White Paper
of Charging Interface Initiative e.V.

Charging Site Recommendations for CCS and MCS for commercial vehicles

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1. Executive Summary

The CharIN e.V. Whitepaper on Charging Site Recommendations provides a comprehensive guide aimed at standardizing and optimizing charging infrastructure for electric vehicles (EVs) and commercial electric trucks. CharIN, a leading industry alliance, brings together a diverse range of stakeholders, including Charge Point Operators (CPOs), original equipment manufacturers (OEMs), and governmental bodies, to develop best practices that enhance the customer experience through technological consensus and harmonization.

This document delves into the essential elements of designing charging sites, particularly focusing on the Combined Charging System (CCS) and Megawatt Charging System (MCS). It emphasizes the need for flexible, scalable, and modular site layouts that cater to varying vehicle types and charging needs. Key considerations include safety protocols, optimal site design, and the importance of aligning charging site features with local regulations and traffic patterns.

One of the primary objectives of this Whitepaper is to minimize disruptions during the charging process, which are often a source of frustration for EV drivers. By standardizing charging site layouts and ensuring the strategic placement of chargers, CharIN aims to prevent common issues such as charging bay congestion and cable management challenges. The document also provides detailed recommendations on the placement and orientation of CCS and MCS inlets on commercial vehicles, informed by industry surveys and best practices.

The Whitepaper's agenda covers critical aspects of charging infrastructure, including the size and modularity of charging sites, safety considerations, grid connection challenges, and the automation of truck charging processes. It highlights the distinction between CCS, designed for standard charging durations of approximately two hours (for large batteries), and MCS, which supports fast charging of large batteries within 30-45 minutes. This differentiation is crucial for planning charging sites that can accommodate both passenger vehicles and heavy-duty trucks, ensuring that each charging use case is effectively addressed.

In addition, the document explores the future scalability of charging sites, recognizing that as the adoption of battery-electric trucks increases, so too will the demand for larger and more complex charging facilities. The Whitepaper proposes a phased approach to site development, considering factors such as grid capacity, investment costs, and regional constraints. By doing so, CharIN provides a roadmap for the gradual expansion of charging infrastructure that aligns with the growing needs of the electric mobility sector.

In conclusion, this Whitepaper serves as a vital resource for stakeholders involved in the planning, design, and operation of EV charging sites. By implementing the recommendations outlined within, the industry can achieve a harmonized, efficient, and user-friendly charging ecosystem that supports the global transition to electric vehicles. The collaborative efforts fostered by CharIN e.V. continue to drive innovation and standardization, ensuring that EV users worldwide benefit from a seamless and reliable charging experience.

2. Introduction

CharIN e.V. (Charging Interface Initiative) is a leading industry alliance committed to establishing a technological consensus within the electric vehicle (EV) charging ecosystem. Our primary objective is to deliver a seamless charging experience for end customers. To achieve this, CharIN unites a diverse group of experts and stakeholders, fostering an environment of open discussion and collaboration. These collaborative efforts lead to the creation of best practice documents that address the varying needs of all parties involved, ensuring a harmonized implementation of charging technologies across the globe.

This Whitepaper is a comprehensive guide designed to offer practical recommendations for charging site layouts. It delves into critical aspects such as safety protocols, the evaluation of different charging bay angles, and the interface with vehicles. The insights provided here are invaluable to a wide range of stakeholders, including Charge Point Operators (CPOs), governmental bodies, and original equipment manufacturers (OEMs). By understanding and addressing the diverse needs of these players, CharIN ensures that the design and operation of charging sites meet the highest standards of safety, reliability, and convenience.

Harmonizing the requirements for charging sites is essential to avoiding poor charging experience that could lead to dissatisfaction among EV drivers. Through the collaborative efforts of its members, CharIN is dedicated to facilitating a consistent, global approach to EV charging. This approach not only enhances the user experience but also supports the widespread adoption of electric vehicles. By driving innovation and addressing emerging challenges, CharIN continues to play a pivotal role in the evolution of electric mobility, ensuring a future where EV charging is efficient, reliable, and universally accessible.

3. Charging Site recommendations

Within this chapter we want to emphasize the importance of certain aspects regarding the principles of designing a charging site for CCS and MCS charging solutions. We concentrate on the use cases with public charging opportunities.

3.1. Use Case overview of CCS and MCS charging

The Combined Charging System (CCS) / North American Charging Standard (NACS) and the Megawatt Charging System (MCS) serve distinct purposes within the electric vehicle charging ecosystem, particularly for commercial vehicles. CCS/NACS supports both fast and slow charging, making it versatile for various use cases. However, its slower charging speeds can be a drawback for heavy-duty trucks, as they require longer charging times, which can be inefficient for en route commercial operations.

On the other hand, MCS is designed to cover power ranges overlapping with CCS and going up to 3.75 MW. This rapid charging capability is crucial for trucks and other large vehicles that operate on tight schedules and need to minimize downtime.

