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Succeed with Quality

Sustainability & climate protection

Successfully implementing a circular economy

The role of innovation, quality standards & digitalization

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Background: a dynamic organizational context

Circular economy (CE) in the Sustainable Development Goals (SDGs)

Since the **UN's 2030 Agenda resolution on sustainable development**[1], governments and companies have increasingly been addressing the 17 Sustainable Development Goals (SDGs). Specifically, **SDG 12** "Ensure sustainable consumption and production patterns" with its **targets** of (1) reducing the generation of waste through prevention, recycling and reuse and (2) an environmentally sound handling of chemicals throughout their entire lifecycle, represents the foundation of a circular economy.

Figure 1: 2030 Agenda and SDG 12

Circular economy at a regulatory level

The shift towards a circular economy (CE) can be seen at various levels:

- **Self-regulation via standards:** new norms and standards such as ISO/TC 323 "Circular economy"
- **Existing legal framework conditions:** e.g. Ecodesign Directive, REACH Chemicals Regulation, Taxonomy Regulation
- **Political programs:** Circular economy programs for changes in the legal framework conditions (see Table 1, page 4)
- **Political consultation processes:** national and European multi-stakeholder processes with the objective of consulting on policies regarding a circular economy (see box on right-hand side)

Ongoing political consultation processes in which the Quality Austria endowed Institute for Integrated Quality Design is currently participating

In Austria, a multi-stakeholder process known as the "UniNEtZ"[7] **project** is currently taking place, with the objective of creating a so-called options report by the end of 2021 that elaborates **political options for action for the federal government** to implement the 2030 Agenda.

Similarly, a policy development process is also taking place in the form of the **Circular Economy Initiative Deutschland,** which has the mission of devising a roadmap for a sustainable circular economy.

Political programs for a circular economy

Program	Vision and objectives	Selected topics (focus)
European Green Deal (2019)[2]	■ EU with a resource-efficient market & without greenhouse gas emissions ■ CE strategy for resource-intensive sectors	■ Reliable sustainability information for consumers ■ Increased recycling of waste ■ Promotion of return and collection systems
New Circular Economy Action Plan (2020)[3]	■ Expansion of the CE to achieve climate neutrality ■ Future-oriented agenda for a cleaner and competitive Europe	■ Product design: improvement of durability, reparability and reusability ■ "Right to repair" ■ Increasing percentage of recycled material in products ■ Substitution of hazardous substances
Austrian Government Program (2020)[4]	■ Combating climate change & creation of a sustainable location for business ■ CE strategy for energy-intensive sectors and waste management	■ Promotion of repair and reutilization ■ Program to avoid the creation of waste & food waste ■ Model regions for CE ■ Expansion of returnable systems
Action Plan: Financing Sustainable Growth (2018)[5]	■ Promotion of sustainable investments ■ Legal framework for an environmentally friendly CE	■ In the Taxonomy Regulation[6], the transition to a CE, waste prevention and recycling is one of six objectives that defines a sustainable investment.

Table 1: Political programs for a circular economy (selection) – own diagram

The circular economy as a motor for innovation and quality

The necessity of sustainable development

From a natural scientific perspective, several **planetary boundaries** – the emission of greenhouse gases, the nitrogen inputs to soils and the global loss of biodiversity – **have already been exceeded.** Globally, 50% of greenhouse gas emissions can be traced back to the extraction and processing of primary raw materials. As a result, climate neutrality in the EU by 2050 will not be possible without the implementation of the circular economy (CE)[3]. ISO standardization also sets the course in this direction with the ISO 14001 as well as the guideline ISO CD 14009.
One thing is clear: the **cost of inaction** is considerable. This is why appropriate concepts are now necessary for a swift transition to sustainable development. The management of this transformation will require new key competences in companies (see the white paper on sustainability management in German by Quality Austria).

From conformity to an opportunity and driver for innovation

In the **traditional view of management**, an environmentally friendly approach is often seen primarily as a cost driver, which is why the optimum extent of environmental and social actions seldom goes beyond regulatory compliance.

The **circular economy (CE)** approach goes well beyond this, and views sustainability challenges as **innovation opportunities for the development of new products, processes and business models**[8]. This allows for an embedded perspective on the economy, environmental protection and regional employment.

Maintaining or even increasing quality through cycling

As a conceptual extension of the established **life cycle approach**, the objectives of the CE are aimed at keeping products, components and materials in cycles of usage that are stable, closed and as permanent as possible. In this way their **quality is maintained or even improved**. Therefore, the CE does not represent a “recycling economy” in the narrow sense. The resulting system perspective requires a stronger **focus on life-cycle services** including maintenance, repair, remanufacturing and high-quality recycling. The basic logic of the CE thus promises the replacement of resource-depleting, energy-intensive and environmentally harmful production of new goods/materials with more service-intensive and regionalized value creation aimed at circulating existing products/materials. At the same time, this also ensures the stable availability of *critical* raw materials.

