

REEL

Regional Electrified Logistics

Charging infrastructure for trucks
2024:02



CLOSER 

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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.



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.



The REEL consortium consists of 45 organizations

The REEL project targets the over-all mission to significantly reduce CO₂, 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

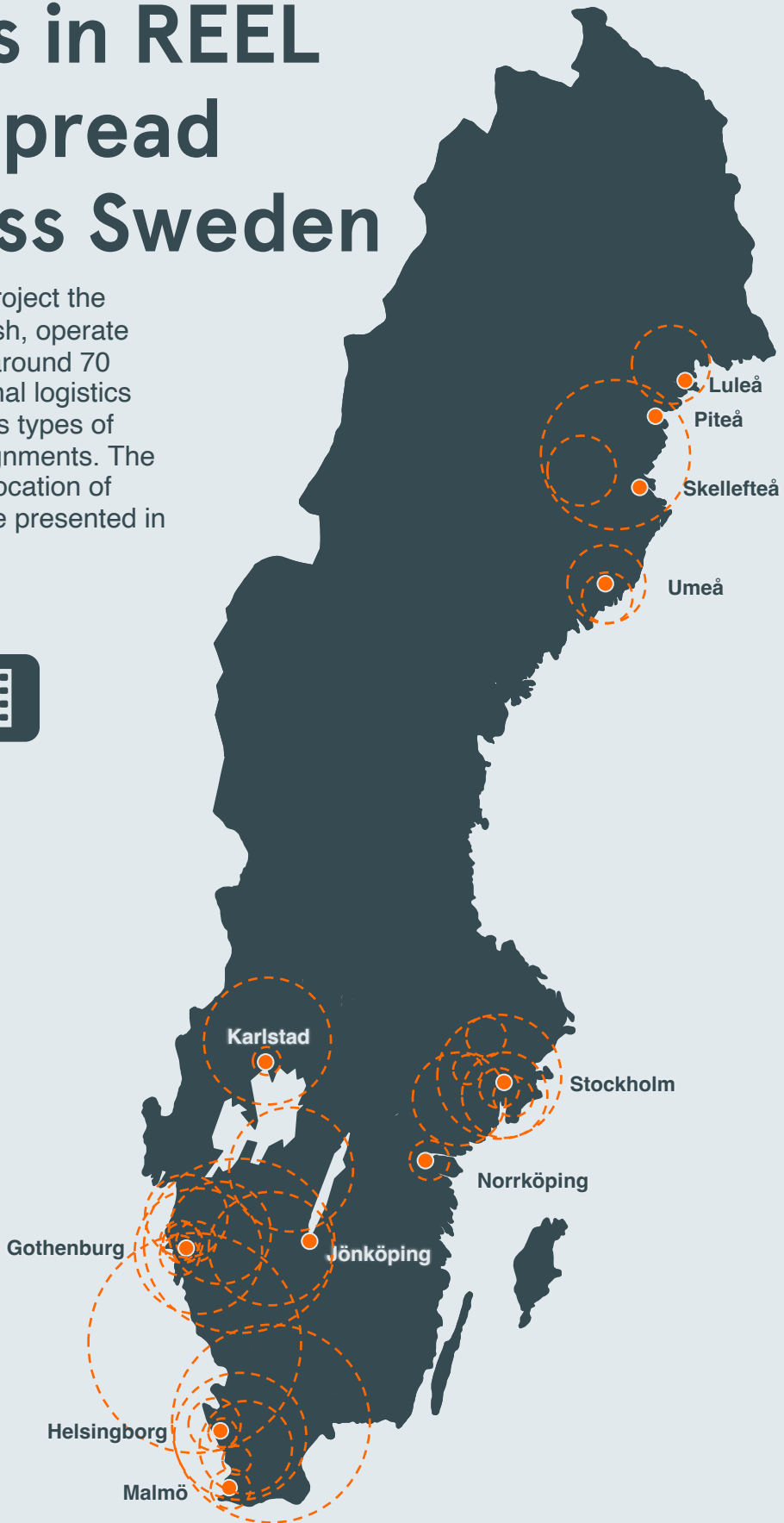


Public co-financing



The transport flows in REEL are spread across Sweden

In the REEL project the parties establish, operate and evaluate around 70 different regional logistics flows in various types of transport assignments. The geographical location of these flows are presented in the map.





1,2 Rifil Malmö. 3 Laddbolaget Bråtebäcken.

Images: CLOSER.

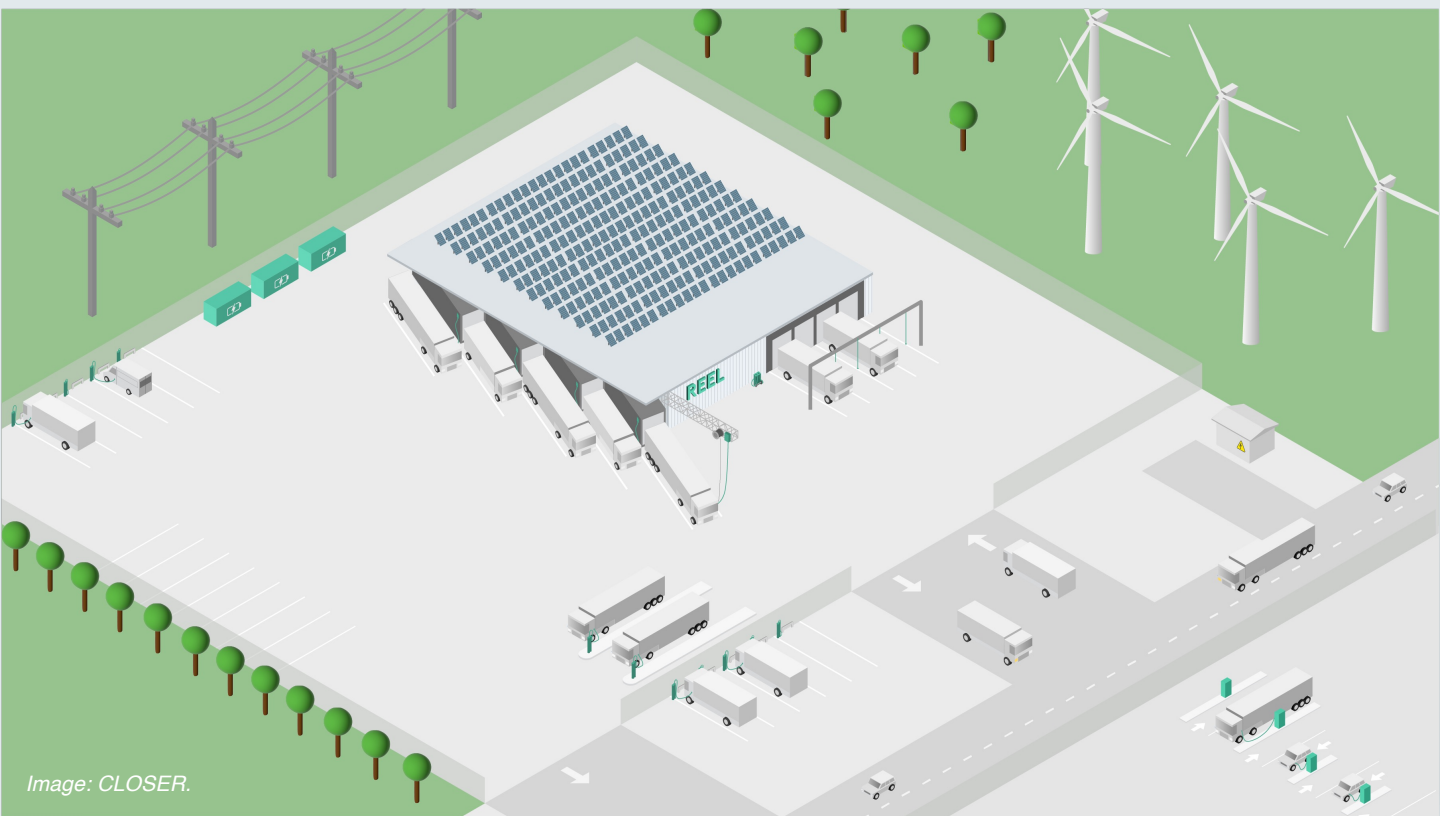


Image: CLOSER.

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.

