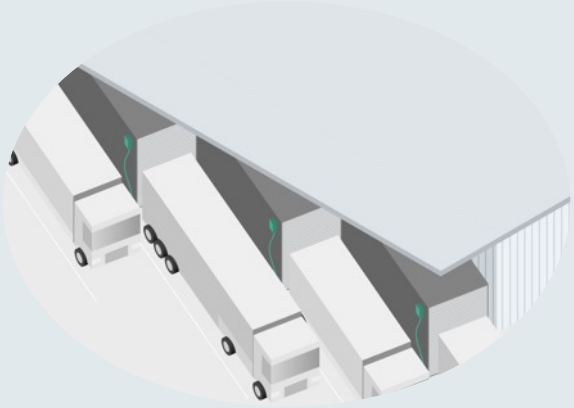
MARTIN & SERVERA

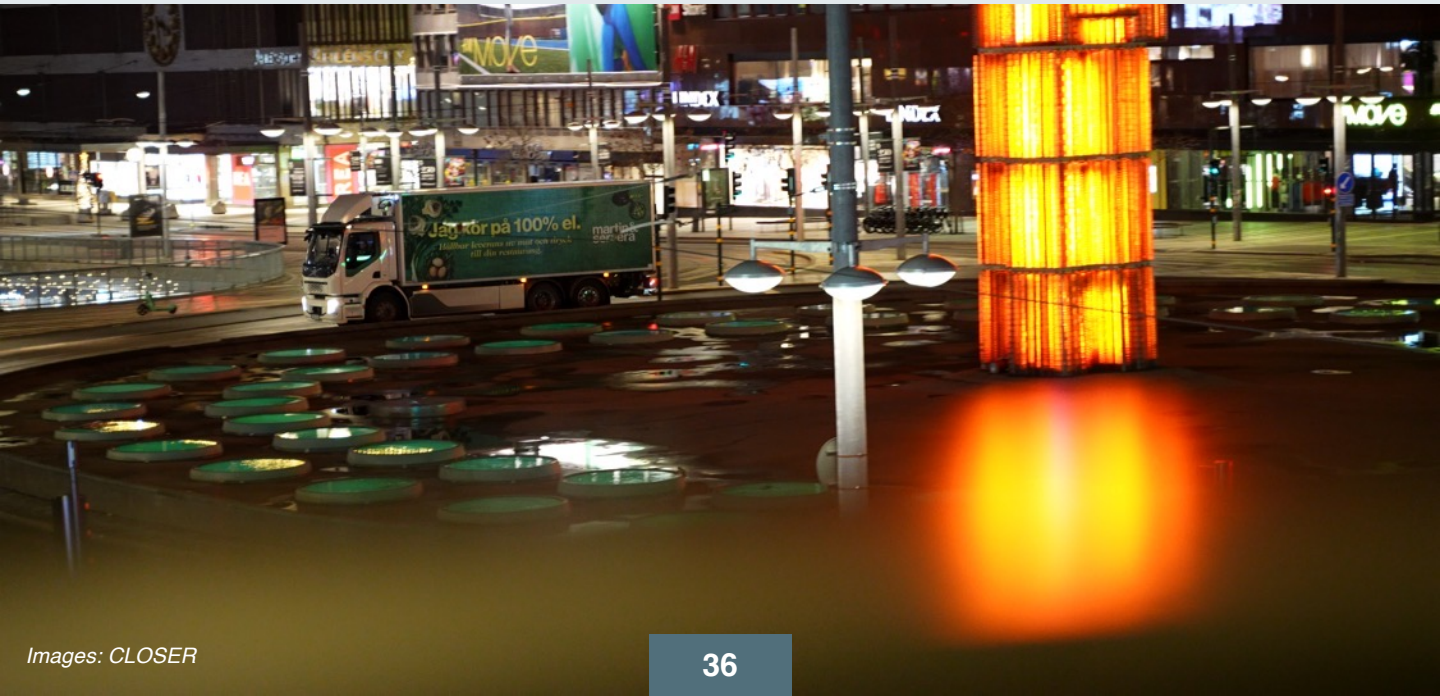


Martin & Servera has a strategy of using on- and offloading times at their terminal for charging.

