European Committee of Manufacturers of Electrical Machines and Power Electronics

CEMEP POSITION PAPER ON CIRCULAR ECONOMY

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1. Introduction

CEMEP, the European Committee of Manufacturers of Electrical Machines and Power Electronics, supports the development towards a circular economy and, as an industry, we seek to actively contribute towards more sustainable manufacturing and responsible consumption. Circularity and material efficiency cover many different aspects and business models for which the challenges, and possible solutions, vary significantly from industry to industry; even within industries. Business-to-business market conditions and solutions differ from those which prevail in a consumer-oriented environment.

This paper provides the CEMEP view on the journey towards a circular economy within our industry, which is characterized as a business-to-business market model for industry delivering products for a wide number of economic sectors and applications. There are both similarities and differences for our three main product groups – electric motors, variable speed drives and uninterruptable power systems – when it comes to material efficiency, which underlines the need for sector or product-group-specific approaches when pursuing the goal of a circular economy.

CEMEP and its members are committed to the transition towards a circular economy. Energy efficiency has, for decades, been a high priority for us and material efficiency is already an industrial market requirement, e.g. durable products, repairability and recycling of materials. Energy efficiency and material efficiency go hand-in-hand and optimizing the use of resources throughout any process makes environmental and economic sense. This requires alignment and coordination. It is important to base future initiatives on a "least life cycle cost" principle in order to focus on the measures that result in the most sustainable use of resources.

CEMEP supports the new EU Circular Economy Action Plan and the many measures encouraging the development of a sustainable and circular economy and is committed to be involved in the further implementation of the action plan.

2. Key points and Policy recommendations

CEMEP strongly supports the vision of a circular economy and the quest for zero waste and increased material efficiency as well as increased energy efficiency. The members of CEMEP have already embarked on the journey towards a circular economy and CEMEP products (electric motors, VSDs and UPSs) are characterized by several circular achievements:

a) A long lifetime by design, as the market requires durable and reliable products. Maintenance and repair services (including availability of spare parts) are well established and contribute to prolonging the working life of industrial products.

b) Increasing use of recycled materials in the production and a high recyclability of the materials in the products. Both motors, VSDs and UPSs contain valuable metals that can be recycled by professional recyclers, and the products are well covered by the WEEE Directive.

c) A shift in packaging away from plastics towards materials based on renewable sources, like wood, wood-pulp and cardboard.

d) Increasing digitalization of the products allowing for optimization of performance and maintenance, which again reduces waste and increases the lifetime of the products.

When developing the regulatory framework and policy measures to support a circular economy, CEMEP recommends considering the following points:

1) Industries are different and there is no one-size-fits-all solution for a circular economy. Business-to-business industries have different market conditions from consumer product manufacturers, and therefore implementation should be done sectorial, with involvement of the sector stakeholders.

2) To balance the tradeoffs between material efficiency and energy efficiency and between durability and recyclability, future initiatives should be based on a “least life cycle cost” principle with focus on the measures that result in the most sustainable use of resources.

3) Coherence between the different legislation, like Ecodesign, WEEE, RoHS and REACH, should be strengthened and conflicting requirements avoided. Further harmonization of national implementation is needed to ensure wide deployment of circular streams.

4) Any actions should look for impact and solutions at the system level rather than narrowing the scope to the component level; as the potential for improvements is, in general, considerably greater here. CEMEP remains convinced that there is still a significant, untapped potential for energy savings at the system level and also for material efficiency through better sizing of the system components.

5) Development of harmonized standards should be used to support the regulatory framework and policy initiatives. Based on the newly developed horizontal CEN-CENELEC standards for material efficiency, the appropriate product-group specific standards should be developed to provide sector-specific measures, in collaboration with all relevant stakeholders.

6) CEMEP encourages the enforcement of such measures through on-the-ground market surveillance, which will ensure homogenous implementation. This will create a level playing field for all, including importers of goods, and ensure actual deployment of any regulation. CEMEP supports the idea of EU-member state cooperation and concerted actions for market surveillance.

7) As far as possible, the EU should work to align regulation and requirements globally to both ensure continued European competitiveness and to push European sustainable solutions globally for maximum effect, e.g. through international trade negotiations.

CEMEP recommends that policy makers support the ongoing development and seek collaborative solutions with a long-term perspective, as well as supporting research and development projects that can foster new circular economy models. Optimizing sustainability and circular models is a complex task, where success is more likely when involving all relevant stakeholders. CEMEP and its members want to be involved in the further discussions on how to proceed towards a circular economy and will contribute positively and proactively.