Six steps to a circular economy

The experiences from the **quality**austria Institute for Integrated Quality Design (IQD) show that six **central approaches** are required for the successful **implementation** of a circular economy:

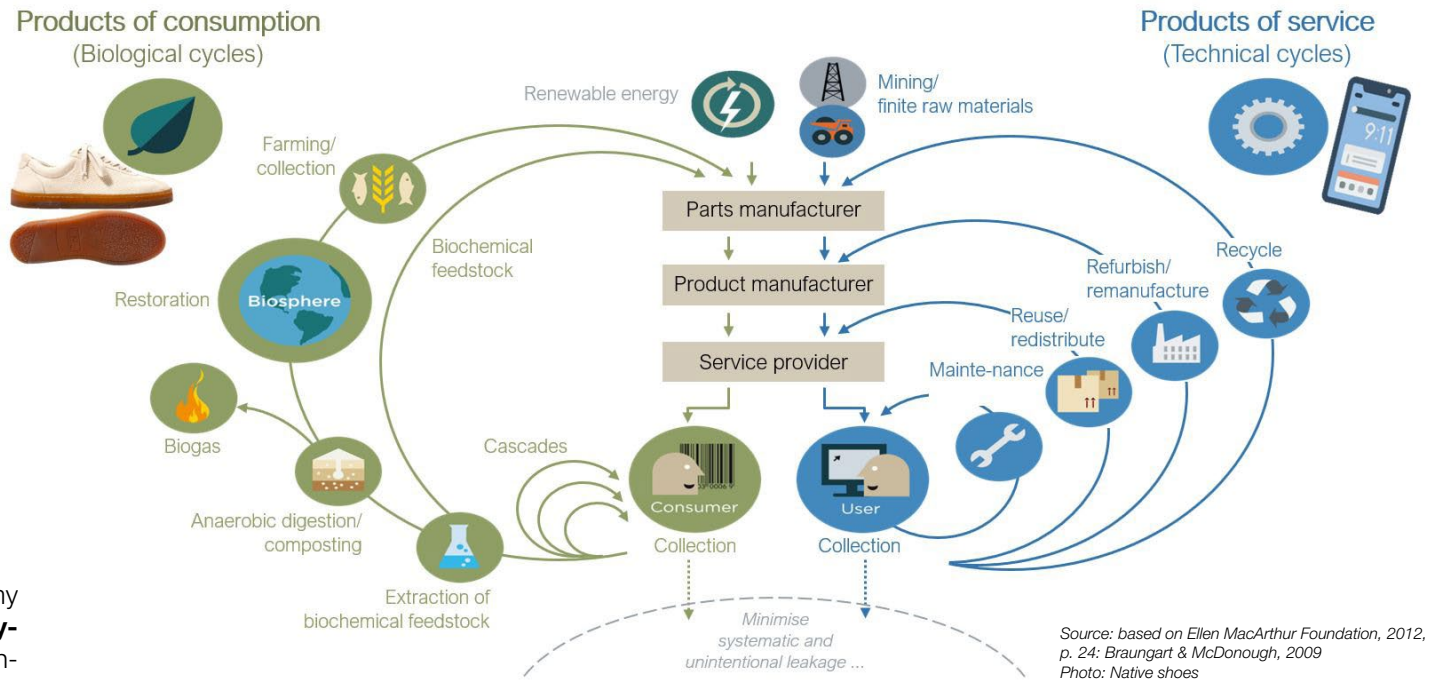
1. Create holistic quality via circular strategies
2. Adapt product designs
3. Make use of new product and process certifications
4. Develop circular service operations through vertical integration and partnerships
5. Transform business models for higher levels of service
6. Harness digitalization as an enabler for intelligent cycling

In what follows, these approaches will be expanded upon in detail.

Quality comes full circle

Two types of circular strategies

The new reference framework for a circular economy differentiates between **technical and biological cycles**, and thus goes well beyond classic waste management concepts.



Source: based on Ellen MacArthur Foundation, 2012, p. 24: Braungart & McDonough, 2009
Photo: Native shoes

Figure 2: The butterfly diagram by the Ellen MacArthur Foundation has become established as a central framework – based on EMF[9]

Biological cycles for *products of consumption*

- Circular strategies: products / components that enter the environment via compost streams, due to abrasion or uncontrolled disposal should be designed for complete biodegradability throughout their life cycle (e.g. biogenic raw materials).
- An extension of the life cycle also applies to products in the biological cycle. Regardless of the objective of recirculation back into the biological cycle, technical cycles should be made use of before.

Technical cycles for *products of service*

- Circular strategies: maintenance / repair (incl. upgrading), reuse, remanufacture/ refurbish and recycling – these are prioritized in descending order with regard to the preservation of the product integrity and the associated ecological benefit (from inside to outside in Fig. 2).
- The majority of products are being “used” instead of consumed: users, rather than consumers, are at the centre of focus
- The value proposition to the users is at the forefront and thus requires a stronger focus on life cycle-oriented services

In both types of cycle, the **elimination of pollutants** from products and materials (so-called substances of concern) takes on a pivotal role, since these lead to a reduction in quality (e.g. toxic recycled material), risks to customers and to occupational health and safety issues (e.g. toxic exposure during product teardown).

