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BRIEF REPORT

A framework of circular business models for fashion and textiles: the role of business-model, technical, and social innovation

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ABSTRACT

The textiles production and consumption system is a priority product-value chain for the European Commission in its 2020 Circular Economy Action Plan. The Action Plan foresees a European Union strategy for sustainable textiles in a circular economy with the aim of creating markets for sustainable and circular textile products, services, and business models. The European Environment Agency (EEA) and its Topic Center on Waste and Materials in a Green Economy (ETC/WMGE) have shown that consumption of clothing, footwear, and household textiles in Europe is on average the fourth highest category of environmental and climate impacts from a consumption perspective and from a vantage point that considers the entire life cycle. The fashion industry is responsible for more than 60% of total textiles used and clothing is expected to remain the largest application of textiles in the future. To enable a sustainable and circular textiles system, a transformation of fashion production and consumption is needed. This transformation requires innovation in business-model design, technology, and social practices through the adoption of specific policy making, education, and behavioral change enablers. In this Brief Report, we present a framework to map and advance the implementation and scaling of circular business models. This is illustrated by exploring four different circular business-model approaches for fashion and textiles, including models based on product durability; access models based on renting, leasing, and sharing; garment collection and resale; and recycling and reuse of materials. For each business-model type, we discuss enablers based on technical and social innovations and policy, behavioral change, and education.

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Circular economy; sustainable consumption and production; fast fashion; European Union strategy for sustainable textiles; sustainable garments; circular business models

Introduction

Textiles and fashion play an important role in the European economy and contribute to job creation within Europe and abroad. At the same time, garment production and consumption patterns generate significant and growing negative environmental, climate, and social impacts. Among all consumption domains in the European Union (EU), consumption of clothing, footwear, and household textiles is the fourth highest pressure category from a consumption perspective for use of primary raw materials and water, the fifth highest for greenhouse-gas emissions, and the second highest for land use after food production (EEA 2019a). Globally, the fashion industry is the second largest consumer of water (1.5 trillion liters per year), responsible for about 20% of industrial water pollution (GFA 2017), and contributes up to 35% (190,000 metric tons per year) of oceanic primary microplastic pollution (UNCC 2018; EEA 2021a). According to different estimates, fashion production and consumption generate between 4 and 10% of global carbon-dioxide (CO_2) emissions (up to 1.7 billion metric tons annually) (Niinimäki et al. 2020; GFA 2020). Furthermore, many textile and fashion workers in the world are paid poverty wages and are subjected to conditions that breach international labor, health, and safety standards (HCEAC 2019; Remy, Speelman, and Swartz 2016).

To reduce the negative impacts of textiles while generating business opportunities and safe and just employment, circular business models can be implemented to keep products and materials "in-the-loop" for longer, allowing for extended use, repair, reuse, repurposing, and recycling, through the adoption of emerging technical and social innovations (EMF 2017; EEA 2021b). However, circular business models will require effective policies and changes in consumer behavior, among other enablers.

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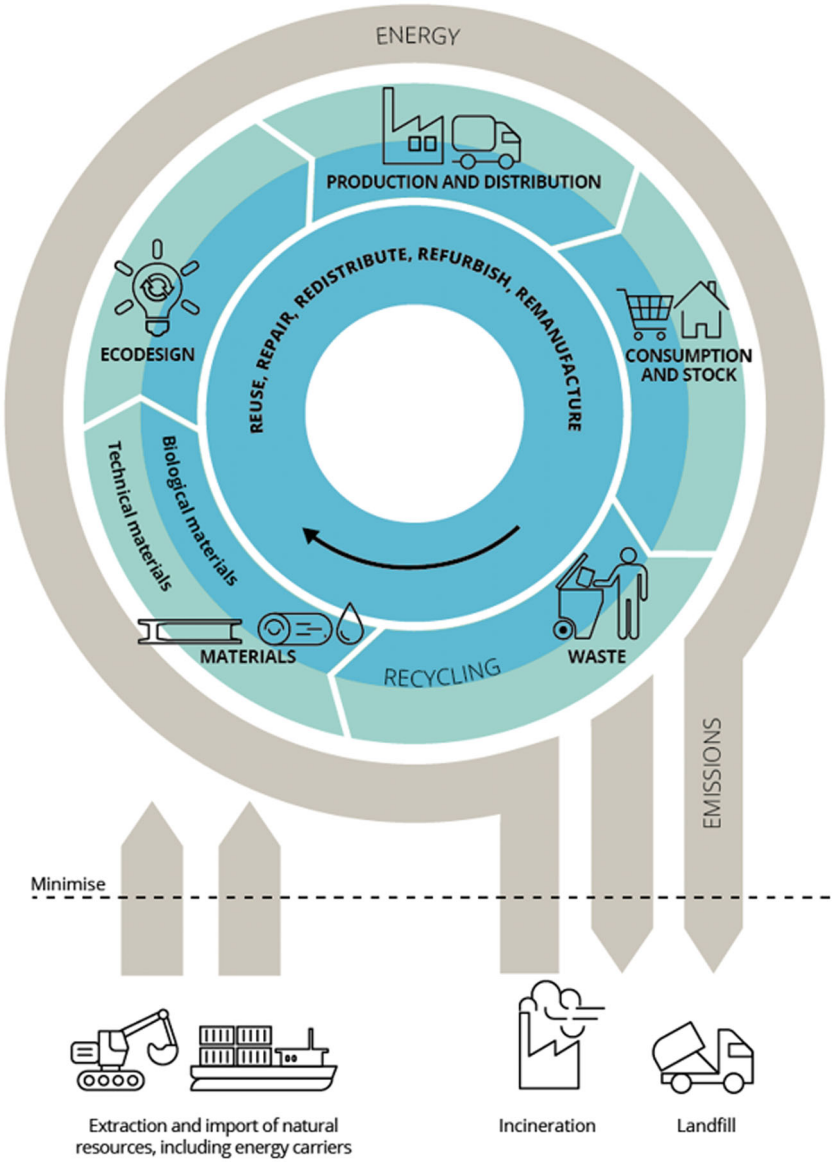

