36th International Electric Vehicle Symposium and Exhibition (EVS36)
Sacramento, California, USA, June 11-14, 2023

E-Charge: System demonstration of long-haul battery electric trucks with megawatt charging system (MCS)

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Executive Summary

E-Charge is a Swedish innovation-project gathering fourteen partners representing stakeholders from the industry and academia with the purpose of enacting an initial system demonstration of battery electric heavy-duty trucks for the long-haul application. A first pre-standard edition of MCS (Megawatt Charging System) will be tested within the project, supporting four real logistics flows in southern Sweden during a year's time. The system demonstration to be conducted in E-Charge will be one of the first tests of battery electric trucks for long-haul application in Europe on public roads, utilizing the emerging MCS standard.

BEV (battery electric vehicle), DC Fast Charging, demonstration, interoperability, heavy-duty

1. Feasibility study

Electrification of the transport sector has been established as one of the main technological paths for reducing CO2 emissions from road freight transport. In 2020, Swedish logistics operators, truck manufacturers, universities, and a neutral coordinator, Closer, started a research and innovation (R&I) feasibility-study, REEL, which was extended in 2022 to incorporate more than 40 partners of different types to set up electrified logistics system demonstrators for different applications [1]. More than 60 vehicles, commercially available medium and heavy trucks as well as several medium heavy-duty truck prototypes being developed, were included. Commercially competitive data between the different types of partners are filtered by the coordinator. In 2022 -3 medium heavy-duty trucks will be commercially available as well.

Long distance road transport will continue to be essential for the welfare society, but it also poses challenges to the technological, ecological, and economic transition towards a sustainable future. In order to take the first steps towards electrifying long-haul road transport with battery electric vehicles (BEVs), a feasibility study - Integrated Electric Long-Haul Truck and Charger System Development, was proposed by a consortium in Sweden in 2020. Electric 40 metric tons vehicles (roughly 88,000 pounds), with long range characteristics, require a complete rethinking of the integrated transport system to support the necessary transition. The two Swedish heavy-duty truck manufacturers, Volvo Trucks and Scania Trucks, participated in the feasibility study together with Swedish Electromobility Centre, a national research center for electromobility, with members from five Swedish technical universities, and Lindholmen Science Park with systems innovation mobility expertise, serving as a platform for interaction between industry members and potential partners in a main project, academia and society, coordinated the study.

The primary purpose of the feasibility study was to either confirm or reject the target of operating long-haul 40-tonne trucks coping with logistics applications requiring driving cycles of 4.5 h of driving, 45 min of charging during driver break and another 4.5 h of driving. The limited time for charging requires utilization of DC fast charging at high-power levels, to avoid logistics losses. As the existing CCS standard supports charging up to 360 kW, the emerging MCS standard, allowing power levels up to 3,75 MW, was chosen instead.

Cooperation across organizational boundaries is rather common in Sweden e.g., when it comes to evaluating new technologies, products, and services. An extensive innovation system has grown over time encouraging initiation of various projects along the Triple helix model of innovation [2]. This particular feasibility study was financed by the industrial partners and the public R&I program for Vehicle research and Innovation sponsored by the Swedish Innovation and Energy Agencies and Transport Administration. The projects within the program are often along the triple and quadruple helix models including, industry, government, academia, and sometimes civil society. Societal and industrial challenges as well new technological opportunities are addressed. The main industrial partners consist of the vehicle industry that guaranteed a large industrial co-financing of projects. The REEL and E-charge projects are hybrid projects with a combination of vertical and horizontal work packages and include multiple types of partners to accomplish an over-all systems innovation.

1.1 Feasibility study results

The workflow of the feasibility study was divided in separate and commonly performed activities to avoid leakage of competitive information. A combination of horizontal and vertical wok packages was set up. In the first categories, partners of similar type collaborate and exchange data, while in the second category partners of different types collaborate to address the challenges but the commercial confident data is kept among the partners. The truck OEMs have each made a description and analysis of innovative concepts needed for the onboard and offboard vehicle and charging service development. Output from each OEM served as input for the workflow performed jointly with the academia (SEC) within the feasibility study. The same process was applied for description and analysis of architectures, interfaces and sites for the integration and test of a system demonstrator which would succeed the feasibility study in the form of a main project. In this workflow, the OEMs investigated suitable logistics flows with external customers and potential internal transport flows connected to manufacturers' production sites.

