



WP1: R6 STRATEGY

SURVEY RESULTS

**Status of the recycling and circularity of
(large) thermoset composite components**



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Executive Summary

The transition toward a circular economy for fibre-reinforced composites is essential to reduce landfill, conserve resources, and manage the growing volume of End-of-Life (EoL) composite structures from sectors such as wind energy and aerospace. Within the EU-funded project EuReComp, circularity strategies (so called R6-strategy) for large composite components are being developed with the objective of transforming composite waste into valuable secondary products.

To better understand the current state of implementation, barriers, and opportunities of large fibre-reinforced composites recycling, a targeted stakeholder survey was conducted in the last year. In this newsletter, we'll give you the highlights of the survey results and give recommendations for action. The results provide important insights into the technical, market-related, regulatory, and workforce dimensions of composite circularity. Section 1 briefly describes the strategic identity of the EuReComp project and the recommendations for action derived from the survey. Section 2 gives a short overview of the introduced R6 framework. Section 3 shows the main insights of the survey.

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Strategic Identity

The R6 Strategic Framework redefines composite waste management by moving beyond a recycling-only mindset toward systematic value retention across the entire lifecycle of high-performance composite components. Developed for sectors such as wind energy and aerospace, the framework establishes a clear hierarchy of six circular pathways: **Reuse, Repair, Refurbish, Remanufacture, Repurpose, and Recycling**. Its central premise is that circularity must be strategically prioritized, data-informed, and economically viable to be scalable.

The framework explicitly targets waste reduction and measurable energy and emission savings while safeguarding material performance and industrial competitiveness. Implementation follows a prioritized decision framework that directs end-of-life (EoL) components toward the highest-value recovery option based on defined quality thresholds, technical feasibility, and market potential. Supported by advanced inspection technologies and digital decision-support tools, it enables coordinated collaboration between dismantlers, repair actors, manufacturers, and recyclers within structured circular ecosystems.

By integrating environmental performance, regulatory alignment, and business model innovation, the R6 Framework transforms composite waste streams into strategic material assets — positioning EuReComp as a scalable European blueprint for composite circularity.

From the survey, specific actions can be derived for accelerating circularity of fibre-reinforced composites:

Establish clear and harmonized European regulatory framework

Policymakers should introduce uniform recycling targets, standardized circularity labels and carbon-accounting mechanisms, and consistent regulatory requirements across regions. Clear rules will provide investment certainty, ensure fair competition, and accelerate the development of recycling infrastructure and circular business models.

Implement digital product passports and standardized labelling

Industry and regulators should prioritize mandatory digital product passports containing material composition and lifecycle information. This also includes a secure data exchange system between dismantling companies, recycling companies and manufacturers. This will improve traceability and transparency, enable efficient quality-related sorting and recycling, and support higher-value recovery pathways.

Develop recycling infrastructure and scalable End-of-Life processing solutions

Both public and private stakeholders should expand research and development of the technical infrastructure for dismantling, sorting, and recycling large composite structures. Particular focus should be placed on separation technologies, automated dismantling processes, and scaling advanced recycling methods such as chemical recycling.

Strengthen education, training, and workforce development

Education providers, industry, and policymakers should develop specialized training programs focused on composite recycling, circular product design, sustainability assessment, and regulatory compliance. Addressing the shortage of skilled workers is essential for scaling circular solutions.

Promote circular product design and cross-value-chain collaboration

Manufacturers should integrate circularity principles into product design, including material simplification and harmonization, design guidelines for reuse and repurposing of (large) thermoset composite. At the same time, stronger collaboration between manufacturers, recyclers, and downstream users is needed to improve material flows, align technical requirements, and enable efficient circular systems.

Strengthen market pull through standardization and incentives

Policymakers should introduce green public procurement criteria that explicitly favor circular composite materials, thereby creating stable demand and accelerating market adoption. In addition, certification frameworks should be standardized to improve transparency, build trust in recycled materials, and reduce commercial and investment risks for industry stakeholders. Targeted financial incentives, such as subsidies, tax benefits, or funding programmes, should also be provided to support the use of recycled and repurposed composite products and to strengthen their competitiveness compared to virgin materials.