3. Industry characteristics regarding circular economy

Electric motors

An electric motor is an electromagnetic device which converts electrical energy into mechanical energy. Electric motors are basically made of metals such as copper, steel, aluminum and cast iron and, more recently, of new materials such as rare earth for magnets; but in low content. Despite the low volume of magnets and low weight of rare earth inside, during dismantling these parts are separated and overhauling is done by specialized companies. Plastic is often used for covers and fans but also the content here is low. Electric motors are used to drive numerous, different applications, such as pumps, fans, compressors, conveyor belts, cranes, lifts etc. As these applications are often critical, with respect to uptime and safety, reliability of electric motors is of a high priority, and they are normally maintained to optimize reliability and durability.

As electric motors convert at least 50% of all electrical energy consumed in Europe, there is a strong focus on energy efficiency. This is partly market driven, but since 2009 also by regulation under the Ecodesign Directive. This had led to the development of even more energy efficient motors, which from 2021 will need to be in energy class IE3 and from 2023 (for 75-200 kW motors) in energy class IE4. This concerns only new products introduced on the market, because due to lack of incentives, the installed base is only replaced at a rate of <5% per year. This means that electric motors have, on average, a more than 20-year lifetime expectation when correctly maintained.

Variable Speed Drives

A VSD, Variable Speed Drive, is a device used to control the speed (or torque) of an electric motor and thus to adapt the motor operating points to the application's needs. One of the benefits of VSD control is significant energy savings, which means that the dominant environmental aspect of a VSD, over its complete lifecycle, is the positive contribution to save energy during the use phase. Therefore, from a sustainability perspective, the most important function of a VSD is its ability to save energy within a motor driven system. Another critical concern which must be considered, is the safety aspect. VSDs control applications and processes where functional safety measures are often highly critical, and these functions must be insured

throughout the lifetime of the VSD. Furthermore, in many situations VSDs are improving the longevity of motors and other mechanical aspects in the drive-chain by decreasing the mechanical stresses involved.

A VSD is a power electronic device with printed circuit boards (PCBs), electronic components and different parts made of steel, aluminum, copper and plastic. VSDs are used widely in industry, infrastructure and buildings for application in energy-related products (ErP or extended products) like pumps, cooling and ventilation systems and compressors, as well as for lifts, cranes and hoists, for machine tools or in marine vessels.

VSDs and electric motors are most often not sold directly to the end user. Some products are sold as components to Original Equipment Manufacturers (OEMs), who build them into their products (e.g. pumps, compressors, lifts). Others are sold through system integrators, who configure and install them, along with the driven application, for the end user. Therefore, many of the products end up in another country than the country where they were first sold.

Uninterruptible Power Systems

A UPS, or uninterruptible power system, is a product used to provide good and reliable electrical power to any application that needs power continuity and quality, using a reserve of electrical energy made, in large part, of lead (batteries). The key benefit of UPS is to provide a power insurance at the lowest possible energy cost, which means that the dominant environmental aspect of a UPS in its life cycle is the energy it consumes to secure this insurance. With that in mind, it is still important also to consider the products regarding material efficiency. Key materials used besides lead are copper, steel and plastic as well as electronic components.

UPSs are used widely in IT applications, but also in industry and transportation, with reliability as the key factor. Another critical concern is safety: UPSs contain an energy reserve, provide power when utility is down, but as they contain both AC and DC hazardous voltages, safety performance must be insured throughout their lifetime.

4. Optimizing lifetime – reliability, durability, maintenance and repair

As stated, electric motors, VSDs and UPSs are widely used in industry, infrastructure and marine applications. A common denominator for these applications is the need for high reliability. Down-time of a motor, VSD or UPS will cause down-time for the application, which will most often be very costly. Therefore, electric motors, VSDs and UPSs are designed for high reliability and a lifetime optimized for the given application and use conditions. As usage and environmental conditions vary considerably, the lifetime of the respective products is also variable. For motors, working lifetime typically ranges from 10 to 30 years, whereas for VSDs a typical range would be from 5 to 20 years and for UPSs, 5 to 15 years. Average usage time for electric motors can vary from 500 hours a year (i.e. a swimming pool pump) to 4,000 hours for industrial motors. A good quality motor can have component lifetime greater than 100,000 hours for the sta-

tor winding and more for other mechanical parts. Operating conditions also vary from stable, indoor locations, to humid, dusty and low or high-variance temperature environments. The most critical parts in electric motors, from a lifetime perspective, are the bearings, whereas for VSDs and UPSs it is the electronic components, which due to physics, have an exponential decrease in durability over age.