The participants of the feasibility study have also jointly evaluated charging standards and services, interoperability, and possibilities with automated connection of charging interface. It was concluded that interoperability will be required between the OEM's vehicles and charging stations. However, it was decided that payment for charging could be handled with standard solutions, such as credit cards. As the system demonstration was expected to consist of only a few vehicles, booking of chargers was deemed to be unnecessary. The development of specific services such as plug and charge was also excluded from the system demonstration due to the same reason.

It was concluded that there are several demonstration projects and companies which can deliver solutions for automated charging connection on the market at that point, but the technology was deemed to still be immature. The research in feasibility study stated that to have substantial benefits with automated connection, it also needs to be combined with autonomous parking solutions. Automated connection of charger interface itself is not necessary as it would only gain approximately 1-2 minutes charging time, while adding complexity and risk to the charging event. By using manual charging connection instead, the project would get feedback regarding handling of the charging cables suitable for higher power levels. Therefore, the feedback could also be evaluated from gender equality perspective to assess the necessity of automated charging solutions.

A definition of what are the long-haul logistics needs in Sweden, system possibilities with peak shaving and/or energy storage and the need of mobile charging was jointly developed by the OEMs and the academia. The same constellation was used for the state-of-the-art analysis with crucial research and innovation issues to be explored and data exchange required in the upcoming main project. Truck OEMs were able to share some of the results gained from their individual research, performed in separation from the other OEM, to evaluate the feasibility of a potential main project through continuous workshops. SEC has mainly presented relevant ongoing and potential future research to be performed in electrified logistics system with all its components. The joint work has made an iterative approach possible, sharing knowledge and re-evaluating the results to continuously shape the future main project.

Several generic logistics flows were described and simulated by the truck OEMs. Power and timing of the charging event within the long-haul transport system were described together with necessary distribution of charging along the road network. Routes and logistics flows, described and analyzed by the OEMs, were mapped with the hypothesis of them being a good start for testing electric long-haul BEVs on public roads with at least one common charging point utilized by both truck brands to test interoperability in the system demonstration. The feasibility study proved that heavy duty long-haul electric vehicles and charging system performance already would be capable of performing long distance transport if the actual flows for the transport would be matched with required charger capacity at dedicated locations.

In parallel, a study of the existing truck stops, rest areas and other suitable places currently utilized by conventional trucks, was conducted. Feasible locations along Swedish main road network, in terms of sufficient parking capacity for trucks and present services, were gathered from several databases. An interactive digital map was constructed, consisting of all the potential locations across Sweden with detailed information about each one. Several sites were characterized as major truck stops (marked with drop symbol on the map, figure 1) as they were of larger capacity (due to number of parking spots), offering a variety of services and/or being strategically located along major highways or next to major intersections. These locations were examined more thoroughly. Apart from the number of truck parking spaces, local fuel providers, net grid owners and landowners were identified at each location. Through these analyses, vehicle OEM's and LSP were able to identify relevant stakeholders to discuss potential involvement in the initial system demonstration.