New competences

... from linear thinking towards a circular way of thinking

In order to implement these thoroughly complex and cross-organizational processes, new competences in companies are required. These predominantly social and cooperative skills are difficult to imitate and are thus well-suited for generating long-lasting competitive advantages in the market:

- Close coordination between the departments for **product design and (after-sales) services**.
- Development of **cyclical infrastructures and processes** that are integrated into the corporate procedures in a cross-functional manner.
- The narrow focus on sales transactions at the point of sale needs to be expanded to **suitable service business models** with continuous user contact.
- Collaboration that **spans multiple value chains and sectors** is required.
- **Digital technologies** are enablers for cross-department and cross-organizational processes.

Product design as a foundation for circularity

Designing products for circularity

In a circular economy, materials should be designed in a way allowing their continuous cycling in closed loops without a loss of quality. When transferred to practice, this means that companies need to **be familiar with all the components of their products** and optimize these for a circular economy.

The challenge here is covering the entire value chain including the subcontractors.

Material transparency enables comprehensive quality statements

According to a recent study, three quarters of everyday products made of plastic do not fulfil these criteria. They contain harmful chemicals which, due to an intransparent mix, are usually not even identifiable[10].

To profitably implement a true circularity throughout multiple loops without a loss of quality, companies must first create **transparency on the composition of their products**. Based on this, statements can then also be made with regard to the product quality.

A "simple" product such as a cleaning agent – conceived of as a product of consumption for the biological cycle – already racks up around 100 ingredients. If one then looks at the significantly more complex packaging, which is geared toward technical cycles, this quickly becomes 300 elements that have to be tested as to their suitability and potentially also optimized for closed-loop cycles.

THE CRADLE TO CRADLE © PRINCIPLE
Take – make – regenerate

© Werner & Mertz

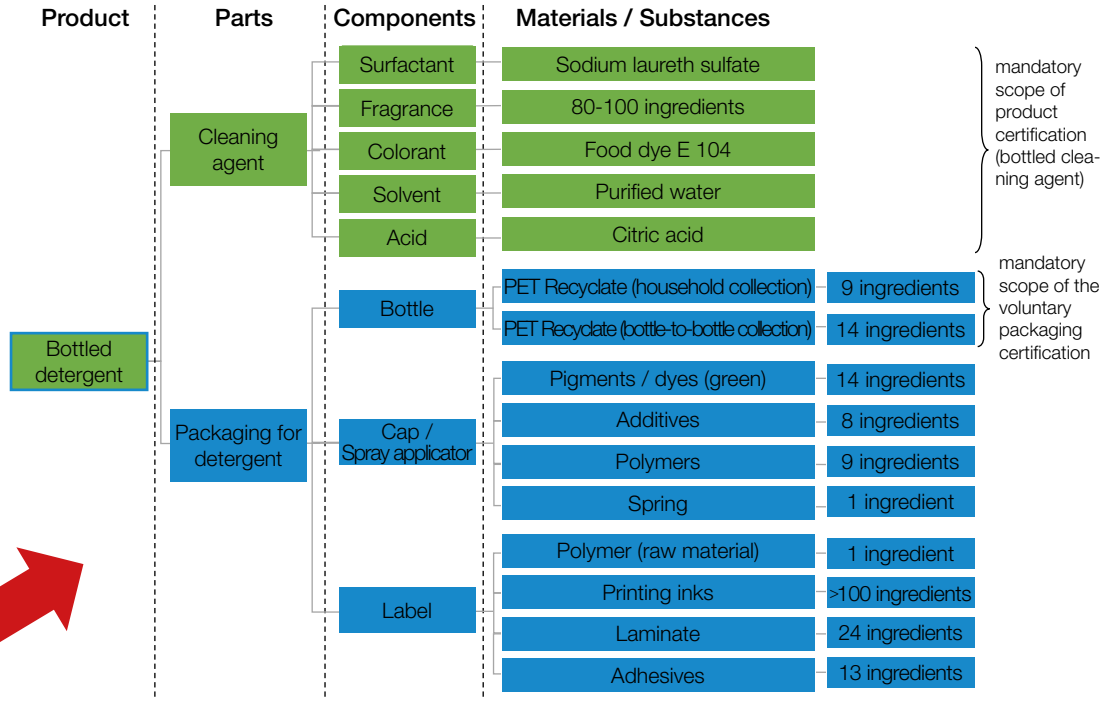


Figure 3: Example of product composition: detergent – source Hansen & Schmitt[11]

Cradle to Cradle® certified products standard

Five certification criteria for a comprehensive assessment

Cradle to Cradle Certified™ is the first comprehensive certification standard for a circular economy. It provides certification for innovative product performance under consideration of five criteria (see Table 2).

Criteria		Description
Material Health	Material Health	use of **human and ecotoxicologically safe** materials
Material Reutilization	Material reutilization	**actual cycling** of the materials used (e.g. use of recycled materials)
Renewable Energy	Renewable Energy and Carbon Management	product-specific company performance in relation to the use of **renewable energies**
Water Stewardship	Water Stewardship	product-specific company performance in terms of **responsible handling of water**
Social Fairness	Social Fairness	Product-specific company performance with regard to **social standards** in production

Table 2: Cradle to Cradle certification criteria – source c2ccertified.org[12]

Further certification and system approaches for a circular economy

Beyond this, there are additional certification and system-oriented approaches with regard to specific cycles that can support quality and environmental management. A selection of these is depicted on the following page.

