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**Powering the future
of electrification:
Insights from
global leaders**



Editor's note

The electrification industry stands at a defining moment. As global demand for electric vehicles, renewable technologies and efficient power systems accelerates, so too does the need for innovation, collaboration, and resilience across the supply chain.

This special CWIEME Berlin report brings together expert perspectives on some of the most pressing challenges and opportunities shaping the future of electrical engineering and manufacturing.

From the European Union's evolving trade policies and tariffs on Chinese EVs, to groundbreaking lightweighting techniques in rotor and stator design, to the transformative potential of the circular economy, each article highlights how businesses must adapt to thrive. Whether it's ensuring compliance with stringent regulatory frameworks, driving efficiency through materials innovation, or embracing closed-loop manufacturing, the themes explored here point

to one shared objective: building a more sustainable, competitive and future-ready industry.

CWIEME Berlin has always been more than a trade show — it is a global platform for exchanging knowledge, showcasing cutting-edge technologies and connecting decision-makers across the electrical manufacturing industry. We hope this report not only informs, but also inspires fresh thinking and collaboration as we collectively navigate the road ahead.

Melissa Magestro, CWIEME Berlin Portfolio Director

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The impact of EU's tariff hike on Chinese EVs



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Impact of EU's tariff hike on Chinese EVs

Compliance with import and export restrictions on electric components

Companies trading electric components — particularly those in the electric vehicle (EV) and energy sectors — face the challenges of tariffs, environmental directives, and compliance requirements. Here, Saqib Saeed, Chief Product Officer at PTR Inc. and CWIEME Berlin advisory board member explores the trade policies impacting the electric component industry and best practice for companies wanting to remain compliant.

EV imports

One of the most pressing issues in the trade of electric components, especially in the EV market, is the increase in tariffs on EV imports from China.

The European Commission has very recently imposed an additional tariff of as much as 35 percent on Chinese EVs, on top of the existing 10 percent. While negotiations are ongoing, both sides are seeking a resolution to avoid further escalation.

One proposed solution is a minimum price commitment for Chinese EVs entering the European market. However, the dynamics could shift significantly with the re-entry of Donald Trump into

the White House. His renewed stance on imposing tariffs on Chinese goods may pressure the European Union to align with similar measures.

This decision is part of the EU's effort to counter what it sees as unfair competition, aiming to level the playing field against Chinese firms that benefit from government subsidies, which makes their products highly competitive.

As a result, the intent behind these tariffs is to shield Europe's promising EV market from heavily subsidised competition and support local industry development.

The newly enforced measures are to last for five years, meaning that companies need to monitor such, and similar, trade developments closely in years to come.

Another area that might become a trade battleground is semiconductor chips. In 2024, the European Commission has been closely evaluating its reliance on China for chip supplies, particularly in the automotive sector.

While European companies have historically maintained dominance in this space, there is growing concern that China could leverage its advanced progress in EV development to gain a competitive edge in chip manufacturing as well.

Meanwhile, the United States is preparing to intensify this global contest by implementing export restrictions targeting up to 200 Chinese companies. These measures aim to block China's access to critical chips that could accelerate advancements in AI and related technologies.

Battery requirements

Another significant regulatory shift pertains to the European Union's focus on battery sustainability and recycling standards, set to take effect in 2027.

Under this regulation, all EV batteries sold in the EU must contain a specified proportion of recycled materials, including critical components like lithium, cobalt, nickel, and lead.

The aim is to ensure that valuable materials are efficiently recovered at the end of a battery's life cycle and reintroduced into the economy to support sustainability goals.

Stricter targets for recycling and material recovery will be adopted over time, with a goal of recovering 50 per cent of lithium by 2027, increasing to 80 per

cent by 2031. Additionally, importers are required to thoroughly document and verify the recycling processes for these materials.

This regulatory effort intends to reduce environmental impact by mandating transparency and accountability in sourcing practices.

Moreover, a **"battery passport"** system will also come into effect, obliging manufacturers to disclose the carbon footprint and supply chain details of each battery.

For companies involved in the EV and battery sectors, these requirements signal an urgent need to ensure end-to-end transparency within their supply chains.

From tariffs to transparency

Tariffs, such as those on the aforementioned Chinese EV components, could impact cost structures and profit margins, particularly for companies heavily reliant on imports from Asia. This is at a time when supply chains are already facing strain as they adjust to new sustainability and transparency standards.

Regarding the EU's battery recycling and passport, a key requirement mandates the documenting of content and sourcing of critical minerals, like lithium, cobalt and nickel throughout the supply chain.

This will be especially challenging for companies operating across multiple continents, as differing regulatory frameworks and standards can complicate compliance.