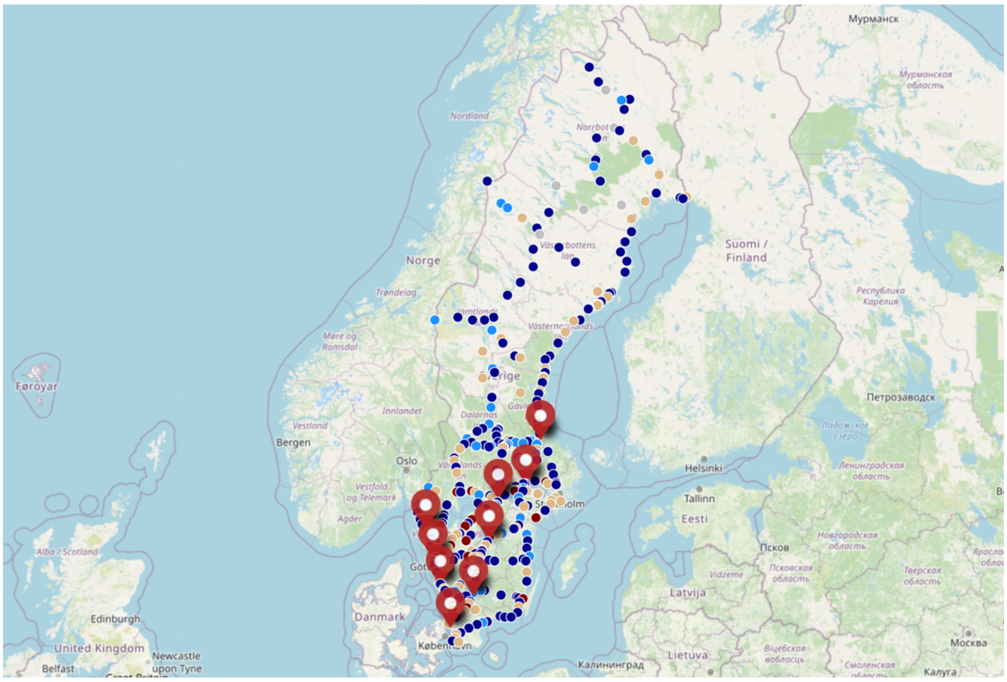

Figure 1: Potential charging locations. The colors represent various types of truck stops, parking, and service facilities. Drop symbols represent larger truck stops.

Three locations were chosen for further investigation together with companies managing those sites. Two of the sites are being operated by Circle K and one by OKQ8, both currently providing fuel, energy, and services at those locations for both private and commercial vehicles. One of the prerequisites for choosing a site was substantial number of trucks using the facilities today. The assumption was that high utilization would ensure relevance of the sites for the project and beyond, as the charging network will potentially emerge in the future. Another prerequisite was the availability of space for installation of charging equipment with room for future expansion. Charging locations were also chosen in relation to the Swedish part of the Scan-Med TEN-T corridor (Trans European Transport Network) which is one of the prioritized transport corridors in the European Union. Although, the demonstration of logistics flows was planned to be conducted during a year's time, the chargers were planned to be written off after two years. In addition, public charging equipment for regional trucks was expected to precede the MCS chargers in Sweden as there were plans for private and governmental initiatives already at the given time.

As both CircleK and OKQ8 expressed their interest in being a part of the succeeding main project, the companies initiated the process of examining available power capacity at the preselected sites to evaluate the feasibility to install MCS-chargers there. If required power levels would be unavailable, an energy storage to balance out peak power level was considered at least at one location within the scope of the project. An evaluation of the market for charging infrastructure was jointly conducted by the partners in the feasibility study which was later synced with the Circle K and OKQ8. Ultimately, ABB was concluded to be the most suitable partner for providing MCS-chargers and later became a part of the consortium for the planned main project. Along with the simulation of logistics flows and evaluation of potential locations for MCS-chargers, the OEMs initiated negotiations with the potential customers, i.e., transport companies which would be operating the prototype vehicles in the main project.

ICA Sweden, DB Schenker and Tommy Nordbergh were chosen to operate three of the four prototype vehicles in the main project. The fourth flow was proposed to be operated by Volvo Production Logistics as an internal flow between one of Volvos component factories and an assembly factory. A fifth flow and a corresponding vehicle was planned during the feasibility study but was later canceled in the beginning of the main project. The energy company Vattenfall was invited to the consortium with a consulting role from the energy production and energy grid perspective. Other energy and grid companies were invited to the project's reference group accompanied by regional authorities.

Through execution of workshops between truck OEMs and the researchers from academia, the potential scope of the research which would be conducted in the main project was determined. Results from truck manufacturers individual in-house research was combined with the state-of-art research description performed by the academia to determine several subsystems of the total electrified logistics system to be explored in the main project. Logistics planning, vehicle energy consumption, chargers (placement, power levels and utilization patterns), electric grid and policy and regulations were chosen as main research areas.