Maintenance information is mandatory as part of instructions and information delivered with the product according to the Machinery Directive. As reliability and durability are critical factors for the users, and since the products are sold on a professional market, maintenance information, service and availability of spare parts are well established market requirements.

Professional repair and maintenance services already exist on the market, either provided by the manufacturers or by independent repair service companies – in some regions outside Europe, there is also a significant unofficial maintenance and repair service taking place. CEMEP members are promoting business models for maintenance. These services are constantly developed further using digital solutions to provide for optimized and preventive maintenance, and there are efforts to enlarge the market coverage for such services. This increases the level of maintenance and contributes to a prolonged lifetime for the products. Only for the smallest VSDs and UPSs, the business case for repair may be negative, when comparing cost of repair to the cost of a new substitute product and taking the criticality of reliability into account.

Information on reparability can be relevant for customers and CEMEP is positive regarding the idea of a reparability index, providing that it is built on a product-group basis with specific standards and contains information that is useful for the customers. Reparability for CEMEP products is generally very high, this is especially true for the larger power sizes.

5. Use of recycled materials and/or reused parts and components

Today, recycled materials are already used in both electric motors, VSDs and UPSs, e.g. in cast iron flanges or housings, lead in batteries and recycled materials for packaging. No solid data exist on the degree of recycled materials used within the industry, except for lead acid batteries used in UPSs, which use 80% recycled material. CEMEP suggests that a study is carried out to assess the actual level and the potential for further uptake of recycled materials.

A key parameter for use of recycled materials is the quality of the materials. A set of quality and performance criteria are set for materials to be used for electric motors, VSDs and UPSs to ensure reliability and safety of the products and these parameters must not be compromised. Another challenge is ensuring that recycled materials live up to the updated RoHS and REACH regulations and safety regulations (e.g. fireproof) as well. CEMEP strongly supports the aim to ensure better coherence between the EU legislation in this field and especially between Ecodesign and RoHS/REACH.

CEMEP depends on the development of the market for recycled materials to provide the required quality and specifications. This is especially evident for plastic materials where there is today, no technical offer on

the market that can answer all of the requirements. This market may need stimulation and support for further development. CEMEP members do not represent a purchasing power for plastics big enough to induce the appearance of new offers but will use such materials if and when they are offered by the market. CEMEP supports the measures proposed in the Circular Economy Action Plan for creating a well-functioning internal market for secondary raw materials but also calls for further measures and incentives.

Reuse of parts and components is only done on a small scale today. The largest potential for further reuse is for passive and mechanical parts, which may be reused directly or after some refurbishment. For electronic components, which constitute the most important part of VSDs and UPSs from a cost perspective, reuse is much more difficult due to the challenges of ageing and the requirements for safety, reliability and up-time.

CEMEP members are engaged in exploring the potential for further reuse of parts and components both for the manufacturing of new products and for spare parts in the repair services. This involves several different issues, like reverse-logistics, disassembly, requalification of parts and components and reintroduction into the manufacturing process. At present, the business case for reuse is not very strong, but this may evolve in the future.

6. Recyclability

In general, the recyclability of both electric motors, VSDs and UPSs is high – estimated to range from 80 to 90%. It is relatively easy to dismantle and separate the products into parts and components. At end-of-life the products are typically handled by professional recyclers following WEEE rules, who know how to get the value out of the products. Collection, dismantling and separation is currently held by service companies which also provide maintenance and reparation. Both collection and treatment are controlled by the WEEE Directive. Metals such as copper, aluminum, steel and lead, as well as the valuable materials in the electronics, are recycled in well-established systems. For the lead batteries, the UPS industry has, for decades, had a well-functioning system for collection and recycling, with a recycling rate of 90%. It is important to note, that part of the batteries are directly recycled by stakeholders, on-site, beyond the control of UPS manufacturers; so it is fair to say that the part of UPS lead batteries that does not appear under UPS manufacturers control are actually recycled locally. This is also the situation in general for a major part of the end-of-life treatment of motors, drives and UPSs outside Europe and to some degree inside Europe, where some of the recycling is not documented through recycling schemes. Therefore, recycling targets should be adapted to this situation and also to the fact that a significant part of CEMEP products are exported out of EU (e.g. by OEM customers). In general, choice of non-contaminated materials as well as labelling of materials, especially plastics, could increase recyclability.

