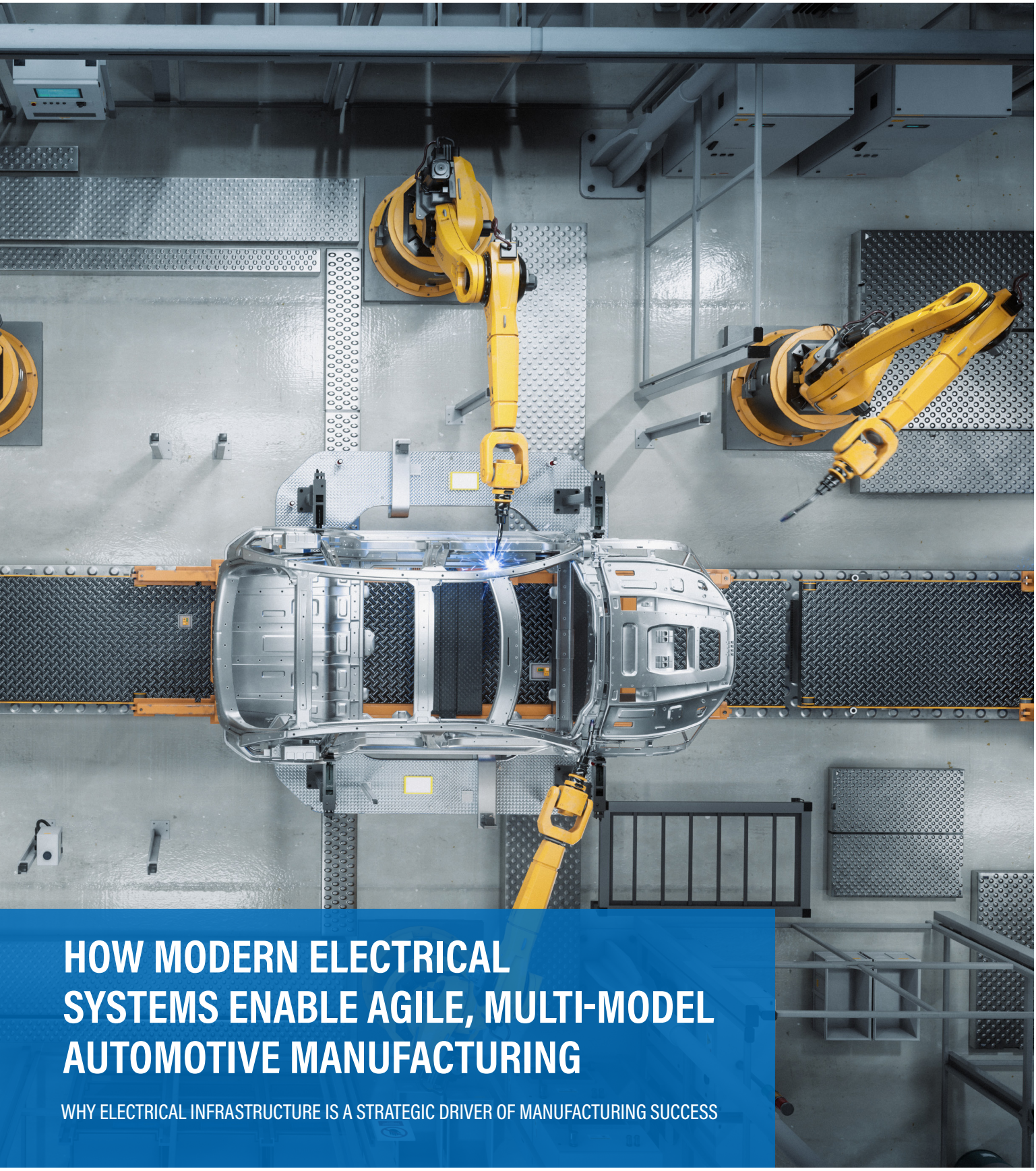

HOW MODERN ELECTRICAL SYSTEMS ENABLE AGILE, MULTI-MODEL AUTOMOTIVE MANUFACTURING

WHY ELECTRICAL INFRASTRUCTURE IS A STRATEGIC DRIVER OF MANUFACTURING SUCCESS

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TABLE OF CONTENTS

INTRODUCTION

Automotive manufacturing is currently undergoing its most disruptive transformation since the introduction of the original assembly line. What once operated on predictable, multi-year model cycles has shifted into an environment defined by volatility, rapid technology adoption, and fierce competition. Today's automakers are tasked with quickly reconfiguring their facilities for mixed-volume production, internal combustion engines (ICE) and electric vehicle (EV) coexistence, and shortened lifecycles, while juggling cost control, labor shortages, and automation integration.