The feasibility study had a timeframe of six months. The study proved that there was a strong interest in testing, demonstrating, and researching long-haul BEVs using Megawatt Charging System, MCS, in real logistics flows. The project participants managed to gather a consortium of partners interested in an initial demonstration of interregional long-haul electrified logistics flows with developed field test vehicles capable of 4.5 h battery powered drive and MCS charging**.** Application for the main project was done after termination of the feasibility study which created the challenge of keeping the consortia active for the duration of the application process. As the application process is not funded by the financier, the involved partners had to finance the involvement individually. Investments in hardware (trucks and charging) used in the future main project would only be partially covered by the financier of the project which required a will and general interest in testing the technology by the parties.

Application for the main E-Charge project was finalized and sent to the financier in June 2021. The application was competing with other projects sent in within the same call. E-Charge main project was granted in the fall of 2021 with the project being initiated soon after.

2 E-Charge main project

Achieving a system transition towards electrified road logistics requires a multi-stakeholder systemwide approach. The consortium in the E-Charge project, which was set up during the feasibility study, aims to develop, conduct, and evaluate a system demonstrator in which long-haul heavy-duty BEVs are operated in real logistics flows and charged with DC fast charging during drivers' statutory breaks [3]. Targeted performance of the vehicles developed for the system demonstration is continuous driving for 4.5 hours which corresponds to the maximum allowed time for continuous driving of a commercial driver in the European Union. The length of the mandatory break (45 minutes) is then utilized for charging to allow for additional 4.5 hours of driving. The MCS system will be utilized with power levels up to 1 MW to sufficiently supply trucks with the energy during the driver's rest and avoid additional standstill and thus logistics efficiency losses.

2.1 Initial system demonstration

As the project kicked off in the late 2021, the project consortium needed to set the details of the initial system demonstration based on the original plan of operating five logistics flows during a year's time. Early on, it was decided that the five logistics flows would instead become four. The logistics flows were finalized in the spring of 2022 with three of the logistics flows being operated by external customers of the truck OEMs Volvo and Scania while the fourth flow would be operated as a part of Volvo Groups internal supply chain between two of its production facilities. All the logistics flows were designed to be authentic, i.e., the electric trucks in the projects will be operated in sharp commercial applications.

Four prototype vehicles of different vehicle combinations will operate in the project. Two of the vehicles will be of standard European truck and semitrailer configuration of a total length of 16,5 meters (roughly 54 feet) and a total maximum weight of 40 metric tons (roughly 88,000 pounds) transporting automotive components and groceries. The other two vehicle combinations will be composed of a swap body truck and semitrailer of a total length of 25,25 meters (roughly 83 feet) and a maximum total weight of 64 metric tons (roughly 128,000 pounds). Figure 2 illustrates the vehicle combinations selected for the project among other truck and trailer combinations allowed on the European roads. One of the vehicles will be transporting general cargo while the other will be transporting groceries. The swap body truck of the latter will be equipped with a cooling unit. The flows and the vehicle configurations were selected to resemble the diesel trucks used on the Swedish roads today as much as possible. However, it should be noted that all of the flows in the project could be characterized as line-haul flows, serving mostly fixed logistics nodes while long-haul flows in general may have non-static points of departure and arrival.