The R6 Framework

The R6 Definitions

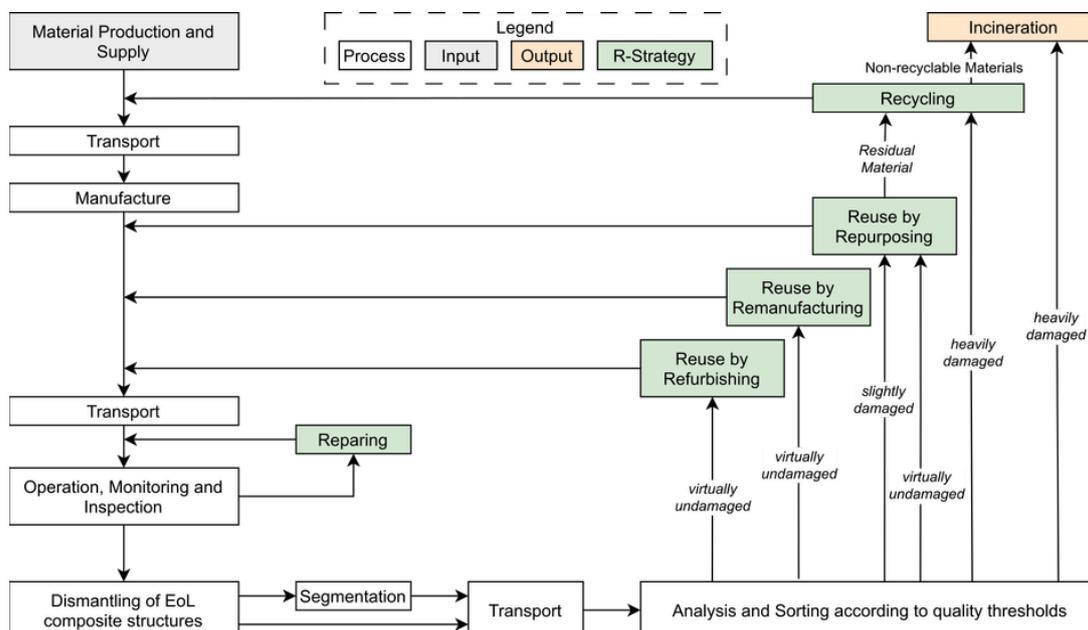
REUSE	Reuse by another consumer of discarded product(s) which are still in good condition and fulfils their original function.
REPAIR	Repair and maintenance of defective product so it can be used with its original function.
REFURBISH	Restore an old product and bring it up to date.
REMANUFACTURE	Use parts of discarded product in a new product with the same function.
REPURPOSE	Use discarded product or its parts in a new product with a different function.
RECYCLE	Process materials to obtain the same (high grade) or lower (low grade) quality.

The R-strategies are not mutually exclusive. Repair can enable reuse. Refurbishment can prepare components for remanufacturing. Repurposing may require prior repair. Recycling may complement reuse when structural reintegration is no longer feasible.

Circularity in composites does not emerge from a single “R” — it emerges from the intelligent integration of all six.

Within EuReComp, the application of the R6 strategies follows a material-specific logic:

- For **EoL GFRP waste**, the project prioritized repair, refurbish, and repurpose pathways. Given the comparatively low cost of virgin glass fibres and the limited economic viability of recycling routes.
- For **EoL CFRP components**, the project focused explicitly on advanced recycling strategies, aiming to recover high-quality recycled carbon fibres for integration into second-generation composite products.



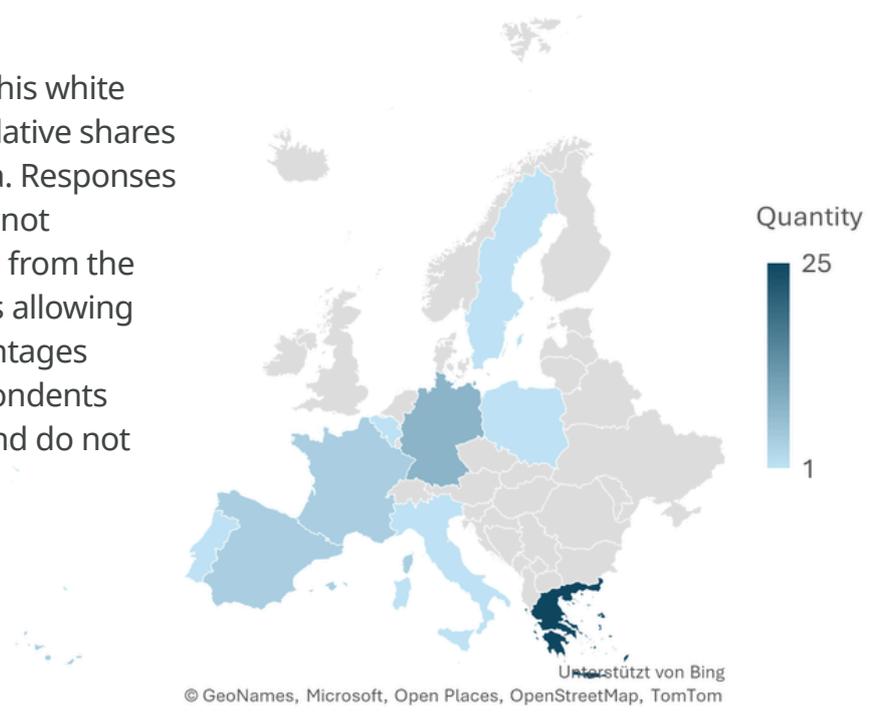
Survey Insights & Data Visualization

From October 2024 to May 2025, we conducted a public survey asking people about status of the recycling and circularity of (large) thermoset composite components. This section presents the consolidated findings of the stakeholder survey. In total, 128 participants took part in the survey, 34% of these participants completed the survey in full. The participants came from 11 different countries.