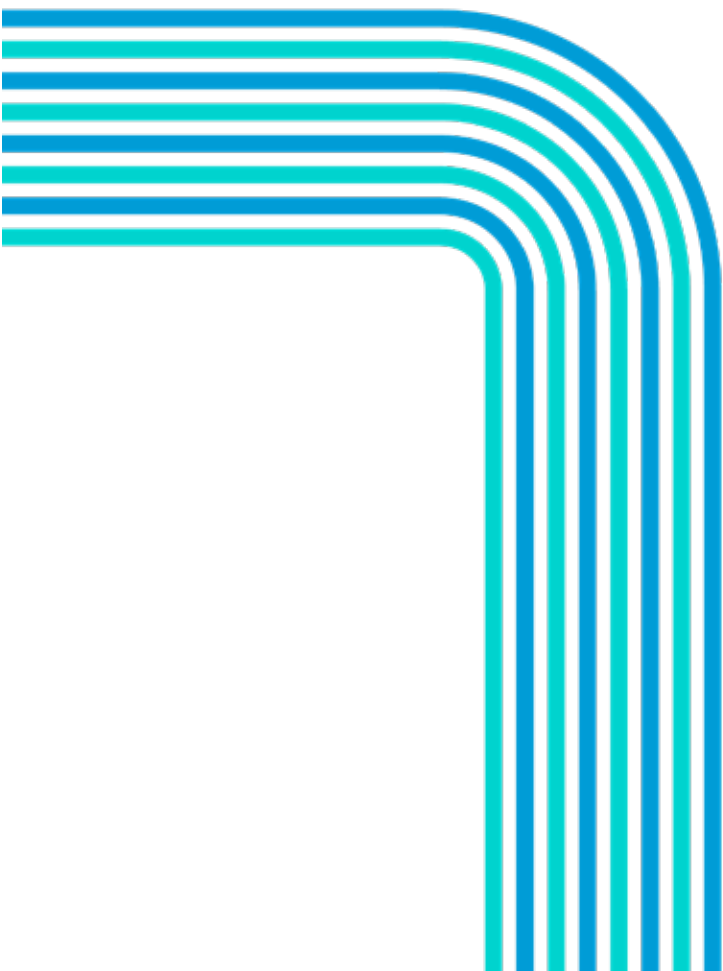
Beyond EV components, companies producing transformers and electric motors are also subject to stricter energy efficiency standards under the EU's Eco-design Directive.

With each revision, the directive's efficiency requirements grow more stringent, pushing manufacturers to adopt new materials and processes.

In some regions, the industry is resistant to these standards due to supply chain limitations and increased production costs.

This resistance is particularly evident in the U.S., where there has been pushback against stricter transformer efficiency requirements amid an already strained supply chain.

For companies in Europe, however, adherence to these regulations is crucial because the risk of non-compliance could mean exclusion from critical markets.





Staying informed and compliant

It must be recognised that meeting regulatory demands is no longer a matter of simple box-ticking exercises but a strategic priority with significant financial implications.

One way to avoid non-compliance is to set up dedicated compliance teams or task forces.

Large corporations may also benefit from engaging professional trade advisory services, especially when dealing with multi-regional supply chains affected by policies like the **Carbon Border Adjustment Mechanism**.

Regular engagement with industry associations and attendance at trade fairs is another effective way to stay informed.

Events, such as **CWIEME Berlin**, offer valuable opportunities for companies to learn about upcoming regulations, new technologies and best practices.

Networking among these forums allows businesses to share compliance strategies and gain insights into new developments, helping them stay ahead of regulatory changes.

As the regulatory landscape for electric components continues to evolve, particularly with the looming 2027 battery passport requirement, companies that fail to meet transparency standards risk being excluded from valuable partnerships and supply chains.

Therefore, now is the time for major Original Equipment Manufacturers (OEMs) to prioritise suppliers who can provide full transparency in their sourcing and production practices.

The keeping up with trade policies and regulatory requirements not only avoids costly fines and delays, but also positions companies as trusted players in the electric components market too.



For more highlights from the 2025 event

or to register your interest for 2026, visit the **CWIEME Berlin website**.

