





CONTENT

PREFACE	4
THAT'S US	6
THIS IS HOW WE HAVE LEARNED	8
FOLLOWING OUR VISION	10
RESULTING IN THESE SOLUTIONS	12
BATTERY CELL	14
BATTERY MANAGEMENT	20
FUEL CELL	24
SHAPING A FUTURE WORTH LIVING	28
MÜHLBAUER SOFTWARE	30
MÜHLBAUER eMOBILITY BRANCHES	32
MB ATECH	34



PREFACE

It's about our future! That is why the topic sustainability becomes increasingly important – for us as a company and employer, but also for our markets and the whole world. From the very beginning, the Mühlbauer Group has been committed to sustainability. Our corporate strategy is based on combining economic necessity, ecological reason and social responsibility in all processes and decisions to create a solid foundation that our customers, business partners and over 4000 employees can rely on at all times. This is also testified by the exceptionally high level of vertical integration, which guarantees short distances, fast delivery times, and the highest quality and makes us unique on the world market.

With our highly competent employees and 40 locations worldwide, we are world market leader in many of our markets and, every day, we work hard to further develop our technologies and meet tomorrow's needs.

In a world in which the speed of innovation is higher than ever before and changes are an essential part of everyday life, the values reliability, speed and entrepreneurial responsibility have become even more relevant.

Our dedicated employees, as well as all the people around the globe who trust in our technologies are our key to success. We are all the more aware of our responsibility to society. When dealing with innovations, especially in the digital domain, the focus must not be on short-term profit maximization; our goal must be to use the latest technologies to make our lives more sustainable – and we look forward to continuing to go this course together with our employees, customers and business partners.

Josef Mühlbauer

RESPONSIBILITY



THAT'S US

At Mühlbauer, we care about eMobility as an important contribution to the worldwide decarbonization strategies. eMobility represents clean and efficient transport, using electric vehicles powered by batteries or hydrogen fuel cells. We will support the growth of these technologies by providing the most advanced production equipment & turnkey assembly solutions for fuel cells, battery cells and battery management systems. Mühlbauer Group is one of the most advanced equipment suppliers in the world. Throughout the years since 1981 we have developed the Group to become market leader

for the production & personalization of smart cards and passports. With continuous passion we are serving 90% of the worldwide RFID market with our high speed bonders and have achieved market leadership in the semiconductor industry with our unique die sorting technology. As a combination of mentioned unique technical competencies, IP's and with the strong support of Mühlbauer Parts & Systems production for rapid prototyping, we have all that is needed to repeat our achievements from other segments in the eMobility industry.

» eMOBILITY FACES A LARGE DEMAND FOR PRODUCTION SCALE-UP AND HAS NO TIME TO LOSE. «

ON THE MOVE



THIS IS HOW WE HAVE LEARNED

How does a new market fit together with far-reaching expertise? Mühlbauer does not start from zero. Our company and all its competencies have their origins in parts manufacturing. Today, our **in-house parts production** facility is our guarantor for rapid prototyping, high-quality and high-precision machine parts – independent of external changes and fluctuations.

A challenging task in the battery and fuel cell sector is the particularly **precise and fast handling of sensitive materials**. Such competence is not developed overnight, but requires years of testing, trial and error, and readjustment. For our new eMobility equipment portfolio, we were able to take over the technologies and experience of our market-leading die sorting machine, which is capable to place over 50,000 dies per hour, having full six side and IR vision inspection.

Our **vision technology**, refined over the decades, also serves us in battery and fuel cell manufacturing for accurate inspection and monitoring of the intermediate or final product. Our custom-developed software has accompanied our equipment for almost 20 years, creating connections, insights into production data, and opportunities for optimization. “Everything from a single source” is not an empty slogan at Mühlbauer, but clearly shows how well hardware and software can harmonize with each other when they are developed in parallel and coordinated.

This wide-ranging know-how and much more acquired skills enabled Mühlbauer to enter the eMobility market successfully. Our costumers can rely on **over 43 years of experience** and a well organized team of experts and smart minds with innovative ideas and the willingness to change the world.