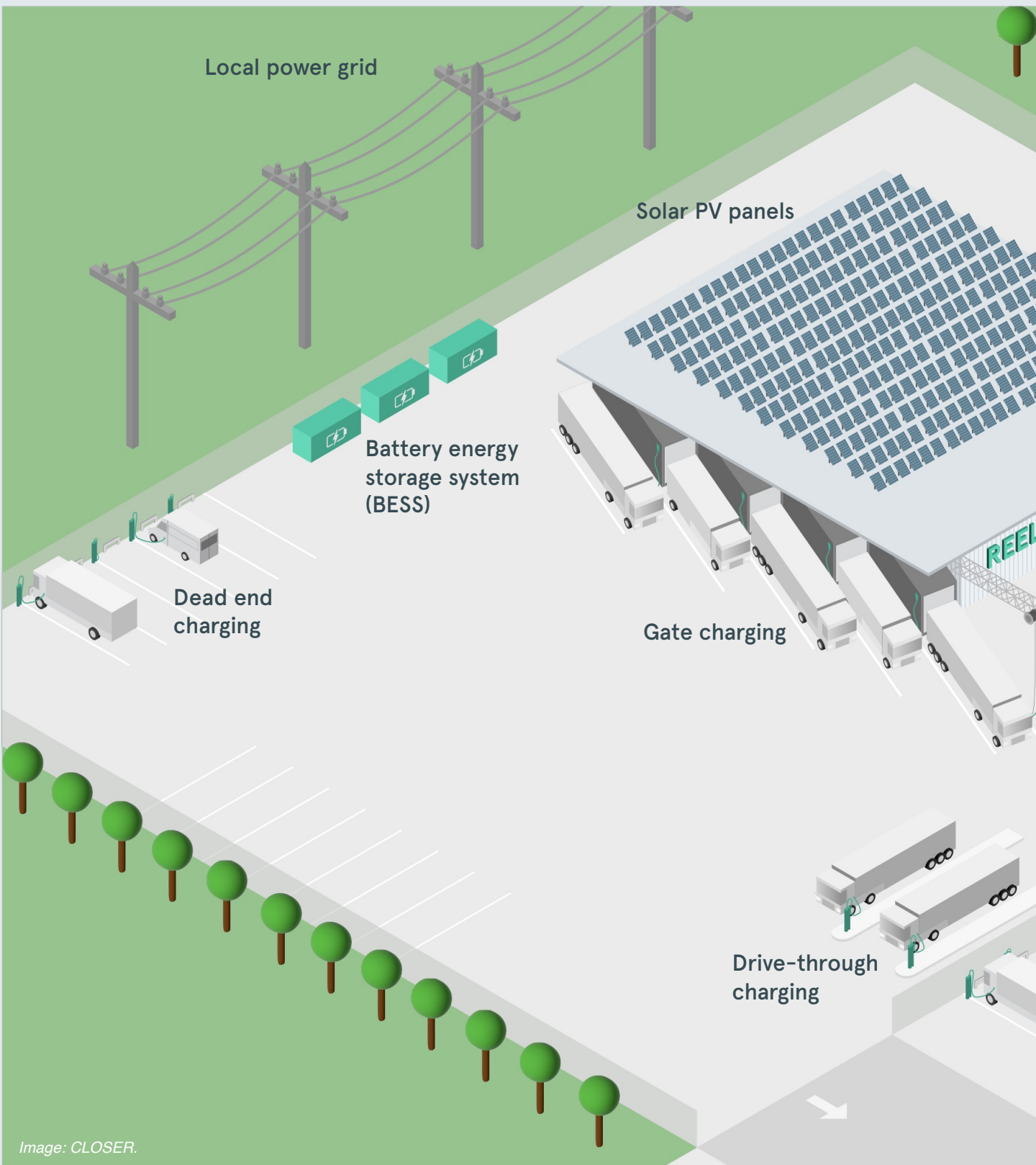
With deployment of electric trucks, transport and logistics companies face the challenge of designing, acquiring and installing necessary charging infrastructure. As the number of electric trucks operating from the same logistics terminal or depot increases, so does the scale of the charging infrastructure. 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.

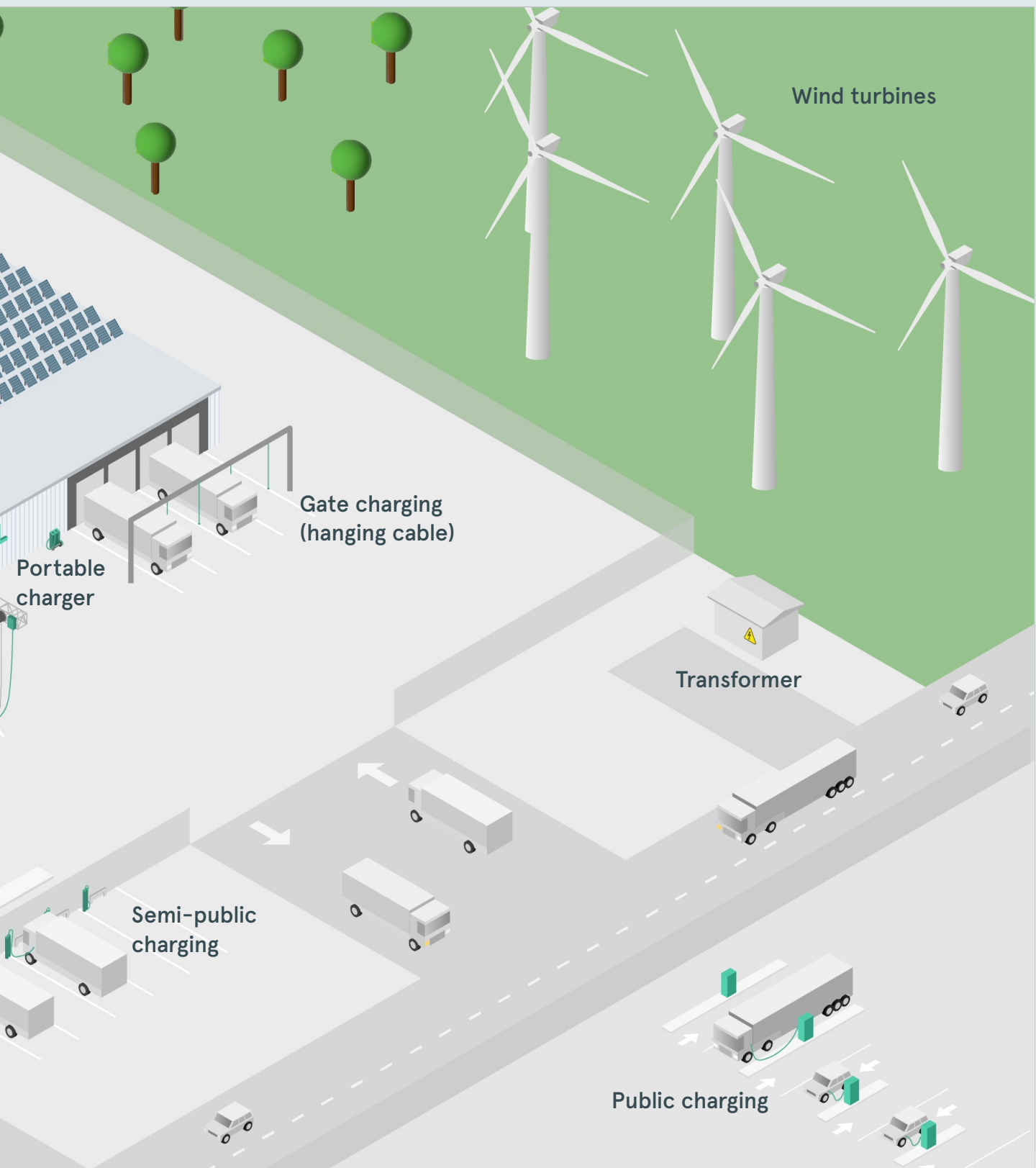
In this report, several solutions chosen by partners in the REEL project are presented.

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.



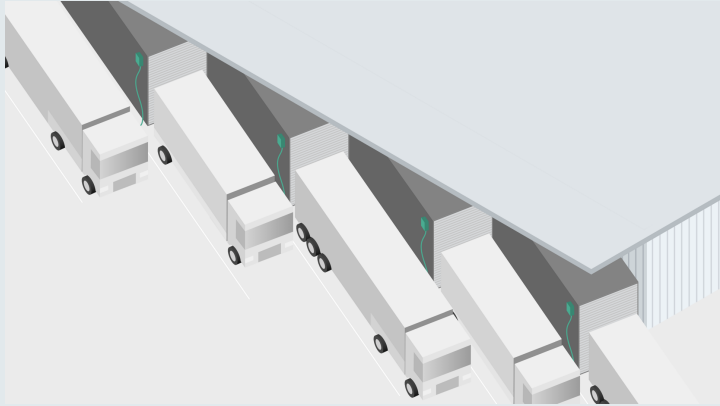
The illustration offers a conceptualized view of the modern logistics terminal predominately served by electric trucks. Apart from various charging designs, it also showcases a simplified view of the adjacent energy and power system.



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.