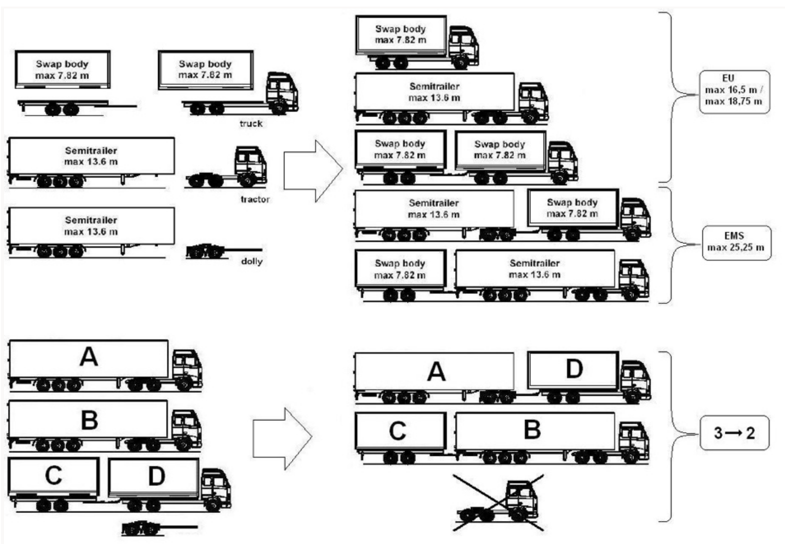

Figure 2: European Modular System for road freight transportation [4]

During specification of the logistics flows for the E-Charge project it became evident that Swedish long-haul trucks are not always operated in the 4.5h + 45 min + 4.5h configuration, although it is rather common to utilize trucks this way for transports across several countries on the European continent. Apart from this traditional set-up, several logistics operators in Sweden, apply a concept called "spetsbyte" which could be translated to "an instant drivers change". The concept is best explained by an example. Truck 1 is leaving point A destined for point B. Truck 2 is leaving the point B destined for point A. Both trucks are travelling towards each other and arrive to the middle point of the route approximately at the same time. The middle point is usually a truck stop but, in some cases, can be an outpost of a logistics company. At the middle point, driver of Truck 1 changes to Truck 2 and vice versa after which both the drivers return to their initial point of departure. The system is used to decrease downtime for the truck and to avoid having the driver to spend time away from their residence. In this set-up the driver is often used on the same routes and always returns home after their shift. Naturally, the given explanation is simplified as variations of the set-up occur depending on the distance of the route, time, and other factors.

The concept of “spetsbyte” poses additional challenges for electrification as the downtime decreases which decreases potential time for charging as the driver and the truck are decoupled. In addition, the charging infrastructure needs to be matched with locations for drivers’ change which may vary from location where the trucks are concentrated along the highway during standstill. Therefore, the flows in E-Charge were designed to address the challenges of this concept by incorporating driver’s change in two of the flows in the project. Both of driver changes will occur at one of the MCS charging locations in the project and will be combined with charging during the standstill.

Prior to implementation of the prototype vehicle in the system demonstration, both OEMs are individually testing a first edition of the long-haul BEVs in-house. Apart from testing the vehicles’ performance, a first series of tests of the MCS-charging is performed at this stage. ABB provides both OEMs with one MCS charger each to ensure readiness of the technology before initial system demonstration. Thus, a total of five MCS chargers are being used within the project. The vehicles, which will be used in the initial system demonstration will be purposely built for the project during 2023 and delivered to the transport companies by Q1 2024.

Apart from the MCS-chargers at three locations, additional charging is required to support the electrified logistics flows in the project. Destination charging was not a priority during the feasibility study while its importance became clear during the specification of the logistics flows. To utilize trucks efficiently and achieving a high milage of the test vehicles, time is crucial not only on the route but also at the point of departure and destination of the goods. The turnaround time at the logistics nodes is rather short when it comes to long-haul transport which requires quite sufficient charging speed before the next transport assignment. However, only MCS chargers are financed through the E-Charge project. MCS chargers at the logistics nodes were deemed unnecessary in terms of power levels, not to mention the challenge of acquiring sufficient power supply to areas with rather low power capacity as is often the case in logistics hubs. Financing non-MCS chargers through the project was not feasible as those kinds of products, CCS chargers, were market-ready and there would not be any innovation that could be attributed to those. Thus, no funding could be acquired.