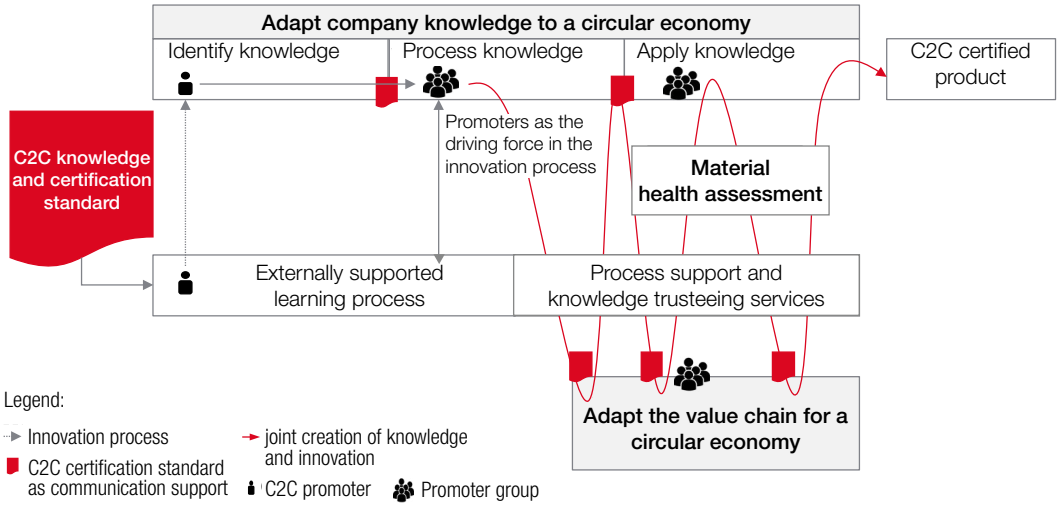


Figure 4: Cradle to Cradle innovation process – source Schmitt[14]

The C2C innovation process (see Fig. 4):

The requirements of the Cradle to Cradle standard can be used by companies as direct **incentives for innovation**[13]. With this in mind, the standard can support companies in obtaining a profound understanding of a circular economy and can be used to develop a shared understanding of the innovation objective with suppliers and other partners[11].

The core factors for success include:

- Identifying employees with interest in Cradle to Cradle as promoters in all departments, networking them and equipping them with the freedom to innovate.
- Developing suppliers and partners in order to close material loops.
- Providing resources for external support in building up a circular value network.
- Aligning the corporate and innovation strategy with a circular economy in the long run.

Quality Austria has offered training and certification products in the area of Cradle to Cradle since 2019: Cradle to Cradle® training and ISO concepts for the promotion of a circular economy