ROTARY PLACEMENT TECHNOLOGY



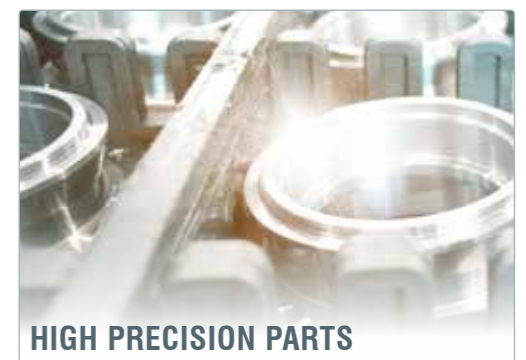
REEL-TO-REEL, REEL-TO-SHEET



UNIQUE VISION INSPECTION

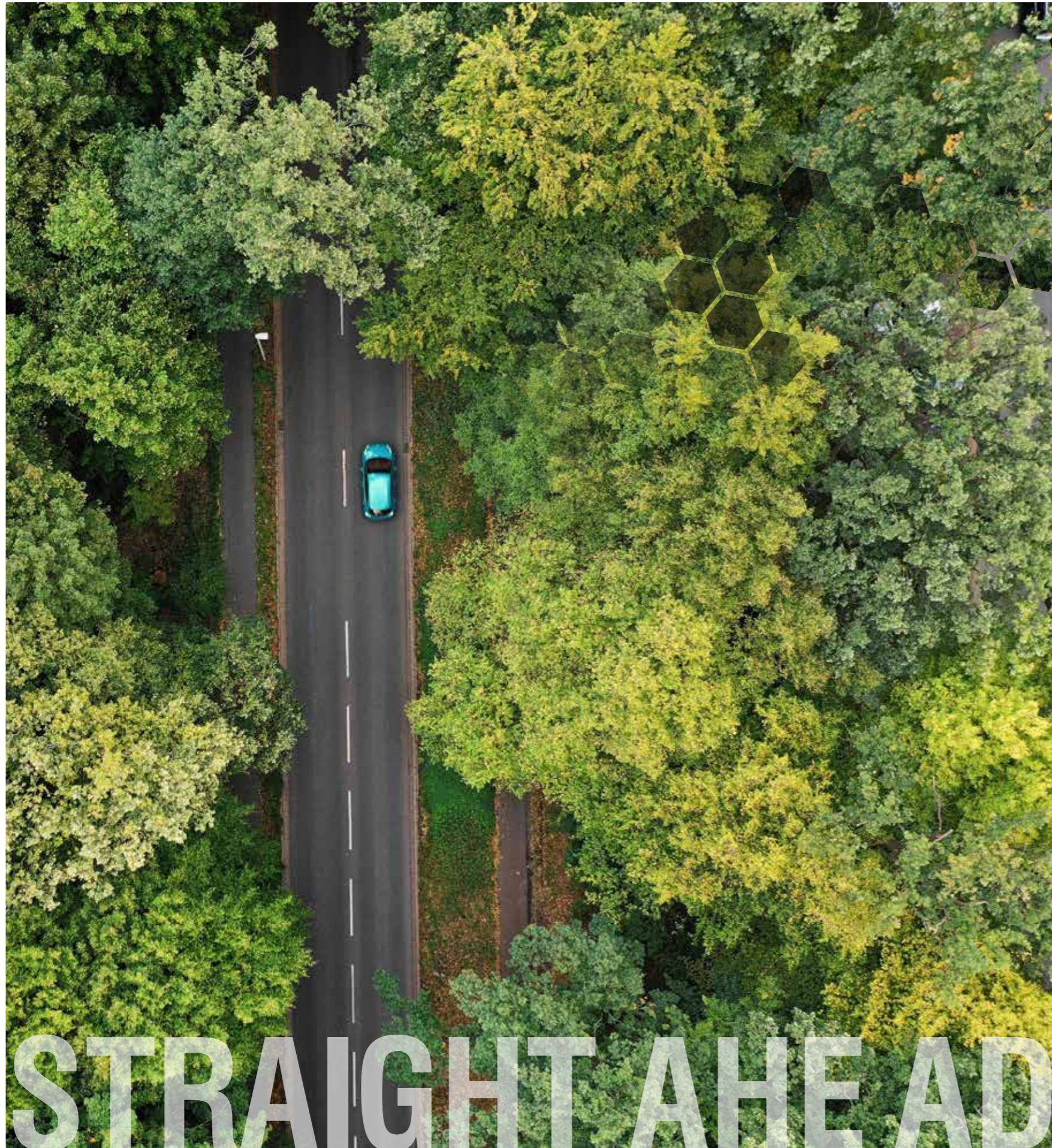


CUSTOMIZED SOFTWARE

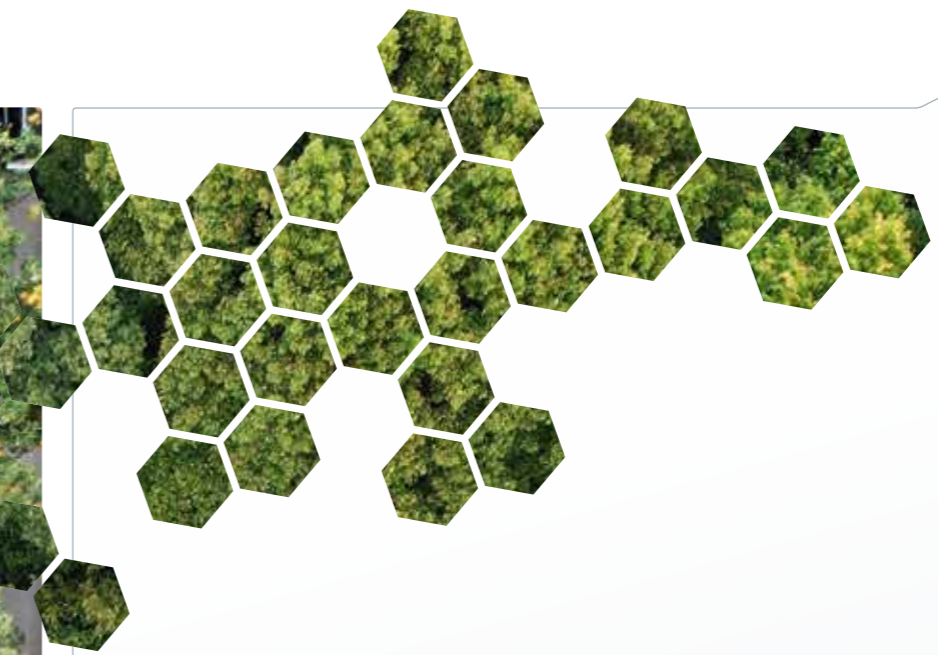


HIGH PRECISION PARTS





STRAIGHT AHEAD



FOLLOWING OUR VISION

The future is electric, and Mühlbauer eMobility is ready to take you there.

Over four decades of technology pioneering, our passion has never faltered. We are already transforming the eMobility industry with our manufacturing solutions for battery management systems, battery cell assembly and fuel cell technology.

Our mission is to provide better quality products with shorter charging time, cells that can power cars over even longer distances and sustainable, eco-friendly engineering – from the manufacturing phase through to the end user and the recycling of components after they have exceeded their service life. Performance that creates perfection – this is what Mühlbauer strives for.



RESULTING IN THESE SOLUTIONS

Mühlbauer developed state-of-the art solutions for 3 eMobility sectors:

Our **Battery Cell Assembly Line** offers customized solutions for the production of battery cells, covering processes from notching over stacking and cell assembly, including X-ray and/or CT quality checks. Its modular concept allows the flexibility to perfectly adapt to the specific cell assembly requirements, e.g. to run as standalone module or as fully automated unit. Our equipment covers pilot production and is scalable up to GIGA capacity solutions.

A Battery Management System (BMS) controls, regulates and monitors cell connecting boards, reports measures and problems, thus protecting the battery against irregular

operating conditions. Our Mühlbauer **Battery Management Assembly Line** fully automatically installs electrical contacts on boards and cells to connect both with each other, enabling the BMS to manage the battery cell. Our line is designed for high scale automotive production capacities.

Our first-of-its-kind **Membrane Electrode Assembly Line with Fuel Cell Stacking Module** and testing unit covers the precise lamination of a specific number of cell layers, including frames, membrane and electrodes with highest precision. Output of the MEA line is a fully completed MEA as defined by product specifications. The fuel cell equipment is designed for high capacity fuel cell system manufacturing with customized product design.

