WHITE
PAPER

Empowering Growth: Advancing EV Charging Infrastructure with Scalable Power Distribution Solutions

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The global transition to electric vehicles (EVs), both for individual and fleet use, has accelerated in recent years, driven by concerns over climate change and the push for cleaner transportation solutions. As the number of EVs on the road continues to rise, EV charging station providers often struggle to keep up. Their need for robust, versatile and scalable charging station infrastructure has become increasingly critical. This white paper delves into an evaluation and comparison of various EV charging solutions, with a focus on the advantages of Starline's ingress-protected power distribution solution, the Series-S track busway.

What's Driving the Growth of the Global EV Market?

Electric vehicles are here to stay, with continued rapid growth in adoption. According to Kelley Blue Book Data[1] , over 7% of cars sold in the U.S. in 2023 were EVs. That number represents a total of 1.2 million cars, a long way up from the 100,000 EVs sold in the U.S[2]. in 2013. As of 2022, there were nearly 3 million electric and plug-in hybrid passenger vehicles registered in the United States. That said, EV adoption is truly a global phenomenon and elsewhere, the numbers are even higher. In Norway, for example, EVs made up 20% of all the country's cars[3] at the end of 2022. In China, 8.77 million EVs will be sold by 2028[4], representing a steady annual growth rate of 5.69% over the next four years. There are more than 10 million battery electric vehicles in use worldwide.

It's not just individual consumers driving EV market growth; companies including Amazon and government agencies like the U.S. Postal Service are transitioning entire fleets to be electric powered. In Amazon's case, it plans to buy 100,000 Rivian electric vans and deliver half of its shipments with net zero carbon by 2030.

Table 1: Types of Electric Vehicles

- Electric Vehicle (EV): cars powered by an electric motor instead of a combustion engine.
- Battery Electric Vehicle (BEV): cars powered by rechargeable battery packs.
- Plug in Hybrid Electric Vehicle (PHEV): vehicles powered by both traditional combustion engines and a battery. Batteries need to be plugged in to recharge.

While the surge in EVs is due to many factors, from improved battery and charging technology to government incentives and greater affordability, one in particular stands out – more widely available charging infrastructure.

According to the U.S. Department of Energy, public EV charging stations have grown from fewer than 500 in 2009 to over 60,000 in 2024[5]. In January, 2024, the U.S. federal government announced $623 million in grants to help build out an EV charging network across the U.S. That said, expanding EV charging infrastructure, both for individual drivers as well a

1. https://mediaroom.kbb.com/2024-01-16-Americans-Buy-Nearly-1-2-Million-Electric-Vehicles-to-Hit-Record-in-2023,-According-to-Latest-Kelley-Blue-Book-Data
2. https://insideevs.com/news/320526/december-2013-plug-in-electric-vehicle-sales-report-card/
3. https://europe.autonews.com/automakers/evs-now-make-20-norways-cars
4. https://www.statista.com/outlook/mmo/electric-vehicles/china
5. U.S. DOE Alternative Fuels Data Center: https://afdc.energy.gov/data

corporate fleets, is no easy feat. In fact, the journey is marred with stories about dead public EV charging stations, range anxiety, and car rental companies like Hertz rethinking the size of their EV fleets. Typical challenges facing EV charging station providers include:

- High upfront costs to install charging stations
- Finding suitable locations with capable electrical infrastructure
- Grid capacity to feed power-hungry EV charging stations
- Existing power distribution infrastucture (i.e. trenching, pipe and wire) limiting power access and ability to expand
- Consumer-facing charging infrastructure (i.e. fixed pedestals) further restricting adaptability and scalability

In other words, scalable, versatile and simplified power distribution solutions are critical to driving the proliferation of EV charging stations forward, for individuals and fleets. In this white paper, we will examine the advantages of track busway technology for power distribution needs, specifically our IP54-rated Series-S solution, in addressing the unique challenges surrounding greater deployment of EV charging infrastructure.

EV Charging Infrastructure

The evolution of EV charging infrastructure is driven by the changing needs of consumers and businesses alike. For EV consumers, the ability to charge quickly and conveniently is paramount. Commercial fleets, estimated to grow from 30 million in 2022 to 240 million in 2030, require scalable solutions that can accommodate many charging stations for multiple vehicles. Additionally, factors such as charging speed, scalability, and ease of deployment play a crucial role in determining the effectiveness of charging infrastructure.

Charging speeds

As the shift toward increased EV and PHEV usage continues, charging speeds have become a key area of consideration. Reported by the U.S. Department of Transportation, there are three levels of charging offering different charging speeds.

