

KREISEL ELECTRIC RECEIVES THE 2023 ENABLING TECHNOLOGY LEADERSHIP AWARD

*Identified as best in class in the European
EV battery industry*



Best Practices Criteria for World-Class Performance

Frost & Sullivan applies a rigorous analytical process to evaluate multiple nominees for each award category before determining the final award recipient. The process involves a detailed evaluation of best practices criteria across two dimensions for each nominated company. Kreisel Electric excels in many of the criteria in the EV battery space.

AWARD CRITERIA	
<i>Technology Leverage</i>	<i>Customer Impact</i>
Commitment to Innovation	Price/Performance Value
Commitment to Creativity	Customer Purchase Experience
Stage Gate Efficiency	Customer Ownership Experience
Commercialization Success	Customer Service Experience
Application Diversity	Brand Equity

A Brief Overview of Europe’s EV Battery Market

Driven by government initiatives, consumer awareness, and demand, the EV market in Europe has grown tremendously in recent years. The EV market has reported an impressive growth trajectory following the introduction of stringent climate targets, laws for reducing carbon dioxide (CO2) emissions, and increasing reliance on green technologies. For instance, the European Union’s (EU-27) plan for the green transition, dubbed Fit for 55, incorporates various laws and provisions for EVs, such as ensuring all new cars and vans registered in Europe will be zero-emission by 2035 and reducing the CO2 emissions of all new cars to 55% and new vans to 50% by 2030.¹ These regulations are designed to incentivize the production and sale of EVs, in turn, drive demand for EV batteries. EU regulations regarding social and environmental risks and raw materials processing and trading in the EV battery industry further pave the way to driving innovation and investment in new battery technologies.

Frost & Sullivan’s research predicts that the prevalence of rigorous battery packaging standards will drive the adoption of superior battery technologies, such as high-end thermal management systems.² Kreisel Electric is a pioneer of state-of-the-art battery technology solutions with its patented immersion cooling architecture that provides the company with a competitive advantage in Europe’s EV battery industry. The company is revolutionizing the EV battery market by offering best-in-class battery safety, performance, and lifetime.

¹ https://ec.europa.eu/commission/presscorner/detail/en/ip_22_6462

² *Global Analysis of Electric Battery Market and Battery Thermal Management System for Electric and Hybrid Vehicles, Forecast to 2025* (Frost & Sullivan, Feb 2019)

Leveraging Advanced Immersion Cooling Technology to Enable Superior Battery Performance

Founded in 2014 and headquartered in Rainbach im Mühlkreis, Austria, Kreisel Electric (Kreisel) leverages the latest lithium-ion technology to develop superior battery products. Its proprietary 21700 battery architecture uses a patented “single cell fuse” technology that incorporates fuse geometries into the battery’s spring elements, enabling the release of any defective cells from the cell combination in rare cases when fault currents are too high. This feature ensures the battery remains resilient and high performing in all conditions.

The company also has a patented hollow block technology within the battery through a combination of material, geometry, and fluidic parameters that control the guidance of the non-conductive liquid to ensure that each cell operates under identical thermal conditions, optimizing the battery's performance. Also called immersion cooling, this unique technology allows for effective monitoring and regulation of the battery's temperature, reducing the risk of potential fire hazards resulting from uncontrolled temperatures.

Kreisel Electric’s 21700 Battery Architecture



The company’s battery technology is designed for longevity without compromising cost and offers superior thermal management, which ensures the batteries operate optimally by keeping temperatures within the ideal range. For instance, when charging and discharging at a C-rate of 1C, Kreisel battery achieves less than one-degree Celsius temperature spread within the cell compared to the 3- to 5-degree Celsius average temperature spread of its competitors, which can lead to lithium plating and cell aging.

The company’s immersion cooling technology offers a competitive price for customers, with a >20% advantage compared to other bottom and sidewall cooling techniques. Frost & Sullivan lauds the battery provider’s state-of-the-art immersion cooling-based battery technology solutions, which give Kreisel a competitive edge in the industry.