Where traditional factories saw large line changes every six to eight years, many plants now make weekly, or even daily layout adjustments to respond to shifting market signals or automation upgrades. Today, EV/hybrid/ICE mixed-model production forces frequent equipment moves and power changes—sometimes within the same shift—to match volatile demand and variant complexity.

Against this backdrop, the cost of misalignment is high. To keep up with the increasing complexities of mixed model manufacturing, automakers must be able to adapt with speed while minimizing downtime, estimated to cost $50,000 per minute[1]. Every hour of hesitation or infrastructure constraint becomes a financial risk. The emergence of new technologies in automation and forecasting, such as gigacasting, modular production islands, and digital twins, deliver newfound agility to the automotive manufacturing process. Leading automakers now deploy digital twins directly on the factory floor[2] to support rapid adjustment. Given these trends, a plant's electrical infrastructure can either accelerate digital, flexible manufacturing, or be the bottleneck that holds it back.

As automakers prepare for the future of flexible model production and changing market demands, they should look to flexible electrical power and the versatility of their facility's infrastructure as a strategic asset. Electrical systems that can be reconfigured quickly, scaled easily, and deployed without disruption will be a make-or-break operational asset.

1. Average Cost of Downtime Per Industry https://www.pingdom.com/outages/average-cost-of-downtime-per-industry/

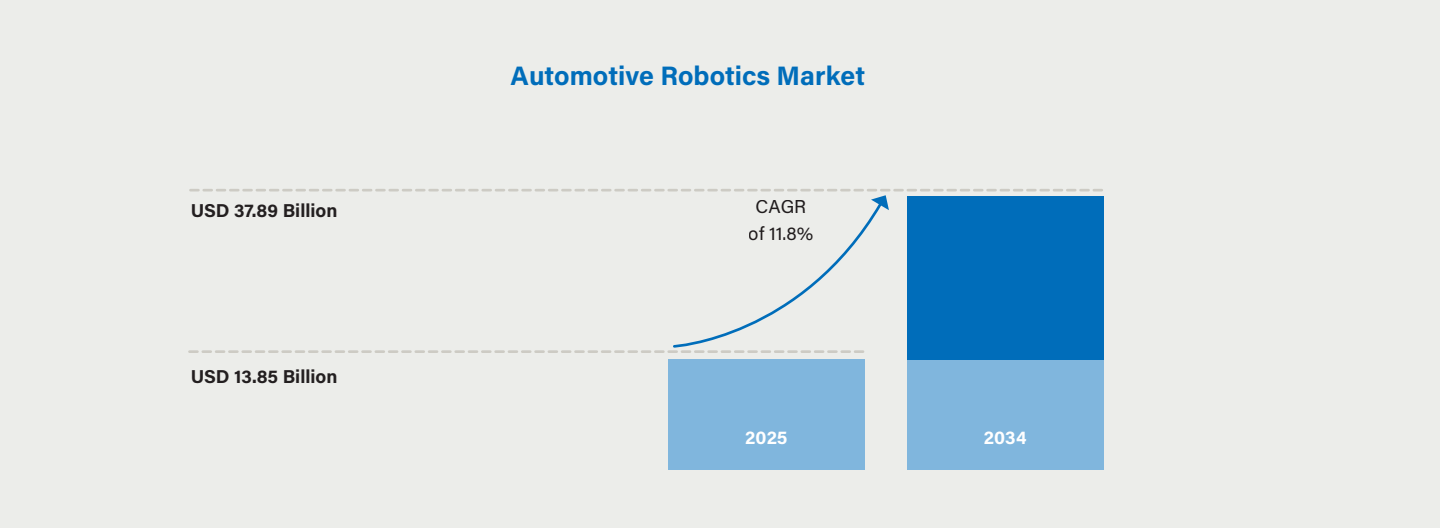
2. Digital Twins in the Automotive Industry Explained | S&P Global