Respondents represent the entire composite value chain, including material manufacturing, processing, application of FRP's and End of Life management with a predominance of material manufacturing and processing. Participating organizations operate across multiple sectors, with particularly strong representation from the materials and chemical industry, mechanical and plant engineering, and construction. Additional contributions come from aerospace as well as waste management and recycling, reflecting the broad industrial relevance of thermoset composites and circularity challenges. Organizations range from SMEs to large industrial companies, alongside public institutions and research centers. Many of them operate at European or global scale, highlighting the international structure of composite value chains and circularity efforts.

Respondents are predominantly engineers, technical specialists, and managers, as well as representatives from research and education. Most have backgrounds in mechanical and process engineering, materials science, recycling, or related technical disciplines, ensuring responses are based on professional and practical expertise.

All quantitative results in this white paper are presented as relative shares based on aggregated data. Responses labelled as 'no answer' or 'not completed' were excluded from the calculations. For questions allowing multiple selections, percentages indicate the share of respondents selecting a given option and do not sum to 100 percent.



Technical aspects

Key statements:

- Recycled materials already widely used—but not yet universal
- Capability gap for large FRP structures
- Technical challenges remain high across key circularity processes
- Recycling is the most frequently selected EoL strategy
- Material Complexity Limits Circular Design Potential

Recycled materials already widely used—but not yet universal

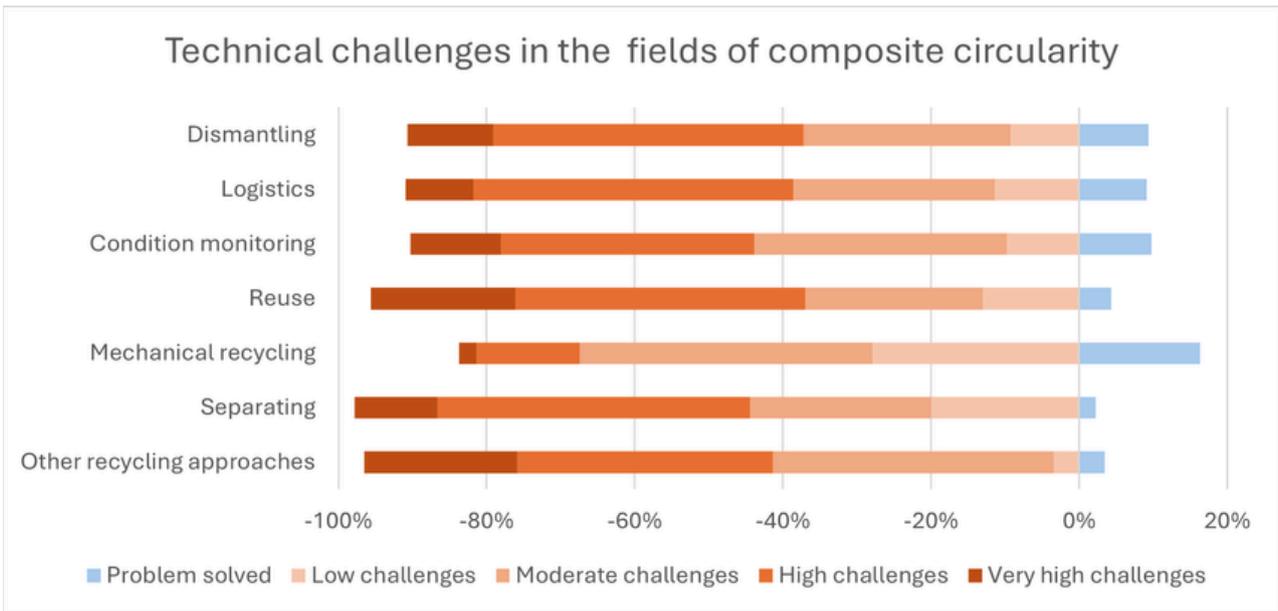
A clear majority of respondents (60 %) already use recycled materials in their products, demonstrating tangible progress toward circular material flows. However, 22 % reported not using recycled materials, and a notable 17 % were unsure. This indicates that while adoption is well established among leading actors, there remains a significant share of organizations at an early stage or lacking transparency regarding material inputs.