Martin & Servera (M&S) delivers food to both privately owned and public restaurants and cafeterias around Sweden. In total, the company has 22 cross-dock terminals 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 by adding a night shift. The company has managed to do this with several private and public customers and has also been provided permits from municipalities to deliver during night in the city centers 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.

The company took delivery of their first battery electric truck (BET) in 2021 and currently operates 12 BETs in their internal fleet, a number that continues to increase. The BETs are based at various locations. The cross-dock terminal in Årsta, Stockholm is the focus for this case description. Currently, four BETs are based in Årsta. Each vehicle is equipped with 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 customer deliveries per round. When the trucks return to the terminal for reloading, they are also charged for about 45 minutes. Chargers with a capacity of 250 kW are installed at the terminal gates. During the longer breaks, they utilize a wall-box charger of 22 kW located in the parking area.





Images: CLOSER

Six of the terminal gates in Årsta have been equipped with charging outlets. The charging infrastructure can deliver a maximum of 250 kW, and each outlet has the possibility to provide 250 kW. The charging satellites are placed on the side of the angled gates. The outlets are held above ground level and retrieved with the help of a wire, and when not used the outlet is placed in a holder, a solution constructed by M&S's own technicians. The power unit is placed inside the building, and the cables are drawn on the outside of the building. Before installing the charging solution, combustible materials were removed. Unattended charging at the gates is not allowed. Besides M&S's own BETs, some of their suppliers utilize the possibility to charge when delivering goods.

C	
# charging outlets	6
Total power to charging station	250
Type of charging	C
Access	-

Images: CLOSER

Investment in charging at Årsta terminal gates

Grid connection, extension, and transformer

Existing grid connection to the terminal was used to supply the charging infrastructure.

Ground works, installation, safety measures, & PM

The main cost driver in this category was the wiring as no ground works were needed. Furter on M&S fire proofed the gates and constructed the solution for retrieving of the charging outlet.

Hardware

Including one power unit placed inside the building and six satelites mounted on the angled terminal gates, each able to provide 250 kW (42 kW distributed evenly).

The charging infrastructure has been co-financed by Klimatklivet (read more on page 51).

Want to learn more?

Please view this film about electrified frozen and refrigerated transports where M&S and Dagab share their insights

Images: CLOSER

Martin & Servera delivers to Fotografiska, Stockholm.

Images: CLOSER.

Investment in semi-public charging infrastructure

Grid connection, extension, and transformer

Existing grid connection to the site was used to supply the charging infrastructure.

Ground works, installation, safety measures, & PM

Including some minor ground works, wiring, and installation costs

Hardware

Including 2 ABB HVC 160 with 9.5-meter-long cables and power cabinet.

The charging infrastructure has been co-financed by Klimatklivet (read more on page 51).

Image: Ragn-Sells

To enable additional electrified transports Ragn-Sells is also building a public charging station at Högbytorp

In 2024 Ragn-Sells will open a public charging station located near the plant, which is also right next to the E18 highway. The station will have a drive-through layout with 8 charging points each able to deliver 350 kW. The station has a high voltage grid connection of 1 400 kW. The station has also been designed to enable access for people with reduced mobility, therefore the charging outlets are not elevated from the ground. Thus, barriers will be installed to protect the chargers from collisions.

In contrast to the other sites described in this report, Ragn-Sells was requested to perform multiple safety efforts to receive a building permit from the municipality of Bro. This have not been the case with any of the other municipalities. Currently, national guidelines are lacking making each municipality to regulate this themselves. The requested efforts included for example (1) a fire hydrant, (2) to have an envelope shaped charging site, able to collect 100 m3 of potential extinguishing water, and (3) wells with oil separators. Early in the process the municipality also had requirements on embankment around the site, which was later dismissed. All in all, those efforts led to extra costs of approximately 1 MSEK. Further on, the Swedish Transport Administration also required Ragn-Sells to build an anti-glare protection along the E18 highway.

Ragn-Sells has contracted Monta as a solution provider for payment services, customer service, and maintenance. Monta will also be used for the semi-public chargers at the plant.