TRENDS DRIVING THE NEED FOR FLEXIBLE MANUFACTURING

Though integration of automation and robotic technology is not new to the automotive industry, several factors are fueling increased adoption, including:

- Labor shortages
- Reduced cycle times
- Global adoption of EVs and autonomous driving technologies
- Advancements in AI and machine learning
- Data processing

Rising manufacturing complexity and the push for greater throughput has automakers prioritizing the productivity and precision delivered by automation technology. Current estimates forecast the U.S. automotive robotic market size to surpass $9 billion and the global market to exceed $37 billion by 2034.



Chart/data from: Automotive Robotics Market Size, Share & Forecast to 2034

As automakers adopt flexible manufacturing practices such as adjacent workstations for subassemblies, specialized robotics for chassis lines, and high-voltage testing for EV production, their factory layouts must also evolve. That not only means processes and reconfigured lines and cells, but also adaptable electrical infrastructure needed to power these evolving technologies.

THE ROLE ELECTRICAL POWER DISTRIBUTION PLAYS

Whether it's installing new equipment, rearranging work cells, or altering assembly layouts, facility operators need reliable, efficient access to power. Robots, AI vision systems, and EV production tools create increased power demand and require more robust electrical distribution. Plants producing both EVs and ICE vehicles must support new electrical equipment for battery assembly and high-voltage powertrains.

Plant electrical infrastructure not only needs to support flexible manufacturing, but also be a strong foundation for key objectives of the manufacturing process:

Enabling Agile Growth

- Integration of new robotics, automated guided vehicles (AGVs), and automation technologies
- Delivering capacity for higher power densities and facility expansions
- Supporting rapid workstation and equipment relocation