» Ready for Industry 4.0 – we are! «



KEY BENEFITS



ALL IN-HOUSE PRODUCTION

- Mühlbauer Parts & Systems
- Rapid prototyping
- > 700 R&D engineers
- Worldwide footprint – eMobility centers located in Europe



UNIQUE VISION

- Total stack accuracy +/- 100 μm
- Particle detection on electrodes down to 20 μm
- “On the fly” vision inspection



GIGA GROWTH

- 3 new eMobility centers in EU
 - » Roding, Germany
 - » Nitra, Slovakia
 - » Stara Pazova, Serbia
- Clean & Dry rooms – for testing and sample production



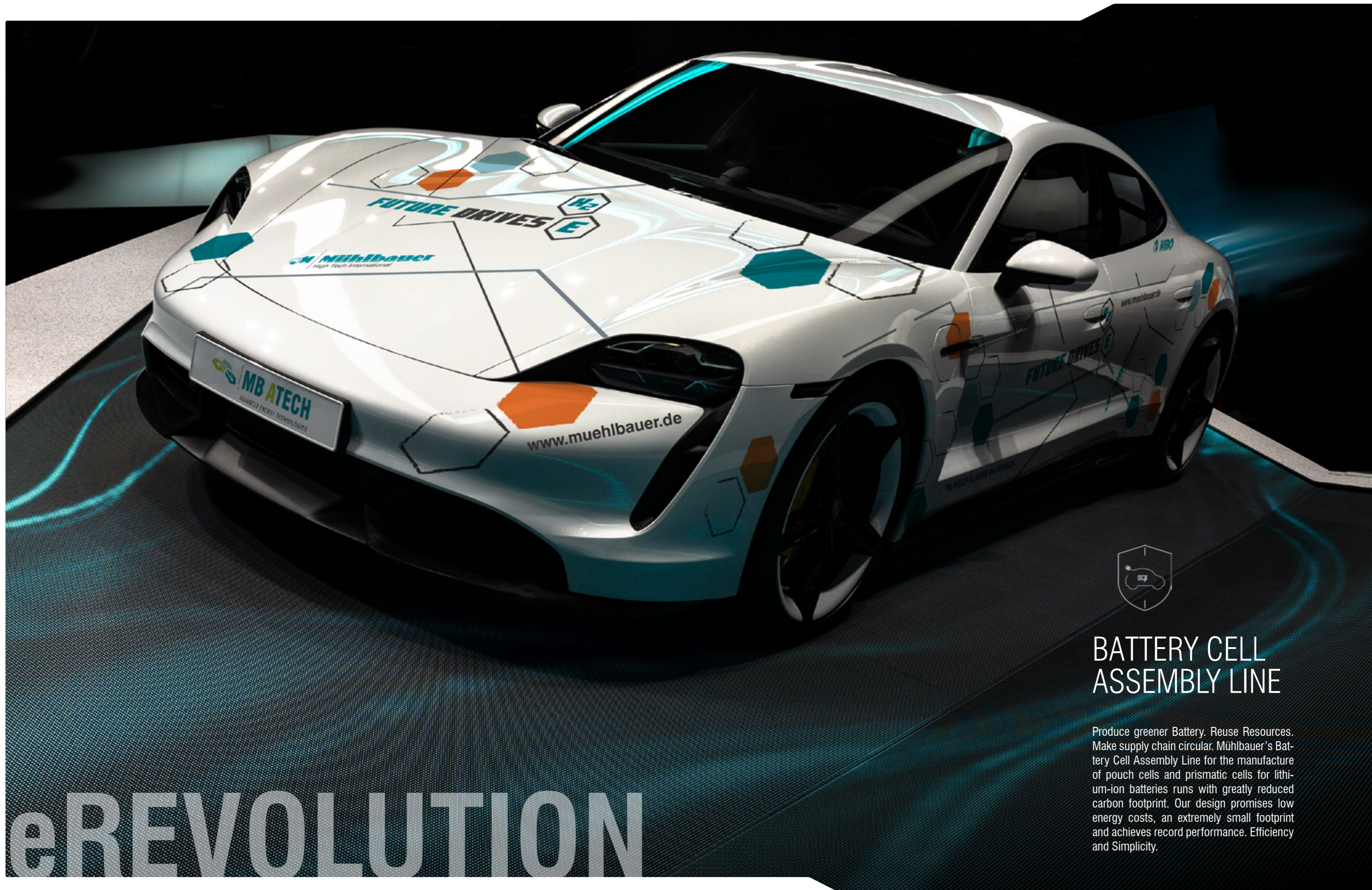
SERVICE

- 24h/7 hotline & remote service
- Full service & spare parts for machine's lifetime
- More than 40 service locations worldwide



INDUSTRY 4.0

- MB PALAMAX® software – Industry 4.0
- Digital solutions for smart factory
- 100% traceability including vision data from each process step