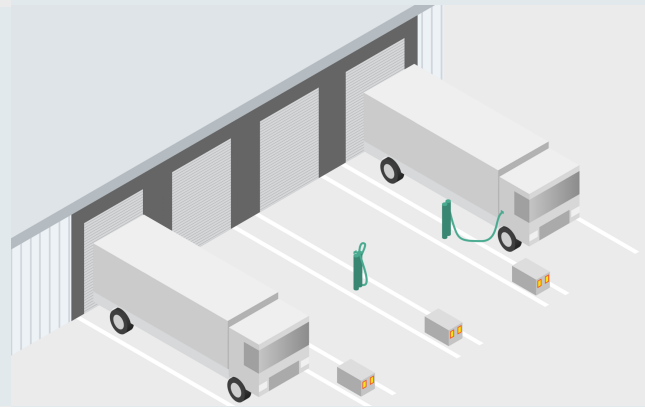


Angled gate charging

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

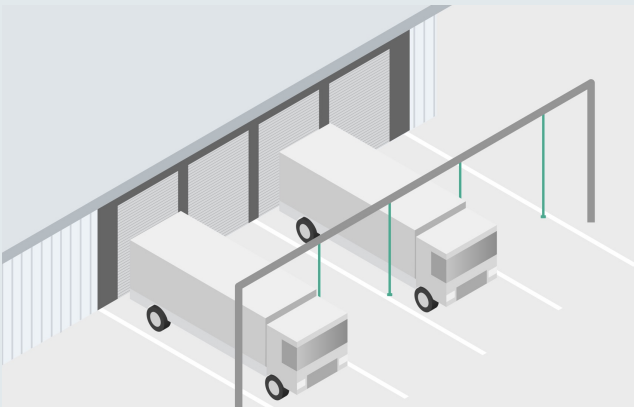
Gate charging (ground)

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.



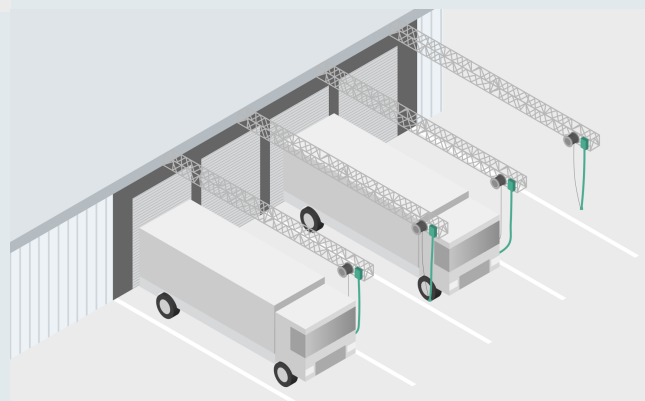
Gate charging (overhead arc)

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.





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 satellites. 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.

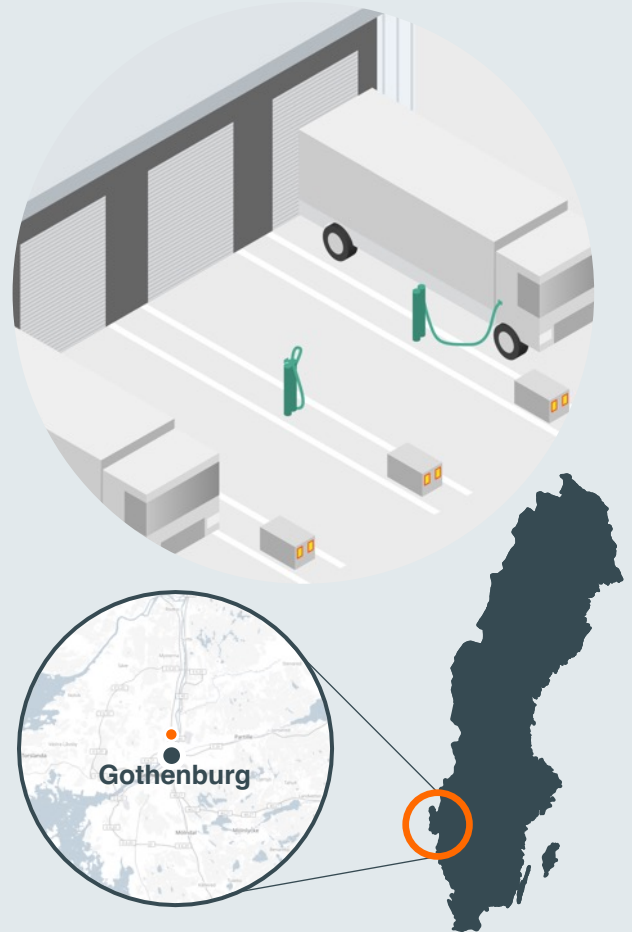
DAGAB

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.

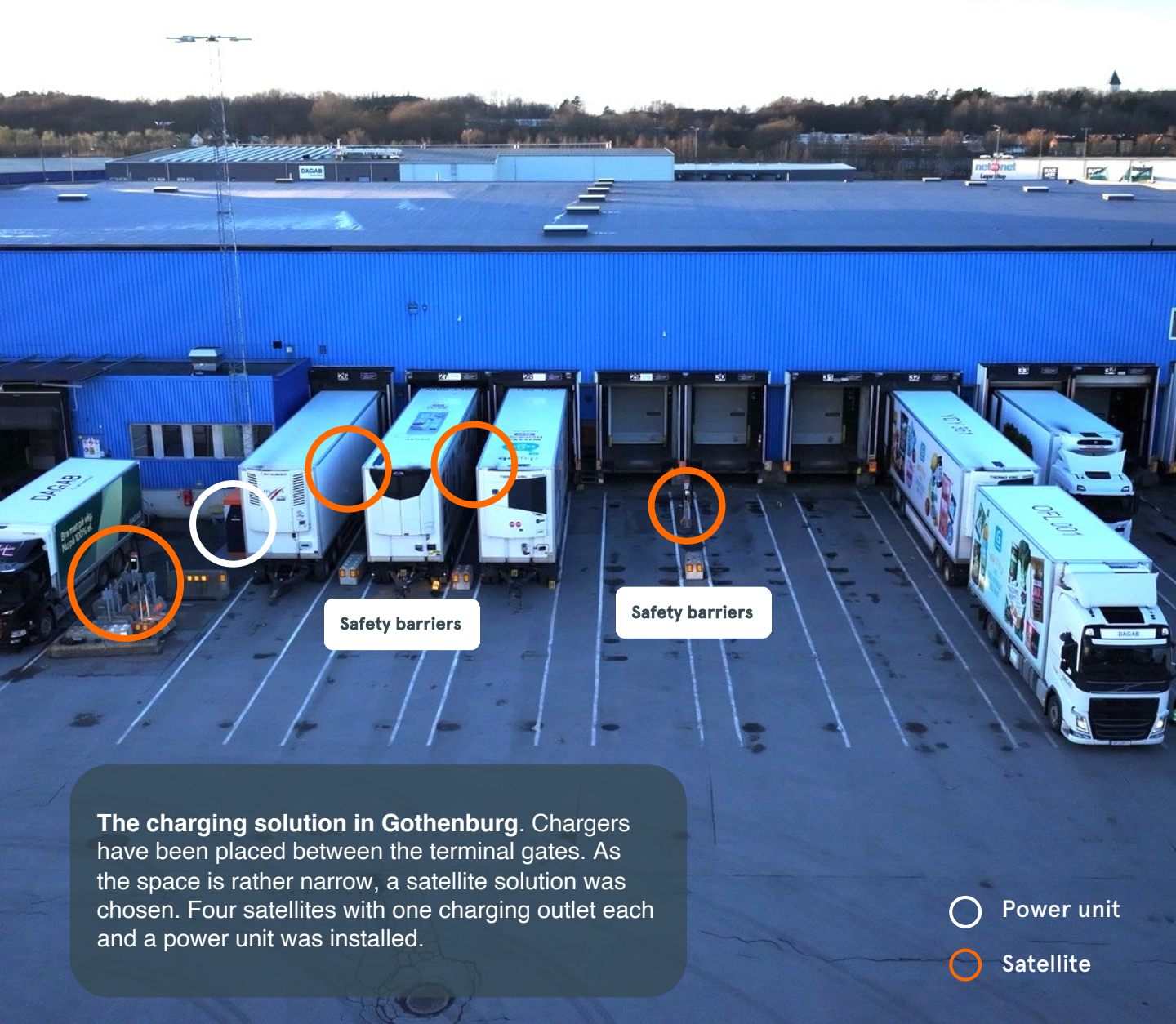
Electrifying the Gothenburg fleet was the next step with delivery of an electric 64-tonne Scania truck in 2022. Charging infrastructure was installed to provide energy for both the truck and the trailer containing a battery for electric propulsion of the cooling unit. The charging in Gothenburg is the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



Charging hardware	Kempower
# charging outlets	4
Total power to charging station	350 kW
Type of charging	Gate charging
Access	Semi-public





Safety barriers

Safety barriers

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.

- Power unit
- Satellite

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.



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Terminal
Rix + Jönköping
10:00 - 22:00

PORTSYSTEM
2000
PORTAR & DOCKNINGAR

Smoke detector

Sprinkler system

Fire curtain

Emergency exit

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.

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).

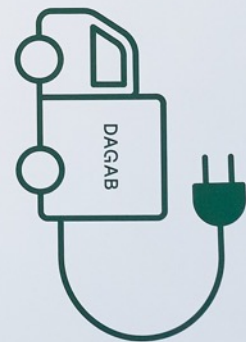
Hardware

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 Klimatkivet (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.



XXG 99M

Want to learn more?



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

FALKENKLEV LOGISTIK



Falkenklev Logistik is a family-owned transport company based in Malmö and Helsingborg. In 2022 the company started to operate five Scania battery electric trucks for local distribution in the city of Malmö on behalf of DHL. In 2022 Falkenklev Logistik founded its own charging company called Rifil.