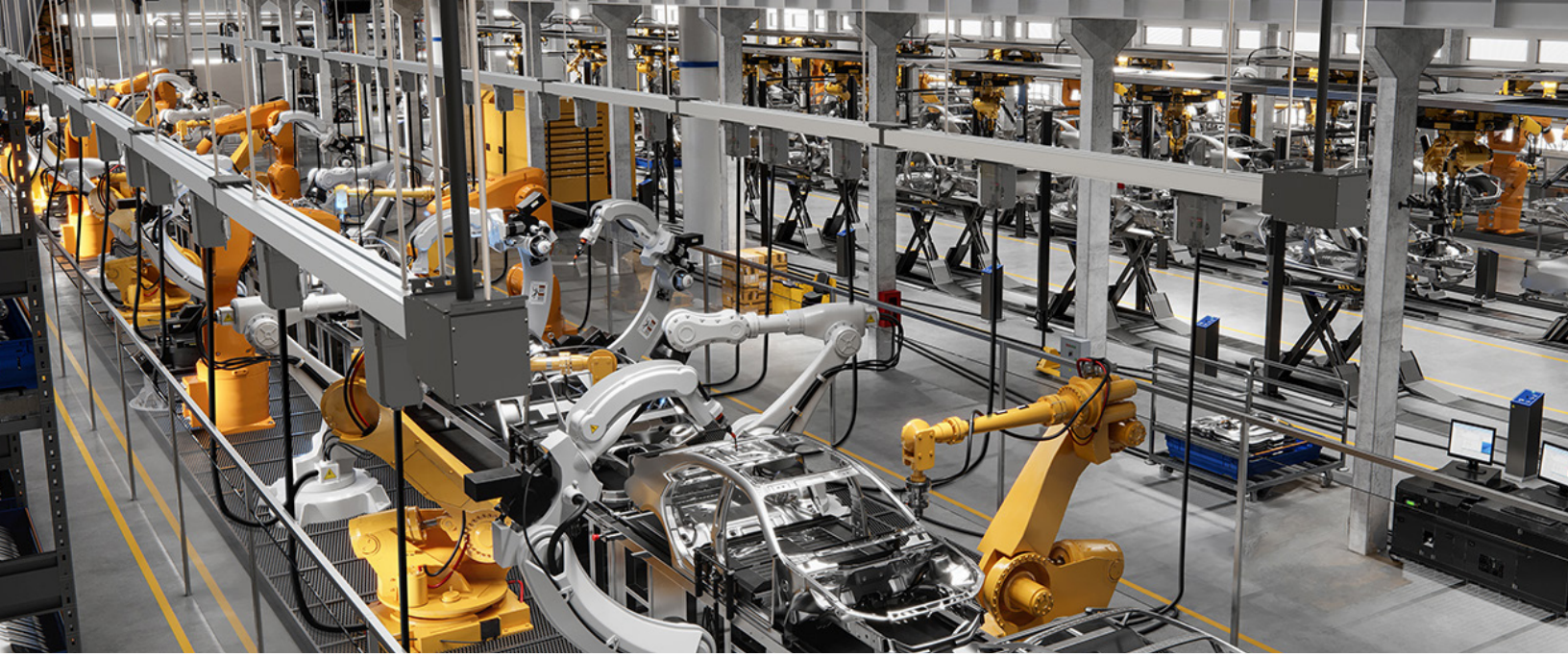
Increasing Uptime

- Reducing time required for model changeover
- Simplifying retooling and subassembly work cell creation
- Reducing operational risk and improving safety for workers and equipment

Powering Operational Visibility

- IoT-enabled condition monitoring to detect operational anomalies
- Machine Learning systems for monitoring failure risks
- Smart Factory AI platforms for scheduling and root-cause detection

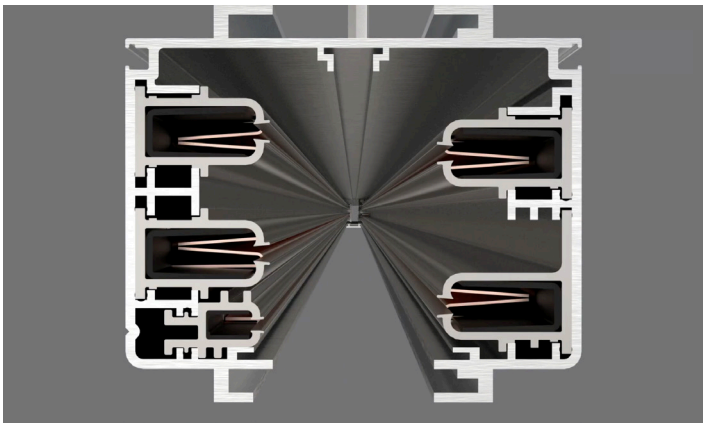
Without flexible electrical infrastructure, incorporating new technologies or adjusting processes for flexible manufacturing models often requires electrical modifications to increase power densities and circuit access. Often these multi-week projects require additional materials, request for proposal development, management approvals, and lost productivity, becoming a financial and operational drain for facilities with legacy power distribution systems like pipe and wire.



ENABLING MODULAR & RECONFIGURABLE PRODUCTION LINES

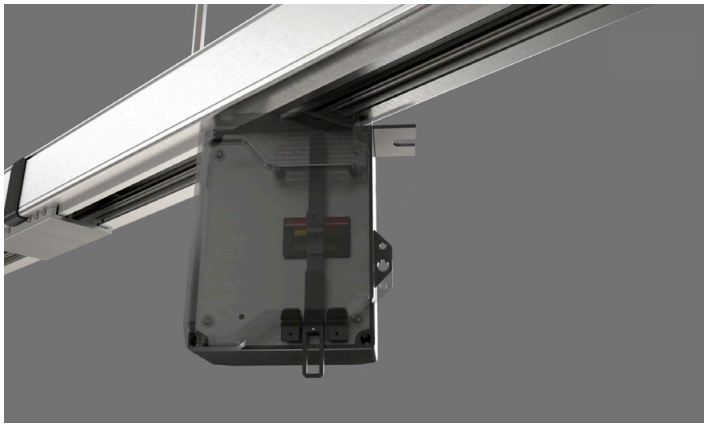
Modular busway electrical systems eliminate the constraints of pipe and wire by delivering open channel access to power. Instead of fixed circuits hardwired in place, floor power distribution units, or hazardous extension cords, busway enables power access directly overhead. Busway's open channel design allows automakers to make quick adjustments to their electrical infrastructure as production layouts and technology evolve. Busway also frees up valuable floor space and increases safety on the plant floor.