C	ABB 350
# charging outlets	8
Total power to charging station	1.4
Type of charging	D -
Access	

Image: Ragn-Sells

Investment in public charging at Högbytorp

Grid connection, extension, and transformer

Including a high voltage grid connection of 1.4 MW, a transformer, and relocation of a power line pole.

Ground works, installation, safety measures, & PM

Extensive groundwork was required due to the nature of terrain. Safety efforts requested by the municipality also constitutes a significant proportion.

Hardware

Includes 8 ABB Terra HP 350 with 4.5-meter-long cables. A 5-year product warranty is also included.

The charging infrastructure has been co-financed by Regionala Elektrifieringspiloter (read more on page 51).

Image: Ragn-Sells, Scania

SCANIA TRANSPORTLABORATORIUM

Electrifying internal transportation at Scania

Scania Transportlaboratorium is an internal transport division set up to partially service Scania's internal transport needs. Partly it exists as a living lab for the OEM to understand trucking business and thus better understand its customers. It is also used to test new Scania products, e.g., drivetrains, and services in real-world conditions. Thus, the company is an early adopter of e.g., electric trucks. Currently, Scania Transportlaboratorium operates six electric trucks in a fleet of 31 vehicles for local and regional transport. There is an additional fleet of trucks for long-haul transports.

All 31 vehicles are stationed at a depot next to Scania's factory in Södertälje. Prior to deployment of the six electric trucks, charging infrastructure was installed. The existing grid capacity was insufficient, with only 50 kW of maximum capacity available. Although, the available time for charging is up to 15 hours, the power capacity was too low to charge all six trucks. In cooperation with Scania Charging Solution Team, a BESS (battery energy storage system) was installed at the site with a total capacity of 1 MWh. Most of the charging is done during the night while in some cases vehicles are charged during drivers' breaks. Six satellites and one power unit have been installed along the property fence, with vehicles parking nose front before charging. Prior to expansion of the electric fleet and charging infrastructure, upgrading the grid capacity is necessary. Another challenge is accommodating all 31 trucks and charging at the current depot. Although it would be preferable to accommodate truck and trailer combinations, the parking space is insufficient.

Investment in charging infrastructure

Grid connection, extension, and transformer

Including an upgrade of their transformer.

Ground works, installation, safety measures, & PM

Including some minor ground works, concrete foundation and safety barriers, and a solution for handling of the charging cable.

Hardware

Including one Alpitronic charger with a 9-meter-long cable. Currently 150 kW is installed but the cabinet can be upgraded to 300 kW when needed.

The charging infrastructure has been co-financed by Klimatklivet (read more on page 51).

Image: Scania

Wibax has introduced a mobile charging solution to use while waiting for a sufficient grid connection at customers´ sites

One of Wibax's challenges on the journey to electrified transports is to keep the transport efficiency. It is undesirable to stop and charge the vehicles for longer time than it takes to unload them. One solution to this is the mobile charging solution WiCharge.

To keep all Wibax's electric vehicles in motion, energy needs to be transferred to the vehicles, usually in a very short amount of time. Charging also needs to be available at various locations along the routes. With a mobile charging station such as WiCharge, charging can be done during the vehicles' natural stops – with just the right amount of power. This makes it possible for Wibax to offer customers electric deliveries, even if they have power supply limitations at their respective locations. WiCharge can simply be plugged into a standard socket, where the battery pack is charged over an extended period of time. When the vehicles are connected to the battery pack, their batteries are charged during loading or unloading of products, which normally takes 45-60 minutes.