Its first investment was a charging station in Malmö near Falkenklev Logistik’s depot. It is currently one of the biggest public charging stations for cars and trucks in Sweden. The station consists of 22 charging outlets and has a grid connection of 2.5 MW. Additional 2 MWh are available from the energy storage connected to the site. An upgrade of the Malmö station will soon be underway and additional three stations will be built around Skåne county.

Falkenklev Logistik continuously updates its fleet with new electric vehicles. Currently, the company operates 14 electric vans, and 6 more heavy-duty electric trucks will soon be added to the fleet, to ensure electric transports for all distribution performed in the city of Malmö.



Charging hardware	Kempower
# charging outlets	22
Total power to charging station	2.5 MW from the grid + BESS
Type of charging	Drive-through
Access	Public



- 1. Power units
- 2. Charging satellites
- 3. Battery energy storage system (BESS)
- 4. Transformer unit
- 5. Self-service kiosk
- 6. Falkenklev electric truck
- 7. Charging price display
- 8. Area reserved for additional chargers

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.

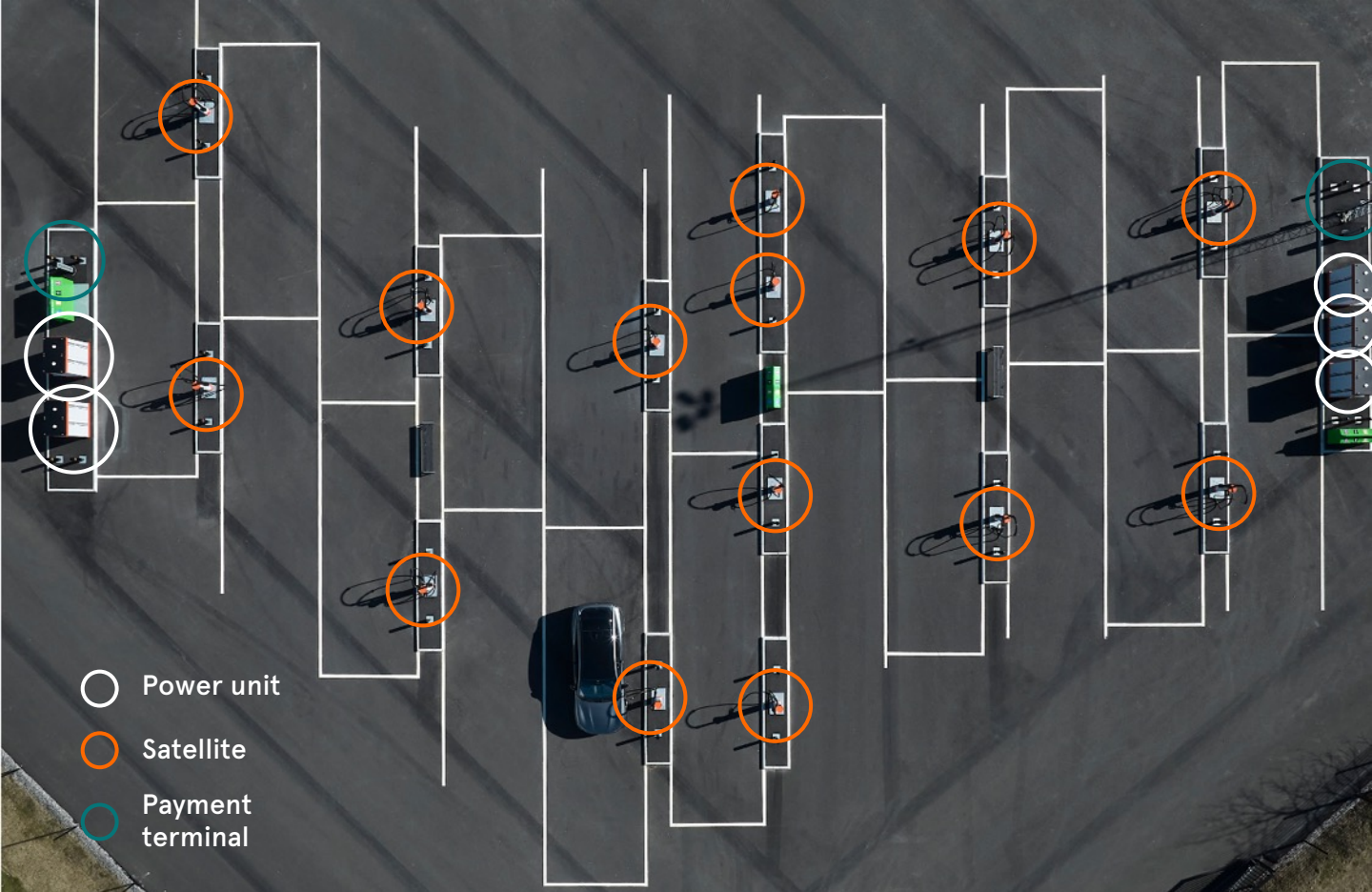
Rifil has also ambitions to become an energy producer. In Perstorp, located in another part of Skåne county, the company is currently building a solar PV panel park to produce electricity for its upcoming charging network. The company's ambition is to become energy self-sufficient.

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.





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.

Erikssons Åkeri charging at Rifil

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



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.



1,2 GLC Göteborg
Images: CLOSER

GÖTEBORGS LASTBILSCENTRAL (GLC)

A local transport company with a major charging hub.

Göteborgs Lastbilscentral (GLC) is a carrier based in Gothenburg jointly owned by various smaller transport companies i.e., GLC is a haulier network organization. As a part of the company's sustainability work, GLC has introduced several alternative fuels including biogas and electricity. The company pursues a rapid introduction of electric trucks and has therefore made a substantial investment in charging infrastructure. In the REEL project GLC is currently operating vehicles from Volvo and Scania. Currently, about 10 electric trucks have been put in operation.

The GLC charging hub is located at GLC's depot and warehouse in Gothenburg. The company has chosen a solution by Kempower consisting of power units distributing power across satellites placed away from power units. The power units and satellites have been placed at the truck parking along the outer fence of the premises. A separate grid connection of 1 MW has been established for the charging station. The capacity was already available in the grid which significantly reduced the lead times. The warehouses, equipped with cooling units have a separate grid connection. Local energy production from solar PV panels is underway.

GLC is a member of TRB (Transporter network) consisting of several haulier associations and transport companies. TRB's main area of operation is fuel distribution through its own network of refuelling stations. Being a member and having the desire for the station to be open to TRB members, one of GLCs demands when choosing charger OEM was the ability to connect TRB's payment system to the chargers. Before a charging sequence can be initiated, GLC needs to authorize access.

More on charging sequence on page 25.



Charging hardware	Kempower
# charging outlets	15
Total power to charging station	1 MW
Type of charging	Terminal parking
Access	Semi-public



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



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.

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



8.2
MSEK

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).



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.



Charging hardware	Kempower
# charging outlets	6
Total power to charging station	2 MW
Type of charging	Drive-through
Access	Public





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.



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.





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.

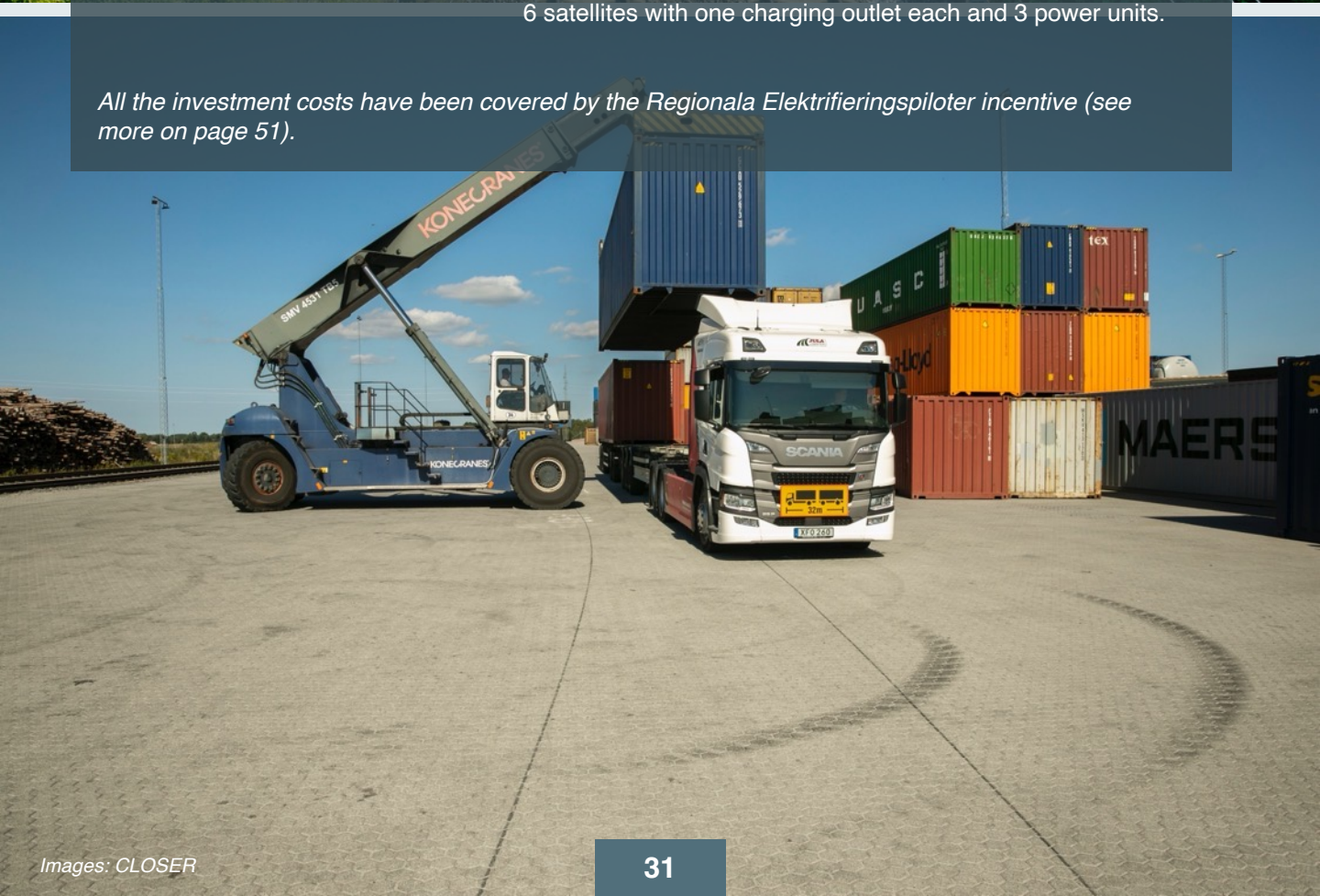
Ground works, installation, safety measures, & PM