WHAT IS BUSWAY?



Open Channel Design

Busway's continuous system design and plug-in units act as panelboards spread throughout facilities, delivering power at the point of use. Plugs can be inserted inside the channel wherever electrical connections are needed.

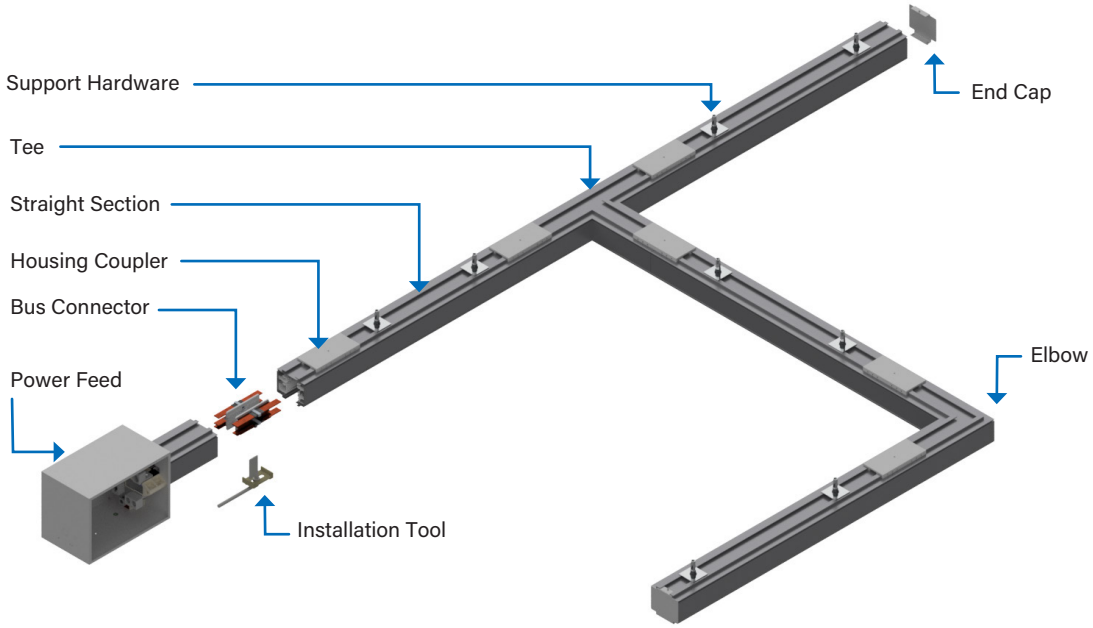


Localized Power Access

Plugs are customized to meet the needs of each facility, with outlets, cord reels, drop cords, power monitoring, and circuit protection.

MODULAR POWER INFRASTRUCTURE

Busway's flexibility comes from its modular, adaptable design. Systems are made with a combination of feeds, straight sections, elbows, and tees, allowing manufacturers to create a customized grid over their factory floor. Additional sections can be added to expand power access without disrupting surrounding operations. Plug-in units inserted along the channel are engineered to order with the receptacles and circuit protection that fit the needs of each area of the manufacturing floor.



Customizable plug-in units deliver power and circuit protection directly at the point of use.

Track busway systems provide fast, safe power relocation without long conduit runs or line shutdowns, converting electrical infrastructure from a potential bottleneck into a strategic asset supporting rapid model changeovers.

MODULAR VS RIGID ELECTRICAL SYSTEMS

Pipe and wire systems present several inherent disadvantages for flexible manufacturing processes, including:

- **Time-Consuming Modifications,** resulting in extended downtime and limited ROI.
- **Lack of Flexibility,** making it challenging to integrate smart manufacturing technology.
- **Rigid Designs** that limit modular manufacturing strategies and hinder the ability to adapt lines for mixed-model production.

SYSTEM DESIGN

With pipe and wire systems, multiple conduit runs must be routed back to panelboards across the facility. Individual runs require electricians to bend tubing, pull wires, hardwire junction boxes, and ensure proper labeling back to panelboards for safety. Modular busway places electrical access including circuit protection directly at the point of use. This not only simplifies changes, but increases operational safety and reduces the amount of labor required to modify a plant's electrical system.