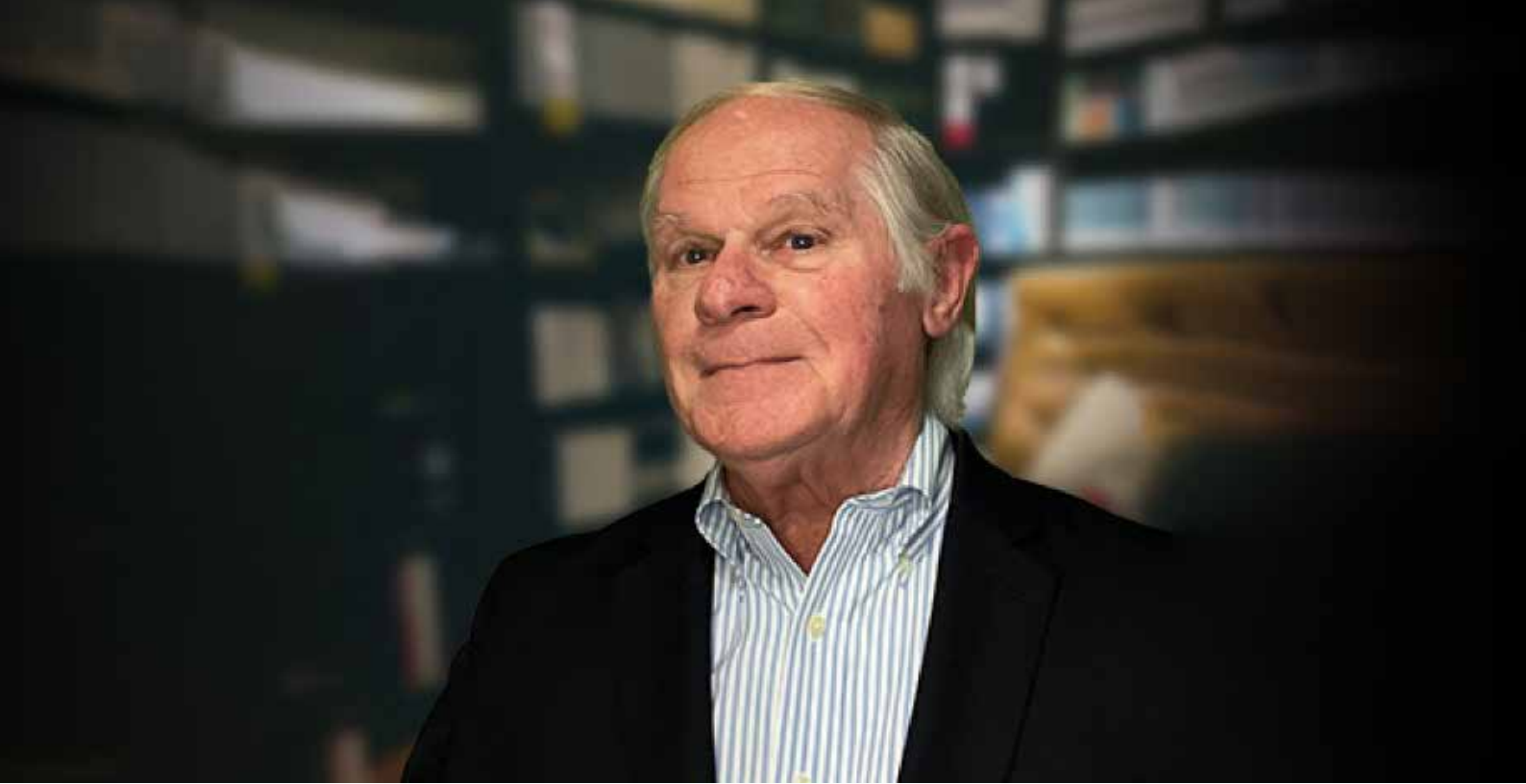
Lightweighting in rotor and stator designs



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Lightweighting in rotor and stator designs: A new era of efficiency and innovation

The latest advancements in motor design and material engineering

With the growing demand for more efficient electric motors, especially in the fields of e-mobility, aviation and space exploration, lightweighting in rotor and stator design has become a top priority for engineers. New materials and design innovations are transforming how we approach motor efficiency, energy savings and sustainability. Here, John Morehead, principle consultant at **Motion Mechatronics** and advisory board member at **CWIEME Berlin**, explores developments in rotor and stator lightweighting and the future of electric motor technology.

In the ever-evolving landscape of electric motor technology, the push toward lightweighting has emerged as a critical factor influencing design and

manufacturing. As industries increasingly prioritise sustainability, the benefits of reducing weight in electric motors extend beyond mere efficiency — they play a pivotal role in enhancing performance, reducing costs and contributing to a greener future.

Statistics show that in 2024, the global EV market is anticipated to generate a revenue of \$786.2 billion. Over the next five years, the market is expected to maintain a steady annual growth rate of 6.63 per cent, bringing the projected market volume to \$1,084 billion by 2029. Additionally, unit sales are forecasted to reach 18.84 million vehicles by the same year, underscoring the sector's robust and sustained expansion.

Weight reduction

One of the key areas of focus in electric motors should be weight reduction. Electric motors tend to be heavy because they are primarily made of metal components, and as the power output increases, this weight concern grows. In my experience, there's a strong push for electric motors to not only be smaller and lighter, but also faster and denser in terms of power and torque. In the last decade, the rise of e-mobility has significantly influenced this industry. Before that, we didn't see much emphasis on lightweighting.

With e-mobility gaining traction, particularly in two-wheelers and small commercial vehicles, the focus on reducing weight in electric motors became

critical. This is essential not only for extending battery life, but also for enhancing flexibility and usability in smaller applications. The aeronautics sector is also making strides in electric aviation, where weight is paramount. The innovations and practices that emerge from this high-level focus will trickle down to the electric motor industry as a whole.