For the same reason no additional chargers along the routes could be financed by the project although they could potentially be important in cases when the project BEVs would not be able to reach a MCS-charger due to weather conditions and traffic. Prior to the main project, it was known that the energy consumption of a battery-electric truck is significantly higher when the road surface is covered in slush during the winter months. Therefore, it was concluded that the project would require additional charging points of CCS standard, serving to improve the resilience of the logistics flows. It was assumed that, by the time of implementation of the system demonstration, public charging stations would start to emerge along the main Swedish highways. It was also later confirmed by the CPOs in E-Charge, OKQ8 and Circle K, without mentioning any specific sites. In March 2022, the Swedish Energy Agency announced a tender for financing public charging and hydrogen refueling stations for heavy-duty vehicles – Regionala Elektrifieringspiloter in Sweden [5]. In July 2022, 139 charging stations and 12 hydrogen refueling stations were announced which would acquire up to 100% financing from the state, see Figure 3. The requirement for the tender was that each charging station must consist of at least two charging connectors providing at least 175kW each. Load balancing between the connectors is permitted. The maximum power for both charging connectors must be at least 350kW and is usually obtained from one of the connectors when the other one is not in use. All the charging and hydrogen refueling stations must be built by September 2023.

Consequently, by the time of inauguration of the initial system demonstration, a sufficient network of CCS chargers will be available which may support the logistics flows when needed. To be able to utilize the various charging standards, the project vehicles need to be equipped with both an CCS and an MCS inlet. This raises questions of potential parallel utilization of both charging systems within the road-based logistics system in the future and whether MCS will replace CCS at some point, as CCS was initially designed for battery electric passenger cars.

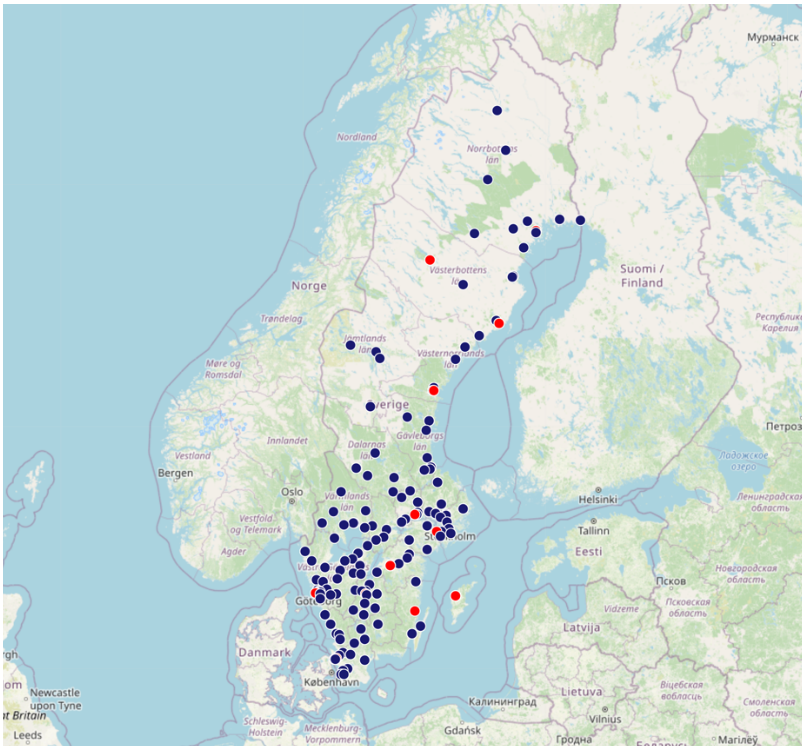

Figure 3: Locations for upcoming charging- and hydrogen refueling stations financed by Swedish Energy Agency. (Charging stations in blue, hydrogen refueling stations in red). [6]

Other practical issues emerged during the specification stage of the logistics flows. Initially, both of the logistics flows transporting groceries were planned to be carried by vehicles and trailers equipped with cooling units. Those plans were later partially dismissed due to added complexity as cooling units are provided by a third party and its integration requires significant efforts. A more practical issue is the requirement of an additional charging point for the trailer adjacent to the ordinary charging point for the truck. The cooling unit on the truck can use the energy from the vehicle's battery while the one on the trailer cannot yet and would require its own battery. The trailers battery would thus be of significant size to maintain a certain temperature for 4,5 hours at a time. It would also require sufficient charging speed. Thus, the overall payload weight of the vehicle combination would be reduced due to the weight of the batteries as battery-electric truck and trailers are not exempt from weight restriction as is the case in US. Consequently, one of the vehicle combinations will be transporting non-temperature-controlled goods while the other will consist of a truck with a cooling unit and a standard trailer.