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.

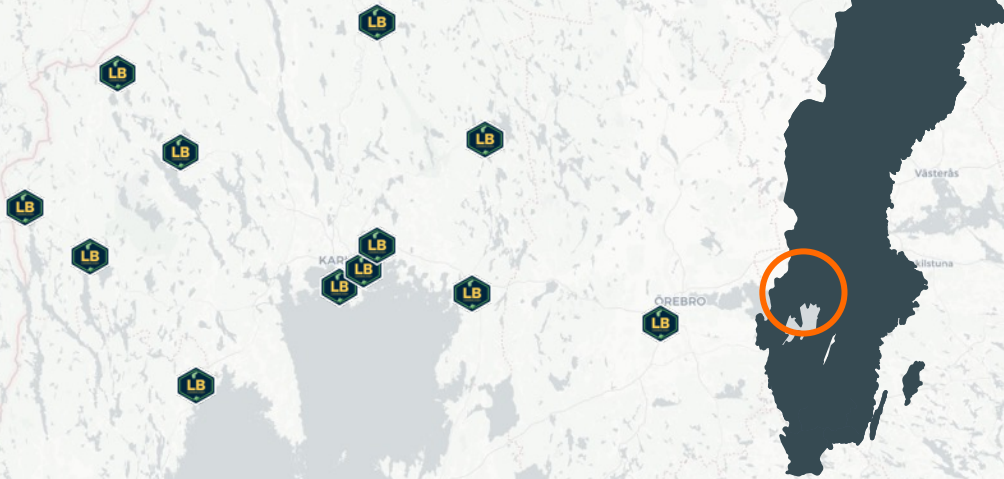
In 2024 another 20 BETs will be added to LBC Frakt's fleet including e.g., wood chip trucks of 70 tons, long-haul 64 tons trucks, asphalt, and refuse trucks. The roll-out will continue with a goal of having 50 BETs in operation by the end of 2025, and 150 BETs by 2030.

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)



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.



This report put focus on the charging site at Bråtebäcken in the outskirts of Karlstad. In Bråtebäcken LBC Frakt is also operating a quarry and a storage for recyclables. There is also an asphalt production facility at the site.

As a first step 3 fast chargers, each able to provide 350 kW and 4 depot chargers with 150 kW, were established in 2023. As a second step, additional 4 fast chargers (350 kW) and 10 depot chargers (150 kW) will be constructed during 2024. The total grid connection is 1.6 MW and will be upgraded to 3.2 MW to enable the second step. The ground works at the site has already been completed for a third expansion with a total of 12 fast chargers and 40 depot chargers. The site is open to the public and the forecast for 2024 is that approximately 25% of all charging will be done by external users and 75% by LBC Frakt. In total around 12 of LBC Frakt's BETs will have Bråtebäcken as their main charging site in 2024.

Charging hardware from Kempower will be used at all charging sites. Currently, Virta is the software provider in terms of payment solution as well as customer support. Further on, LBC Frakt will also use an additional software from a Swedish start-up; BEV_R, to enable planning of charging and routes for the BETs.

For most charging sites, Laddbolaget has chosen high voltage grid connections as it is seen as the financially most viable solution in the long term.



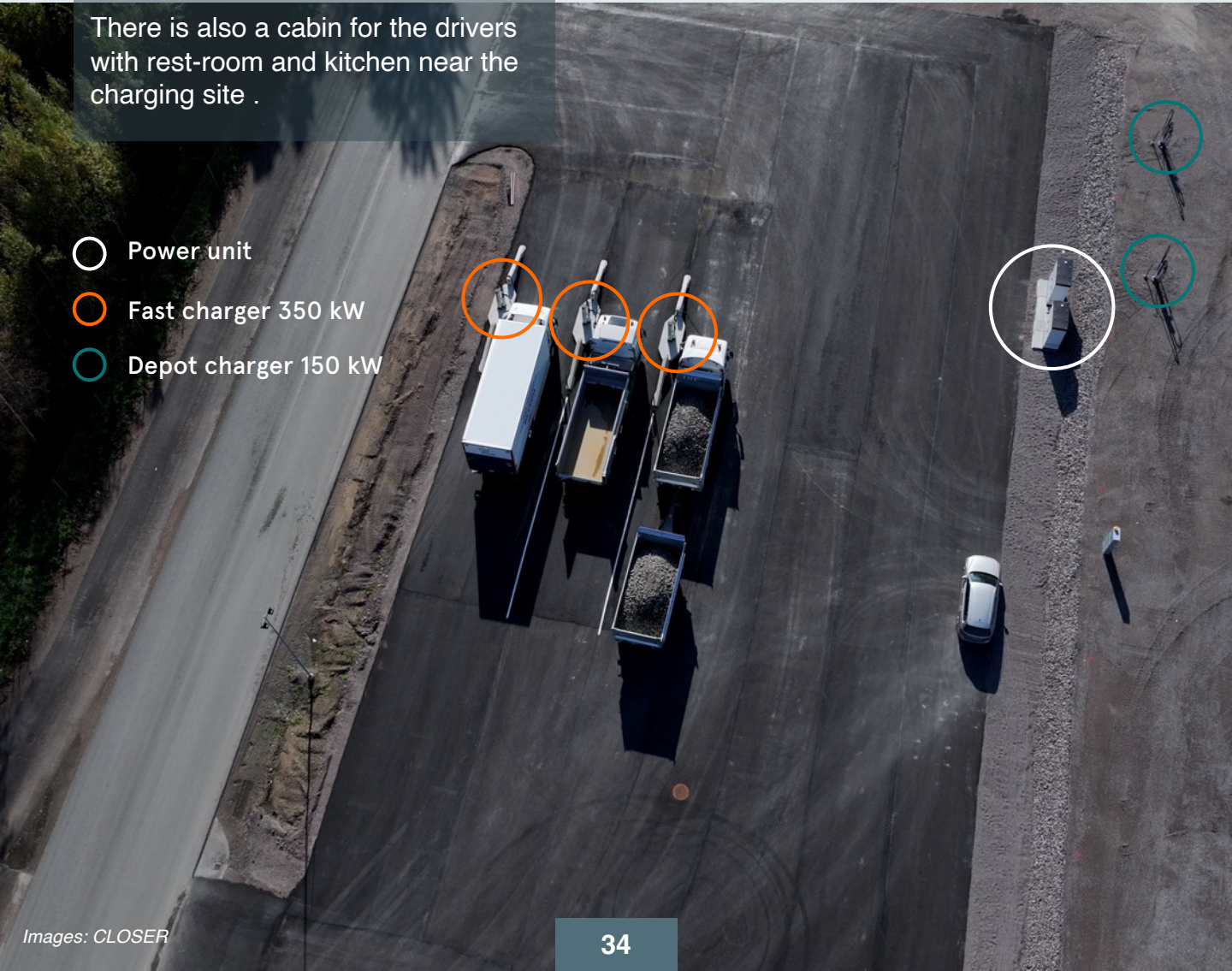
Charging hardware	Kempower
# charging outlets	7 (21)
Total power to charging station	1.6 MW (3.2 MW)
Type of charging	Drive-through
Access	Public



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 .

- Power unit
- Fast charger 350 kW
- Depot charger 150 kW



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.