BATTERY CELL ASSEMBLY LINE

Produce greener Battery. Reuse Resources. Make supply chain circular. Mühlbauer's Battery Cell Assembly Line for the manufacture of pouch cells and prismatic cells for lithium-ion batteries runs with greatly reduced carbon footprint. Our design promises low energy costs, an extremely small footprint and achieves record performance. Efficiency and Simplicity.

eREVOLUTION



BATTERY CELL

Battery Cells are mainly produced in three types: Cylindrical Cells – manufactured by winding the electrode sheets and separators, Prismatic and Pouch Cells – mostly produced by stacking the electrode sheets

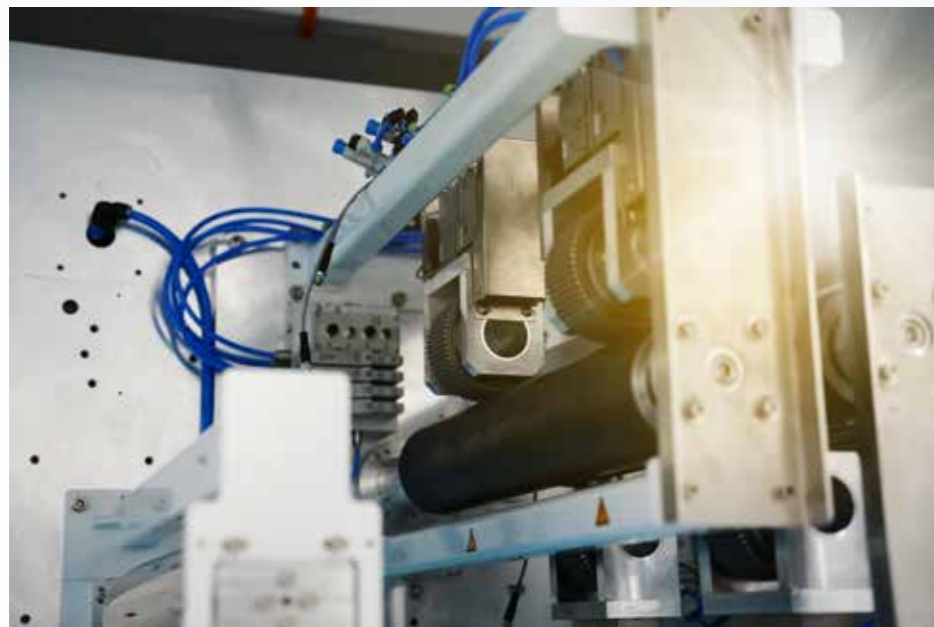
and separators. In the eMobility market, the most promising developments focus on Prismatic and Pouch Cells, also called Stacked Cells – the future of the industry.

NOTCHING EXCELLENCE

Notching is a crucial **roll-to-roll** process for converting battery foils. This process involves two key stages: a **shear slitting system** that divides the battery foil into distinct lanes and a **laser cutting station** that precisely shapes the foil, including the addition of tabs. Mühlbauer's notching system is equipped with a specialized web handling mechanism designed to effectively manage challenging webs, simplifying the conversion process. This mechanism includes

various **controlled web tension zones, web guiding systems** utilizing steering frames, and movable Un-/Rewinders that ensure the optimal web position for achieving high-precision conversion.

Operating at high linear speeds of **up to 180 m/min**, Mühlbauer's system features **auto-splice** capabilities on Un- and Rewinders, facilitating swift roll changeovers with minimal downtime.



MÜHLBAUER BATTERY CELL STACKING SOLUTION

Mühlbauer developed an outstanding Stacking Solution, which combines high speed and high precision in one line – scalable to GIGA capacity solutions!

Our stacking solution is able to incorporate two stacking heads with total throughput of up to 10 sheets/sec. Mühlbauer stacker support Z-folding stacking & single sheet stacking with pre-laminated separator. Additionally, Mühlbauer is prepared for next generation technologies with our development turnkey solution for Li-metal and Solid-state batteries.

Machine advantage is a very high precision placement with a **total stack accuracy of +/- 100 µm**. Vision systems are integrated into each process step, special **top and bottom particle detection on electrodes** are integrated before and after cutting, to ensure no particles follow to stacking process.

Early rejects are included at each process station after vision detection. The footprint makes a huge difference, and our focus during development has been targeted towards footprint savings.