Limited capability to process large End-of-Life (EoL) structures

Nearly half of respondents do not process large-scale EoL composite structures at all. Only 9 % can process components in their original size, while 17 % rely on segmentation and 7 % can handle both approaches. The relatively high “not sure” rate (19.0%) further suggests limited organizational integration of EoL handling processes. This points to a critical infrastructure and capability gap in managing large composite waste streams, such as wind turbine blades or large structural components.

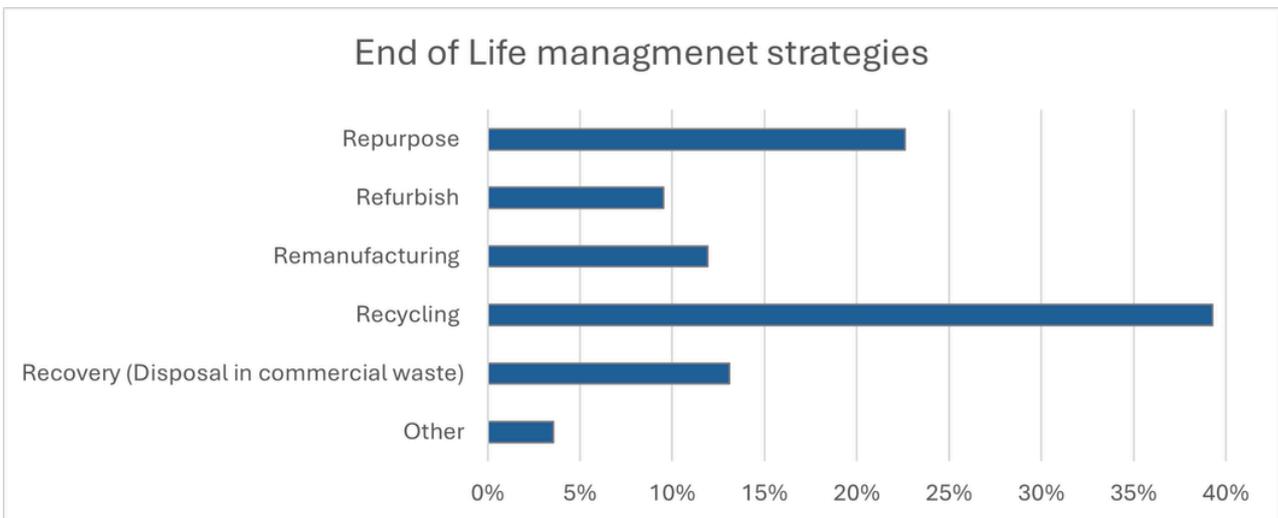
Technical challenges remain high across key circularity processes

Respondents identified dismantling, logistics, separation, and reuse as particularly challenging. These fields were most frequently rated as involving high or very high technical challenges, reflecting the complexity of composite structures, material heterogeneity, and limited standardization. Separation processes and logistics in particular appear to be major bottlenecks, emphasizing the need for improved design for disassembly, automated dismantling technologies, and optimized reverse logistics chains. In contrast, mechanical recycling appears comparatively more mature. This suggests mechanical recycling is currently the most established and operationally feasible recycling route for FRP, although limitations in material quality and reuse applications remain.



Recycling dominates end-of-life strategies, but higher-value options are emerging

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Material Complexity Limits Circular Design Potential

Material diversity within composite products continues to present a major challenge for circular design. While 54 % believe reducing material variety is feasible with moderate or major efforts, 42 % see no realistic chance of reduction. Only 4 % consider reduction possible without effort. This highlights structural constraints related to performance requirements, multi-material construction, and legacy product designs.