Encouraging Efficiency at Each Stage: A Meticulous Approach to Battery Development and Market Expansion

Drawing on a wealth of experience and unparalleled expertise, Kreisel Electric leverages a stage gate approach that allows the company to innovate and ensure efficiency throughout battery development. The process involves a deliberate and methodological progression from A-sample, B-sample, and C-

sample to a full-fledged product. The company conducts full validation at all stage gates. Upon reaching each stage, it can optimize timelines by leveraging its research and development (R&D) capabilities and partner networks and quickly circle back when needed without compromising efficiency. Kreisel leverages a comprehensive predevelopment team, testing team, and in-house testing facility to ensure its products meet the highest quality and performance standards.

The company also partners with leading international testing facilities, to augment its rigorous testing procedures. Since its inception, the company has prioritized technological innovation, dedicating over 40% of its 207 employees to R&D and testing activities. Since commercializing its first product in late 2019 with a public transport application, Kreisel has remained steadfast in its commitment to enhancing and

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**– Rabin Dhakal,
Senior Research Analyst**

expanding its line of products. Backed by the proven efficacy of its meticulous model platform, the company has standardized battery development procedures while exploring new avenues for growth.

Kreisel demonstrates strategic foresight and develops products catering to various industries, such as marine, industrial, off-highway, commercial, and stationary applications. To increase output and improve production capabilities, Kreisel is working with John Deere to invest in expansion. This collaboration includes opening a new

production facility at the John Deere factory in Saran, France, and investing in a battery assembly facility in the United States. By the end of 2024, the company's total output is projected to be approximately >2 gigawatt-hours, with a plan to further increase production capabilities.

Kreisel is committed to ensuring product standardization and competitiveness by investing in developing leading battery technologies. For instance, its best-in-class battery pack, the KBP63 uses the company's patented immersion cooling technology to cater to customers' requirements in various industries. The company's success does not overly depend on a single market. No single application accounts for more than 50% of its market share; a testament to its compatibility across various markets.

Frost & Sullivan applauds Kreisel for its commitment to ensuring superior product development efficiency and technological capabilities, allowing the company to provide top-of-the-line products and expand its reach across various applications.

Driving Innovation and Quality in EV Battery Technology Through Strategic Partnerships

Given the EV battery industry's ever-evolving nature, Kreisel taps into customers' unmet needs with its extensive experience in the field and ensures a rigorous product development process to maintain quality and reliability at each stage. Its battery technology is produced on a semi-automated line resulting in less product complexity, which has been a critical goal throughout the development process. In addition, Kreisel establishes various strategic partnerships to achieve its quality goals, including a successful collaboration with Shell. The partnership has enabled Kreisel to optimize and achieve the right combination of liquid and materials with its battery technology. The Kreisel-Shell collaboration has also led to the development of a premium, high-quality, and safe battery solution at competitive prices. The partnership represents a leap forward in battery technology, offering enhanced battery performance even

under fast-charging conditions and providing an astounding >20% improvement in battery lifetime compared to other fast-charging solutions.³

Strategic alliances with leading companies, such as John Deere, have helped Kreisel establish relationships with large suppliers and access reliable supply chains. By tapping into the manufacturing and distribution expertise of John Deere, Kreisel has been able to leverage the company's world-class supply chain management, manufacturing capabilities, quality assurance, logistics coordination, and cutting-edge automation solutions, allowing it to accelerate progress and deliver products of unparalleled quality and performance to its customers. Frost & Sullivan commends Kreisel on its extensive experience and strategic collaborations with industry leaders such as Shell and John Deere, which allow the company to produce high-quality, reliable, and competitively priced battery solutions.

Delivering Unparalleled Customer Service Experience to Establish Trust and Loyalty

Kreisel Electric has solidified its position as a leading player in the EV battery market by leveraging its technological capabilities and powerful competitive edge through a strategic collaboration with John Deere. John Deere, a global leader in the delivery of agricultural, turf, construction, and forestry equipment, acquired a majority ownership stake in Kreisel in late 2022. This alliance has allowed Kreisel to establish a robust service network and expand its presence in Europe and the United States.⁴ Kreisel understands that customer satisfaction requires excellent financial and aftermarket services, which is why it values its relationship with John Deere. Kreisel has access to the financial stability, reliability, and supply chain network of John Deere, which enable the company to offer customers an unparalleled service

experience. The company also recognizes that its products require a long-term outlook on service, and with the extensive support of John Deere, the company's customers are assured of a trustworthy and reliable product.