Standardization activities & certifications

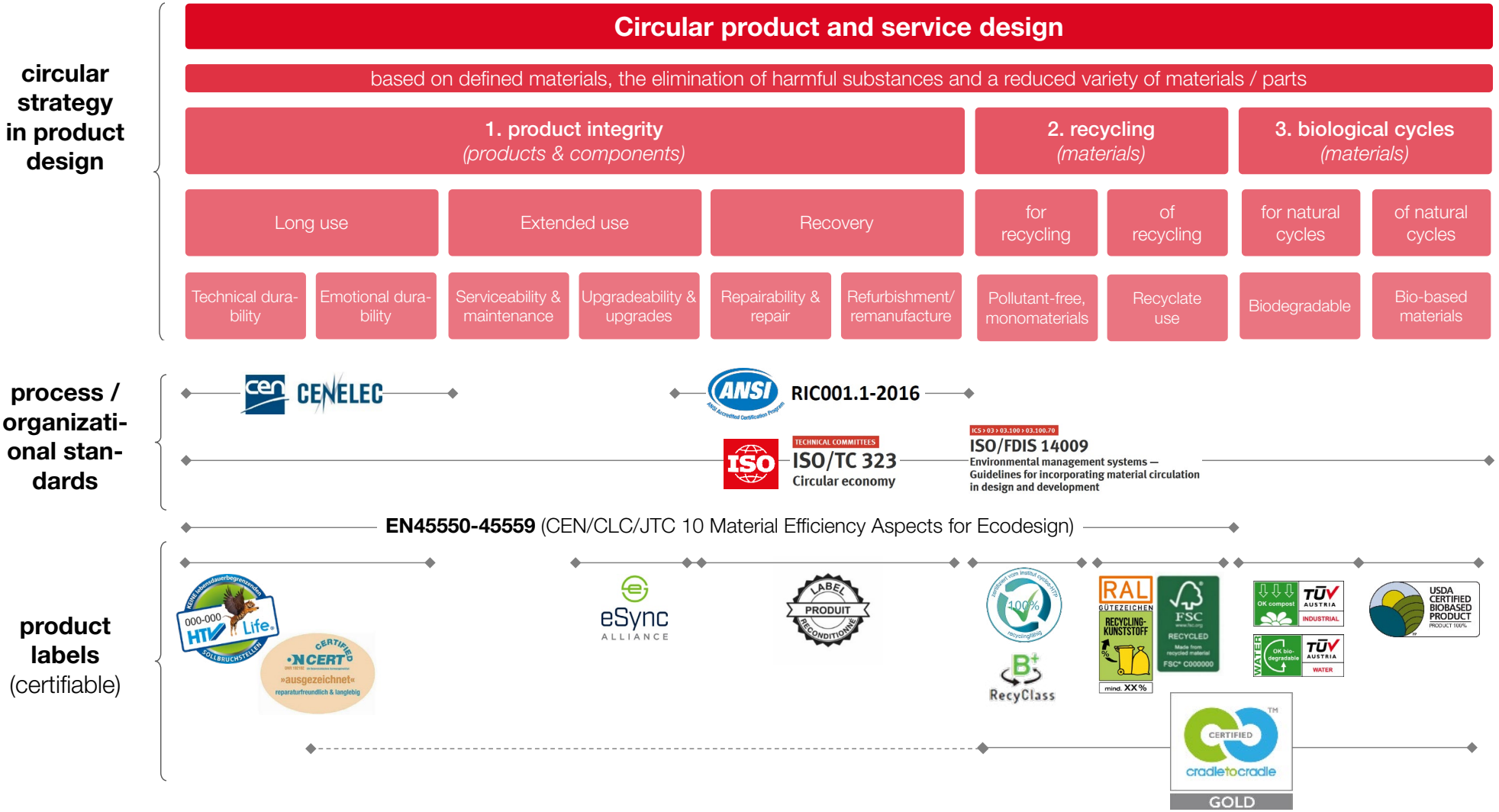


Figure 5: Standardization activities and possible certifications – own diagram

Strategic integration of circular services

Circular value creation architectures

In the operative implementation of a circular economy, companies need to establish new processes and infrastructures for circular services. Against this backdrop, organizations face the classic question of **"make or buy?"** (Fig. 6). The posing of this strategic question leads to four new **value creation architectures** (and associated changes in position in the value creation cycle) that make it possible to free up the opportunities and potentials of a CE:

- **Make:** Companies can establish proprietary systems and can thus develop their own circular competences, e.g. in repair or collection processes. This enables holistic cycling and provides competitive advantages.
- **Ally:** Strategic partnerships or equity investments in specialized service providers are conducive to individual cycles. For example, independent repairers can be certified.
- **Buy:** Classic outsourcing is particularly well-suited to standardized recycling processes. In certain cases, recourse can also be made to public systems (e.g. public collection points for packaging).
- **Do nothing:** The absence of a strategic integration of circular processes can lead to a laissez-faire architecture, in which autonomous third parties exploit the remaining market potential (e.g. in secondary markets).

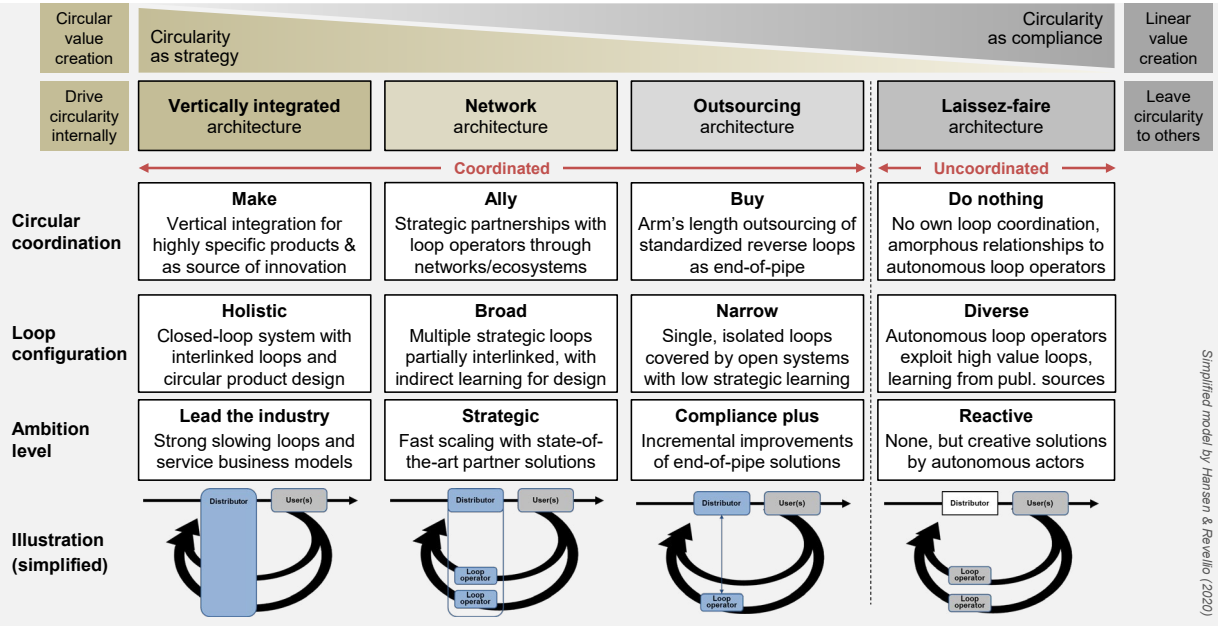


Figure 6: Circular value creation architectures as a strategic guideline – source Hansen & Revellio[11]

Vertical integration increases for higher-quality circular strategies

Companies that aim for **higher-quality circular strategies** (i.e. repair, reuse and remanufacturing) and their **associated competitive advantages** usually strive for greater vertical integration.