WiCharge Mobile Charging

- **1** Northvolt Voltpack Mobile System battery pack of **281 kWh**
- 150 kW DC charger
- Powered by a 16-125 A connection
- Installation in a 10-foot standard container

Images: WIBAX

Case summary (1 of 2)

	DA AB	F	C	A	BC F
C	Kempower	Kempower	Kempower	Kempower	Kempower
	4	22	15	6	7
	350 kW	2 500 kW (+ BESS)	1 000 kW	2 000 kW	1 600 kW
Low or High Voltage	Low	High	Low	High	High
Separate or Shared	Shared	Seperate	Seperate	Shared	Seperate
	Terminal gates	Drive-thru (next to terminal)	Terminal parking	Drive-thru (next to terminal)	Drive-thru (next to quarry)
A	Semi-public	Public	Semi-public	Public	Public
F	Fire safe isolation, sprinklers, smoke detectors, fire curtains, exits	N/A	N/A	N/A	N/A
	ChargeEye	ChargeEye, E.ON Navigator, Vourity	ChargeEye, TRB Tapnet	ChargeEye, ChargeNode, CheckWatt	Virta
	3.5 MSEK	18 MSEK	8.2 MSEK	14 MSEK	7.7 MSEK
	Klimatklivet (36%)	Klimatklivet (50%)	Klimatklivet (40%)	Regionala E-piloter 1 (100%)	Regionala E-piloter 1 (91%)
~ 2023	600 kWh	1 500 kWh	1 500 kWh	Data not available	Data not available

Image: CLOSER

Case summary (2 of 2)

	&	- (1)	- (2)	.	BA[3]
C	Kempower	ABB	ABB	Kempower	Alpitronic
	6	2	8	6	1
	250 kW	320 kW	1 400 kW	50 kW (+ BESS)	150 kW
Low or High Voltage	Low	High	High	N/A	Low
Separate or Shared	Shared	Shared	Seperate	Shared	Shared
	Terminal gates	Loading bay	Drive-thru (next to production site)	Terminal parking	Charging at loading bay
A	Semi-public	Semi-public	Public	Private	Semi-public
F	Non-combustible material in gates, no unattended charging	N/A	Fire-hydrant, extinguishing water and oil collection	N/A	Auto. cancel of charging when specific chems. are loaded
	ChargeEye	Monta	Monta	ChargeEye	N/A
	3.2 MSEK	1.9 MSEK	25.3 MSEK	2.1 MSEK	0.9 MSEK
	Klimatklivet (14%)	Klimatklivet (35%)	Regionala E-piloter 1 (77%)	No incentives	Klimatklivet (40%)
~ 2023	600 kWh	350 kWh	Data not available	750 kWh	850 KWh

Image: Scania

Incentive schemes in Sweden for truck charging infrastructure

Actors in Sweden can apply for public co-funding for the procurement and installation of charging infrastructure. Below is a summary of the current incentive schemes.

Klimatklivet

Administrated by the Swedish Environmental Protection Agency

Non-public charging infrastructure

- A maximum of 50% investment support, but for large enterprises the limit is 20% (in calls before autumn 2023 40% was the maximum for large enterprises).
- Evaluates possible support for applicants in competition based primarily on a cost-effective emission reduction.
- Historically, 2-4 calls per year, open for around 14 days each.

Public charging infrastructure

- A maximum of 70% investment support of total cost.
- Support is awarded through a competitive tender procedure. Applications in the same geographical area compete.
- Historically, 2-4 calls per year, open for around 14 days each.
- Based on Commission Regulation (EU) no 651/2014, article 36a.

Regionala elektrifieringspiloter

Based on Commission Regulation (EU) no 651/2014, article 36a, or Commission Regulation (EU) no 1407/2013. Administrated by the Swedish Energy Agency.

Call 1: Spring 2022

- A maximum of 100% investment support of total cost was awarded to 130 public charging stations.
- Support was awarded based on the strategic placement to enable an accelerated transition to regional electrified heavy freight transport and project feasibility.

Call 2: Spring 2023

- A maximum of 25% supplementary support for experimental development during the implementation of the pilots that received funding in the first call.

Call 3: Autumn 2023

- A maximum of 70% investment support of total cost for stations close to high truck traffic road sections and 90% for stations close to less busy road sections.
- A maximum of 25% investment support for energy storage solutions
- Support was awarded based on the support effectiveness, strategic placement, actor constellation, and time-plan.
- In total 96 public charging stations were awarded support.

Call 4:

- To be confirmed

Image: Unsplash

Investment in 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. All charging infrastructure investments, except for Scania Transportlaboratorium, have received subsidies from the Swedish state via Klimatklivet or Regionala Elektrifieringspiloter with a subsidy share ranging from 14% to 100%.