An important aspect within the project, potentially having a major effect on the timeline, is the utilization of the MCS chargers in public locations. As the MCS standard is only emerging, it is yet to be certified for being used publicly. The process of acquiring a pre-standard certification is rather complex with an uncertain timeline. Several organizations are involved in the standardization process. The outcome is uncertain, and the granted standard may require additional safety features during charger utilization such as physically restricted access to the charging equipment. However, other experimental charging equipment has been acquiring these kinds of certifications before which is why the charger OEM ABB and the rest of the project team perceives the risk of timeline disruption as rather limited.

2.2 Multi-disciplinary modelling and analysis

To understand how the new system can be introduced with long term net benefits for society, people, and industry, academic system research is carried out in the E-Charge project by SEC, Swedish Electromobility Centre, through Chalmers University of Technology, Linköping University, Lund University and Uppsala

University. Five PhD students jointly working within individual research areas, are set to acquire a licentiate at the time of project's termination. The base of the research activities consists of exploring the effects the electrification of long-haul trucks has on the total system and the corresponding subsystems.

The cost-effectiveness of the system is studied with the vehicle, charger dimensioning, battery degradation and other battery related costs in mind. Batteries' life span will be modelled in relation to the depth of charging cycles and various power levels. In addition, a techno-economic dimensioning of the battery will be performed to understand how a cost-effective system can be constructed in relation to the battery. E.g., the costs of various battery sizes will be compared to the corresponding load capacity and energy consumption of a truck. The goal is to create a model for evaluating battery related costs for a new segment of heavy-duty electric trucks at an early stage and thus have better basis for decisions regarding battery dimensioning for a specific truck, charging infrastructure and choosing an appropriate charging strategy.

The vehicles' energy consumption is modelled to explore the impact of various weather, wind, road, and load conditions on the range. By exploring the energy consumption of the trucks in the initial system demonstration and corresponding charging curves, a verified and open model for energy consumption will be constructed as well as a detailed description of the various energy consuming aspects during the operation of a long-haul BEV. The impact of introducing battery electric vehicles on long-haul flows for the overall logistics systems is explored in close collaboration with the participating transport companies through discussions and interviews. Changes and cost effects on the logistics system will be explored and compared to the advantages of electric heavy-duty trucks. The expectation of the analysis is to obtain insights on how electric trucks may be efficiently introduced in the logistics system.

Impact on the electric grid from charging at high power levels will be explored as well. System diagrams, load profiles and specifications will be examined with the assistance of Vattenfall which will provide some of basis for the research. One of the major goals within the activity is to establish how the MCS-charging system may be scaled up efficiently considering the high-power levels to comply with the limitations of the electric grid. Policy and regulation are bases of another focus area within the research in the project. Apart from examining various existing policies and regulations introduced to support electric trucks around the world, an analysis will be performed of what specific policies and regulations are required to support long-haul BEVs.

A simulation of the planned logistics flows is being carried out which will be further developed in a simulation of the total road transport system in Sweden. The simulation will be performed with MATSim, which is an open-source for implementing large-scale agent-based transport simulations [7]. Results of the simulation will show the current traffic flow of heavy-duty trucks on Swedish roads on an aggregated level which, with the help of the inputs from findings from other research activities, will allow for studying possible effects of a scale-up of electric heavy-duty trucks. A specific expected output is to gain insights on where the public charging infrastructure should be placed to efficiently support the transition towards electric heavy-duty BEVs.

Additional support for research in all areas is planned to be obtained through data exchange from the participating industry partners. However, data exchange has proved to be a delicate subject as it is often restricted by the business interests and legal limitations. To manage this challenge, the researchers have gathered and expressed their needs regarding input data from the industry partners which the latter have examined and notified which data will be possible to exchange with researchers and which will not. Most of data from the system demonstration vehicles will be shared to the researchers apart from some exceptions due to high technological and/or business sensitivity. When it comes to larger datasets such as e.g., vehicle movements from the total OEM fleet which would be beneficial for the MATSim model, a solution for data exchange is yet to be found. Apart from understanding the introduction of the heavy-duty system, another overall ambition is for researchers to indicate what areas the automotive industry should focus on in the future development of their products in the electrified heavy-duty trucks segment.