Figure 1. Simplified representation of a circular economy. *Source*: EEA (2021b).

Despite the increasing emphasis placed on circular economy and circular business models, for example in the European Commission's 2020 European Union Circular Economy Action Plan, only a limited number of tools have been developed so far to help navigate the rapidly evolving arena of circular business models and innovations, as well as for assessing circularity (EC 2018). Furthermore, besides addressing how innovations can be built into circular production and consumption patterns, there is a need to analyze how different enablers can support the scaling up of circular business models and increase their viability and market penetration. Collaboration across society by governments, companies, and consumers alike is essential to achieve truly systemic change and to accelerate the implementation of a circular economy by implementing innovations and circular business models.

In this vein, the European Environment Agency (EEA) developed a representation of the circular economy that focuses on different phases in a product's lifecycle and the flow of materials and energy throughout it (EEA 2016). This representation was further developed in a report of the EEA Topic Center on Waste and Materials in a Green Economy (ETC/WMGE) (EEA 2019a) and in a briefing by the EEA (EEA 2019b). In this Brief Report, we describe a further evolution of this circular economy representation into a framework to describe and analyze circular business models in order to map and advance their implementation and scaling up. As an illustration, we apply the framework to the fashion and textiles sector, with a specific focus on the role of innovation at multiple levels, and on interactions between innovations, policy, and educational and behavioral change enablers. This framework, introduced in the EEA ETC/WMGE report "Business Models in a Circular Economy" (EEA 2021b), constitutes an orienting rather than a restrictive tool to study circular

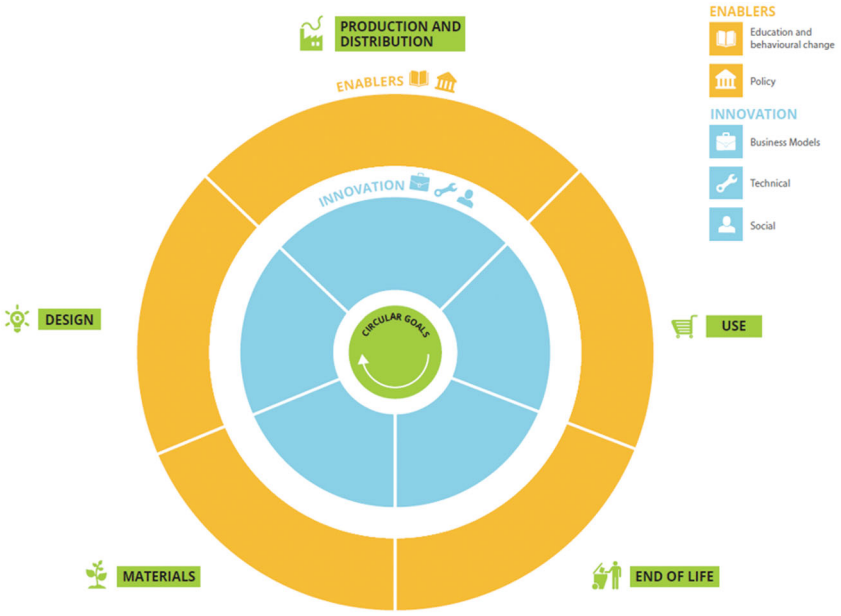

Figure 2. Framework for business models in a circular economy. *Source*: EEA and ETC/WMGE.

business models together with their systemic context. It is applied to explore potential business models for a circular fashion system, including a menu of options and needed transformations. This is useful to navigate the broad range of business models and technological and social innovations emerging in fashion and textiles. The framework can be used to map existing initiatives that aim to create circular business models and to identify which innovation aspects and/or enablers need to be addressed and/or are still missing. This discussion provides a basis for building and implementing coherent strategies for systems transformation: from the development of innovative products and processes to the mitigation of negative impacts.

Business models in a circular economy: a conceptual framework

The circular economy is one fundamental alternative to the linear take-make-consume-dispose economic model. This linear model aims at continuous economic growth and assumes (incorrectly) unlimited abundance of resources with widespread availability and access, as well as unlimited capacity of the environment to absorb waste and emissions. Instead, the circular model aims at minimizing resource inputs to the economy by reducing the use of new materials for production and extending the lifetime of existing products. This is possible through combining technical innovations, such as developing materials with less environmental impact and more efficient production processes, with new forms of consumption, such as longer use or service-based models, or by promoting the repurposing, reusing, and recycling of products and materials.