GIGASCALE MANUFACTURING

With a focus on innovation and sustainability, we have revealed our inaugural ATECH giga center on July 8, 2023, serving as a hub for innovative ideas to come to life. Encompassing 20 acres of land, our Giga factory showcases efficiency and scale, establishing a new benchmark within the industry.

This expansion includes a dedicated dry room, where our battery cell assembly lines operate under precise conditions to ensure optimal performance, maintaining strict control over humidity and temperature. At the core of our operations is Advanced Automation, where precision and productivity converge on our battery cell assembly line. The Giga plant has the potential to revolutionize various industries, from electric vehicles to sustainable energy solutions.

**“It’s not just about what we make;
it’s about how we make it.”**

We prioritize maximizing our global impact while minimizing our environmental footprint through the utilization of renewable energy sources and the implementation of eco-friendly practices. Mühlbauer is broadening its horizons by establishing a new production site in Slovakia (Nitra) and Serbia (Stara Pazova).





BATTERY MANAGEMENT SYSTEM

The Battery Management System (BMS) plays a crucial role for electric vehicles. It manages the entire operating cycle of EVs and ensures battery system safety, temperature control, charge balance, and more. The BMS can perform a variety of functions depending on the application.



KEEPING PERSPECTIVE



BATTERY MANAGEMENT SYSTEM

The Mühlbauer Group offers fully automated battery management system equipments for production of cell connecting boards. Our line is designed for high scale automotive production capacities and covers process steps from parts assembly over connector placement to final testing. Our modular concept consists of four assembly lines, which are also available as stand-alone modules, and is compliant with PHEV and EV sizes.



Based in Nitra, Slovakia



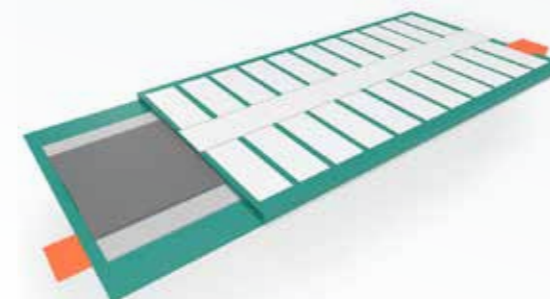
MÜHLBAUER BATTERY MANAGEMENT SYSTEM ASSEMBLY LINE

Our high speed BMS Assembly Line manufactures the control boards, which are mounted on top of the battery cells, thus creating an electrical connection between board and cell. MB cell connecting board assembly line includes parts assembly, contact placement, connection of the contacts via a specific substrate, and final testing per specification for electrical performance and quality. The customizable modules of our BMS Assembly Line can be configured as

semi-automated or fully automated systems, flexibly tailored to product requirements. Our unique serial production solution promises high speed, impressive accuracy and high flexibility.

- Line consist of:
 - » Pre-assembly line
 - » Frame assembly line
 - » Final assembly line
 - » Test line

TURNKEY BMS SOLUTIONS



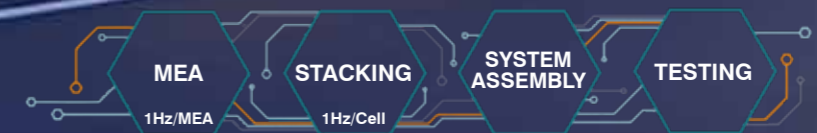


FUEL CELL

Mühlbauer sees great opportunities for eMobility by using fuel cells to decarbonize heavy-duty transport infrastructures such as trucks, ships, trains and passenger cars that need to maintain long-distance capability. For this reason, the automation of fuel cell production lines is one of the most important areas of development at Mühlbauer.

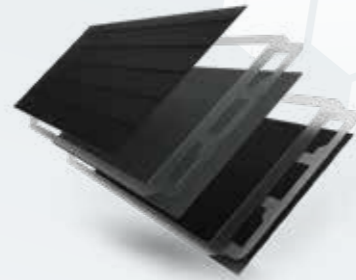


NO LIMITS





FUEL CELL



MEA INTEGRATED PRODUCTION PROCESS



MB MEA LINE

MÜHLBAUER MEMBRANE ELECTRODE ASSEMBLY LINE

The Mühlbauer fuel cell portfolio consist of first-of-its-kind fully automated MEA production line, fuel cell stacking line and testing. The fuel cell equipment is designed for high capacity fuel cell system manufacturing with customized product design. The MEA line covers the precise lamination of a specific number of layers, including frames, membranes and electrodes with highest precision. Output of the line is a fully completed MEA as defined by product specifications. Mühlbauer's MEA line has been developed for high speed & accuracy manufacturing, reaching **speed of up to 20 m/min & alignment accuracy of 100 µm**. Mühlbauer systems are also capable of high scale electrolyzer manufacturing.