The use cases for these systems are outlined in this CharIN whitepaper, highlighting scenarios such as regular day or night charging at home, quick in-between charging at public hubs, and high-demand locations like highways. For heavy-duty trucks, relying solely on CCS/NACS for charging would be impractical due to the extended charging times, making MCS the preferred choice for these vehicles.

In summary, while CCS offers flexibility across different vehicle types and charging scenarios, MCS is tailored for the high-speed demands of commercial vehicles, ensuring that trucks can quickly return to operation without significant delays.

3.2. Size of a charging site

Different factors will lead to the fact that the size of the charging sites will increase in the course of time:

1. The ramp up of battery electric trucks will grow over time, still a foresighted provision of an initial network is key to support the transition
2. Available grid capacity is a bottleneck and grid expansion can take time, often measured in years.
3. Finally, high investment costs for hardware and grid connections suggest a phased approach.

3.3. Site layout

3.3.1. Site design considerations

3.3.1.1. Modularity

Modularity is a key principle when designing charging stations. It allows for flexibility and scalability, enabling adjustments based on specific requirements.

3.3.1.2. Parking Layout

Charging stations can adopt either a 45-degree fishbone design **or** 90-degree parking**, without** local limitations. These layouts optimize space utilization and accessibility

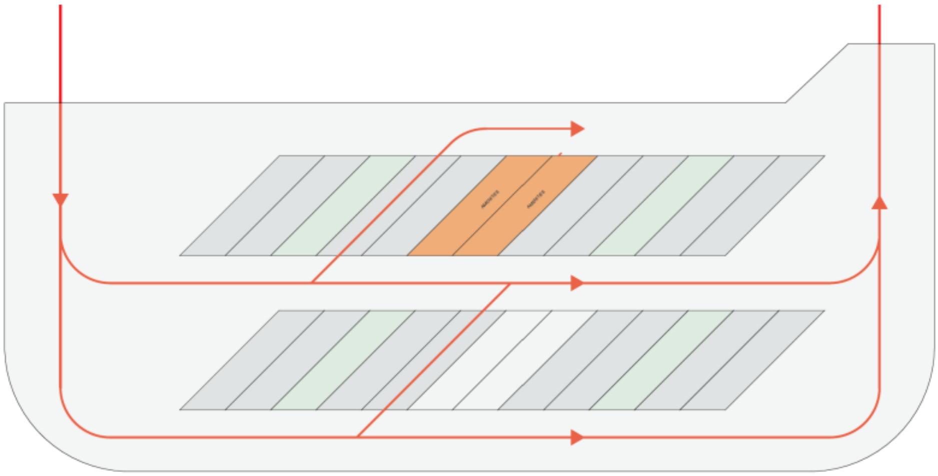


Figure 1 45° fishbone modular parking bay design Source: Milence

The fundamental design decisions for a charging site can be among other distinguished by the following factors:

Traffic and parking flow

1. 90 degrees versus 45 degrees (fishbone) arrangement of parking bays
2. drive-through parking (only forward driving) versus back ward parking

These two factors also interfere with one another as, e.g., 90-degree arrangement of parking bays and drive through parking mean, that roads need to allow for 180/90 degree turns of the trucks

Essential height and width:

1. Drive through height (if sites are equipped with canopies etc.) should at least equal 5m
2. Parking bay width should, beyond minimum requirements, also consider for allowing a safe evacuation route and enough space to fully open the door of the truck

3.3.1.3. Traffic Direction

Consideration of UK traffic direction is essential. Aligning the charging station layout with local traffic flow ensures safety and efficiency.

3.3.1.4. Truck Parking Orientation

CharIN emphasizes the need to adapt charging station layouts to local traffic regulations, especially in regions with left-hand traffic, such as the UK. The integration of CCS and MCS charging solutions in the UK requires specific design adjustments to ensure both safety and efficiency. Charging stations must accommodate left-side parking and drive-through configurations to minimize complex maneuvers for large vehicles, particularly trucks. Additionally, aligning the charging points with local traffic flow ensures that the vehicles can be charged efficiently without disrupting the movement of other vehicles. This approach not only improves the user experience but also ensures that UK-specific traffic regulations are fully respected while maintaining the global consistency of charging infrastructure.

3.3.1.5. Drive-Through Parking

Drive-through parking is preferable to backward parking. Backward parking poses collision risks with ground-level chargers.

3.3.1.6. Clearance Height

Ensure a clear drive-through height of 5 meters to accommodate various truck sizes.

3.3.1.7. Charging Bay Dimensions

The charging bay width should be minimum 4.7 to 5.05 meters, with a maximum of 90 cm between the charger and the truck. This space allows for safe evacuation routes and full truck door opening. The charging bay length should be minimum 19 meters.