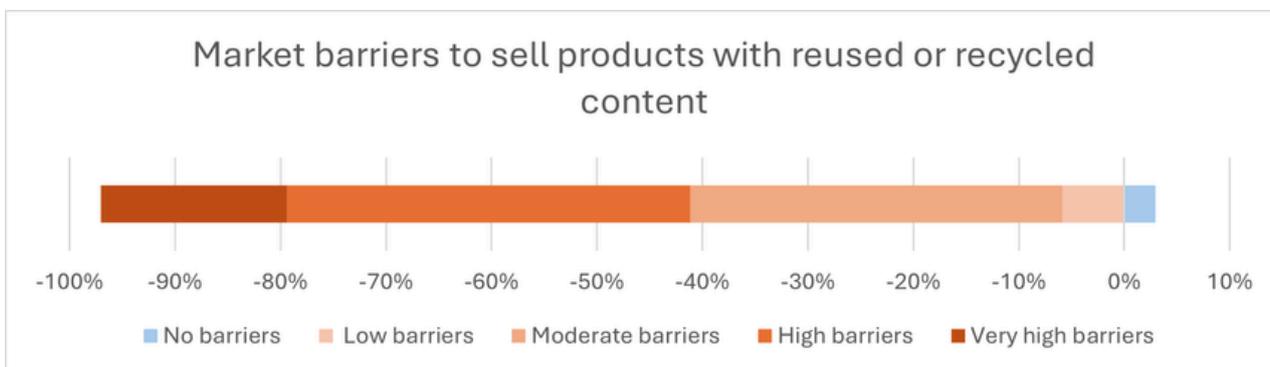
Market-related aspects

Key statements:

- Market barriers exist but are rather moderate
- Demand for recycled composite products has increased significantly
- Regulatory standardization identified as the most important improvement measure

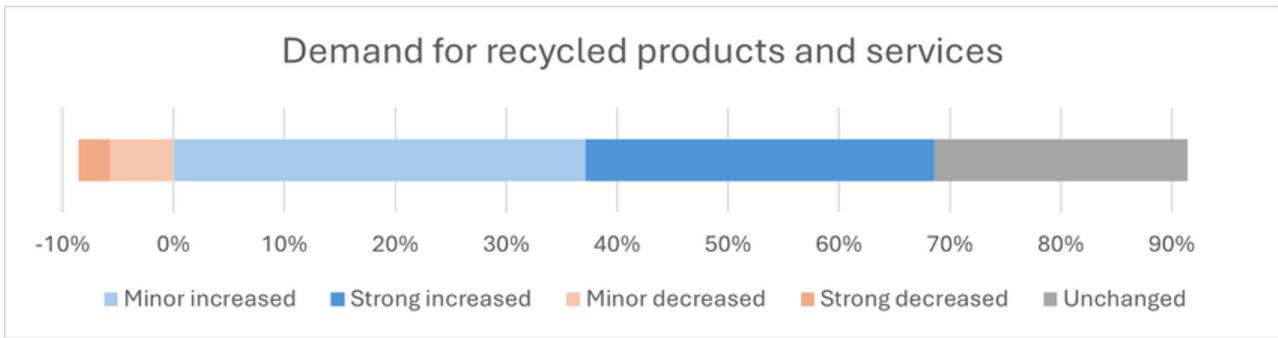
Market barriers exist but are rather moderate

Most respondents perceive market barriers as present but not prohibitive. The largest share (38 %) reported low barriers, followed closely by 35 % indicating moderate barriers. Only a small proportion of organizations experience high or very high barriers, while 18 % reported no barriers at all. These findings suggest that the market environment for recycled and reused composite products is increasingly favorable. However, the persistence of moderate barriers for more than one-third of respondents indicates ongoing challenges related to market acceptance, pricing competitiveness, certification requirements, or customer confidence in recycled materials.



Demand for recycled composite products has increased significantly

The survey reveals a clear positive demand trend over the past five years. A strong majority of respondents reported increasing demand, including 37 % observing a minor increase and 31 % reporting a strong increase. Meanwhile, 23 % saw no change, and only 9 % experienced declining demand. This trend confirms that circular composite solutions are gaining traction in the market and that customer awareness and acceptance of recycled materials are growing. The increasing demand provides a strong economic foundation for further investments in recycling technologies and circular product development.



Regulatory standardization identified as the most important improvement measure

Respondents identified regulatory and market standardization as the most critical lever to improve End-of-Life management and circularity. The most frequently selected priority was the standardization of regulatory frameworks (25%), including measures such as defined recycling quotas, harmonized emission regulations, and clearer international trade conditions. Market standardization more broadly (19%) and government incentives (18 %) were also identified as key enablers. These measures could help create a level playing field and improve investment certainty. In addition, respondents highlighted the importance of accelerating technological implementation (17 %) and improving supply chain coordination (13 %). These findings underline the need for stronger collaboration between manufacturers, recyclers, and downstream users to enable efficient circular material flows. Only a small minority (7 %) saw reduced bureaucracy as necessary to improve.