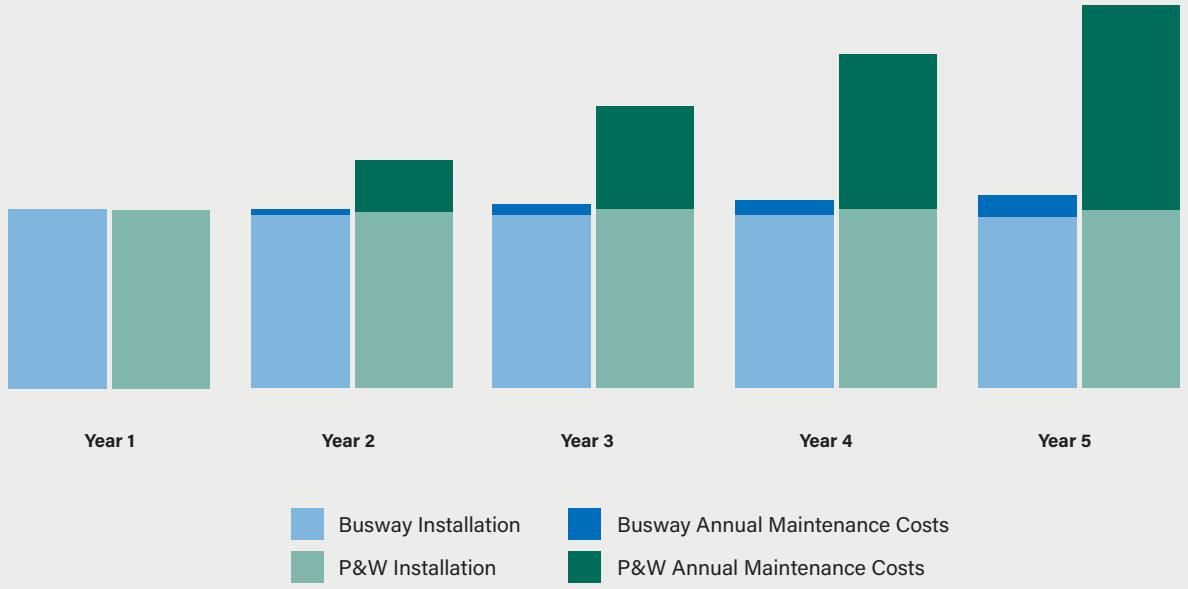
Multiple runs of conduit overlayed and hardwired to a factory ceiling

Continuous open-channel busway with easily modified circuits

SYSTEM INSTALLATION & TCO

Traditional conduit and wiring systems have a low cost for materials, but high labor costs during installation. With busway systems, initial material costs are higher, but installation is faster, reducing labor costs. Ultimately, the different labor requirements make Day 1 installation costs for both systems almost equal. In this installation example, the total cost of ownership (TCO) of a pipe and wire system rises steadily over five years due to labor expenses for relocating circuits. With busway, the ability to relocate circuits by moving plug-in units eliminates labor costs, which results in a lower TCO over time.

Example of 5 Year Cumulative Total Cost of Ownership for Open-Channel Busway vs. Pipe and Wire (P&W)



MEETING THE ENERGY DEMANDS OF MIXED-MODEL MANUFACTURING

Automotive model changeovers have become faster, more frequent, and more complex as plants shift toward mixed-model production, where EVs, hybrids, and ICE vehicles share the same assembly line. To support flexible production models, automakers need to reconfigure workstations, robotics, and testing equipment with unprecedented regularity.

Traditional fixed conduit slows these changes, creating costly downtime and obstructing new process adoption. Mixed-model environments, already challenged by high variation and the need for rapid changeovers, require power infrastructure that can adapt just as quickly.

Flexible busway systems address these challenges by providing plug-and-play power drops that scale with EV-heavy tooling or contract when ICE or hybrid volumes shift. This allows plants to integrate new EV processes, such as high-voltage tests or battery handling, into legacy lines without disrupting production.

For mixed-model production lines, busway's open access design helps automakers overcome operational challenges such as:

Flexible Equipment Locations

Changing equipment locations or rebalancing production lines to support shifts between EV and ICE models.