3.3.1.8. Exit Road Width

The exit road width should be between 9 and 13 meters to accommodate truck turning circles.

3.3.1.9. Regional Constraints

Consider regional constraints during design and implementation. Local regulations and infrastructure availability may impact station layout. Regional constraints for charging site layouts can encompass a variety of local regulations and environmental conditions that influence design choices. For instance, some regions may require that vehicles only park forward into the charging bay. This rule necessitates a layout that provides sufficient turning space and appropriate approach angles, potentially limiting design options and requiring modifications to standard configurations. In addition, local traffic regulations might dictate the orientation of the bays or even restrict certain maneuvers, such as reversing into a bay or executing tight turns, to enhance safety and traffic flow. Other regional constraints could involve zoning laws that limit the physical dimensions of the facility, such as setback distances, height restrictions on canopies or structures, and specific requirements for pedestrian access or emergency exits. These regulations may also extend to grid connection standards, where limitations on local electrical infrastructure might affect the overall design and capacity of the charging site. Each of these constraints needs to be carefully considered to ensure that the charging infrastructure is both compliant with local rules and optimized for user experience.

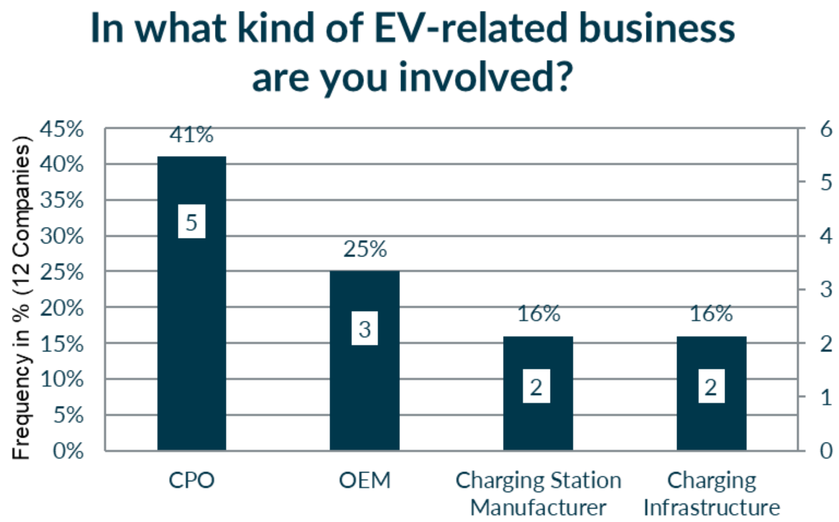
3.3.1.10. Trailer Drop

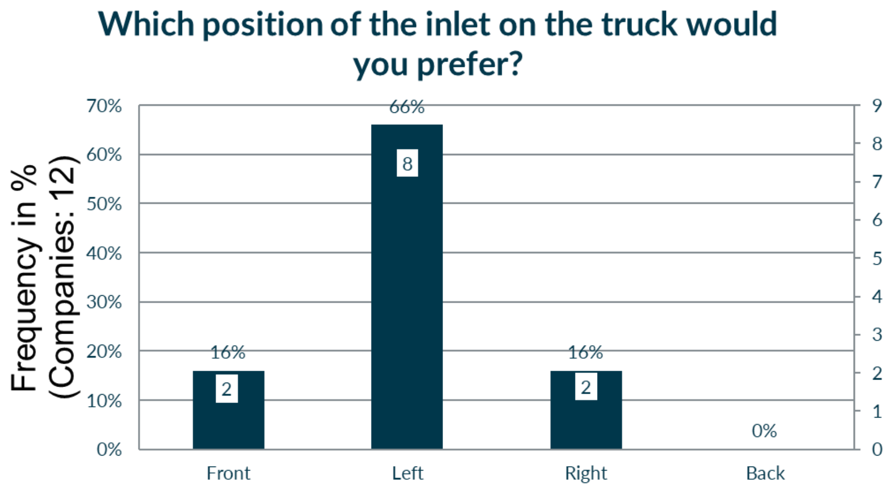
CharIN highlights the operational challenges associated with dropping trailers during charging. While dropping the trailer can free up space and potentially allow for easier maneuverability, it complicates the charging process by requiring additional steps and increasing the risk of misalignment with the charging station. Moreover, trailer drops can introduce safety risks, such as improper reconnection and logistical delays. Therefore, avoiding trailer drop during charging is recommended to streamline operations and reduce potential hazards.

3.3.2. CCS/NACS and MCS inlet position for electric commercial vehicles

Due to the standardization of the MCS inlet on the left side of the electric truck, a survey has been conducted (on 13.10.2023) within a working group of CharIN. The results indicated a preference for having the CCS/NACS connector on the left side of the electric truck even though responders were not a representative number of participants for the whole industry.