- This is particularly due to the higher level of specificity and strategic relevance of these activities for the core business. Accordingly, repair offers have to be closely coordinated not only with product designers, but also with the distribution, whereas by contrast, recycling at the end of the life cycle requires less coordination amongst departments and partners.
- This means that vertical integration enables higher degrees of loop closing (therefore also higher-quality reuse) and better feedback into the product design.

Business model innovation

From product vendor to service provider

Product designs and circular services (e.g. maintenance, repair) necessary for the circular economy can only be successful when manufacturers (and retailers) develop their **business models** more strongly in the direction of services. This can take place to varying degrees:

- **Product-oriented:** Products continue to be sold, but are coupled with comprehensive after-sales offers (e.g. repair).
- **Use-oriented:** Products are now only made available, e.g. via rental, leasing or sharing options.
- **Results-oriented:** Instead of the product, a result i.e. a "performance" is sold (e.g. 10% savings on the total cost of ownership); the provider performs the service with the best possible technology.

Depending on the **actor and their position** in the value creation cycle, this can lead to different types of business models (see Figure 7)[16]. For example, with the business model of "maximizing product uptime", manufacturers can link circular services to the product based on a fee or can provide products to the customer through leasing or "total care". The case study of the Hilti fleet management (see info box) shows how manufacturers can become quality leaders in their industry in this way.
Alongside this producer business model, the study by the German National Academy of Science and Engineering (acatech), in cooperation with the Institute for Integrated Quality Design (IQD), distinguishes between **21 further actor-specific business models** for the circular economy[16].

Case study: Hilti Fleet Management, Liechtenstein

Hilti is a leading direct marketer for premium tools in the business-to-business market. The products are designed with longevity in mind and are marketed together with comprehensive services. The Hilti fleet management service is a total care business model that provides customers with tools as a service in return for a monthly rate. The service includes the use, maintenance, repair and upgrades. Thanks to an innovative Internet of Things-based approach, the tools are increasingly monitored digitally in order to optimize the service (e.g. preventive maintenance)[16].

Actor's main role	Circular strategy	Id	Business model pattern	Service Level (sub-pattern)		
				Product-oriented	Use-oriented	Result-oriented
Supplier (molecules/ materials)		A1	Circular raw materials supplier	Molecule & material recycling	Materials bank	–
		A2	Process molecule service provider	–	Molecule & material leasing	Molecule & material performance
Supplier (mechanical engineering)		B1	Machines/components 'as new'	Machines/components 'as new'	Rental machines/ components 'as new'	Pay per reman machine performance
		B2	Machine/component remarketing	Used machines/ component sales	Rental machines/ components	→ see B1 Pay per reman machine performance
Producer		C1	Proprietary material cycles	Waste cherry picking	Materials bank partnership	–
		C2	Product 'as new'	Selling Products 'as new'	Product leasing 'as new'	→ see C6 Total care producer
		C3	Used product remarketing	Used product sale	–	–
		C4	Out-of-warranty repair service	On-demand repair	→ see C6 'Leasing producer'	→ see C6 Total care producer
		C5	Upgrades, spares & accessories	Modules & accessories shop	Upgrade subscription	–
		C6	Maximising product uptime	Fee-based maintenance	Leasing producer	Total care producer
Retailer & service points		D1	Retailer as cycle manager	Retailer as cycle manager	→ see C1 Materials bank partnership	–
		D2	Retail remarketing & reman	Used goods on sale	Rent-a-wreck fleet manager	–
		D3	One-stop shop (retail)	Integrated service point	Rental retail	Total care retail
Repair provider		E1	Repair gap exploiter	Repair transaction	Repair-based rental	–
Prosumer		F1	Prosumer support system	Do-it-yourself repair	Peer-to-peer sharing	–
Logistics provider		G1	Material reverse logistics	–	–	Pay per recycling logistics performance
		G2	Refurb logistics services	–	–	Pay per refurb performance
		G3	Spare parts management	–	–	Pay per spare part performance
Recovery manager		H1	Revitalised products	Used goods bargain	–	–
		H2	Coordinator of informal collection	Fair-trade recyclates	–	–
Intermediary		I1	Recycling platform	Recycling platform	–	–
		I2	Used goods & sharing platform	Used good platform	Sharing platform	–
Emerging actors	All	J1...x	?	?	?	?

Figure 7: Actor-specific CE business model types – source acatech CEID[16]

Digitalizing the cycles: quality 4.0

Smart circular strategies

The increasing intelligence of products and the networking thereof in the Internet of Things allows quality managers to have a broader scope of action than before, enabling them to shape quality across entire value chains[16-18]:

- Digital technologies allow the actors within the value chain (manufacturers, service providers and further partners) to **exchange data and use this data in collaboration**.
- For example, digital technologies can be used to gain **insight into the status, location and performance** of products ("smart use") – even if they are built in as components. This insight improves the **understanding of the customer's business**.
- If data is used beyond the scope of the use phase and for the improvement of the **product life cycle as a whole**, this is referred to as a **smart circular strategy**[17]: Smart maintenance & repair, smart reuse, smart remanufacturing, and smart recycling (see Figure 8).
- Companies with **service business models** will find it easier to offer services for these intelligent cycles.

Smart products provide companies with **direct information on their use, material flows and customer requirements**.