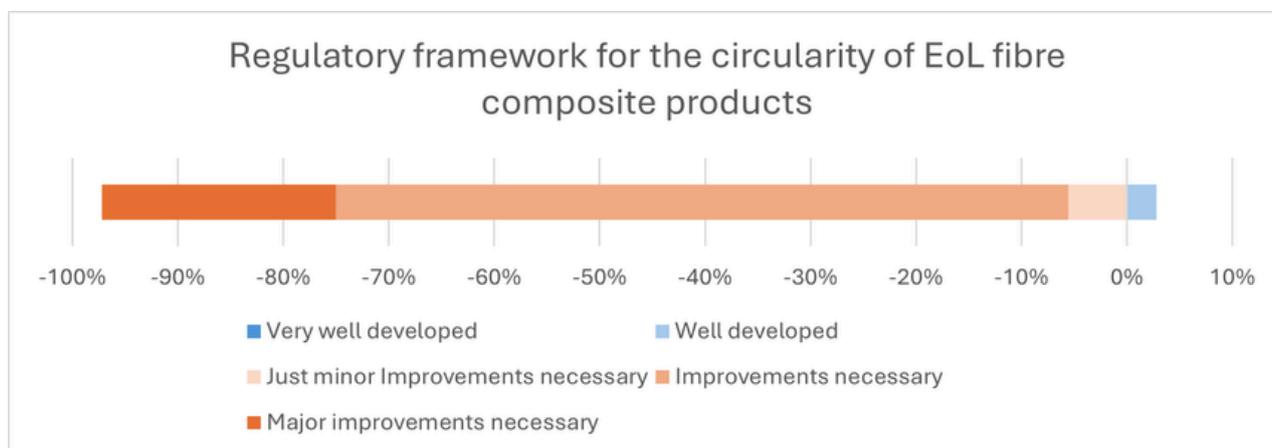
Political & legal aspects

Key statements:

- Regulatory framework widely perceived as inadequate
- Strong support for uniform recycling rates, product passport and mandatory take-back systems
- Standardized circularity labels considered essential

Regulatory framework widely perceived as inadequate

An overwhelming majority of respondents believe that the current regulatory framework requires significant improvement. Nearly 70% stated that improvements are necessary, while an additional 22 % consider major improvements necessary. Only 6 % believe that minor adjustments are sufficient, and just 3 % consider the framework well developed. Notably, no respondents rated the regulatory framework as very well developed. This result highlights a clear consensus that current regulations do not adequately support the circularity of fibre-reinforced composites. Key issues likely include regulatory fragmentation, lack of clear recycling targets, inconsistent international rules, and insufficient economic incentives.

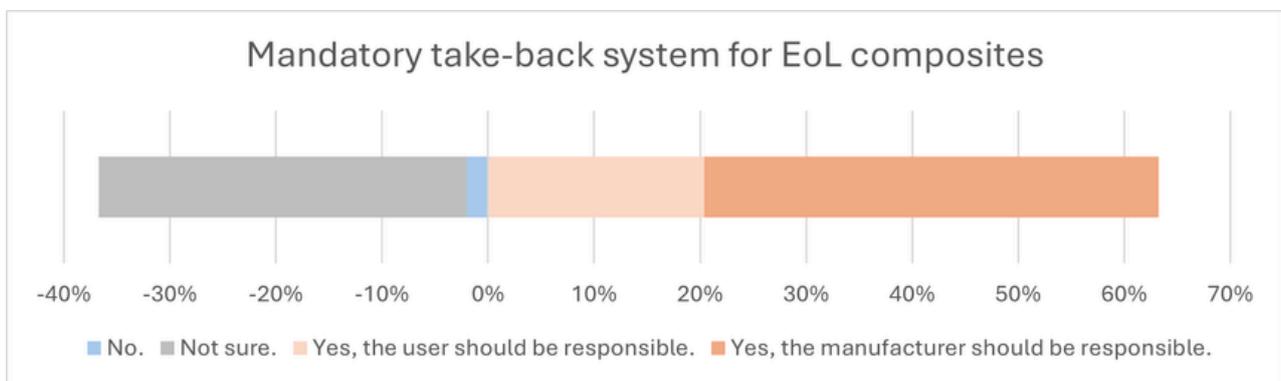


Strong support for uniform recycling rates, product passport and mandatory take-back systems

The survey results show strong support for regulatory measures that improve transparency, responsibility, and standardization in composite circularity. A clear majority of respondents support the introduction of uniform recycling rates for composites, with 81 % in favor and only 19 % opposed. This indicates broad agreement that harmonized recycling targets could provide regulatory clarity, ensure fair competition, and create stronger incentives for investment in recycling infrastructure.