The survey participants were ABB, Allego, BP, Burns & Mcdonnell, DTNA, EVGo, MAN, Milence, Power Electronics, Shell, Volvo





Even if the indication points towards the left position of a CCS/NACS inlet on an electric truck it should be still possible to place a second inlet on the other side of the vehicle considering different use cases or customer needs. In case of an already existing MCS inlet (on the left side) the choice of positioning the CCS/NACS inlet at any side of the vehicle is the choice of the vehicle manufacturer. But for providing a good customer experience for en route charging it is recommended to have at least one CCS/NACS inlet on the left of the vehicle near the front axle.

Cable management

To avoid cables lying on the ground the shortest possible cables length should be chosen

- Cable dispenser design (Retractable)
  A retractable cable management system has benefits to provide much longer cable length if needed at the charging spot
- Cable dispenser design (Gantry)
  A gantry design has benefits for better availability in any charging spot of the vehicle and for handling of the heavy cable with connector.

3.3.2.1. CCS chargers

Due to the uncertainty of the CCS inlet location in the truck, different options could be used:

- Charger can be located between two bays with the potential of serving two bays at the same time. This setup minimizes the CAPEX of the site but might result in unserved trucks or power availability being diminished by simultaneous charging sessions.
- Two chargers can be allocated to a single charging bay (left and right). This setup enables redundancy by having two connectors per bay (one on the left side of the truck, one on the right side). However, it has an increased CAPEX investment.
- Charger can be located as overhead charging. This will provide more charging space for the e-truck.

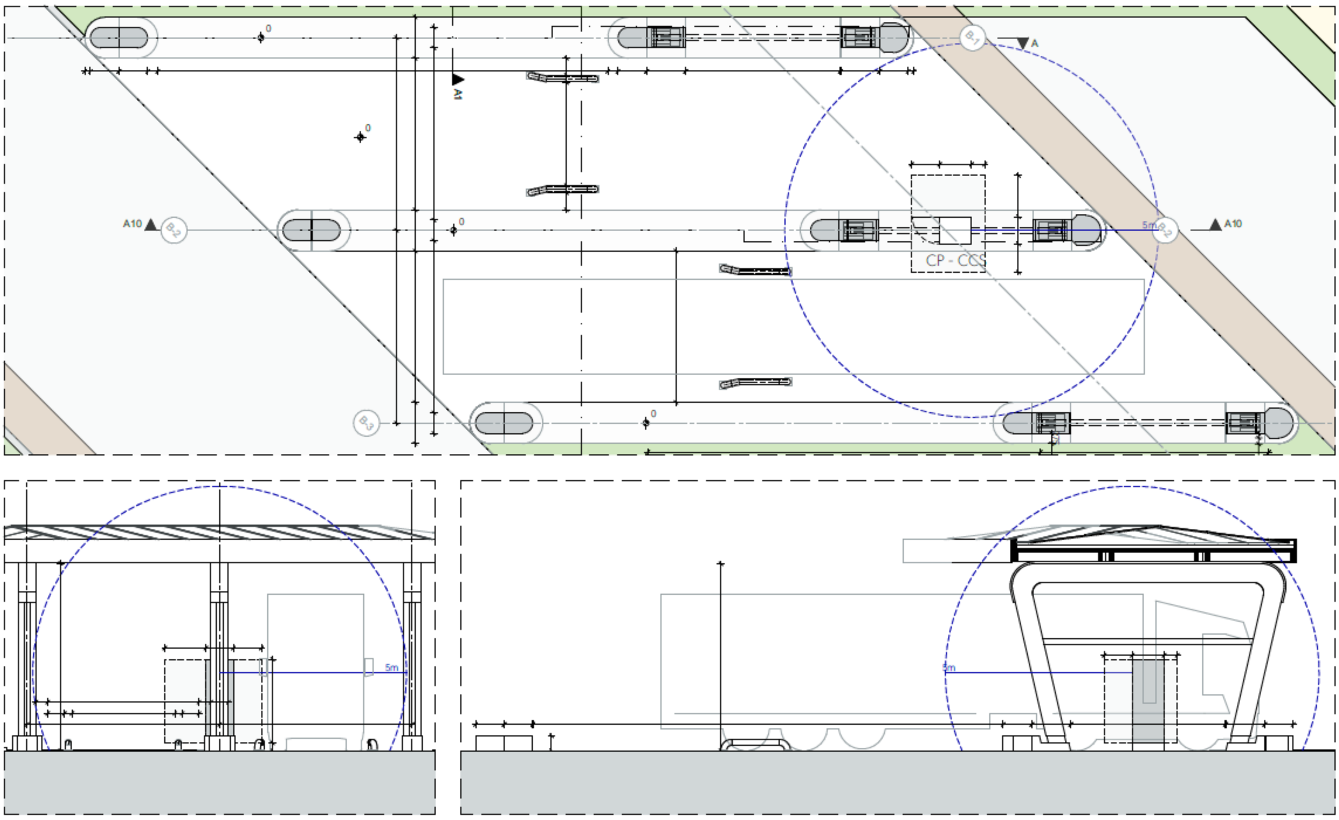


Figure 2 Charging site layout Source: Milence

3.3.2.2. MCS chargers

Due to the standardization of the MCS inlet position on the left side of the truck, the best option for the charger location:

- Charger should be located on the left of the parking bay.