Based on this information, **quality managers** can apply advanced quality methods for the designing of smart circular strategies, and thus enable **lower costs** or **greater customer benefit**.

Better feedback into product design as a competitive advantage

The insight gained and made digitally available in the maintenance, repair, remanufacturing and recycling processes can help to identify possibilities for improvement in the product, component and material design, and thus serves as a basis for valuable feedback to the research and development department (R&D) – the continuous improvement process is therefore accelerated.

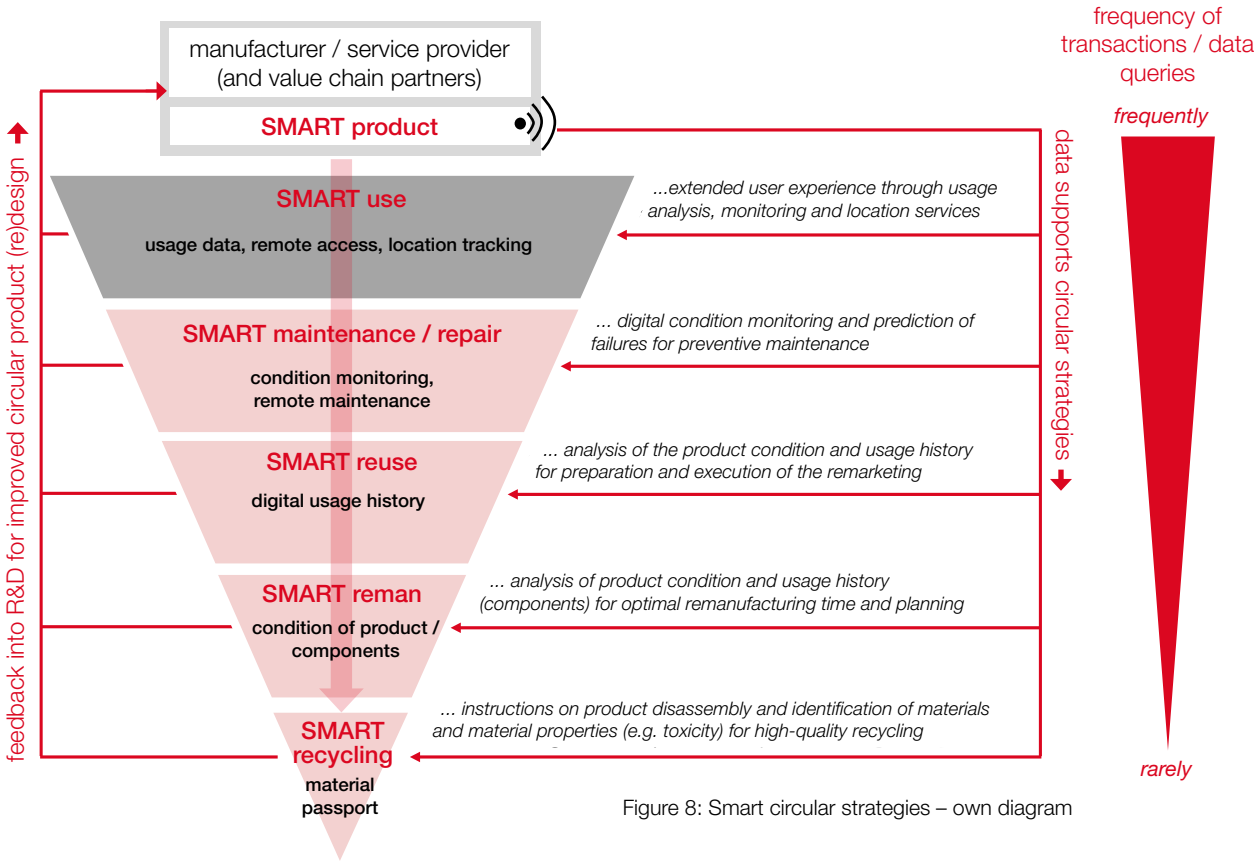


Figure 8: Smart circular strategies – own diagram

Best practice: smart remanufacturing at SKF

Performance business model "rotation for life"

The company AB SKF is a leading manufacturer of rolling bearings. SKF has developed the performance business model "rotation for life", in which the products are made available to the customers for a monthly fee.

The service package consists of training, lubrication system management, condition monitoring, root cause analysis, routine checks and maintenance, as well as the remanufacturing of rolling bearings. This regular remanufacturing replaces the new production, lowers costs and enables an attractive pricing structure for the customers. Then, the all-in-one package results in **long-term customer relations and additional sources of income**.[19,20]