During product design (environmentally conscious design) tradeoffs exist and are necessary between recyclability and durability, as certain processes used to increase durability may have negative consequences for recyclability. For products that must withstand vibrations or are being used in environments with high humidity or condensation, thorough fastening techniques are needed to make sure that the product will

work well. However, processes such as gluing and potting impede disassembly and thus reduce recyclability. It is important to be aware of such tradeoffs and to provide guidance on how to resolve these conflicting targets.

Critical raw materials are used to some degree – for VSDs and UPSs typically, will not be directly visible as raw materials in the product but only embedded within the electronic components. The VSD and the UPS industry are users of the electronic components and not involved in the design or choice of raw material for components. Professional recyclers are established on the European market with expertise in extracting such materials from e.g. printed circuits.

Regulation of recyclability is generally well covered by the WEEE Directive, although the effectiveness of this directive could benefit from further harmonization of the national implementation. CEMEP strongly supports more uniform waste collection schemes amongst the member states. Requirements on labelling of plastics could increase recyclability. Other progress will be made by deploying robust, industry recycling processes in a larger number of countries.

7. Refurbishment and remanufacture

For electric motors, refurbishment and remanufacture of failed or end-of-life motors is a well-established business both in and outside of Europe. Whereas this contributes positively to material efficiency, at the same time it delays the introduction of more energy efficient motors, and as energy efficiency requirements are tightened, it must be considered whether re-introduction to the market of less efficient motors should continue to be allowed. Here, the balance between energy and material efficiency must be carefully considered, especially as the recyclability of materials is very high, as illustrated above.

Within the VSD and the UPS markets, there is presently, for various reasons, quite a limited market for remanufactured products. A major barrier for remanufactured products is the demand for high reliability and safety and the cost associated with downtime of a VSD or an UPS. Due to the physics of materials in components, e.g. semiconductors, the durability of electronic components will decrease exponentially with age, which makes reuse of these components less attractive and remanufactured products will likely be second-class products; for which, today, the market does not exist. Another barrier is the constant update of material requirements in regulations like ROHS and REACH, which means that older components for potential reuse may not meet existing regulations.

Further to this, especially for VSDs, the challenge of reverse logistics or takeback of end-of-life products is quite complicated, as the products are not sold directly to the end customer but through different channels like OEMs, system integrators or distributors.

Finally, the products are generally optimized for durability, reliability and to withstand harsh environmental and operational conditions, which can make “design-for-remanufacturing” difficult. In order to obtain a positive business case for design changes, incentives will be needed.

Regarding refurbishment, CEMEP members provide services that help to increase the product lifetime. This includes exchanging key parts and components, such as batteries, capacitors, fans, control cards and power cards, in addition to updating features such as digital connectivity and updates to firmware/software. Efforts are made to increase the market coverage for these services as well as to expand with more features or sub-systems.

8. Packaging

Packaging is needed to ensure durability when transporting the products. Different materials are used for packaging, including plastics. A transition is taking place for substitution of plastic-based packaging towards renewable resources such as paper, pulp, cardboard or wood. Studies are also underway to use less paper documentation, fewer plastic bags, and to find more environmentally friendly materials for impact-absorption than the currently used foams. CEMEP foresees that the use of plastic packaging will be ended before 2030. Also, the use of returnable packaging is emerging within the industry. When updating the Packaging Directive, it is important to ensure that requirements are not contradictory to regulation outside the EU, resulting in some materials being mandatory in one region and prohibited in another.

9. Digitalization

Digitalization can support material efficiency and circular economy in several ways. Through products and systems interoperability, with data exchange and through new digital solutions (e.g. reducing paper manuals by implementing an electronic nameplate in the device). Digitalization and automation of the manufacturing processes can reduce material waste and facilitate use of recycled materials. Digitalization may also enable an easily accessible marketplace for recycled materials with full transparency and traceability or even with materials “offering themselves” to the marketplace when a product reaches end-of-life. CEMEP supports the development of digital product passports, if they are well aligned to the industry standards as well as the global standards, so that the solution can be used also outside Europe.

Digitalization can also support the development and uptake of new circular business models. With more sensors and high connectivity, future VSDs will be able to register and handle large amounts of performance data, which enables optimization of the performance not just for the VSD itself but for the entire motor driven system; the extended product. In the same way, increased digitalization of UPSs will allow them to be used for monitoring optimization of the installed system. Furthermore, digitalization supports the development of new services such as predictive maintenance that can optimize the lifetime of the products.

CEMEP is positive to exploring the potential of introducing “product-as-a-service” as a tool for increased material efficiency. Such business models may fit some parts of the market, whereas they will probably not be feasible for other parts. Financial incentives could be helpful to stimulate such business development and CEMEP will be happy to discuss such possibilities further.