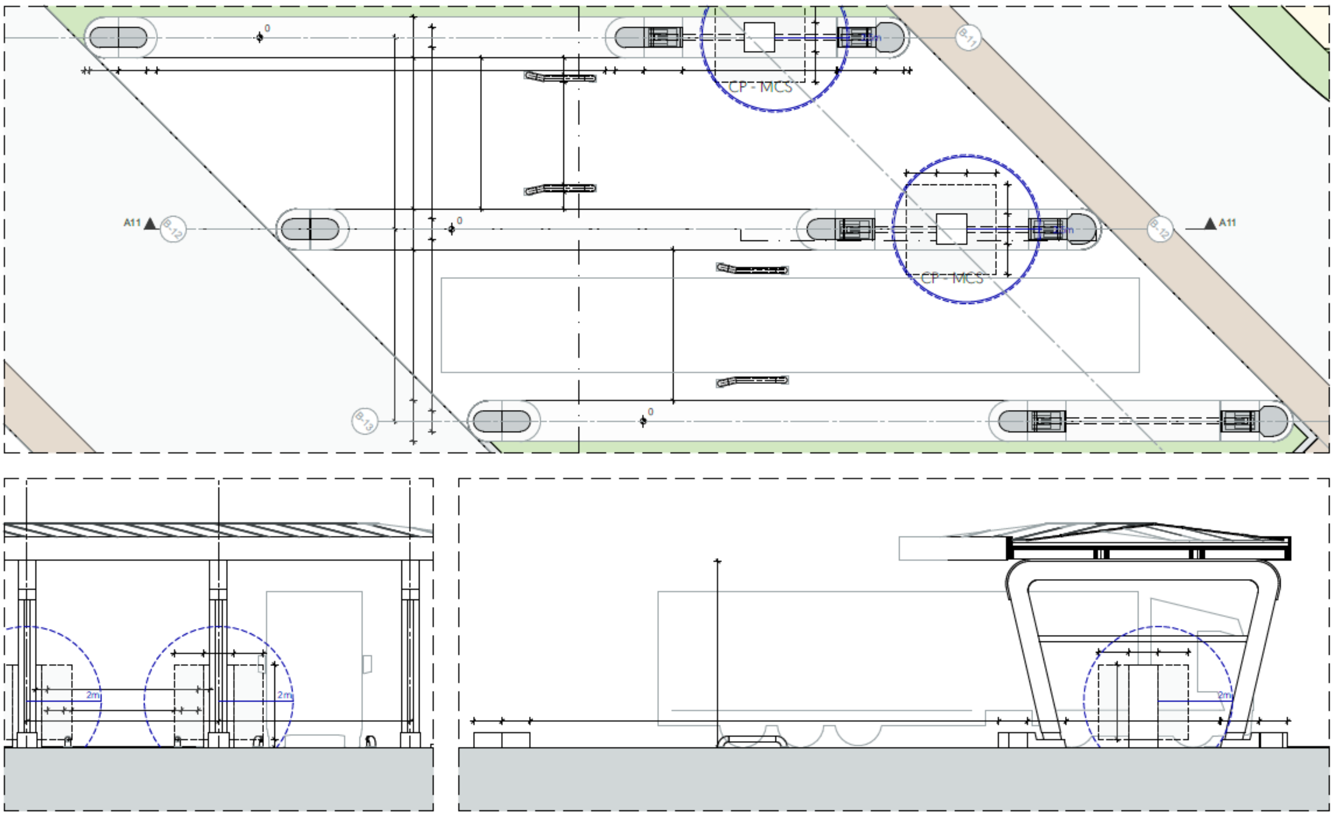


Figure 3 Charger position in charging bay Source: Milence

3.3.2.3. Trailer charging

Charging Trailer Electric APU Batteries

Electric trailers equipped with Auxiliary Power Units (APUs) require consistent power to maintain refrigeration or other auxiliary functions during stops. Unlike traditional diesel-powered APUs, electric APUs rely in some cases on AC charging infrastructure to operate efficiently.

Refrigerated electric trailers parked overnight at rest areas require reliable power to sustain cooling systems. Typically, dedicated 22 kW AC outlets are installed at each parking bay to provide continuous power, reducing reliance on diesel APUs and maintaining cargo integrity.

When trailers are detached from trucks at logistics hubs, fixed AC shore power connectors or portable charging units ensure continued operation. Which is not recommended due to operational inefficiency and parking lot occupancy.