Reducing weight can also lead to cost savings and a significant reduction in carbon emissions, which is an imminent and continuously growing concern in today's industry. Furthermore, there's a burgeoning interest in the circular economy, and I see electric motor manufacturers starting to design their products with reusability and recyclability in mind.

The emergence of start-ups

Another area impacting the industry is the emergence of start-ups. Historically, it was quite challenging for start-ups in the electric motor sector to gain traction. Many new companies struggled to secure commercial orders due to customers' reluctance to work with unproven entities. However, the landscape has changed. Many of the companies driving innovation in e-mobility and electric aviation are themselves relatively new. They are more open to collaborating with start-ups and incorporating innovative components that enhance their technology.

This shift has made it easier for new motor technology companies to enter the market. Just ten years ago, concepts like axial flux motors were relatively niche, but now they're gaining popularity, largely due to e-mobility. While the manufacturability of axial flux designs still presents challenges, rapid advancements are on the horizon, particularly with new soft magnetic composite materials that facilitate easier production.

New materials

The electric motor industry is in a period of rapid evolution. Companies that have long relied on traditional materials, like cast iron, are starting to explore alternatives like aluminium for motor enclosures. Aluminium could provide sufficient durability for over 90 per cent of industrial applications.

We're also seeing exciting developments with entirely new materials, such as carbon nanotubes, and advances in 3D printing technology. Although 3D printing for motor stators isn't widely adopted for mass production yet, its potential to revolutionise motor manufacturing is clear. Additionally,

innovations like electrostatic motors are pushing the envelope on weight reduction and material efficiency.

The merging of motors and control technologies is another significant trend. The integration of microprocessor power, power electronics and sophisticated software algorithms allows for the design of higher performance motors that can effectively address certain limitations. This convergence is transforming the industry from a purely electromechanical focus to a more holistic approach that includes electronics and software, enhancing overall motor performance and efficiency.

Aerospace

The advancements in electric motor technology are profoundly impacting both the aviation and space sectors. For instance, as electric aviation continues to grow rapidly, weight reduction becomes a critical factor in designing electric motors. This trend is pushing us to explore innovative designs and materials that can significantly lower the weight of motors without sacrificing performance.

In the space sector, new entrants like SpaceX are driving innovation. They challenge the traditional,

conservative approaches that have dominated the industry for so long. Start-ups are now more willing to adopt cutting-edge technologies, which encourages us to rethink electric motor designs and their applications. This collaborative environment between established firms and newcomers leads to exciting developments, ultimately making electric propulsion systems more efficient and viable for aerospace.

The circular economy

The circular economy plays a significant role in electric motor manufacturing by encouraging manufacturers to rethink the lifecycle of their products. In the past, electric motor manufacturers did not typically design their products with recyclability in mind. However, there is a growing trend where companies are now focusing on making electric motors that are not only reusable but also recyclable to a higher degree. This shift is crucial, as it helps reduce waste and resource consumption in the production process.

For instance, by optimising designs and materials, manufacturers can minimise the use of raw materials, which contributes to lower carbon emissions. Additionally, with advancements in technology, we can explore innovative ways to recycle components and recover materials at the end of a motor's lifecycle. This approach not only aligns with environmental sustainability goals but also presents opportunities for cost savings and efficiency improvements in production. Overall, integrating circular economy principles into electric motor manufacturing is a vital step towards a more sustainable and responsible industry.

Look to the future

The future of the electric motor industry is incredibly promising. With new players entering the market, we can expect to see a plethora of innovations. The existing large motor companies may have long histories, but they face competition from upstart firms that bring fresh perspectives and novel technologies.

As we move forward, we can expect to see more electric motors designed with integrated controls. The importance of software in optimising motor

performance cannot be overstated. We're at a point where the pace of technological advancement is accelerating, and what seems expensive and exotic today could be commonplace within the next decade. As the industry embraces new materials, designs, and integration strategies, we will see a future where electric motors are lighter, more efficient and increasingly integral to various applications, from industrial uses to personal mobility solutions.

To learn more about innovations in the electric motor industry head over to the **CWIEME Berlin website** where we facilitate a platform for industry experts to share their knowledge and solutions to an international audience.

The circular economy in electric manufacturing



Fernando Nuño

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Closing the loop in electrical manufacturing

Embracing circularity creates challenges and opportunities

Since life began some 1 billion years ago, an intricate web of cycles and relationships has developed. Sunlight is the only input, and nothing is wasted. For the electrical industry, adopting a more circular approach to manufacturing can advance sustainability and offer unique economic opportunities, say Fernando Nuño and Bruno De Wachter, members of the advisory board for electrical manufacturing trade show, CWIEME Berlin.