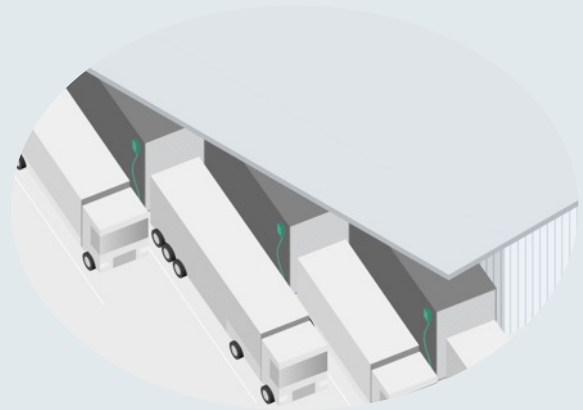
MARTIN & SERVERA

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.



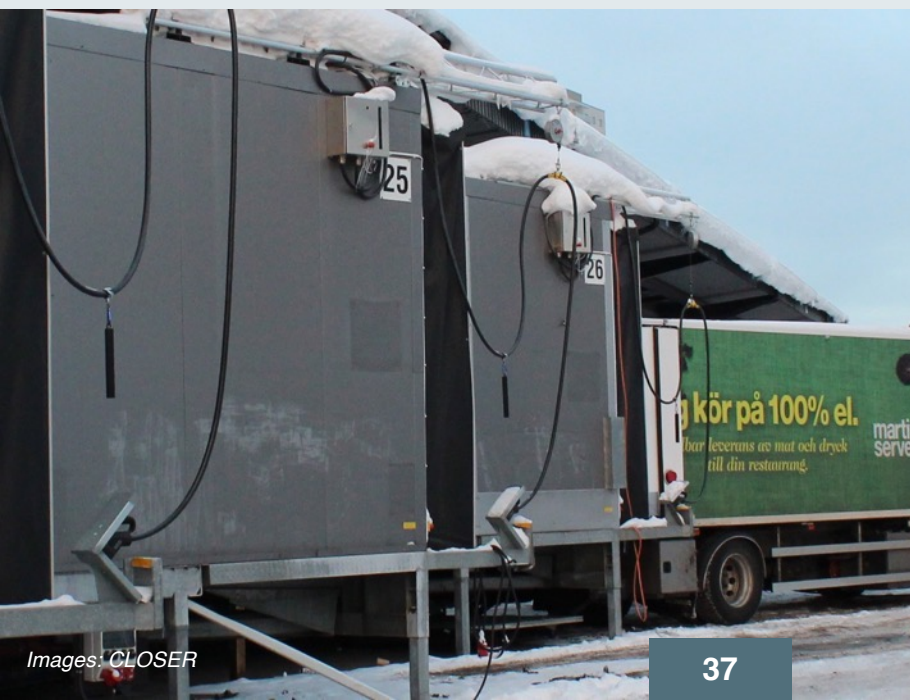
The company took delivery of their first battery electric truck (BET) in 2021 and currently operates 12 BETs in their internal fleet, a number that continues to increase. The BETs are based at various locations. The cross-dock terminal in Årsta, Stockholm is the focus for this case description. Currently, 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.





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.

Charging hardware	Kempower
# charging outlets	6
Total power to charging station	250 kW
Type of charging	Gate charging
Access	Semi-public



Investment in charging at Årsta terminal gates



■ Grid connection, extension, and transformers

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. Further 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 satellites mounted on the angled terminal gates, each able to provide 250 kW (42 kW distributed evenly).

The charging infrastructure has been co-financed by Klimatkivet (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



Fotografiska

J. LINDBERG
J. LINDBERG



Martin & Servera delivers to Fotografiska, Stockholm.

Images: CLOSER.

RAGN-SELLS



Charging infrastructure at a newly established Ash2Salt plant in Högbytorp.

Ragn-Sells is a corporate group involved in waste management, environmental services, and recycling. In 2022, Ragn-Sells opened the world's first Ash2Salt-facility for the recovery of valuable raw materials from fly ash on a large scale. The plant can process up to 150 000 tonnes of fly ash each year. That corresponds to roughly half of all fly ash produced in Sweden, resulting in many transports to and from the plant.

Soon after the plant opened, Ragn-Sells put an electric truck in to operation together with the transport operator Foria.

The truck is allowed for a total weight of 75 tonnes and operates two shifts each day to maximize the use of the truck. The on- and offloading normally takes around 45 minutes which provides a good opportunity to charge the truck. Therefore, a charging solution with two charging outlets was installed near the reloading bay. A key factor when choosing charging equipment was that it would be safe and adapted to the industrial and corrosive environment at the plant. In addition, 9.5-meter-long cables were chosen to be able to locate the charging post more protected.



Charging hardware	ABB HVC 160
# charging outlets	2
Total power to charging station	320 kW
Type of charging	At loading bay
Access	Semi-public

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).



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

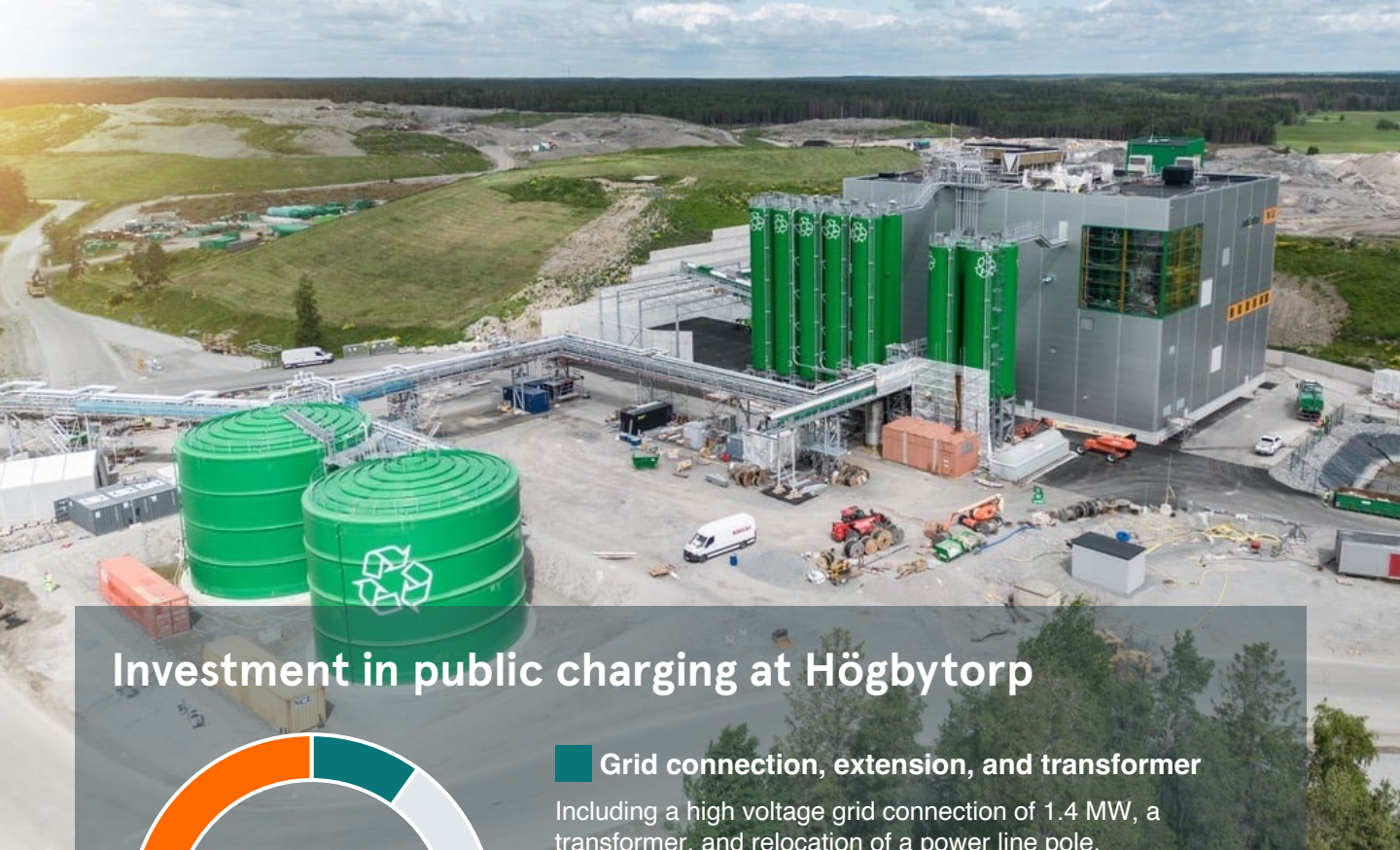
In 2024 Ragn-Sells will open a public charging station located near the plant, which is also right next to the E18 highway. The station will have a drive-through layout with 8 charging points each able to deliver 350 kW. The station has a high voltage grid connection of 1 400 kW. The station has also 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.

Charging hardware	ABB Terra HP 350
# charging outlets	8
Total power to charging station	1.4 MW
Type of charging	Drive-through
Access	Public





Investment in public charging at Högbytorp



25.3
MSEK

■ 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).



