STORM POWER COMPONENTS

Applications Note

The Case for Longer Laminated Busbars: Why, Where and How to Manage Key Design Issues

Over more than 100 years since inception, busbars have become ubiquitous integral components in electrical distribution systems, evolving from simple copper rods to include advanced multi-layer, laminated structures spanning up to twenty feet and offering custom form factors to accommodate the diverse requirements of modern electrical systems.

The idea of busbars emerged with the advent of centralized power systems during the late 1800s. Early busbars were simply solid copper or iron rods or strips used to distribute power within switchgear or power plants. The term busbar likely derives as an abbreviation of the Latin word "omnibus," meaning "for all" because a busbar serves as a central point for distributing electrical power to multiple circuits.

Some of the key milestones in busbar evolution include:

Early 1900s

- **Industrial Power Needs:** As industrial plants and urban areas grew, the need for reliable and scalable power distribution systems increased. Early busbars were used in open configurations, mounted on insulators to distribute power within large switchboards.
- **Material Choices:** Copper became the material of choice due to its excellent conductivity, though aluminum later emerged as a lighter, cost-effective alternative.
- **Insulation Advances:** Initially, busbars were exposed, leading to safety concerns. By the mid-20th century, insulation techniques (e.g., rubber coatings, varnish) improved safety and reliability.

1950s-1980s: Laminated Busbars and Compact Systems

- **Emergence of Laminated Busbars:** The concept of laminated busbars was introduced in the mid-20th century to address problems of electrical noise, inductance, and compactness. Layers of conductive material were separated by insulation and laminated to reduce inductance and EMI.
- **Applications in Electronics:** Laminated busbars found applications in compact electrical devices, high-power inverters, and industrial machinery where space was at a premium.
- **Thermal Management:** As electrical systems grew more powerful, managing heat dissipation became a key design focus.

Applications Note:
Creating Longer Laminated Busbars

1990s: Modular and Configurable Busbars

- **Customization for Industries:** Sectors like telecommunications, renewable energy, and data centers demanded modular, configurable busbar systems tailored to specific applications.
- **Advances in Insulation:** Polymeric materials like Mylar, Kapton, and epoxy composites improved insulation performance and reliability in harsh environments.
- **Computer-Aided Design:** The adoption of CAD tools allowed engineers to model complex busbar geometries, for optimizing electrical performance and manufacturability.

2000s-Present: Long and Configurable Busbars

With the rise of new applications, extended-length busbars became necessary to distribute power efficiently across vast distances.

Key Drivers for Long Busbars:

- **Renewable Energy:** Long busbars are essential for connecting solar farms and wind turbines spread over large areas.
- **Data Centers:** High-current busbars power server racks across expansive facilities.
- **Transportation:** Electric buses, rail systems, and ships need long, continuous power distribution systems.

Manufacturing Improvements:

- **Advanced Lamination Techniques:** High-precision lamination processes ensure consistent quality across long spans.
- **Segmented Designs:** Modular segments with interconnects to simplify transportation, installation, and maintenance.

Design Considerations and Technological Issues for Long Laminated Busbars

Laminated busbars consist of layers of conductive material, typically copper or aluminum, separated by thin dielectric film for insulating layers. The layers are then bonded together using heat and pressure to form a single, flat, and rigid conductor.

The laminated structure provides excellent thermal and electrical performance and allows for custom shapes and sizes to be easily produced, as well as enabling vertical integration of various components as part of the busbar assembly.

Storm Power leads the industry in advanced design and production of laminated busbars, which can be of benefit for optimizing weight vs performance in a number of ways. By combining the busbar and associated cabling, components etc. into a single pre-assembled compact structure, laminated busbars can minimize size and weight while reducing overall heat dissipation.

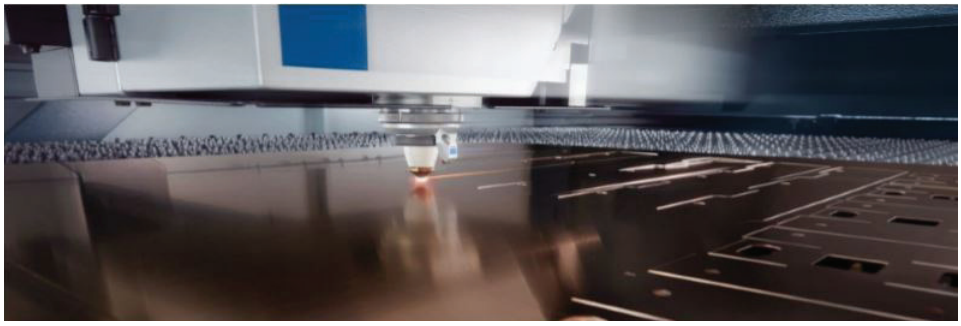
These complex laminated busbars are commonly used in power distribution systems for EV power modules, switchgear, transformers, and other high-power equipment.

Applications Note:
Creating Longer Laminated Busbars

Storm Power is the industry leader when it comes to designing and manufacturing longer laminated busbars. Some of the key technology areas that enable Storm's unique capabilities for producing custom laminated busbars of 20 feet or more include:

- **Materials Technology:** Development of high-conductivity copper alloys and lightweight aluminum composites has reduced resistive losses and overall weight.
- **Lamination Improvements:** Uniform adhesive distribution and precision pressing enable the production of consistent, reliable busbars up to 20 feet or more.
- **Thermal and Electrical Modeling:** Simulation tools allow Storm Power engineers to predict and mitigate heat buildup, voltage drops, and inductance over long spans.
- **Precision CNC Machining:** Turning and milling with multi-axis capabilities provides versatility for producing an endless array of copper or aluminum fabrications with tolerances as close as .001".
- **Press/Fused Welding:** This manufacturing technique heats and squeezes individual copper laminates into a nearly solid copper bar state. Using copper sheets in varying sizes from 0.003" to 0.045" thickness positioned between heated graphite blocks, the process uses tonnage to press sheets together, creating a tight bond.

Storm Power also has one of the largest cutting beds in manufacturing today. Our custom built bed can handle parts up to 20 feet in overall length. Coupling that with 6,000 watts of cutting power, makes our laser a one-of-a-kind solution for fabricating large, precision busbars.



Summary

At Storm Power Components, our engineering teams have decades of experience with designing complex busbars that have proven reliable in the most demanding of deployments. This is because we always start with the end goal of the system in mind and then bring our knowledge, experience, and creativity together in a holistic manner to achieve those goals, including when it comes to fabricating and delivering the largest laminated busbars in the world, as well as some of the most complex and compact designs.