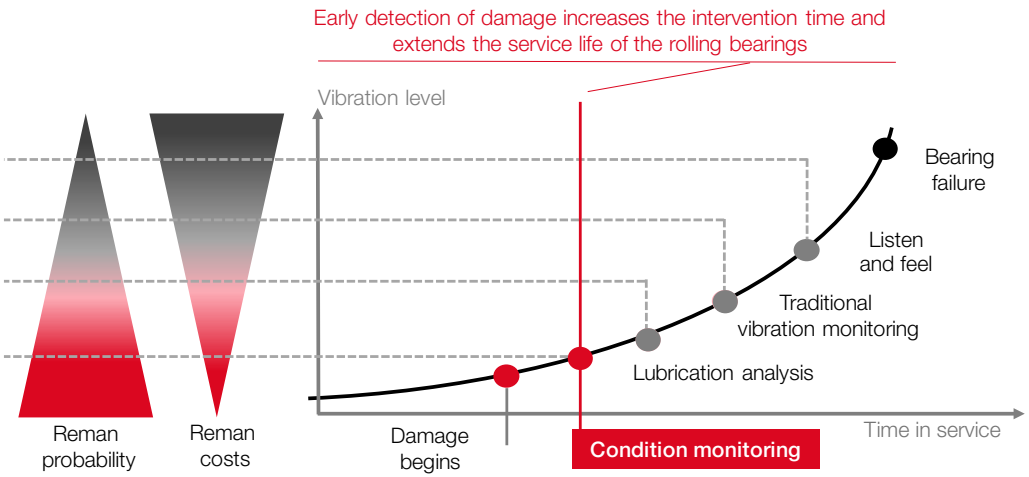


Figure 9: Smart remanufacturing at SKF – own diagram based on SKF[19,20]

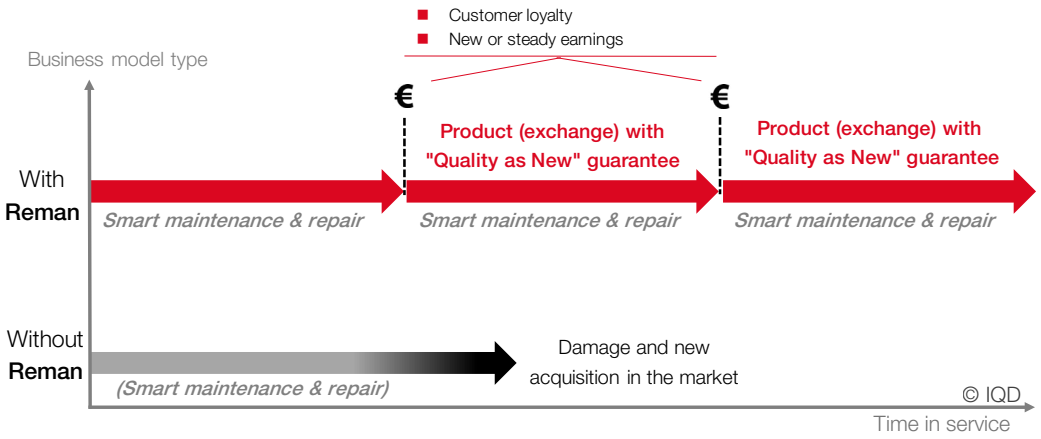


Figure 10: Product exchange with "like-new quality" guarantee – own diagram

Quality 4.0 as a driving force

- By using smart components and **condition monitoring**, SKF is able to **detect disturbances in advance** in order to replace the rolling bearings and remanufacture them long before severe failures occur.
- This enables **costs reductions** and **increases the likelihood** that a remanufacturing of the bearings is technically possible (Figure 9).
- Bearings can be remanufactured multiple times and are thus considerably cheaper. This facilitates an **attractive pricing structure**.
- The product exchange, with its "quality as new" guarantee, and the associated remanufacturing become a **pivotal competitive advantage** for the company (Figure 10).

A **performance business model** with digital technologies enables the exchange of the bearing with a "quality as new" guarantee, as well as the remanufacturing of old bearings at the optimum point in time.

Conclusion

Circular economy as an opportunity – the bottom line in 6 points

1. National, European and global **framework conditions** show a **very dynamic development in the direction of a circular economy**. We are seeing the rise of a new urgency for companies to adjust to this shifting organizational context. They must do so both in order to remain legally compliant as well as to be one step ahead of the changed framework conditions and **reinforce their competitiveness by differentiating themselves** in the market.
2. **New quality challenges and potential for value creation** arise in the circular economy, on the one hand through technical cycles for products of service (maintenance, repair, reuse, remanufacturing and recycling), and on the other through biological cycles for products of consumption (biodegradability based on biogenic raw materials).
3. **Product design is the basis of quality in the circular economy**: materials, components and products have to be designed specifically for recirculation. New product quality characteristics can be distinguished in the market using certifications such as Cradle to Cradle.
4. Based on product designs that are fit for circulation, **circular services** (e.g. repair) are made possible and can then be offered by the providers via **vertical integration** (make) or **partnerships** (ally). As a consequence, the position of the providers in the value creation cycle is also altered. In this way, experiences gained from the circular services can be incorporated back into the product design.
5. In order to offer the necessary circular services in the circular economy, **product, usage and performance-oriented services** are required, as are corresponding adjustments to the business models.
6. **Digital technologies** – especially smart products and the networking thereof – are an **enabler** when it comes to optimizing or even enabling circular services such as maintenance, repair, reuse and remanufacturing.

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More about the IQD here: https://www.qualityaustria.com/en/company/institute-for-integrated-quality-design/

Sustainability from the perspective of the circular economy was also picked up as a trend in the “Quality 2030 Future Radar” (Quality 2030 project) - background information on the **study** can be found here: https://www.qualityaustria.com/news/qualitaet-2030-was-steckt-dahinter (in German language)

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