SCANIA TRANSPORTLABORATORIUM



Image: 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.



Charging hardware	Kempower
# charging outlet	6
Total power to charging station	50 kW + BESS
Type of charging	Depot parking
Access	Private

WIBAX

Wibax is a chemical supplier that is building its own charging network at depots and customers' sites.

Wibax sells, purchases, processes, and distributes liquid chemical products and bio-oils to the base industry. The company operates 19 terminals and depots around Sweden, Finland, Estonia and Norway. Their first electric truck was put into operation in 2022 and the electric fleet is continuously growing. The electric truck fits well to Wibax's transport set-up since the loading and unloading of chemicals normally takes around 45-60 minutes at their terminal or at customers. Wibax is therefore seeking to install the charging infrastructure right by the loading and unloading bays. So far, they have installed chargers at six locations and have similar solutions at all sites, within restricted areas.

All chargers have been prepared with RFID readers to make it possible for their suppliers to charge. To enable transition of its fleet, Wibax is currently running a project where available grid capacity at all their sites is investigated together with their grid operators. In addition, Wibax is looking at the possibility to invest in wind-mills and local energy storages.

As one of many partners in the REEL project Wibax is in need of charging infrastructure better adapted to industrial environments. That includes for example corrosion-resistant cabinets, better solutions for handling of long charging cables, and mobile solutions where the charging cabinets can be moved more easily, for example if a customer contract is changed and there is a need to move the infrastructure to another customer.

One of the locations where Wibax already has installed charging infrastructure is at its depot located in the port of Skellefteå. This is further described in the box below and at the following page.



Charging hardware	Alpitronic
# charging outlets	1
Total power to charging station	150
Type of charging	At loading bay
Access	Semi-public





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).



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.



Case summary (1 of 2)

	DAGAB	Falkenklev	GLC	JULA Logistics	LBC Frakt
Charging hardware	Kempower	Kempower	Kempower	Kempower	Kempower
Number of charging outlets	4	22	15	6	7
Total power to charging solution	350 kW	2 500 kW (+ BESS)	1 000 kW	2 000 kW	1 600 kW
Grid connection Low or High Voltage	Low	High	Low	High	High
Grid connection Separate or Shared	Shared	Seperate	Seperate	Shared	Seperate
Type of charging	Terminal gates	Drive-thru (next to terminal)	Terminal parking	Drive-thru (next to terminal)	Drive-thru (next to quarry)
Access	Semi-public	Public	Semi-public	Public	Public
Fire safety measures	Fire safe isolation, sprinklers, smoke detectors, fire curtains, exits	N/A	N/A	N/A	N/A
Related software	ChargeEye	ChargeEye, E.ON Navigator, Vourity	ChargeEye, TRB Tapnet	ChargeEye, ChargeNode, CheckWatt	Virta
Total cost	3.5 MSEK	18 MSEK	8.2 MSEK	14 MSEK	7.7 MSEK
Received incentives	Klimatklivet (36%)	Klimatklivet (50%)	Klimatklivet (40%)	Regionala E-piloter 1 (100%)	Regionala E-piloter 1 (91%)
~ Utilization per day year 2023	600 kWh	1 500 kWh	1 500 kWh	Data not available	Data not available

Case summary (2 of 2)

	Martin & Servera	Ragn-Sells (1)	Ragn-Sells (2)	Scania Transportlab.	WIBAX
Charging hardware	Kempower	ABB	ABB	Kempower	Alpitronic
Number of charging outlets	6	2	8	6	1
Total power to charging solution	250 kW	320 kW	1 400 kW	50 kW (+ BESS)	150 kW
Grid connection Low or High Voltage	Low	High	High	N/A	Low
Grid connection Separate or Shared	Shared	Shared	Seperate	Shared	Shared
Type of charging	Terminal gates	Loading bay	Drive-thru (next to production site)	Terminal parking	Charging at loading bay
Access	Semi-public	Semi-public	Public	Private	Semi-public
Fire safety measures	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
Related software	ChargeEye	Monta	Monta	ChargeEye	N/A
Total cost	3.2 MSEK	1.9 MSEK	25.3 MSEK	2.1 MSEK	0.9 MSEK
Received incentives	Klimatklivet (14%)	Klimatklivet (35%)	Regionala E-piloter 1 (77%)	No incentives	Klimatklivet (40%)
~ Utilization per day year 2023	600 kWh	350 kWh	Data not available	750 kWh	850 kWh

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: *preliminary Spring 2024*

- To be confirmed

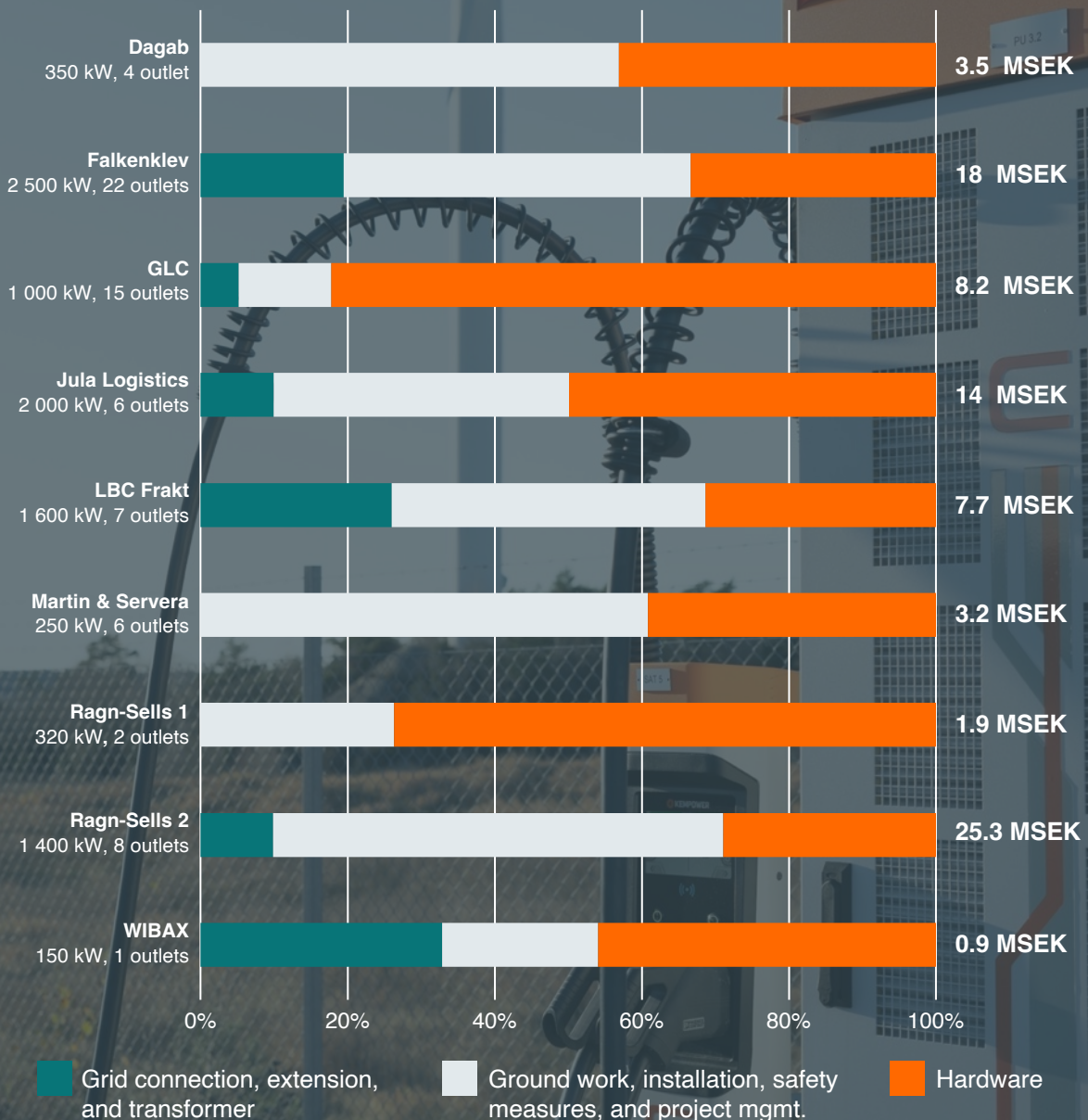
Investment in charging infrastructure

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 asphaltting have been large cost drivers in many installations.