Table 2: Charging Station Levels

	Level 1	Level 2	DC Fast Charging
Voltage	120 V AC	208 – 240 V AC	400 V - 1000 V DC
Typical Power Output	1 kW	7 kW – 19 kW	50 – 350 kW
Estimated PHEV Charge Time from Empty	5 – 6 hours	1 – 2 hours	N/A
Estimated BEV Charge Time from Empty	40 – 50 hours	4 - 10 hours	20 minutes – 1 hour
Typical Locations	Home	Home, Workplace, and Public	Public

For most daily in-town driving, a standard 120-volt outlet inside of a residential garage for overnight charging will be sufficient. But for longer trips or for those who need to charge their batteries quickly, this type of charging, called Level 1, is insufficient. A Level 1 charger can take anywhere from 40-50 hours to charge a BEV to 80% from empty and 5-6 hours for a PHEV.

Level 2 charging in residential, workplace and public charging applications is becoming more common. It requires a 240-volt connection for residential or a 208-volt in commercial applications. Level 2 charging increases speed to charge significantly depending on the model of vehicle, cutting the time to charge a BEV from empty to 80% down to anywhere from 4-10 hours and only 1-2 hours for PHEVs.

Finally, Level 3 direct current fast charging, known as DCFC or simply "fast chargers," is the quickest for recharging vehicle batteries and is considered to offer "rapid charging." These chargers are only found in commercial and public charging infrastructure and, depending on vehicle model, can charge BEVs for 80% in 20 minutes to 1 hour. Importantly, Level 2 chargers are most commonly seen in public locations and are a popular option for charging electric fleets as well. Level 2 stations outnumber Level 3 chargers by a margin of about 10:1 and are more likely to see mass deployment because of the reduced power needs compared to Level 3 and the extended charging times required at Level 1.

Scalability of Charging

When electric vehicles were first beginning to be used, charging stations were more of a novelty and installing one or two charging stations in convenient locations was not terribly challenging. With increasing EV adoption, a single charging station or two, especially a Level 1 station mounted by the closest exterior outlet, is simply insufficient. Properly deploying Level 2 chargers in commercial spaces and for fleet charging must be a scalable process. Planning today to meet the current EV charging needs, as well as mapping out ways to meet future demand, will spell charging scalability success.

Ease of deployment

Charger types for various locations and uses are often selected based on the voltages available, how long vehicles would be parked at the location (think quick stops at a highway rest station versus longer visits to a shopping center or day-long parking in an office parking garage) and costs. Although all are key factors to consider when adding EV infrastructure, ease of deployment is another critical element. Ease of deployment takes into account more than how much money is required to implement charging. Time, labor, complexity of equipment and challenges to overcome are also key components.

Common Power Distribution Solutions for Charging Station Infrastructure

Based on the trajectory of EV use for both consumer and commercial applications, and the current state of charging infrastructure, it's clear there will continue to be growing demand for charging infrastructure. There are multiple options for distributing power to charging stations, whether inside industrial facilities, in parking garages or in open parking areas. The most common methods include:

- **Underground Conduit (pipe & wire):** Burying power cables underground requires trenching and is a common method for laying electrical infrastructure in new construction projects. While trenching can be effective in certain situations, initial installation is often expensive and time-consuming, requiring extensive excavation and disruption to existing infrastructure. Because of this, it is a much more permanent approach that makes future modifications extremely difficult and costly, and is not suitable for retrofitting existing spaces. Even when trenching is used in new construction projects, pipe and wire solutions are required, further adding to costs and time required for installation. Furthermore, maintenance and repairs can be challenging, particularly in urban environments where access to cables buried under concrete or pavement may be limited or nearly impossible.

- **Overhead Conduit (pipe & wire):** The approach involves running power cables overhead through conduit pipes. While this method offers greater flexibility (especially for retrofit applications) and easier access for maintenance compared to trenching, it still presents challenges in terms of scalability and efficiency. The installation of conduit pipes can be cumbersome, including when retrofitting existing buildings or infrastructure. Adding on to a pipe and wire system can be labor- and time-intensive, presenting challenges for future scaling needs.

- **Busduct/Track Busway:** Busduct and track busway involve distributing electricity via overhead-mounted busbars, which can be connected to at any point along the installation. Busduct and track busways are more conducive to retrofitting and are gaining popularity due to the faster installation time and scalability. The key difference is that busduct features busbars that are fully enclosed in metal, while track busway consists of an open channel track with busbars inside. Because busduct is fully enclosed, once installation is complete, access to busbars is more restricted, making maintenance and modifications more difficult and costly. Due to its open channel design, track busway is accessible for connection across the entire length of the bus, allowing greater flexibility, ease of reconfiguration, and quicker installation. This reduces upfront costs, while providing unparalleled scalability and adaptability.

Choosing the right power distribution solution is a critical decision that will depend on the specific circumstances of each installation. Due to the increased demand, new scenarios are emerging for EV charging infrastructure. These include considerations such as whether the location is new or retrofitted, indoor or outdoor, and the availability of existing infrastructure. Each scenario presents its own set of challenges and opportunities, requiring tailored solutions to meet the specific needs of the application. Ultimately, the most scalable, flexible, and cost-effective solution is track busway, but until recently it has not previously had the robustness needed to operate in many of the environments where charging infrastructure is needed.