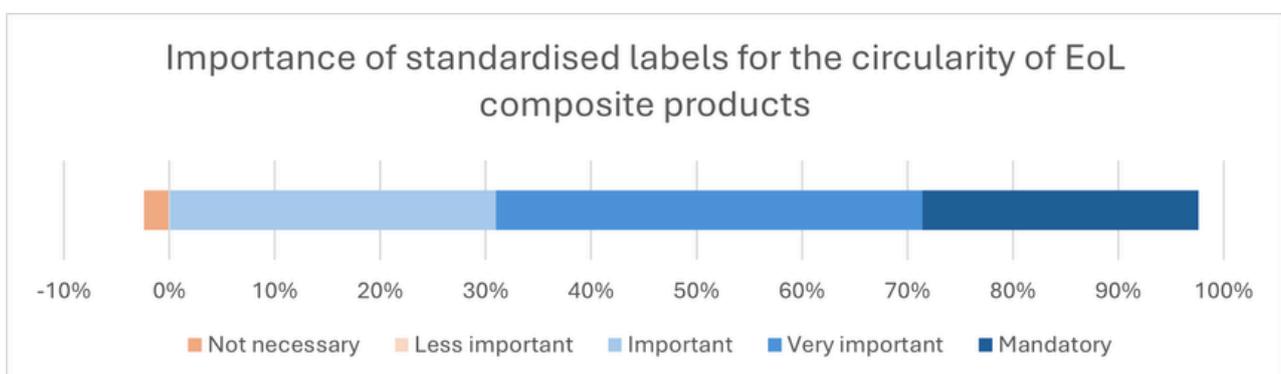
Support is even stronger for the introduction of digital product passports. Nearly 90 % of respondents favor digital passports containing material information, while only 10 % oppose them. This reflects a strong recognition that improved material transparency is essential for efficient sorting, recycling, and lifecycle management of composite products.

There is also considerable support for mandatory take-back systems. Most respondents believe such systems would be beneficial, with 43 % assigning responsibility to manufacturers and 20 % to users. Only 2 % oppose take-back systems entirely. However, a relatively large share (35%) remains uncertain, suggesting that while the concept is widely accepted, questions remain regarding practical implementation and responsibility allocation. These findings suggest strong alignment with the principle of extended producer responsibility.



Standardized circularity labels considered essential

Standardized labelling for composite circularity is widely seen as critical. Two-thirds of respondents consider such labels either very important or mandatory. Only 2 % believe labels are not necessary. This strong support highlights the importance of clear, standardized information to enable market transparency, facilitate recycling, and build trust among customers and stakeholders.



Specialist training & further education

Key statements:

- Developed skills mostly on a good basis, but knowledge gap in the field of legal framework
- Priority competence areas: Circular economy, LCA, and technical recycling expertise
- Significant shortage of skilled workers

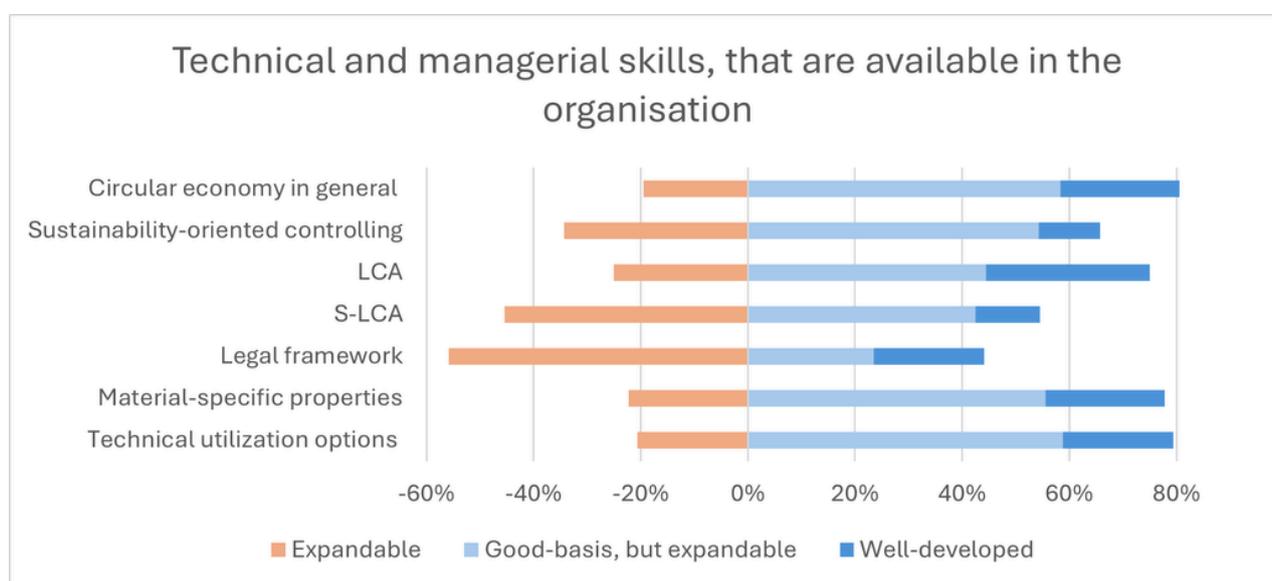
Developed skills mostly on a good basis, but knowledge gap in the field of legal framework

Across all assessed competence areas, most respondents indicated that current expertise provides a good basis but still needs expansion. This is particularly evident in:

- Technical utilization options
- Material-specific properties
- Circular economy in general
- Sustainability-oriented controlling

This indicates that organisations have established initial competencies but require further development to fully support circular composite systems.