Global economic development and population growth have created a critical need to adopt a more sustainable and 'natural' approach to consumption. Creating a circular economy offers a solution by minimising waste and maximising resource value throughout product lifecycles.

Standards for the circular economy in energy-related products were produced by the European Committee for Standardisation and European Committee for Electrotechnical Standardisation (CEN-CENELEC). The series **EN 4555X** encompasses durability, the ability to remanufacture, repair and reuse components or the entire product, and upgrade. It also considers recyclability, recoverability, the use of recycled materials and only deploying critical raw materials where they are really needed.

The standards revolve around three top level European Commission aims: extending product lifetime; the ability to re-use components or recycle materials from products at end-of-life; and the use of re-used components and/or recycled materials in products.

What goes around

The primary benefits of implementing circularity in the electric manufacturing sector are largely environmental. Circularity helps combat resource depletion by reducing the reliance on extracting finite materials. Additionally, manufacturing secondary materials typically has a significantly lower environmental impact compared to producing materials from virgin resources, contributing to a more sustainable and efficient production process.

According to Draghi and von der Leyen, implementing a circular economy at a local level generates jobs through repair, reuse, and recycling services, thereby contributing to a country's economic growth.

For instance, in the UK, between 2014 and 2019, nearly 90,000 new jobs were created in the circular economy sector, bringing total employment in this area to over half a million. Furthermore, projections suggest that with ambitious policies focussed on reuse, repair and remanufacturing, over 450,000 additional jobs could be created across the UK by 2035.

A circular economy can also be seen as a geo-political tool. Metals are traded commodities, so relying on imports comes with its own risks. Reducing this reliance fosters regional or national material sovereignty.

Certain metals, such as steel, copper and aluminium, are crucial to regulatory ambitions like the green energy transition. Focussing on circularity can improve accessibility to them on a regional or continental level, offering the option to trade with other regions in times of surplus.

The objective to close the loop at national and regional levels also nurtures technological innovation focussed on material recovery at end-of-life.

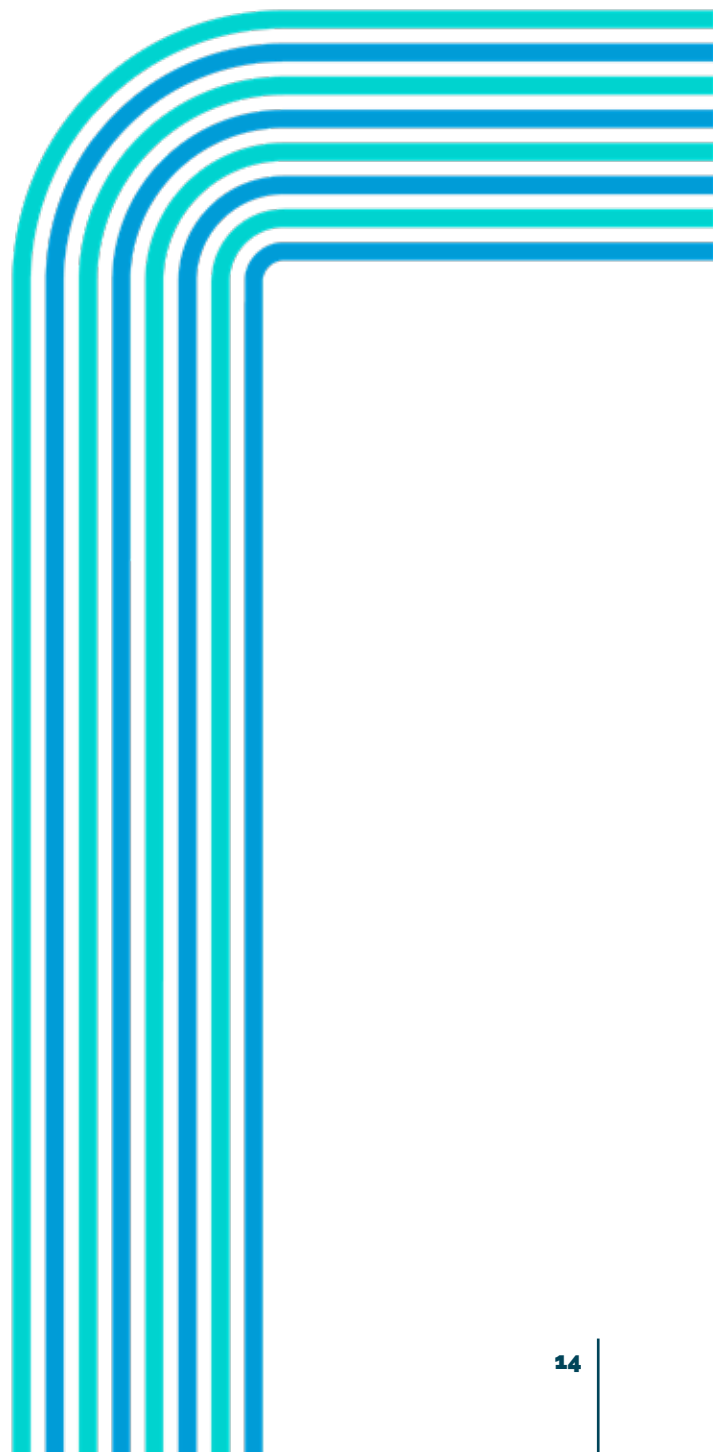
Should we reduce product lifespan?