IP54-Rated Track Busway Technology

The Starline Series-S Track Busway was designed to be the most robust, versatile and flexible overhead power distribution system available. Its adaptability makes it the ultimate solution to solving EV charging infrastructure needs, whether in new or existing facilities, indoors or outdoors or for whatever your power needs are. The Series-S combines the performance, functionality and flexibility of our track busway system with the added benefit of an IP54 ingress-protection rating.

IP54 ingress-protection rated electrical enclosures are protected from limited dust ingress and water spray from any direction.

Series-S allows users to install the system anywhere that additional water, dust or other contaminants require up to an IP54 rating. The protection level extends to the uniquely designed plug-in units, which are offered with a wide variety of watertight IEC- and NEMA-rated devices to meet any need. It is available from 100 amps to 1250 amps with 3-phase systems rated up to 600Vac or 600Vdc. Additional features include:

- Availability in 5- and 10-foot sections, with custom lengths upon request
- Overhead, wall and rack mounting options
- UL, IEC & ETL certifications
- Aluminum housing with corrosion-resistant coating
- Splashproof and highly dust-resistant design with watertight IEC and NEMA device options

Modular busbars located within protective enclosures are now a key component to EV charging infrastructure. Connectors enable easy connections to charging stations, while the IP54 rating allows for the track busway's use in covered outdoor installations, as well as various other environmental conditions, including industrial sites. In short, Starline's Series-S modular systems provide a custom-mounted power grid with an open channel for the insertion of customizable power plug-in units at any location.

Advantages of IP54-Rated Track Busway

Unlike pipe and wire or busduct, IP54-rated track busway offers flexibility to make quick and easy changes with the scalability to accommodate higher power loads, which makes it suitable for various levels of charging installations. Currently, many charging providers are challenged by limited space and fixed stations with a limited number of available plugs. Series-S busway and its multiple mount options offer scalability to charging providers, enabling them to meet the demands of the ever-growing EV market.

Limitations of Alternative Solutions

Conventional pipe and wire solutions are inherently rigid systems. With flexible mounting options, Series-S eliminates the need for trenching, reduces installation time and labor, and requires no routine maintenance. It also eliminates the need for numerous panels and long runs of pipe and wire, facilitating quick modifications and reconfigurations of power access points despite space limitations. To make changes with pipe and wire, providers must source additional material (and expertise) or incur the high costs of attempting to stock excess material. Finally, trenching brings high costs and disruptions to the charging site, making it a significant hurdle to expansions and reconfigurations.

Series-S reduces the need to constantly rely on outside support for changes to the electrical system. Instead of the unwieldy configurations of conventional solutions, the IP54 system creates a clean, sleek layout that is ready to scale up as EV adoption increases, no matter the environment where charging is needed.

It's Time for a Paradigm Shift in Power Distribution for EV Charging Stations

The expansion of EV charging infrastructure faces a range of challenges. From financial and regulatory issues to land availability, accessibility and grid capacity, expanding a global network of EV charging stations is a herculean task. Today, most EV chargers are typically mounted on charger pedestals or attached to a wall in spaces like parking garages or the exterior of a building facility. Unfortunately, these mounting types are inflexible, limiting the ability to scale up quickly or accommodate greater demand over time. Most pedestal chargers only offer a minimal number of plugs that can be used simultaneously. They are also inflexible to any future changes or reconfigurations due to their stationary structure.

The solution is to embrace a paradigm shift in how EV charging works. Instead of bringing vehicles to fixed power stations with a limited capacity for higher density use, bring the power wherever it's needed, leveraging a system that isn't hardwired into ceilings or walls. In that regard, Starline's Series-S IP54-rated stands out, enabling EV charging station providers to:

- Overcome the challenges of limited space (and generate maximum space savings)
- Eliminate costly and disruptive trenching through overhead busway installation
- Scale up quickly to accommodate layout changes and/or future capacity
- Lower the total cost of installing charging stations by eliminating costly electrical equipment (i.e., panels, runs of pipe and wire) and minimizing the need for specialized electrical labor
- Power monitor and load balance appropriately
- Deliver optimal voltage and ampacity on a mass scale
- Leverage areas where water splashes and dust occur

As a streamlined, flexible yet robust power distribution solution, the Series-S system gives charging station providers incredible flexibility and scalability, whether they are expanding existing locations or building additional stations. Continued progress and growth in EV use hinges on the successful expansion and building of EV charging stations. For that, track busway systems with the right protections are a necessity.

To learn more about Starline's IP54-rated Series-S Track Busway, visit: starlinepower.com/busway/series-s/

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