A business model broadly describes how a business proposes, creates, delivers, and captures value for its customers and its wider group of stakeholders (Magretta 2002; Richardson 2008). A circular business model can be defined as one that acts within closed material loops (Mentink 2014) or one that combines the creation of economic value with the narrowing, slowing, or closing of resource loops (Bocken et al. 2016; Lewandowski 2016). Overall, circular business models can be seen as the means to realize circular goals such as longer use, reuse, or recycling, supporting the transition to a circular economy (EEA 2021b). Similarly, they can assist in the implementation of the 9R strategies for increasing circularity of the economy introduced by Potting et al. (2017), as they are based on smarter product use and manufacture (refuse, rethink, and reduce), extended lifespans of products (reuse, repair, refurbish, remanufacture, and repurpose), and useful application of materials (recycle and recover).

Among many representations of a circular economy, a simplified one has been developed by the EEA and introduced and discussed first in the 2016 report "Circular Economy in Europe" (EEA 2016) (Figure 1). In this depiction, circular economy goals are at the center of circular flows of materials (middle circle in Figure 1) that circulate throughout subsequent product-life cycles such as material extraction, design, production, distribution, consumption, and waste. Goals and materials are surrounded by another circle, representing circular flows of energy. Elements to be minimized are also represented, and these are emissions, incineration,

landfilling, extraction, and import (in the European context) of natural resources.

This representation has been further developed into a framework in the EEA ETC/WMGE report "Business Models in a Circular Economy" (EEA 2021b) where further levels (or circles) have been added, representing the innovations and enabling conditions that are needed to realize a circular economy (Figure 2). The framework has circular goals at the center (repair, reuse, recycling, and so forth), and it is structured into different life cycle phases (materials, design, production and distribution, use, and end-of-life). Innovations are shown in the first circle around the center (in blue in Figure 2), and are divided into three categories: business models, technical innovations, and social innovations that can contribute to the achievement of a circular goal(s) in a life cycle phase. A second circle is built around enablers (in orange in Figure 2), representing policy making, education, and behavior-change components which support the implementation and uptake of innovations, so they can scale up and foster a system transition.

In this framework, we can refocus business models as a mean for implementing circular goals and placing business-model innovation in the context of two other important innovation dimensions – technical and social. Technical (or technological) innovation can be defined as an iterative process initiated by the perception of a new market and/or service opportunity for a technology-based invention. Technological inventions thus need to be integrated into new markets and adopted by customers and users to be considered as innovations. Furthermore, being iterative, innovations are not static and imply cyclical improvements and reintroduction of inventions, as well as iterative adaptation processes by markets and users (Garcia and Calantone 2002; Griffin and Page 1993; Freeman 1991). Social innovations encompass the emergence and adoption of new solutions and processes that meet a social goal(s), while simultaneously reconfiguring behavior and modes of collaboration, thus leading to new or improved capabilities and relations, better use of assets and resources, and new organization models in addition to the development of new social norms that, once diffused and adopted, can lead to social change (Pue, Vandergeest, and Breznitz 2016; Howaldt, Kopp, and Schwarz 2016; EEA 2021b). Overall, both technical and social innovation are described as processes instead of end-states or linear strategies for business development. In addition to analyzing business models in the context of technical and social innovation, the framework acknowledges and emphasizes the importance of policy, education, and behavioral change to enable innovation.

We apply the framework to the circular textiles system. The reason for this decision is that textiles have been identified as a key value chain in the EU Circular Economy Action Plan due to their considerable environmental impacts and potential for improved circularity. We analyze the following four approaches of circular business models for textiles, which are based on different principles of circular economy and often highlighted in the literature (e.g., Bocken et al. 2016):

- *Longevity and durability:* This business-model approach is focused on extending the lifetime of garments, thus reducing the need for purchasing new items and allowing for various modes of reuse. It is often combined with design for repair, customized production for promoting emotional product attachment, and offers of repair and maintenance services.
- *Access-based models:* These business models are based on renting, leasing, and sharing of garments. Examples include renting of workwear or hospital or restaurant linen, single-occasion clothing (including wedding or dinner dresses), and baby clothes (including reusable diapers) or leasing everyday-wardrobe sharing. Access-based models aim to lower resource utilization by increasing the use rate of the product stock.
- *Collection and resale:* Business models related to resale focus on extending the useful life of textiles beyond the first user. Textile-collection and resale models include secondhand retail as well as collection and resale to the market for reuse and recycling.
- *Recycling and reuse of materials:* These models emphasize turning textile waste into raw materials to produce new textiles. They involve reusing parts and cuts and producing recycled fibers for re-spinning and use in other products.

While not covering the whole range of possible business models in circular textile systems, the approaches above represent examples that are built around different circular economy principles. Each of them depends on multiple levels of innovation and relies on the design and implementation of enabling policies, as well as on education and behavioral change. Taken together, they contribute in different ways to the achievement of the goals of a circular economy (reuse, repair, redistribute, refurbish, and remanufacture). Via these examples, we aim to showcase how the framework described in this Brief Report can be used to map multiple elements that compose circular business models,

identifying connections between these elements and informing the definition of implementation strategies.