All actors state that they will still own and operate their own infrastructure going forward and that most of the energy used in their operations will be charged within their own network of chargers. The main reason for that is to secure energy price and availability with regards to time, place, and power.

The investment 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. Further on, ground works including excavation, wiring and asphalting have been large cost drivers in many installations.

Below, the cases and division between cost categories are presented:

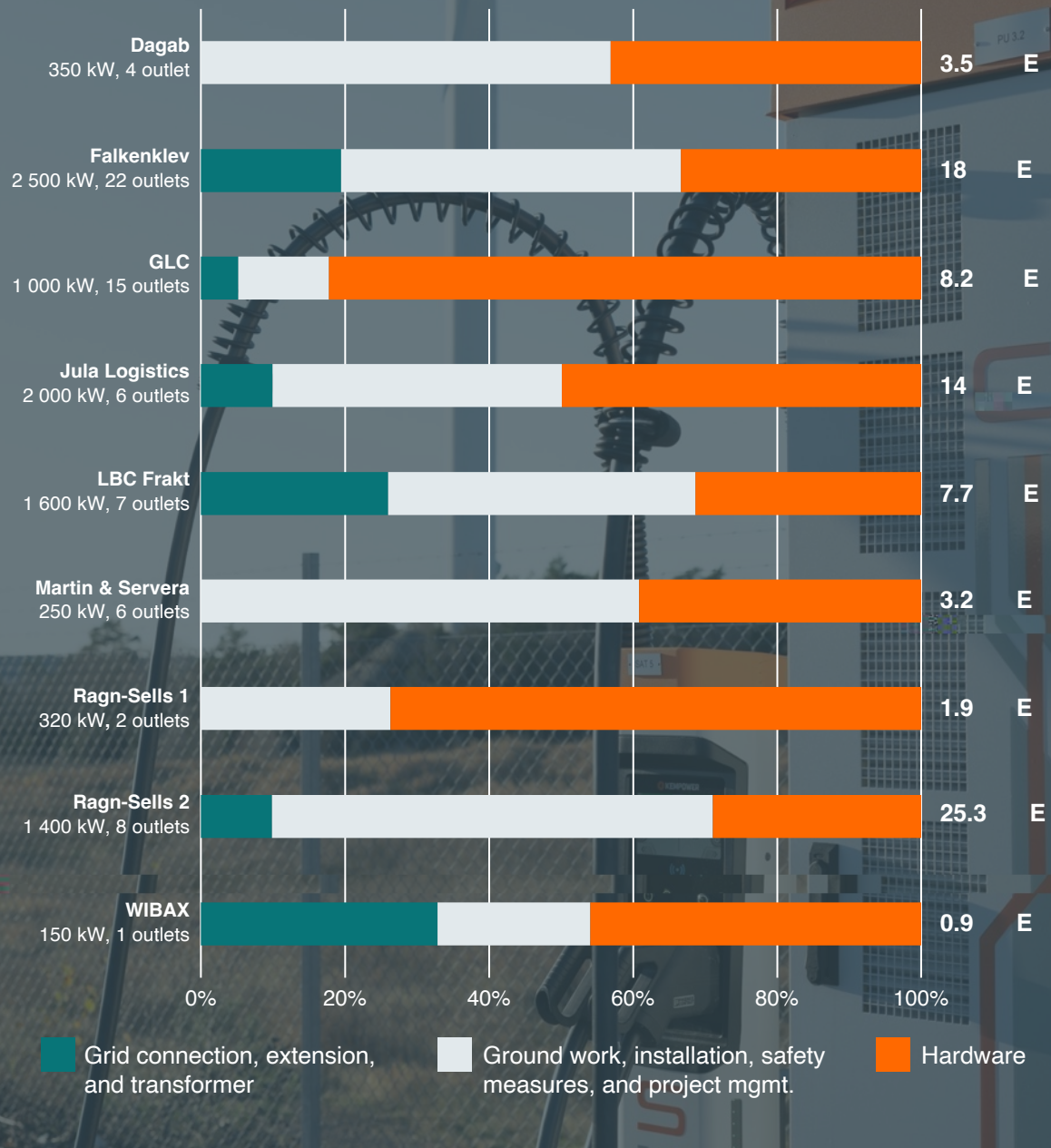
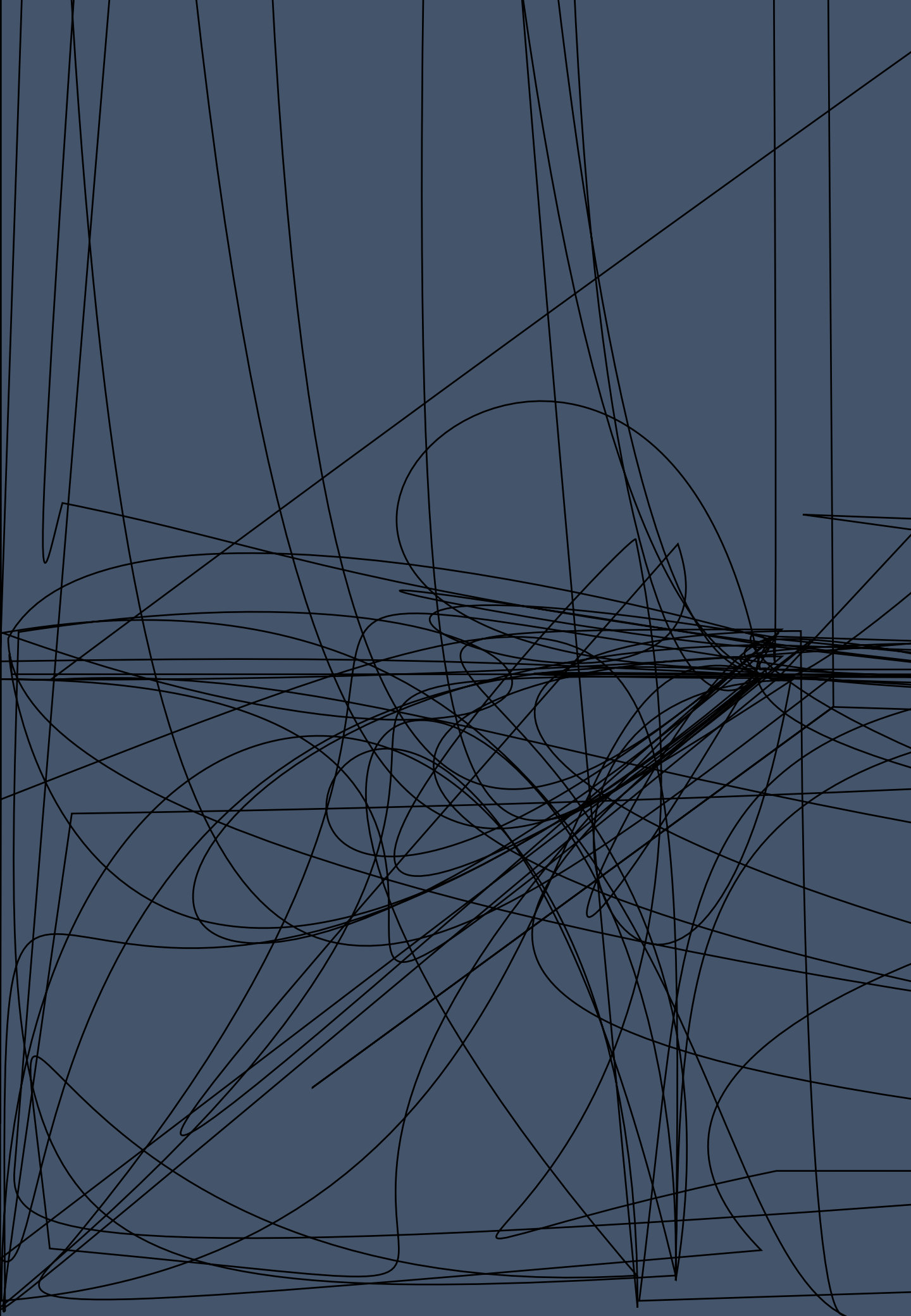


Image: CLOSER



4 Grid costs as connection, power fees, and transmission

Currently, there are approximately 170 local grid areas in the country with a sole grid operator in each of these with their individual pricing models. Below current pricing from 2024 is presented from the perspective of transport companies in this report.