However, some areas show more pronounced knowledge gaps. The legal framework stands out as the weakest area, with 56 % of respondents stating that competencies remain significantly expandable and only 21 % considering them well developed. Similarly, Social Life Cycle Assessment (S-LCA) shows a substantial need for development, with 46 % reporting expandable knowledge and only 12 % rating competencies as well developed. Life Cycle Assessment (LCA) shows comparatively stronger maturity, with 31% of respondents indicating well-developed expertise, suggesting that environmental assessment methods are already relatively well established in many organizations.

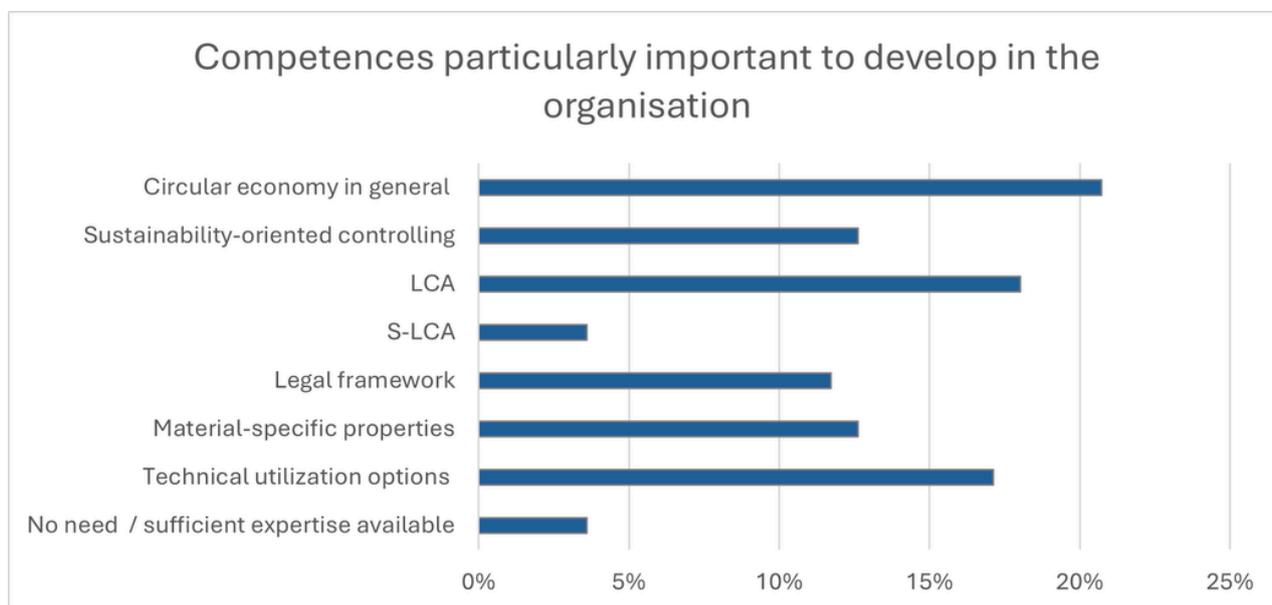


Priority competence areas: Circular economy, LCA, and technical recycling expertise

When asked which competencies should be prioritized in the coming years, respondents highlighted several key areas:

- Circular economy in general
- Life Cycle Assessment
- Technical utilization and recycling options

Only a small minority indicated that no additional competence development is needed, confirming that workforce upskilling is widely recognized as essential for enabling circular composite systems. These findings demonstrate that organizations are seeking both strategic competencies (such as circular economy integration and sustainability management) and technical expertise (such as recycling technologies and material behavior).



Significant shortage of skilled workers

One of the most critical findings relates to workforce availability. Only 17 % of respondents reported that they can recruit qualified personnel without difficulty. In contrast, 44 % can meet their staffing needs only with extended recruitment periods exceeding six months, and 40 % cannot meet their demand for skilled workers at all. This means that more than 80% of organizations face delays or shortages when recruiting qualified personnel in composite recycling and circularity roles.

This shortage represents a major bottleneck for scaling circular composite solutions, as technical implementation depends heavily on specialized expertise in materials science, recycling technologies, sustainability assessment, and regulatory compliance.



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