Business approaches toward a circular fashion

Approach I: longevity and durability

Current models of fast fashion imply cheaper garments, rapidly refreshing collections, and decreasing garment quality and durability. Over 70% of the climate impact of the fashion sector is generated by upstream activities, including raw material production, preparation, and processing. The remaining 30% is associated with downstream activities involving transport, packaging, retail, use, and end-of-use (GFA 2020). Furthermore, some impact categories for the fashion sector, including land use and negative social impacts (e.g., exploitation, unhealthy working conditions), are completely related to production. While extending the lifetime of garments involves more washing and drying – which increases energy use, water use, and use of detergents to maintain clothes for longer periods – these impacts can be offset by reduced volumes of production and waste. For example, lengthening the average life of clothing by nine months enables an approximately 30% annual reduction in carbon emissions, water use, and waste generation (WRAP 2017).

Circular business models based on longevity and durability seek to extend both the quality of garments and their lifespan through longer and multiple uses. In other words, these circular business models include strategies to enhance physical attributes (textile quality), as well as emotional durability of garments (how long people stay in love with their clothes and how long clothes stay in fashion) (WRAP 2017). These improvements reduce the need for buying and producing new garments, limiting environmental impacts and the generation of textile waste. Furthermore, enhancement of longevity and durability could potentially lead to higher product quality which in turn could contribute to greater customer satisfaction with garment purchases, increasing brand attachment and business profitability. Improving physical durability of garments is possible by using quality materials; relying on sturdy assembly methods; setting quality standards; choosing dyes, finishes, and processes to suit selected fabrics (instead of more generic ones); testing for quality; using labels with clear instructions for maintenance and care; and educating consumers to recognize and buy good quality garments (WRAP 2017). In addition, brands or third parties could offer repair and maintenance services and product guarantees.

To enable business models based on durability of garments, policies need to target design choices by defining quality requirements and increasing taxation on less durable products. Such policies should be informed by science-based evidence and existing guidelines that include, for example, the Jeans Redesign Guidelines developed by the Ellen MacArthur Foundation that set out minimum requirements to ensure durability, recyclability, and better environmental and social performances in jeans manufacturing (EMF 2021). Many brands are implementing actions for extending longevity and durability of their garments, for instance by using designs that remain fashionable, building attachment of customers to clothes using (e.g., with storytelling linked to support of social initiatives; see GEA Waldviertler 2020), engaging in environmental projects (Tentrée 2020), and creating personal connections with designers or producers. Emotional attachment to garments can also be built through personalized production such as tailor-made clothes or 3D body-scanning apps and other virtual platforms that also reduce returns from online shopping. There is a need for policies to align with these contributions and to facilitate actions for enabling circular business models for durability. This includes also regulating marketing, minimizing returns, and supporting peer-to-peer technologies, among other strategies.

Most of the above-mentioned options for extending longevity and durability depend on design and rethinking of what is valuable in garments: quality and durability versus low prices. The design stage is fundamental for implementing models based on longevity and durability. Design for attachment and trust, design for reliability and durability, design for ease of maintenance and repair, and design for dis- and reassembly are only some of the possible approaches to implement these business models (Bocken et al. 2016). The increased costs of more durable products can be justified by making consumers aware of future savings from avoiding frequent buying, by complementing the product with after-sale maintenance or repair services, and by facilitating secondhand markets for the product.

Among the enablers to business models based on longevity and durability, consumer behavior is important, requiring education about the economic and environmental benefits of using clothes longer and buying more durable garments, as well as awareness-raising about repair skills and maintenance practices for durability (such as suitable washing guidelines). Policies need to reinforce these potential changes in consumer behavior by actions such as reduced value-added tax (VAT) on repair services (recently introduced in Sweden; see

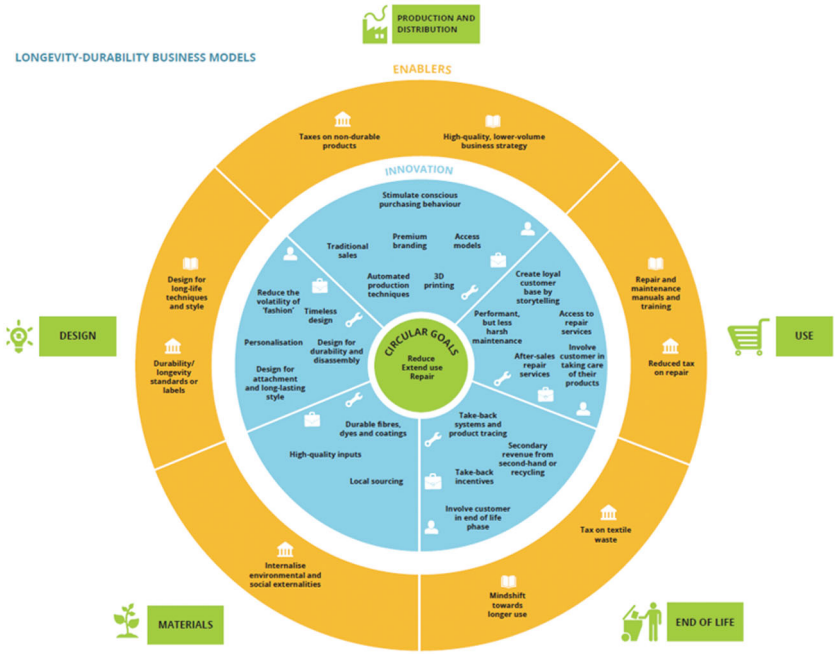

Figure 3. Innovations and enablers for circular business models based on longevity and durability. *Source*: EEA and ETC/WMGE.