2.3 Scaling up

Apart from preparations for the initial system demonstration and research activities, the coordinating partner Lindholmen Science Park (LSP) is managing a workflow around an outlook on the large-scale electrification of the heavy-duty trucks in the future. As proposed in the application for the main E-Charge project, one of the project's expected outputs is to provide input for policies aiming to scale-up the electrification of long haul transport with special focus on localization of public charging infrastructure.

The input was decided to be gathered through interaction with project partners and some external stakeholders, mainly energy companies since only one of those is represented in the consortium. Interaction was determined to consist of interviews with representatives from one of the companies at a time. Interviews are being conducted by LSP starting in Q1 2023. LSP was deemed to be a feasible interviewer considering it being the coordinator of this workflow and a neutral part within the project without own business interests. A questionnaire has been constructed and adjusted for each type of actor, i.e., truck OEM, charger OEM, transport company, CPO, being subjected to the specific interview. The questions in the interviews are exploratory, encouraging the interviewees to a discussion rather than giving short answers. LSP maintains a trustee function in relation to the interviews meaning that it is the only partner being the owner and gatekeeper of the answers provided during the interviews and taking responsibility in anonymizing the answers before using them outside the trustee function. At this point, March of 2023, interviews with all project partners have been conducted varying in the number of interviews per partner due to varying constellations of participants from the partner organizations.

In August 2022, Swedish Energy Agency together with Swedish Transport Administration has been assigned the task of formulating an action program for a fast, coordinated, and efficient roll-out of public and non-public charging infrastructure (along with hydrogen refueling infrastructure) for private and commercial vehicles by the Swedish government [8]. This action program will be the first but ideally not the only public initiative to which the E-Charge project will provide a policy input for. The action program is to be presented due to 1st of November 2023 and a close connection has already been established between E-charge consortium and the relevant governmental agencies.

Naturally, the potential input will become even more relevant as a result of the future experiences from the initial system demonstration. Thus, the abovementioned governmental task is not expected to be the only channel for the input from the project. In addition, LSP plans to conduct supplementary series of interviews in the future to ensure that the experiences from the system demonstration are disseminated to the policymakers. Also, it is expected that the interviewees may answer the same questions differently over time due to new experiences and/or internal and external factors which are not possible to foresee but which may have large implications on the area of electromobility and the society, e.g., the current energy crisis in Europe.

Another goal of the interview study is to explore prerequisites for an upscaled system demonstration, succeeding the initial one conducted in this main project. The new project is set to be formulated and applied for during the ongoing main E-Charge project. At the time of the formulation of the current project application, the up-scaling was assumed to constitute of increased geographical scope and/or the number of trucks, logistics flows and partners. Since the start of the main project, it became evident that there is a level of discrepancy regarding the scope of the follow-up project among partners. Thus, a part of the abovementioned questionnaire is on the theme of potential focus area of a follow-up project. A very preliminary result from this part of the questionnaire is that partners express an interest in investigating other subsystems supporting and enabling the electrification rather than in the hardware of trucks and chargers itself. One particular area of interest is the energy system in terms of how future rest areas and logistics entities could supplied with energy at high power levels which the distribution, regional and especially long-haul heavy-duty trucks are expected to require.

Acknowledgments

E-Charge is an innovation project financed by FFI, Strategic Vehicle Research and Innovation. FFI is a collaboration between the Swedish Innovation Agency - Vinnova, the Swedish Transport Administration and the Swedish Energy Agency and the automotive industry.

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Presenter Biography

Nikita Zaiko joined Lindholmen Science Park (LSP), a non-economic organization hosting several R&I-programs e.g., mobility, in 2020 in the role of project manager. He is coordinating and participating in several complex innovation projects involving multiple stakeholders from the industry, academia, and public sector, with electrification of heavy-duty vehicles being the common theme. He holds a M.Sc. in Logistics and Transport Management from School of Business, Economics and Law at Gothenburg University.