MÜHLBAUER STACKING MODULE

Our Fuel Cell Equipment is designed for high capacity fuel cell system manufacturing with customized product design. The stacking system has multiple configurations with the possibility of high automation or semi-automated process steps, covering stacks for a variety of industries, including automotive, aviation, energy storage and marine applications.

The stacker consists of customized magazines for BPP & MEA as input materials and pick & place heads in order to ensure that each head is picking always the same product. This is needed to maintain the proper configuration, while materials significantly differ in behavior.

During the transport to the place position, automatic "MB on the Fly" inspection is performed, which corrects the final placement position in x & y & theta directions without stopping the movement.

Our stacking station guarantees:

- Total stack accuracy of +/- 100 µm
- Cycle time of 0,5 sec per MEA resp. BPP

After each placement, post-placement inspection will be performed to ensure that total accuracy is maintained. With cutting-edge technology and unrivaled precision, Muehlbauer's ZSW stackers redefine the assembly process, setting a new benchmark for productivity in the industry.



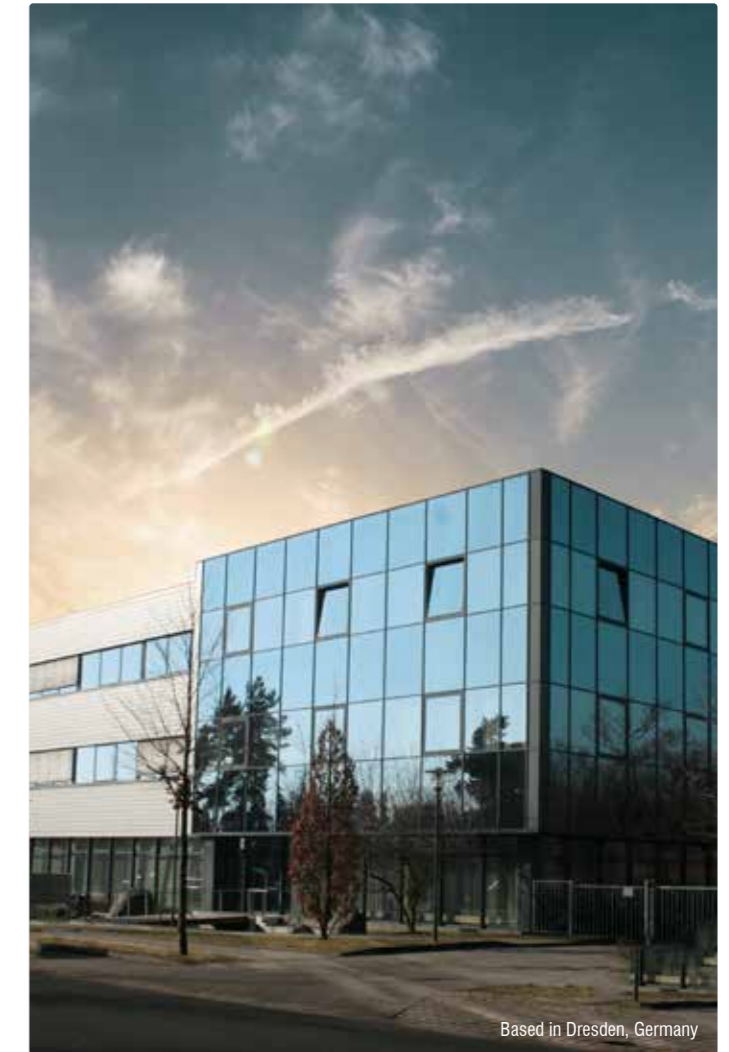
TURNKEY EQUIPMENT SOLUTIONS

1Hz Line Balance

→ over 60.000 Stacks / Year

Assumptions: 1Hz | OEE 85% | 3 shifts | 7,5 hour | 209 days

→ ca. 20 Mio Cells / Year (320 Cells / Stack)



Based in Dresden, Germany



Production of ZSW Stacker



SHAPING A FUTURE WORTH LIVING

We have to find a balance between using and generating resources. Mühlbauer deals consciously with raw materials and permanently compares energy consumption with the resulting benefit for people. The goal is to keep CO₂ emissions as low as possible and ultimately reduce them to zero – with the most innovative technologies of the future.