Ministry of Finance Tax and Customs Department 2015), eco-design measures, and incentives for green public procurement, among others.

Innovation and enablers for circular business models based on longevity and durability can be represented in our framework (Figure 3), highlighting how these models require changes through the implementation of multiple technological, social, and business innovations in addition to specific policy and behavior-change enablers, along all life-cycle stages. The framework assists in defining coherent strategies that connect multiple levels of innovation with enablers. For example, starting from a technical perspective, innovations in materials and design – such as more durable fibers and design for durability and disassembly – can be combined with novel solutions for production and distribution, such as 3D printing. These changes require new skills in the workforce and alterations in the organization of production and retail. Production innovations lend themselves to integrating personalization tools (for example 3D body-scanning technology implemented on a smartphone) and can facilitate after-sales repair services (for example by reprinting worn-out parts from an existing file). Repair services need to be affordable and available, and consumers need to adopt the habit of choosing repair over buying new items. Such behavioral change can be supported by education, nudging, or marketing practices that embed sustainable behavior into new social norms. All of the above can be enabled within coherent strategies by implementing standards for durability, reducing taxes on repair, and taxing textile-waste production.

Approach II: access-based models

Access-based circular business models transform the way we acquire and use clothes, switching modes of consumption from ownership to use and return. While they mostly require changes in the design, production, distribution, and use stages, they also depend on key innovations in materials and end-of-life management (Figure 4). These models imply renting schemes for clothes and textile services including washing and maintenance, as well as more informal models such as wardrobe-sharing and swapping. The former models make products accessible and affordable to a wider market and are increasingly common for expensive garments used on special occasions. In such models, companies charge consumers with a periodic rental or leasing fee or on a pay-per-use basis. While these models can be combined with traditional business models, broadening the customer base of a business, they do entail a refocusing of business strategies toward providing logistics, take-back schemes, quality control, maintenance, replacement (when needed), and repair services.

Access-based models can reduce consumption by increasing garment-use rates and facilitating better maintenance, which in turn reduce the environmental impacts of production of new garments and can offer micro-business opportunities. However, the impacts of logistics and shipping and taking back garments have to be considered along with possible rebound effects as access-based models could lead to increases in the number of used garments.

Technological innovations that can play an important role in further developing and upscaling

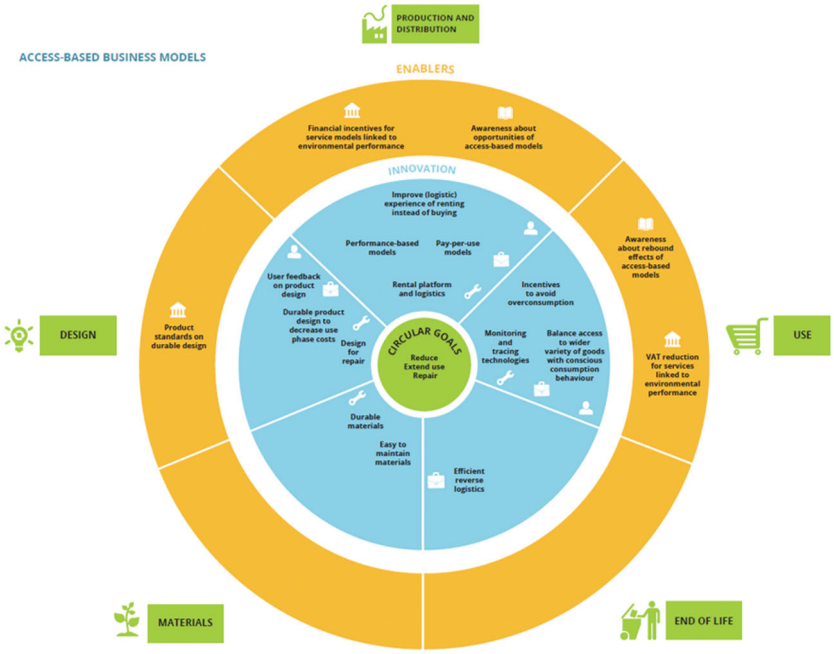

Figure 4. Innovations and enablers for access-based circular business models. *Source*: EEA and ETC/WMGE.

access-based models include more flexible and user-friendly sharing and renting platforms and product-tracking technologies. Development of durable and easy-to-maintain and refurbish materials is also fundamental for offering to customers high-quality products after multiple uses.

To enable access-based models, policies need to reduce taxation on maintenance activities, implement extended producer responsibility (EPR), and provide value-added tax (VAT) exemptions for sharing systems and incentives to startups with a focus on renting or sharing and that promote longer and more efficient use of garments and textiles. A shift to a different set of fashion retail/consumer relations and a change in fashion-buying habits is also needed. While renting provides a reduction in cost for acquiring the garment, it may also involve collateral costs for collecting and returning garments after use and committing to fixed dates for availability and returns (Watson, Gylling, and Thorn 2017).