AC charging at 22 kW is the most practical and cost-effective solution for trailer APUs. It provides sufficient power during idle periods or overnight stays and lowers investment compared to high-power DC systems.

Charging Trailer Propulsion Batteries

For trailers equipped with propulsion batteries, DC fast charging is required to ensure efficient operation during long hauls. Charging solutions must be integrated into existing infrastructure to minimize downtime and support fleet management.

Trailers with propulsion batteries charge simultaneously with the truck via DC connections. The APU continues to draw power from its source, as dedicated charging for APUs is not expected during propulsion battery recharging.

Fleet depots typically use modular charging stations that combine DC fast charging for propulsion batteries and AC outlets for trailer APUs. This ensures synchronized charging and optimized power management.

Standardizing connectors (e.g., CCS2/NACS) and communication protocols (e.g., ISO 15118) ensures compatibility between trucks and trailers and facilitates effective power distribution. Implementing bidirectional charging (V2T - Vehicle-to-Trailer) can also enable energy sharing between truck and trailer, optimizing overall efficiency.

3.3.3. Safety aspects

Safety is a critical consideration in the design and operation of electric vehicle (EV) charging sites, particularly given the unique risks associated with high-power charging systems like CCS (Combined Charging System), NACS (North American Charging System) and MCS (Megawatt Charging System). These systems, while efficient, require stringent safety measures to mitigate the risks of fire, accidents, and other hazards.

3.3.3.1. Fire Safety Measures

EV fire safety at charging sites is a critical consideration for ensuring public safety and maintaining trust in EV infrastructure. Key aspects to address could include proper site design to facilitate emergency response and adherence to safety regulations and standards. Charging equipment should be equipped with fault detection and automatic shutdown features to prevent overheating and electrical faults. Adequate spacing between vehicles and chargers can help contain potential fire spread, while the use of fire-resistant materials and barriers can enhance safety. Furthermore, charging site operators and emergency responders should be trained on handling EV-specific fire scenarios, such as thermal runaway and high-voltage battery fires. Regular maintenance and inspections of charging stations also play a vital role in identifying and mitigating potential hazards before they escalate.

3.3.3.2. Accident and Hazard Prevention

Accidents involving EVs at charging stations can occur due to various factors, including improper use of equipment, vehicle collisions, or faults in the charging system. To address these risks, charging sites must be designed with clear signage and markings to guide vehicles safely into charging bays. Furthermore, the layout should allow for easy access by emergency vehicles. Physical barriers or bollards can also be installed to protect charging equipment from accidental impact.

3.3.3.3. Electrical Safety

Given the high voltages involved in CCS. NACS and MCS charging, it is essential to implement rigorous electrical safety protocols. This includes regular maintenance and inspection of all electrical components to prevent faults. Grounding and bonding of all metallic parts, proper insulation, and the use of residual current devices (RCDs) can help reduce the risk of electrical shock or short circuits.

3.3.3.4. Emergency Response Preparedness

It is vital for charging sites to have a well-defined emergency response plan that includes evacuation procedures, coordination with local emergency services, and regular safety drills for staff. Additionally, charging stations should be equipped with clear instructions and emergency contact information for users to follow in the event of a problem.

By addressing these safety aspects, the risks associated with EV charging can be significantly reduced, ensuring a safe and reliable charging environment for all users

3.3.4. Labeling

CharIN emphasizes the importance of clear and consistent labeling at charging stations to enhance the user experience. An ideal charging station should prominently display key information such as power levels, charging duration, and real-time pricing. This transparency helps users make informed decisions about their charging sessions. Additionally, labeling should be intuitive and consistent across all stations, ensuring that users can quickly and easily identify the necessary information, minimizing confusion. Proper labeling also contributes to operational efficiency by reducing user errors and optimizing the flow of vehicles through the station.

3.3.5. Grid connection

3.3.5.1. General

One of the central efforts for DC Truck charging facilities is getting a sufficiently dimensioned grid connection.

The main challenge is caused by the fact, that public charging infrastructure has a very volatile load curve. This volatile load curve, if the charging park is only fed via the public grid, leads to the necessity that the grid connection point needs to be dimensioned according to the maximal expected peak load. This dimensioning often is not possible or possible only with additional efforts (grid extension costs). Furthermore, volatile loads pose a risk to the distribution net operator, as they might cause over/ under voltage and frequency.
Before this background it will often be necessary to install a form of load balancing, which can be realized via a Battery Energy Storage System (BESS) that stabilizes the load. The rough functionality will be that the BESS pulls energy from the grid in low load windows (when there is a low usage of the charging infrastructure) and will feed energy into the internal systems in high load windows to cut of the peak from the load curve (peak shaving).