Intelligent networking of machines and processes. Mühlbauer lives Industry 4.0!





SOFTWARE

MB PALAMAX® & MB VISION 100% TRACEABILITY & QUALITY

Our machines have a unique combination of vision systems communicating with MB PALAMAX® industry 4.0 traceability software. This combination ensures that each process performed by the machine is inspected and evaluated whether the process has been performed correctly or must be rejected. All performed processes, images, data, etc., are automatically communicated

with our MB PALAMAX® system, which evaluates the data and creates detailed reports, which can be customized towards the needs of operation management. MB PALAMAX® can be easily controlled via smartphone or tablet, which provides the perfect flexibility to manage your production from wherever you prefer.



PALAMAX.MONITOR



PALAMAX.STATS



PALAMAX.REMOTE



PALAMAX.TRACE



PALAMAX.MAINTAIN



PALAMAX.COST



PALAMAX.RECIPE



INDUSTRY 4.0 READY



eMOBILITY BRANCHES

» A RELIABLE PARTNER WORLDWIDE. «



EUROPEAN TECHNOLOGY
LEADERSHIP BY PERFORMANCE

INDUSTRY 4.0 READY

PRISMATIC AND POUCH CELL
ASSEMBLY LINES

100% PROCESS CONTROL AND TRACEABILITY

RECORD PERFORMANCE

LOW ENERGY COSTS

MORE THAN 42 YEARS OF EXPERIENCE

TURNKEY SOLUTION PROVIDER

PROCESS INSPECTION WITH X-RAY AND/OR CT

100% EU MANUFACTURING SUPPLY CHAIN

SMALL CARBON FOOTPRINT

INNOVATIVE BATTERY CELL
EQUIPMENT TECHNOLOGY

GIGA CAPACITY SOLUTIONS

RAPID PROTOTYPING
IN-HOUSE PRECISION PART PRODUCTION

UNIQUE HIGH-SPEED
STACKING TECHNOLOGY



MB ATECH



eMOBILITY TECHNOLOGY CENTERS

MÜHLBAUER GERMANY

Muehlbauer Group Headquarters
Josef-Muehlbauer-Platz 1, 93426 Roding, Germany
Phone: +49 9461 952 0, Fax: +49 9461 952 1101
info@muehlbauer.de, www.muehlbauer.de

MÜHLBAUER SLOVAKIA

Muehlbauer Technologies s.r.o.
Novozámocká 233, 94905 Nitra, Slovakia
Phone: +421 37 6946 000, Fax: +421 37 6946 501
info@muehlbauer.sk, www.muehlbauer.sk

MÜHLBAUER SERBIA

Muehlbauer Technologies d.o.o.
Evropska 17, 22300 Stara Pazova, Serbia
Phone: +381 22 215 5100, Fax: +381 22 215 5130
serbia@muehlbauer.de, www.muehlbauer.com

MÜHLBAUER USA

Muehlbauer Inc.
226 Pickett's Line
Newport News, VA 23603-1366, USA
Phone: +1 757 947 2820, Fax: +1 757 947 2930
info@muehlbauer.com, www.muehlbauer.com

eMOBILITY SERVICE HUBS

MÜHLBAUER MALAYSIA

MB Automation (Malaysia) Sdn. Bhd.
No. 3 Jalan TU 62, Taman Tasik Utama,
75450 Melaka, Malaysia
Phone: +60 6 2517 100, Fax: +60 6 2517 101
info@muehlbauer.com.my, www.muehlbauer.com.my

MÜHLBAUER CHINA

Muehlbauer Technologies (Wuxi) Co., Ltd.
No 23. Huayi Road, Wuxi New District
2141 Wuxi, Jiangsu, China
Phone: +86 510 8190 0100, Fax: +86 510 8190 0101
info@muehlbauer.cn, www.muehlbauer.cn



MB ATECH GmbH

Josef-Muehlbauer-Platz 1 | 93426 Roding | Germany
Tel.: +49 9461 952 0 | Fax: +49 9461 952 1101
Mail: emobility@muehlbauer.de | Web: www.muehlbauer.de