Innovation and enablers for circular access-based business models can be represented in our framework (Figure 4). The figure highlights how these models require changes throughout all the life-cycle stages, with an emphasis on (and a broader range of options in) the distribution and use phases. In particular, this framework points to the fact that the end-of-life phase is often overlooked in access-based business models. Many access-based models can be rather linear and designed to increase consumption instead of decreasing it (e.g., Levänen et al. 2021). Especially in policy, attention should be paid to not just stimulating access-based models as such, but to make sure that these models live up to their circularity potential by supporting and achieving the closing of material loops. In order to design coherent and comprehensive strategies for implementing access-based models, it is thus not only necessary to link innovations with suitable social change and viable business models. It is also essential to put in place enabling policies and supporting education, allowing for access-based models that stem from more sustainable materials and have reduced impacts at the end-of-life.

Approach III: collection and resale

Closing material loops is a fundamental principle of the circular economy. It is the one stage that turns linear economic models into circular ones (EEA 2021b). As a consequence, business models that target closing the materials loop are the ones most directly associated with the goals of circular economy to reuse, recycle, and reduce. These business models aim to exploit residual value by collecting waste products and preparing them for reuse and recycling, thus reducing the need for new production and virgin-material extraction (Figure 5). However, the extent to which reuse effectively contributes to reduced consumption of new products, or rather enables consumers to acquire additional products, is still unclear and needs to be further assessed. Studies estimate that on average about 60% of clothing reuse replaces new purchases, contributing to reduced consumption (Farfetch 2020; Farrant, Olsen, and Wangel 2010).

Collection of used textiles can be brand-selective (with companies taking back only garments they

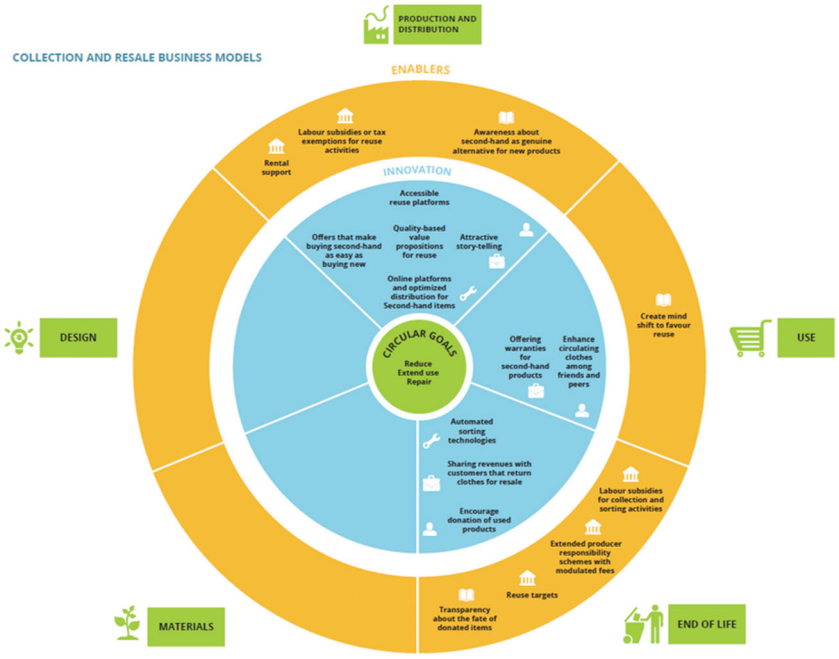

Figure 5. Innovations and enablers for collection- and resale-business models. *Source*: EEA and ETC/WMGE.

have sold in the first place) or unselective (with companies accepting all textiles for collection). Take-back schemes can be operated by the brand itself or by third parties. Collected garments are checked for quality and resold at a lower price. In some cases, customers that provided the used item are compensated with a voucher or part of the resale revenue. Products that are not sold are usually returned to the customer or donated to charities.

Unselective collection of used textiles usually occurs through curbside collection or textile-waste containers operated by waste-management companies or charities. The disposed textiles are sorted, often involving social workers and volunteers, and sold on the global market. Only about 10% of collected items are reused locally (Watson and Palm 2016). In general, a large share of collected textiles is exported for reuse or recycling abroad, mostly in Africa and Asia. Textile-to-textile recycling is negligible (<1%) (EMF 2017) and most recycled textiles are processed into insulation materials (Islam and Bhat 2019).

Similar to what is observed for business models based on renting and leasing, logistics is a major component of business models predicated on collection and resale. Companies aiming to develop such business models typically face considerable costs for collection and sorting while reselling returns relatively low revenues.

Policy enablers for collection- and resale-business models include reducing taxation and providing support to rental services, secondhand retail, collection, and sorting activities, as well as defining and implementing reuse targets. In the EU, for example, the Seventh VAT Directive (2006/112/EC) ruled that secondhand sales should be taxed on the basis of the difference between the purchase and the resale price rather than the full resale price (EEA 2021b). Innovation through automated sorting could lower logistics costs and lead to faster and more effective selection for reuse and up to double recycling rates per year (Ecotextile News 2019). Regional textile-sorting centers can also facilitate collection and can be designed to operate as wholesalers (HCEAC 2019).