How: Plug-in units are hot-swappable, simplifying circuit relocation or additions without costly delays or rewiring.

Dynamic Power Needs

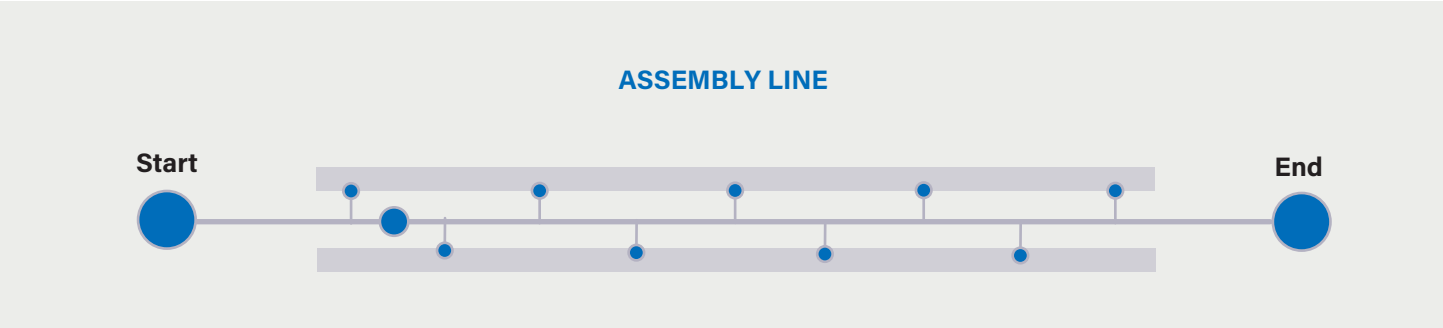
Different electrical loads for EV, ICE, or hybrid processes and increased power needs from automation tech and robotics.

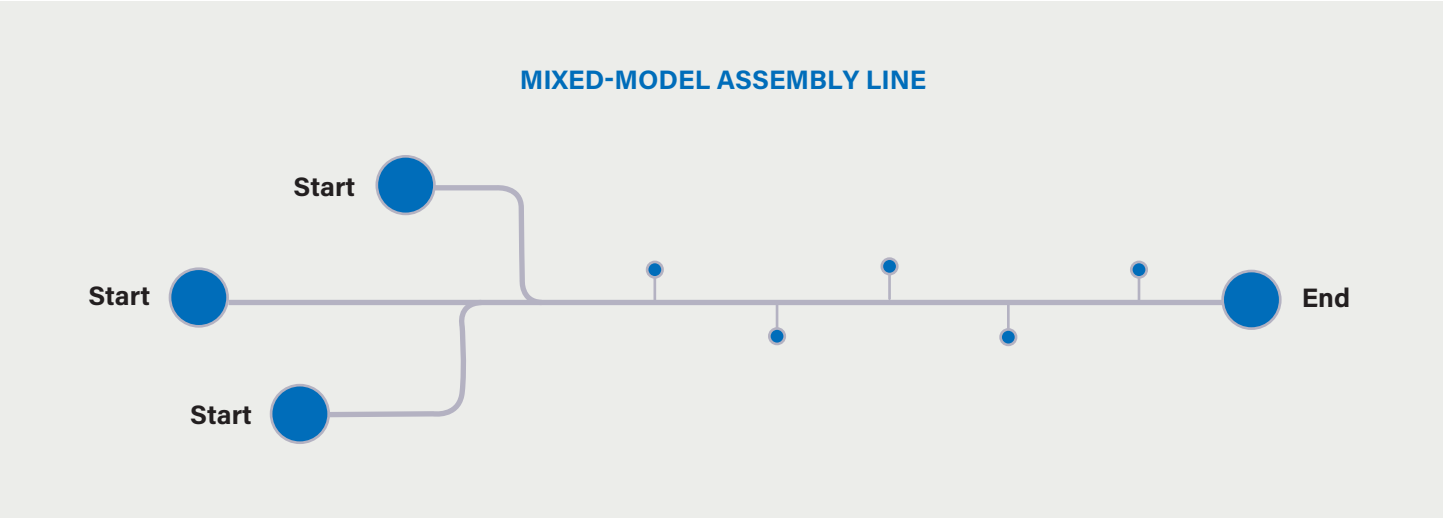
How: Busway systems range from 60-1200 amps and include increased ingress protection for areas exposed to liquids or dust.