In theory, a circular economy mindset would favour making product lifespan as long as possible. However, in domains where technology is progressing and improving the products' energy efficiency and recyclability of the materials used in manufacturing is high, a long lifespan hampers the uptake of this new technology.

In some cases, such as for motors and transformers, it might be more efficient to recall products before end of life and replace them with more efficient units. Because the materials used are highly recyclable, it's better to re-use them in new products that are more energy efficient.

Many companies are already embracing recycling and circular practices. For example, a partnership between ABB and Stena Recycling is ensuring that end-of-life machines are efficiently recycled, with metals reused in new European products. ABB claims its large motors and generators are 98 per cent recyclable, with the remaining two per cent of materials suitable for incineration with heat recovery.

By focussing on the end-of-life management of these machines, companies can reduce environmental impact and ensure equipment is regularly upgraded. ABB also works with Stena Recycling on its transformers, and says it plans to have over 80 per cent of all its products and solutions based on a circular approach by 2030.





Recycling

Multiple recycling sites and secondary smelters exist in Europe and around the world. For instance, Germany features specialised recycling centres like Elektro-Recycling Nord in Hamburg for appliances and electronic waste, and Cabo in Berlin and the Ruhr area, which focusses on separating metal and plastic, especially from cables.

However, recycling end-of-life products can be challenging due to collection issues, complex material separation, and fragmented global recycling streams. For example, motors often face varying practices: large and medium motors are recycled for copper, small motors are often exported, and very small motors in appliances frequently end up in landfills.

Material separation complicates recycling, such when handling composites like the cast resin in dry transformers. Global markets and inconsistent EU e-waste classifications further hinder effective regulation.

To combat this, collection could be optimised through Producer Responsibility Organisations (PROs). These are entities established by manufacturers to fulfil the collection, recycling and waste disposal of their products. This can increase material recovery rates and shift the environmental and financial burden of waste management away from governments and consumers.

Closing the loop

Producers and manufacturers could develop further guidance on how to dispose and dismantle their products. In addition to PROs, manufacturers can develop business models to recover the end-of-life products of their customers and properly recycle them, which creates value-retention opportunities.

At the same time, design engineers can collaborate with recycling companies to develop designs that facilitate dismantling and separation at end-of-life. Design engineers can also collaborate with the metals industry to deepen their knowledge of the metallurgical properties of commonly used materials

like copper. This would help in developing designs in which metals are combined with materials that are easy to separate in the smelting and refining process.

In nature, each organism occupies an individual niche. It borrows materials from its environment and returns them at the end of its life. The same can be true for electrical manufacturing, and trade shows such as CWIEME Berlin help by enabling constructive discussions between all players of the value chain — both upstream and downstream of manufacturers — creating a more sustainable, circular economy.

How evolving energy networks, materials, and automation are shaping transformers beyond design and methodology



Ales Bertuzzi

Advisory board member
CWIEME Berlin



Transforming the future

How energy networks, materials and automation are shaping transformers

The transformer industry has long been considered a niche market, with slow innovation compared to other sectors. However, evolving energy networks, material advancements and automation are now forcing the industry to rethink transformer design and functionality. Here Ales Bertuzzi, **CWIEME Berlin** advisory board member, explains how we are entering a new era in transformer technology.

Having spent years in the energy sector, I have witnessed numerous market fluctuations. However, nothing compares to the past five or six years, particularly in North America, where the industry has experienced unprecedented growth.

The drive to reduce carbon emissions and combat global warming has significantly accelerated the transition towards electric energy, with nuclear and

renewable sources taking precedence over fossil fuels. This shift creates a need for more efficient and reliable transformers to support modern energy networks.

Despite its crucial role in power distribution, transformer technology remains largely unchanged. Transformers still rely on traditional materials such as copper and silicon steel, both of which are becoming increasingly expensive and scarce.

Additionally, transformers suffer from energy losses of between five and ten per cent, which are dissipated into the air due to inefficiencies. There is a huge opportunity to rethink transformer design and innovate beyond current limitations. By collaborating and embracing new technologies, we can accelerate progress and enhance energy reliability.

Material innovations

One of the most promising areas for transformer innovation is materials. While silicon steel has long been the industry standard for transformer cores, alternative materials are gaining traction. Amorphous materials, for instance, have been used in specialised applications for years due to their low energy loss properties. Chinese manufacturers have already integrated amorphous materials extensively into their distribution networks, leading the way in transformer efficiency.