Digitalization is, and will increasingly be, an asset for the circular economy, provided that fair and secure transmission of data is ensured and given that regulations do not restrict the data handling unnecessarily. Collaborative research projects can help foster the development of digital solutions and associated business models for products and systems interoperability of material efficiency aspects.

10. Market Surveillance

To ensure homogenous implementation, CEMEP encourages that measures are enforced through effective on-the-ground market surveillance. Such market surveillance should be effective for both European manufactured goods and for imported goods. This will create a level playing field for all and ensure actual deployment of any regulation. Therefore, it is important that any legal measure is practically enforceable for the market surveillance authorities. CEMEP welcomes the idea of increased cooperation between the Commission and the member states on market surveillance and the concept of concerted actions.

11. Towards a circular economy

CEMEP supports the journey towards a circular economy and increased material efficiency. With increased use of digital solutions and interoperability between systems and operators. New services and business models should optimize durability and increase the lifetime of the products. The trend of business development is moving from pure product-based business models towards more service-based solutions, where incentives for the manufacturers for optimized lifetime of the products are increased. Future EU initiatives within circular economy should support and strengthen this trend.

Regulation, or other policy instruments, could be useful to support the creation of a market place for high quality recycled materials that can be sourced for the manufacturing of electric motors, VSDs and UPSs and a market place for remanufactured or refurbished products with a scale that provides positive business cases for takeback and re-manufacturing. Development of platforms and eco-systems for circular loops for the products, in the form of takeback programs and effective collection schemes, is an important but also a more long-term objective that will require extended cooperation between industry and policy makers.

On the product development side, more emphasis from industry must be placed on product designs that support separability, repairability, serviceability, reuse and recycling. This can be in the form of modular design, new fixing techniques, digital solutions or other features.

As stated, energy efficiency and material efficiency are interlinked and require alignment and coordination to ensure the optimal tradeoff. It is important to base future initiatives on a “least life cycle cost” principle in order to focus on the measures that result in the most sustainable use of resources. This should be done in a way that avoids incompatible constraints such as targets for long lifetime (supporting for high material efficiency) conflicting with targets for higher energy efficiency (where new products are often more efficient). CEMEP welcomes the introduction of carbon footprint and recommends that this implemented both

for products and for the contribution of the products, e.g. contribution to energy savings, which for some products is by far the most important environmental aspect.

Any actions should look for impact and solutions at the system level rather than narrowing the scope to the component level, as the potential for improvements in general is considerably greater here. CEMEP remains convinced that there is still a significant untapped potential for energy savings at the system level.

In the coming EU Action Plan for a circular economy, the European standards for energy and material efficiency should form the basis for implementing measures. These standards represent widely accepted methodology for assessing different aspects of circularity and material efficiency. The existing horizontal standards for material efficiency should be supplemented with more product-group specific standards that considers the conditions of the B2B market. Using European harmonized standards enables transparent information and a strong link to the global landscape. Many CEMEP members volunteer to actively participate in the development of their product-group specific standards. CEMEP also suggest that these standards are used to support Green Public Procurement, so that assessment of sustainability is performed coherently and based on solid methodology.

CEMEP supports the aim that green claims must be substantiated by thorough methodology and documentation, such as the Product Environmental Footprint or other schemes that builds on recognized standards and 3rd party evaluation.

As an industry, CEMEP has been driving towards circularity for many years and will continue to do so in future. Our industry has a long history of developing durable, long-lived and energy efficient products, of maintenance services and of lead-battery recycling. Besides, there is an increasing focus on sustainable production methods, increased recyclability and improved repair and maintenance provision. Digitalization, data analysis and the increased use of sensors provide new opportunities to optimize both energy and resource utilization throughout the life cycle.

CEMEP recommends policy makers to support such development and seek collaborative solutions with a long-term perspective as well as supporting research and development projects that can foster new circular economy models. Incentives for innovation projects, such as Horizon Europe funding for circular economy projects or tax incentives, can both propagate and accelerate this development. Any regulation should be pan-European and fully harmonized. Independent national initiatives should be discouraged, in order to ensure a sustainable business framework for the whole European industry. And as far as possible, the EU should work to align regulation and requirements globally to both ensure continued European competitiveness and to push European sustainable solutions globally for maximum effect.

CEMEP is the European Committee of Manufacturers of Electrical Machines and Power Electronics, representing an industry with 130,000 employees. The members of CEMEP are the National Associations in Europe, representing manufacturers of electric motors, variable speed drives and uninterruptible power systems