It is important to make calculations based on likely use of the charging infrastructure to understand which subscription is most beneficial. The high voltage connections in general have a higher base grid cost while the transmission cost is lower in comparison with low voltage connections.

	Dagab, GLC	Falkenklev	Jula Logistics	LBC Frakt	M&S	Ragn-Sells	WIBAX
Local grid area (Localization)	GBG (Gothenburg)	MMO (Malmö)	FBN (Falköping)	VAL (Värmland)	STH (Stockholm)	UPS (Bro)	SKT (Skellefteå)
Local grid operator	Göteborg Energi Nät	E.ON Energidist.	Falbygdens Energi Nät	Ellevio	Ellevio	E.ON Energidist.	Skellefteå Kraft Elnät
Grid connection Low or High Voltage	Low	High	High	High	Low	High	Low
Base grid costs (SEK/month)	655	2 330	5 128	20 000	2 600	2 330	548
Transmission cost (SEK/kWh)	0.113	0.1016	0.105	0.05	0.09	0.0588	0.018 - 0.02[2]
Power fees (SEK/kW)	56.3/month	83.6/month	39.63; 56.29[1]/month	294/yr; 75[2]/month	74; 78[2]/month	76.4/month	28; 68[2]/month

[1] Peak time: Nov-Mar 07:00-19:00
[2] Peak time: Nov-Mar 06:00-22:00

5 Licensing fees

The actors in REEL are also subjected to licensing fees for software related to charging infrastructure. Various pricing models are applied usually including charge management system and a payment solution. The cost varies from a monthly fee of 270-1000 SEK/charging outlet to a turnover based fee ranging between 3-10%, or a combination of both.

Image: Unsplash

Public charging infrastructure for heavy-duty trucks in Sweden

The aforementioned incentive scheme Regionala Elektrifieringspiloter (REP), has been perhaps the most important accelerator of the build out of public charging infrastructure for heavy-duty trucks in Sweden, yet. Financing of up to 100% was awarded for 130 locations across Sweden, in 2022. Location was one of the key factors examined, with the requirement of a maximum of 3 km diversion from the TEN-T (Trans European Transport Network). During the third REP call in the autumn 2023, additional 96 charging stations were awarded financing.

In total, about 230 charging stations will be built by the end of 2025. The exact number of stations is uncertain as some of the projects might not be finalized. Experiences from the first call in REP show that acquiring grid connection is an obstacle in many cases. In addition, acquiring land might be challenging for some as well. As of January 2024, about 30 REP stations have been put into operation. Additional stations for heavy-duty trucks, financed by other schemes, predominately Klimatklivet, are in operation as well. The map on the right illustrates all the planned REP-stations.

AFIR – EU's Alternative Fuel Infrastructure Regulation

EU's member states have agreed upon a regulation for specific deployment targets for renewable fuel infrastructure that each member state will need to meet in 2025 or 2030. This includes for example:

- from **2025** and onwards, charging stations of at least 150kW for **cars and vans** need to be installed every **60 km** along the EU's main transport corridors, the so-called 'trans-European transport (TEN-T) network'.
- charging stations for **heavy-duty vehicles** with a minimum output of 350kW need to be deployed every **60 km** along the TEN-T core network, and every **100 km** on the larger TEN-T comprehensive network from 2025 and onwards, with complete network coverage by **2030**
- **hydrogen refuelling** stations serving both cars and trucksli must be deployed from 2030 onwards in all urban nodes and every **200 km** along the TEN-T core network
- **users** of electric or hydrogen-fuelled vehicles must be able to **pay easily** at recharging or refuelling points with payment cards or contactless devices and without a need for a subscription and in full price transparency.
- **operators** of charging or refuelling points must provide consumers **full information** through electronic means on the availability, waiting time or price at different stations.

Image: Unsplash

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