3.3.5.2. Infrastructure and Grid connection examples

Example 1: Small site

- Chargers:
  - 6xCCS DC-HPCs (350kW)
  - 2xMCS DC-HPCs (1300kW)
- Load factor: 0,8
- Needed electric AC infrastructure:
  - Grid Handover: Compact Secondary Substation walk-in or non-walk-in (steel or concrete) equipped with:
    - Secondary Medium Voltage Switchgear 10-20kV, <=630A, 16-20kA/1s
      - 1-2 Bays connecting to the public grid (Point or Ring connection)
      - 1 Handover bay with Fused Load break switch or Circuit Breaker
      - 1 Metering solution for MV Metering, depending on market and DNO requirements (can be metering bay, sensors etc.)
      - 2 outgoing bays with Load break switch or Circuit breaker to feed the internal MV grid
  - Internal Grid Station (steel or concrete): 2 pcs. Needed Compact Secondary Substation walk-in or non-walk-in
    - Secondary Medium Voltage Switchgear 10-20kV, <=630A, 16-20kA/1s

· 2 Bays with load break switch. 1 connecting to the Grid Handover Station one connecting to another internal Grid station to built-up an internal ring

            - 1 Transformer Handover bay with Circuit Breaker and Protection Relay (minimal protection functionality: overcurrent protection)
        - Transformer: Biological Esther isolated or dry Distribution Transformer
            - Power: 2000kVA
            - Primary Voltage: 10-20kV
            - Secondary Voltage: as per local standard (i.e. 0,4kV)
            - Minimal Protection functionalities: Overheating protection with warning and tripping signal that can be integrated in a local remote control and communication system (i.e. Via Modbus)
        - Low Voltage Switchgear: Distribution board dimensioned according to transformer power and local secondary voltage (AC)
            - Incoming switch: Circuit breaker with remote operability and integrability into a local emergency-off circuit
            - Charger connections: 3xCCS and 1xMCS per Station
                - Connection CCS: 1 Fuse per charger with technical properties acc. To charger manufacturers standard. For additional control these outgoings can be realized with remote controllable circuit breakers to allow a charger specific switch off from remote, i.e. For service works
                - Connection MCS: 1 Circuit breaker per charger with technical properties acc. To charger manufacturers requirements. For additional control a remote controllability can be realized, as described above
    - Recommended secondary equipment:
        - Load management system to ensure the load factor and the right prioritization, as well as providing potentially required values to the DNO
        - Energy Management System when a BESS is part of the solution
        - DNO remote control and monitoring system where required

Example 2: Large site

- Chargers:
    - 24xCCS DC-HPCs (350kW)
    - 12xMCS DC-HPCs (1300kW)
- Load factor: 0,8
- Needed electric AC infrastructure:
    - Grid Handover: eHouse walk-in (steel or concrete) equipped with:
        - Air Isolated Primary Medium Voltage Switchgear 10-20kV, <=1250A, 16-25kA/1s
            - 1-2 Bays connecting to the public grid (Point or Ring connection)
            - 1 Handover bay with Circuit Breaker as handover switch
            - 1 Metering solution for MV Metering, depending on market and DNO requirements (can be metering bay, sensors etc.)
            - 2 outgoing bays with Circuit breaker to feed the internal MV grid

- Internal Grid Station (steel or concrete): 8 pcs. Needed Compact Secondary Substation walk-in or non-walk-in
- Station Type 1: 4 pcs. Needed
    - Secondary Medium Voltage Switchgear 10-20kV, <=630A, 16-20kA/1s
        - 2 Bays with load break switch. 1 connecting to the Grid Handover Station one connecting to another internal Grid station to built-up an internal ring
        - 1 Transformer Handover bay with Circuit Breaker and Protection Relay (minimal protection functionality: overcurrent protection)
    - Transformer: Biological Esther isolated or dry Distribution Transformer
        - Power: 2000kVA
        - Primary Voltage: 10-20kV
        - Secondary Voltage: as per local standard (i.e. 0,4kV)
        - Minimal Protection functionalities: Overheating protection with warning and tripping signal that can be integrated in a local remote control and communication system (i.e. Via Modbus)
    - Low Voltage Switchgear: Distribution board dimensioned according to transformer power and local secondary voltage (AC)
        - Incoming switch: Circuit breaker with remote operability and integrability into a local emergency-off circuit
        - Charger connections: 3xCCS and 1xMCS per Station
            - Connection CCS: 1 Fuse per charger with technical properties acc. To charger manufacturers standard. For additional control these outgoings can be realized with remote controllable circuit breakers to allow a charger specific switch of from remote, i.e. For service works
            - Connection MCS: 1 Circuit breaker per charger with technical properties acc. To charger manufacturers requirements. For additional control a remote controllability can be realized, as described above
- Station Type 2: 4 pcs. Needed
    - Secondary Medium Voltage Switchgear 10-20kV, <=630A, 16-20kA/1s
        - 2 Bays with load break switch. 1 connecting to the Grid Handover Station one connecting to another internal Grid station to built up an internal ring
        - 1 Transformer Handover bay with Circuit Breaker and Protection Relay (minimal protection functionality: overcurrent protection)
    - Transformer: Biological Esther isolated or dry Distribution Transformer
        - Power: 3150 kVA
        - Primary Voltage: 10-20kV
        - Secondary Voltage: as per local standard (i.e. 0,4kV)
        - Minimal Protection functionalities: Overheating protection with warning and tripping signal that can be integrated in a local remote control and communication system (i.e. Via Modbus)
    - Low Voltage Switchgear: Distribution board dimensioned according to transformer power and local secondary voltage (AC)