Shared Workstations

Integration of new tooling and supporting shared workstations with diverse tasks.

How: Plug-in units can be customized with multiple outlets and tailored drop cord lengths to meet the unique needs of different workstations.





LOOKING TO THE FUTURE

As mixed-model manufacturing accelerates, automakers are adopting electrical systems that go beyond today's requirements, prioritizing flexibility to seamlessly handle production shifts across vehicle platforms. Modular busways enable plants to expand capacity or reconfigure layouts quickly as model mix and technologies evolve, while delivering higher power density that supports electrified manufacturing and the increasing digitization of production processes.

By utilizing busways, automakers position their plants to meet the demands of mixed-model manufacturing today while remaining ready for the energy challenges of tomorrow.

IMPROVING UPTIME AND POWER RELIABILITY

Modern automotive plans are continuously striving for higher reliability, smarter operations, and improved uptime. While AI-driven analytics, IIoT platforms, and environmental sensors all strengthen predictive maintenance (PdM) strategies, many automakers fail to consider the role power distribution plays in failure mitigation and downtime reduction.

Busway systems with integrated power monitoring capabilities do more than deliver power; they offer continuous visibility, enable faster response capabilities, and maximize uptime while reducing disruption.

Busways are designed to reduce downtime through:

Circuit-level Monitoring

Branch circuit level metering devices deliver real-time actionable data to PdMs. This level of granularity helps teams monitor equipment performance, identify irregularities early, and maintain optimal equipment operations on the factory floor.

Improved System Communication

Busway metering's extensive communication protocols simplify integration with facility BMS, including incorporating audible alarms and circuit breaker position sensing.

Localized Circuit Protection

Busways place circuit protection devices adjacent to equipment, instead of in distant electrical rooms, making it easier and faster to isolate circuits, manage shutoffs, or plan maintenance windows.

Feed Monitoring

Integrated temperature sensor technology and feed monitoring allow for easy visibility into system capacity and connection health. This continuous monitoring supports proactive management and helps ensure system stability.

THE RISE OF ON-PREMISES DATA CENTERS

As modern automotive plants evolve into highly digital, software-defined production environments, automakers are investing in on-prem data centers to support the speed, reliability, and security requirements of data-driven manufacturing. Unlike cloud infrastructure, on-prem and edge data centers deliver instantaneous local processing to prevent bottlenecks that could slow or stop manufacturing.

On-prem data centers also give automakers greater control over security, cost, and intellectual property, all of which are increasingly important as vehicle platforms become more intelligent. By bringing compute power to the factory floor, automakers can support advanced automation, predictive maintenance, and AI-enabled quality systems while maintaining full oversight of the infrastructure that keeps production running. For decades, modular busway systems have been the power infrastructure of choice for data centers around the world due to their reliability, scalability, and high ampacity capabilities.

CONCLUSION

In the era of flexible manufacturing where automakers must support mixed-model production, evolving automation technologies, and volatile market demands, power infrastructure has become an essential strategy for increasing manufacturing agility.

Busway is designed for adaptability, reducing downtime, and cutting total cost of ownership by enabling:

- Quick no-shutdown electrical reconfiguration.
- Plug-and-play power drops for new or replacement equipment.
- Versatile power access in high-automation environments.
- Localized circuit protection and power monitoring.
- Improved electrical safety and reliability.
- Rapid scaling and relocation of equipment.

As production demands continue to shift faster than traditional power infrastructure can adapt, manufacturers that modernize their electrical systems today will be the ones ready to respond and grow tomorrow. Investing in flexible power architecture isn't just an operational enhancement, it's a strategic advantage in the race toward future-ready manufacturing.

ABOUT STARLINE

Starline is a global leader in power distribution equipment. For more than 30 years, Starline Track Busway has provided data centers, manufacturers, and commercial buildings with the most flexible, reliable, and customizable overhead power distribution systems on the market. Starline's continuous innovation enables our products to handle the intensive requirements of automation technology and AI, all while minimizing downtime and supporting agile growth.

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