“Since commercializing its first product in late 2021 with an off-highway application, Kreisel Electric has remained steadfast in its quest to enhance and expand its line of products. Backed by the proven efficacy of its meticulous model platform, the company has standardized battery development procedures while exploring new avenues for growth.”

**– Rabin Dhakal,
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The company's reputation for excellence has been forged through the successful execution of lighthouse projects, such as developing the world's fastest racing boat and the first-ever fully electric rally racing car. The high-performance technology and top-notch safety standards incorporated in these projects have been carried over to the company's standardized

products, such as the KBP63 battery pack. In addition to the 63 kWh Kreisel KBP63 battery, three new concept Kreisel batteries were introduced at the 2023 CONEXPO-CON/AGG, including 20 kWh and 40 kWh power options. These new models offer industrial and marine customers increased packaging flexibility and utilize the battery technology provider's scalable, modular architecture and patented immersion cooling technology. Kreisel customers value the direct comparison they can make between the products used in the energy-intensive racing area and the products they use. This provides customers with a strong sense of confidence in the brand, knowing they can access the same tried-and-tested technology.

³ <https://www.shell.com/business-customers/lubricants-for-business/news-and-media-releases/2020/shell-and-kreisel-electric-form-strategic-alliance-to-offer-high-performance-electric-battery-solution.html>

⁴ <https://www.deere.com/en/news/all-news/kreisel-electric-expanding-battery-production-capacities/>

Frost & Sullivan is impressed by the results of the collaboration between Kreisel Electric and John Deere, which has allowed the company to solidify its position in the EV battery market, expand its service network, and offer an unmatched service experience to customers all while maintaining excellence through the successful execution of lighthouse projects.

Conclusion

Kreisel Electric is a pioneering battery technology solution provider that has developed a patented immersion cooling-based battery architecture that gives the company a competitive edge in the industry. The company's commitment to excellence is evident in its comprehensive predevelopment team, testing staff and in-house testing facility, which ensure that its products meet the highest quality and performance standards. Through collaborations with leading companies such as John Deere, Kreisel can leverage world-class supply chain management, manufacturing capabilities, quality assurance, logistics coordination, and cutting-edge automation solutions, that help to reinforce its position as a market leader. With products that cater to a broad range of industries, such as marine, industrial, off-highway, commercial, and stationary applications, Kreisel is well-positioned to capitalize on the growing demand for superior battery solutions and emerge as a critical player in the market.

With its strong overall performance, Kreisel Electric earns Frost & Sullivan's 2023 European Enabling Technology Leadership Award in the EV battery industry.

What You Need to Know about the Enabling Technology Leadership Recognition

Frost & Sullivan's Enabling Technology Leadership Award recognizes the company that applies its technology in new ways to improve existing products and services and elevate the customer experience.

Best Practices Award Analysis

For the Enabling Technology Leadership Award, Frost & Sullivan analysts independently evaluated the criteria listed below.

Technology Leverage

Commitment to Innovation: Continuous emerging technology adoption and creation enables new product development and enhances product performance

Commitment to Creativity: Company leverages technology advancements to push the limits of form and function in the pursuit of white space innovation

Stage Gate Efficiency: Technology adoption enhances the stage gate process for launching new products and solutions

Commercialization Success: Company displays a proven track record of taking new technologies to market with a high success rate

Application Diversity: Company develops and/or integrates technology that serves multiple applications and multiple environments

Customer Impact

Price/Performance Value: Products or services provide the best value for the price compared to similar market offerings

Customer Purchase Experience: Quality of the purchase experience assures customers that they are buying the optimal solution for addressing their unique needs and constraints

Customer Ownership Experience: Customers proudly own the company's product or service and have a positive experience throughout the life of the product or service

Customer Service Experience: Customer service is accessible, fast, stress-free, and high quality

Brand Equity: Customers perceive the brand positively and exhibit high brand loyalty

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- **ROI & Margin:** Implementation Excellence
- **Transformational Growth:** Industry Leadership



The Innovation Generator™

Our 6 analytical perspectives are crucial in capturing the broadest range of innovative growth opportunities, most of which occur at the points of these perspectives.

Analytical Perspectives:

- **Mega Trend (MT)**
- **Business Model (BM)**
- **Technology (TE)**
- **Industries (IN)**
- **Customer (CU)**
- **Geographies (GE)**