From the customer perspective, acceptance of buying and wearing used clothes is still highly variable across countries. Recent consumer surveys and sales trends, however, indicate the possibility for a much larger switch of purchases to the secondhand market. A recent survey by ThredUp (2019) indicates that over the past four years resale has grown over 20 times faster than the apparel market and that today over 40% of consumers consider the resale value of garments and footwear before buying.

One promising option for enabling the resale market is to selectively locate secondhand stores in central shopping areas, making them more visible and contributing to creation of a mind shift among customers and retailers, while stimulating existing businesses to dedicate some of their space to secondhand sales (Watson et al. 2017). With regard to donations, a clothing tax-donation receipt can be created as documentation of charitable clothing donations and used by the donor to claim tax deductions similar to the provision available in the United States.

The EU has adopted an obligation for the separate collection of textile waste by 2025 (Directive (EU) 2018/851). Additionally, the EU Waste Framework Directive stipulates a combined target

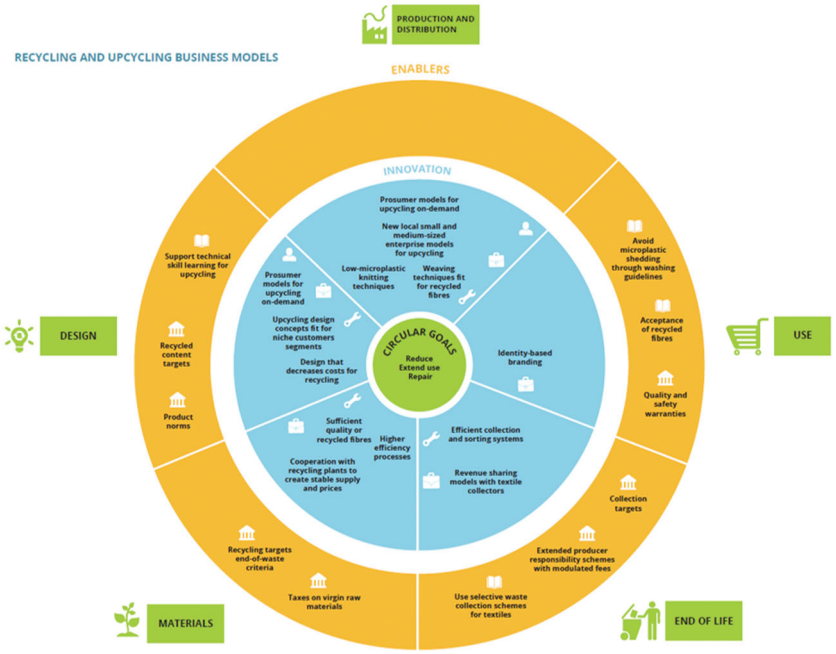

Figure 6. Innovations and enablers for recycling- and upscaling-business models. *Source*: EEA and ETC/WMGE.

for reuse and recycling, and some member states are establishing more specific reuse targets (RREUSE 2016). Schemes based on EPR make producers responsible for bearing the costs of managing garment end-of-life and can increase the collection rate of post-consumer garments (EEA 2019a).

Our framework can assist in defining coherent strategies of collection and resale through the mapping of innovations and enablers in the life-cycle stages from distribution to end-of-life (Figure 5). For example, accessible reuse platforms could allow for enhanced sharing of garments and/or returning end-of-life clothes for resale. All of this can be enabled by increasing awareness about the quality and durability of secondhand clothes, as well as by implementing policies on reuse targets and EPR. However, collection- and resale-business models have to be complemented by recycling and material-reuse models (see the following section) for addressing all of the circular economy goals together.

Approach IV: recycling and material reuse

Textiles account for up to 22% of mixed waste worldwide (Nørup et al. 2019), and 92 million metric tons of textile waste are produced every year (GFA 2017). Fashion consumers today dispose of between 11 and 30 kilograms (kg) of textiles per person each year in European countries, the UK, and the United States (EEA 2019b; Dahlbo et al. 2017; Allwood et al. 2006). One out of every five garments ends up directly as garbage, without ever being sold or used (GFA 2020).

While waste is increasing as a result of fast fashion, textile-recycling rates remain low, partly due to lack of collection and sorting schemes, due to design and manufacturing processes that do not allow for high recyclability (e.g., textile blends) and also due to remaining technical and economic barriers to recycling processes. Globally, the recycling rate of post-consumer textiles was only 15% in 2015, and the share of textiles recycled into similar quality products is below 1%. Over 70% of textiles at their end-of-life are landfilled or incinerated, representing a missed opportunity for enabling circularity and adding value to garment products.

Circular business models based on recycling and reuse turn products that cannot be redeployed for their original purpose into raw materials for (re)manufacturing. This contributes to reductions in resource use in the textile-value chain and the negative impacts associated with the landfilling and incineration of textile waste (Figure 6).

The use of recycled materials can help to highlight value-proposition strategies that can in turn attract a growing, eco-conscious customer base. Some brands even emphasize the recycled content of their garments and make reused fabrics or parts as prominent elements of their product design, labels, product advertising, and marketing.