The key challenge is sourcing these materials at scale. Every era has had its defining material — whether it was salt, gold, steel or oil. Today, we must identify and invest in the materials that will define the future of energy infrastructure. Lithium, once abundant, is now facing supply constraints, leading to the exploration of sodium as an alternative. Similarly, as copper prices rise, aluminium is becoming a viable substitute. By embracing new materials and creating economies of scale, we can drive down costs and improve efficiency.

Introducing automation

Historically, the transformer industry has resisted automation due to the flexibility required for custom designs and the relatively low production volumes. However, this is changing. The demand for transformers is surging, and manufacturers face delivery times of two to three years. This backlog highlights the urgent need for automation to streamline production and meet growing demand.

Automation offers several advantages beyond increased efficiency. It allows for greater customisation, ensuring that transformers can be tailored to specific energy network requirements. It also addresses the critical skills gap in the industry — machine manufacturers must invest in automation to bridge this divide.

However, one of the biggest challenges is the automation of transformer production itself. Currently, every machine manufacturer is highly specialised in their field, making it difficult to integrate automated processes across the entire supply chain. Collaboration between manufacturers could provide a solution, ensuring that automation is implemented holistically rather than in isolated segments.

Additionally, 3D printing of transformers, while not feasible anytime soon due to technical complexity, remains an exciting prospect for long-term innovation. In the meantime, automation can significantly improve the production process, making transformers more accessible and cost-effective.

Regulatory barriers

One of the primary barriers to automation in the transformer industry is the lack of standardisation across markets. In Europe, for example, each government enforces different specifications for transformers, effectively creating trade barriers. This fragmentation makes large-scale automation impractical, as manufacturers must produce small batches of varied designs rather than high volumes of standardised units.

If governments were to align their specifications, it would lead to greater efficiency, lower costs and more competitive pricing for consumers. Standardisation would enable manufacturers to automate production more effectively, benefiting both energy providers and end users.

Looking ahead

To stay competitive in this rapidly evolving market, we must embrace innovation at every level. Whether through advanced materials, automation or regulatory changes, the transformer industry has the potential to change in ways that were previously unimaginable. However, for this to become a reality, we must shift our mindset from maintaining the status quo to actively seeking new opportunities for efficiency and sustainability.

The next few years will be critical in defining the future of transformer technology. By fostering collaboration between manufacturers, material scientists and policymakers, we can drive meaningful change and ensure that transformers continue to play a pivotal role in the global energy transition.

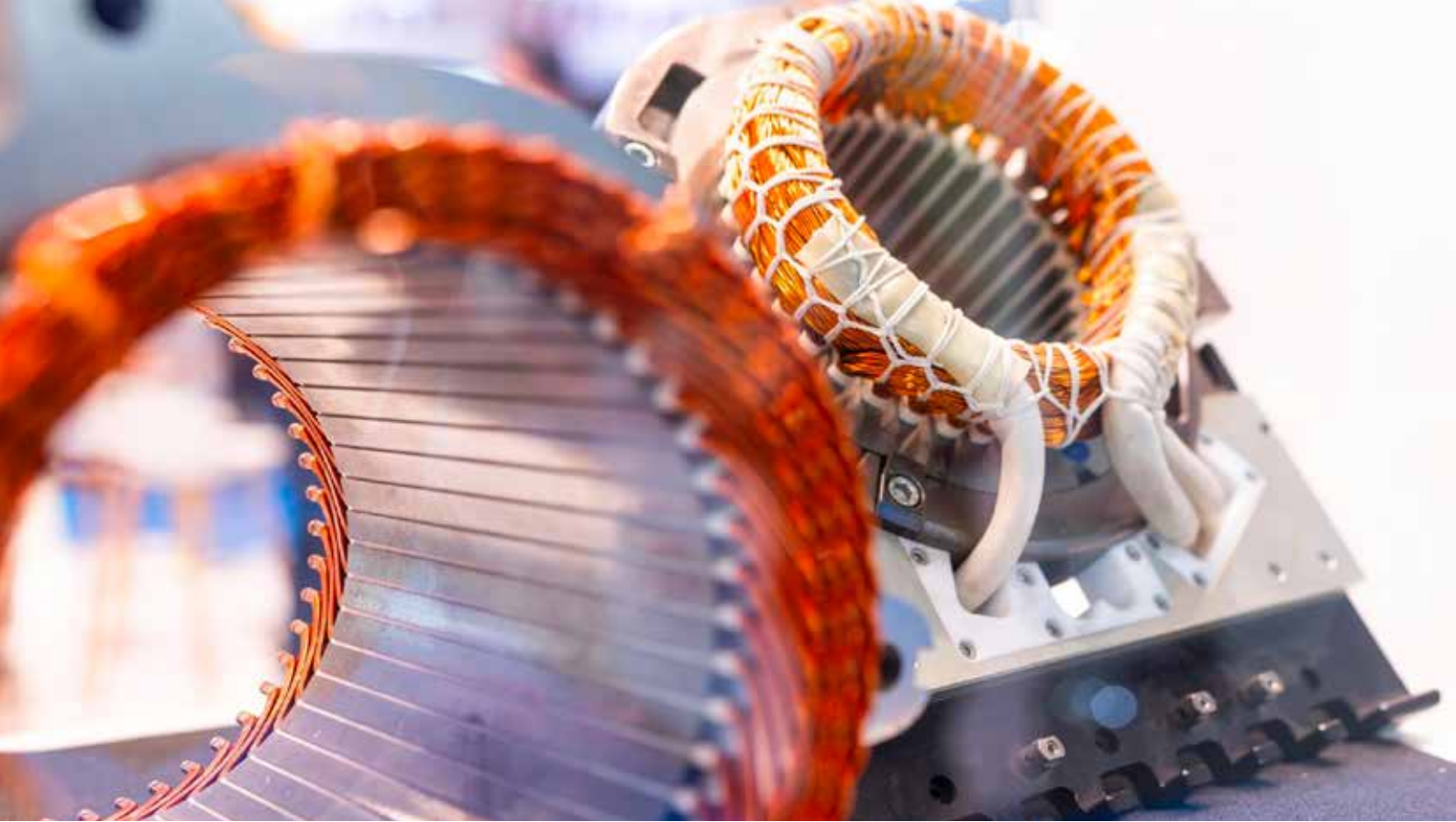
The energy landscape is shifting, and so must we. The time for innovation is now. That's why events like CWIEME Berlin are so important. It's a place for industry leaders to come together and discuss how to move the industry forward.