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



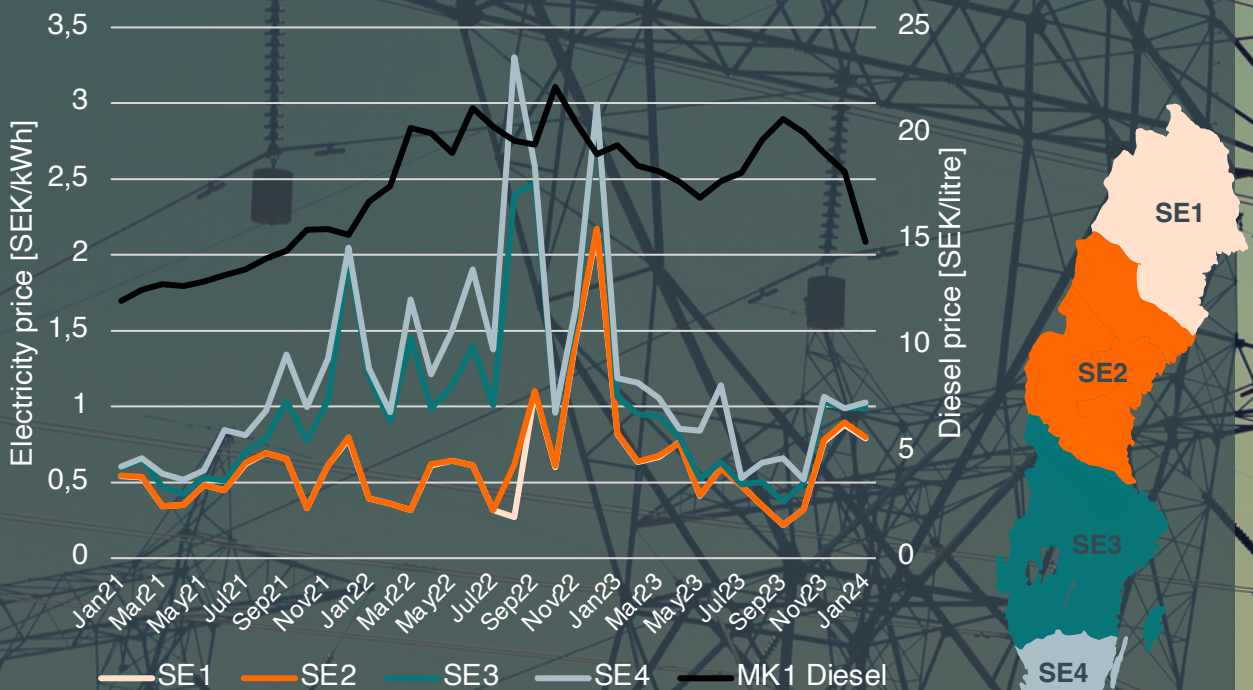
Operational cost for charging infrastructure

The operational cost for charging consist of e.g., (1) electricity price, (2) energy tax, (3) service and maintenance, (4) grid costs as connection, power fees, and transmission, and (5) licensing fees, each described below.

1 Electricity price

The actors in REEL are located across Sweden and therefore subject for various electricity prices as Sweden is divided into four electricity price areas. For the last couple of years, the prices have generally been lower in SE1 and SE2, as seen in the graph below. The actors have various strategies to reduce their costs and balance the risk in fluctuating electricity price. Some of them produce own electricity and some are utilizing the strategy of buying electricity to spot price, fixed price, or a combination of both.

Development for average monthly diesel price and electricity spot price in Sweden



Note: Electricity prices do not include energy tax, while diesel prices include energy tax, both excl. VAT.

Source: Vattenfall and OKQ8.

2 Energy tax

In 2024, the Swedish government has decided that the energy tax for electricity will be increased to 0.428 SEK/kWh (excluding VAT) from 0.392 SEK/kWh in 2023. For companies in the service sector based in northern Sweden the tax is deducted with 0.096 SEK/kWh.

3 Service and maintenance

This category includes both the planned and unplanned service and maintenance of the charging infrastructure. In multiple cases the actors pay a yearly fee for e.g., filter replacement and dust removal for approximately 20 kSEK per power unit. Further on, actors have been offered service agreements for charging outlets ranging between 500-1 000 SEK/month. Multiple actors are investigating the possibility to change service provider alternatively to serve charging infrastructure in-house, which some of the actors have already chosen.

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/kWh)	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

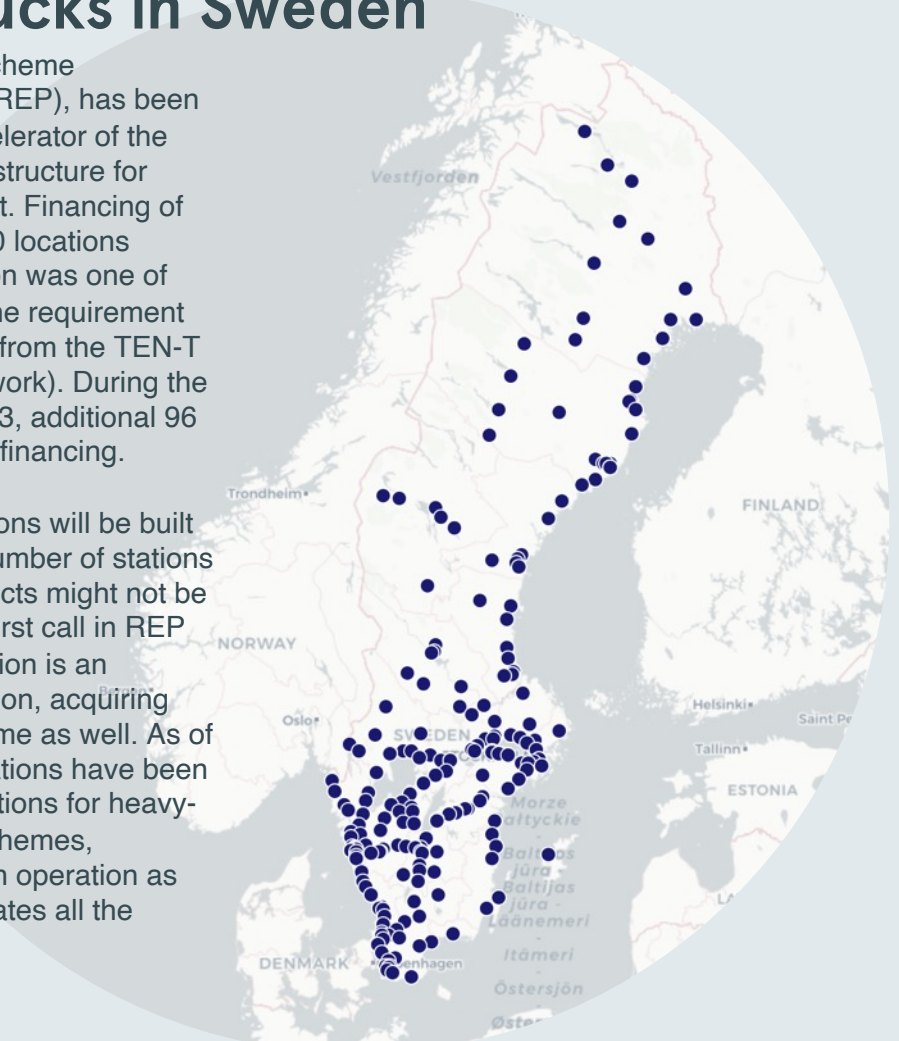
5 Licensing fees

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.

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 trucks 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

Megawatt Charging System (MCS)

Currently, the electric trucks on the European market are equipped with CCS2 (Combined Charging System) inlets while the charging infrastructure is of CCS2 standard as well. CCS2 standard is currently limited at 350 kW of power. The standard was originally developed for cars and was chosen for trucks as the only feasible standard available.

Considering the limitations of CCS2, a global cooperation was initiated through CharIN with the goal of developing a new charging standard for heavy-duty applications. The emerging standard is called MCS. As the name suggest, the standard is set to break the MW-mark in terms of power. The standard is expected to become finalized by the end of 2024 with commercial introduction in 2025. MCS is expected to be utilized by heavy-duty trucks, electric aircrafts, and maritime applications.



CCS2



MCS

Max power	350 kW	3.75 MW
Max voltage	200 - 920 V	1250 V
Max current	500 Amps	3000 Amps

E-Charge

One of the first field tests of the emerging MCS standard are set to be performed in the Swedish project E-Charge. The overall goal of the project is to operate four battery-electric trucks for long-haul applications on four authentic logistics flows during a 12 moth-period. The trucks will have an adequate range to drive for 4.5 hours and using the mandatory driver's break of 45 minutes to charge the vehicle before another 4.5 of driving.

Three MCS-chargers will be built on three locations in southern Sweden to support these logistics flows. Both MCS and CCS charging will be used, MCS during the short breaks and CCS at logistics terminals and in other cases if necessary. Power levels of up to 1MW are expected to be reached with MCS in the project. One of the MCS chargers will be supported by a BESS (battery energy storage system). The MCS test are set to begin in the autumn of 2024. The project is partially financed through the Strategic vehicle research and innovation programme (FFI).



Scan the QR-code to learn more about E-Charge.

Partners in E-Charge



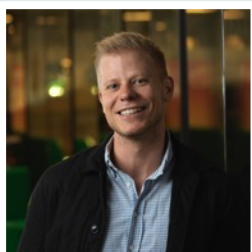
V O L V O



- Lindholmen
- Science Park
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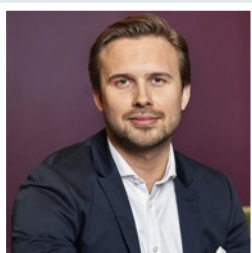
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