- Incoming switch: Circuit breaker with remote operability and integrability into a local emergency-off circuit
- Charger connections: 3xCCS and 2xMCS per Station
    - Connection CCS: 1 Fuse per charger with technical properties acc. to charger manufacturers standard. For additional control these outgoings can be realized with remote controllable circuit breakers to allow a charger specific switch off from remote, i.e. For service works
    - Connection MCS: 1 Circuit breaker per charger with technical properties acc. To charger manufacturers requirements. For additional control a remote controllability can be realized, as described above

- Recommended secondary equipment:
    - Load management system to ensure the load factor and the right prioritization, as well as providing potentially required values to the DNO
    - Energy Management System when a BESS is part of the solution
    - DNO remote control and monitoring system where required

3.3.6. Future technologies

3.3.6.1. Automation of truck charging

Evolution of charging technologies will include their automation. Automation of truck charging offers significant advantages for the industry. It will streamline operations, reduce human intervention and hence minimize safety hazards and other human related risks. On the other hand, implementation of charging automation will require a significant upfront investment in infrastructure. Also, the industry will have to choose suitable solution out of the available portfolio and standardize them.

3.3.6.2. Charging Station timeslot Booking

To provide convenient and efficient management of e-HDV fleet operations, OEMs, CPOs and solution suppliers proposes idea of advanced time and energy booking system. Such system is for example being developed by EV Roaming Foundation.

Once completed, the system will offer e-HDV drivers / fleet operators to in advance book a timeslot at a charging station on a chosen location.

4. Conclusion & Next Steps

The Charging Site Recommendations Whitepaper serves as a vital resource in the ongoing effort to establish a standardized, efficient, and user-friendly charging infrastructure for electric vehicles and commercial trucks. By outlining key considerations such as optimal site design, safety measures, and grid connection challenges, this document provides a framework for developing scalable and future-proof charging sites. The integration of both CCS/NACS and MCS charging solutions ensures that a wide range of vehicle types and operational needs are addressed, facilitating seamless transition to electrified transportation.

Moving forward, the continued collaboration of industry stakeholders, including CPOs, OEMs, policymakers, and energy providers, will be crucial in implementing these recommendations effectively. Standardization efforts must be strengthened to ensure interoperability across different regions and vehicle manufacturers, requiring close cooperation with regulatory bodies to harmonize charging infrastructure requirements.

Pilot projects should be initiated to test and refine best practices, addressing real-world challenges in grid connectivity, automation, and charging site efficiency. The development of advanced energy management solutions, such as battery storage integration and load balancing strategies, will be essential to overcoming grid capacity constraints.

Investment in research and innovation must continue, particularly in automation and user experience improvements, to make charging faster, safer, and more accessible. The adoption of emerging technologies, such as automated charging solutions and bidirectional energy management, will play a key role in optimizing charging infrastructure.

As the electrification of commercial transport progresses, industry-wide cooperation will be necessary to ensure the successful deployment of robust and scalable charging networks. By aligning efforts and continuously refining best practices, the industry can create a seamless and efficient charging ecosystem that supports the widespread adoption of electric mobility.

5. Reference

This document was created by the Focus Group Charging Connection and Infrastructure of the CharIN association.

The Charging Infrastructure and Connection focus groups of CharIN are dedicated to advancing the standardization, efficiency, and scalability of charging solutions for electric vehicles, particularly for high-power applications like the CCS, NACS and MCS.

The Charging Infrastructure Focus Group addresses the design, layout, and operational requirements of charging sites, ensuring they meet industry standards and user needs. This includes aspects like site modularity, safety measures, grid integration, and the accommodation of different vehicle types. The goal is to create a seamless, reliable, and future-proof charging experience.

The Charging Connection Focus Group within CharIN focuses on the standardization and optimization of charging interfaces and connectors to ensure seamless interoperability between electric vehicles and charging infrastructure. This group works on defining technical requirements for charging plugs, inlets, cables, and communication protocols, ensuring compatibility across different manufacturers and markets.

Together, these focus groups drive innovation and collaboration among OEMs, CPOs, utilities, and policymakers, shaping the future of electric mobility infrastructure worldwide.

Special thanks to the contributors:

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