Beyond manual: transforming the coil winding industry with automation



Nicola Acampora

Head of growth
CWIEME Berlin



Three ways automated coil winding enables technological advancement

From skyscraper-sized wind turbines to pacemakers no bigger than a pen lid, humanity needs efficient, compact electrical coils in a range of sizes and designs — and lots of them. Here, Nicola Acampora, head of growth for **coil winding trade show CWIEME** Berlin, explores three ways automation helps the industry meet demand.

Traditionally, as in virtually all manufacturing, coils were wound manually. Using skilled workers to manufacture coils enables a range of winding topologies, but the process is prone to inconsistencies and labour bottlenecks. These

drawbacks often make manual winding incompatible with modern requirements.

Today, new industries like electric mobility, renewable energy and telecommunications all require high-performance coils. Demand in these industries has rocketed, and companies now need massive quantities of top-quality coils.

Automation has begun to close this gap, offering speed, consistency and design flexibility while also reducing costs. Here's a closer look at how automation is shaping the coil winding industry.

Production volumes

EV sales drastically increased between 2020 and 2025. According to the **International Energy Agency** (IEA) In 2023, one in five (18 per cent of) vehicles sold were electric or hybrid, bringing the estimated global fleet size in 2024 to around 40 million vehicles. With up to four motors in each EV, the accelerating adoption of e-mobility presents a significant challenge to the supply chain. Without automation, coil winding for motor production could stall the rollout of EVs.

Similarly, during the transition to renewable energy, demand for resources used in coil winding, like copper, will grow. For example, the global wind turbine fleet is expected to need over five million tonnes of copper, according to **Wood Mackenzie**. Here, efficiency gains in coil winding will be crucial. More efficient coils allow manufacturers to build better generators with improved energy conversion rates.

Precision manufacturing

Automation can also help deploy new types of winding technology. For example, one type of winding now common in EV applications is hairpin winding. Hairpin winding allows for a higher slot fill factor, meaning more copper can be packed into the stator, reducing resistance and improving heat dissipation.

Unlike traditional coil winding, which relies on continuous wire winding, hairpin technology requires precise shaping, bending and insertion to manufacture a coil — tasks more suited to robotic automation than manual intervention. Automation would ensure exact dimensions, reducing variations and improving electrical performance.

Defect detection

Employing AI and machine learning at the quality control stage can also improve manufacturing processes. For instance, automated machine vision systems could identify winding errors in coils faster and more accurately than a human.

Computer vision systems are especially useful when manufacturing micro coils for medical technology or aerospace. Miniature coils can be less than 0.5mm in diameter and often use wire so fine it is practically invisible to the naked eye.

When deployed throughout the manufacturing process chain, such automated inspection systems

could help manufacturers identify production deviations much sooner, reducing waste and ensuring the quality of finished products.

Furthermore, real-time analytics combined with automated adjustments to winding speed and wire placement could improve consistency and address defects before they became significant.

By providing higher precision and repeatability, faster production times and better material efficiency, automation is transforming electrical manufacturing in a range of sectors.



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