Looking at reuse of parts and fabrics, the labor-intensive and highly skilled manufacturing process of upcycling is still a barrier for mainstreaming material reuse circular business models (Singh et al. 2019). Training in technical and business-management skills, quality testing, and more effective infrastructure for collecting, sorting, and recycling are some of the areas

where further efforts are needed. Design-knowledge hubs and other physical or virtual platforms to showcase new approaches to design, produce, and market recycled and upcycled garments have the potential to enhance the visibility of innovators for sustainable fashion and amplify learning and sharing of successful approaches and practices for upcycling (e.g., the Closed Loop Fashion Knowledge hub).

Innovation for more effective recycling and design for recycling is also essential. Design for disassembly and using a sustainable material mix can greatly improve garment recyclability. Creative remanufacturing, which uses production leftovers on internal or external sections, to decorate new garments can reduce the use of virgin material by 17% and save about 8,000 kg of CO_2 during the production of 10,000 garments (Runnel et al. 2017). Chemical recycling, which preserves fibers more effectively than mechanical recycling, could increase fiber recycling by over 60%, allowing for the production of 100% recycled garments (Niinimäki et al. 2020).

To enable material reuse and recycling activities, policies need to incentivize the production and retailing of sustainable textile products and, at the same time, disincentive less sustainable ones. Taxes on virgin raw materials and recycled content thresholds need to be implemented to stimulate production modes which take full advantage of the potential of fiber to be recycled (EEA 2019b, 2021b). Taxes and bans on incineration and landfilling of textile waste would support the development of reuse and recycling (EEA 2019a). Clothing labels to encourage recycling of used garments could include a recycling message to a local charity or recycling center.

Innovation and enablers for circular business models based on recycling and material reuse can be represented in our framework (Figure 6). The framework allows for discussing synergies between innovations at different life-cycle stages and across technical, social, and business domains, as well as identifying their enablers, or the lack of them. In the use phase, for example, one enabler that could foster implementation and upscaling is to increase consumer preference for buying recycled garments over virgin-fiber garments. Furthermore, recycling and material reuse business models could be integrated with access-based models and models for increased longevity and durability through, for example, personalization and repairing services.

Conclusion

The development and successful upscaling of circular business models require alignment of different types of technical, social, and business-model innovation, supported by well-designed policy and consumer behavior-change strategies and initiatives across the life cycle. In this Brief Report, we have proposed a framework that integrates these key components for a system transformation into a tool to analyze circular business models in a systemic context. We discussed possible uses of the framework by means of examples of four business-model approaches for textiles and fashion.

Policies are needed to enable changes in consumer behavior and to incentivize more sustainable design and production modes. Many of the policies identified in the framework complement and reinforce each other as well as other changes across fashion-value chains. These policies include durability and longevity standards and labels, taxes on fast-fashion products with short lifetimes, reduced taxes on repair, EPR schemes, and financial incentives to "slow-fashion" companies. In the absence of these policy enablers, behavioral changes and innovations will not succeed in limiting fast-fashion impacts and achieving a circular economy.

A comprehensive policy strategy for enabling textile and fashion circular business models will have to be designed considering the entire life cycle of products, with a focus on supporting new modes of acquisition of garments, creative remanufacturing, remaking, customization, prosumerism, and other emerging solutions for more sustainable fashion. Policies aimed at specific stages of the fashion lifecycle will have reduced impact if not complemented by initiatives at other stages. Policies should also reinforce education enablers and support the development of skills and consumer behaviors in line with different circular models.

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References

Allwood, J., S. Laursen, C. de Rodriguez, and N. Bocken. 2006. *Well Dressed? The Present and Future Sustainability of Clothing and Textiles in the United Kingdom*. Cambridge: Institute for Manufacturing, Cambridge University.

Bocken, N., I. de Pauw, C. Bakker, and B. van der Grinten. 2016. "Product Design and Business Model Strategies for a Circular Economy." *Journal of Industrial and Production Engineering* 33 (5): 451–320. doi:10.1080/21681015.2016.1172124.

Dahlbo, H., K. Aalto, H. Eskelinen, and H. Salmenperä. 2017. "Increasing Textile Circulation – Consequences and Requirements." *Sustainable Production and Consumption* 9: 44–57. doi:10.1016/j.spc.2016.06.005.

Ecotextile News. 2019. "Automated Sorting System Scaled Up," July 12. https://www.ecotextile.com/2019071224490/materials-production-news/automated-sorting-system-boosts-recycling-prospects.html

Ellen MacArthur Foundation (EMF). 2017. *Circular Fashion – A New Textiles Economy: Redesigning Fashion's Future*. London: EMF.

Ellen MacArthur Foundation (EMF). 2021. *The Jeans Redesign: Insights from the First Two Years 2019–2021*. London: EMF.

European Commission (EC). 2018. *Environmental Potential of the Collaborative Economy*. Luxembourg: Publications Office of the European Union.

European Environment Agency (EEA). 2016. *Circular Economy in Europe – Developing the Knowledge Base*. Copenhagen: EEA.

European Environment Agency (EEA). 2019a. *Textiles and the Environment in a Circular Economy*. Copenhagen: EEA – European Topic Centre on Waste and Materials in a Green Economy.

European Environment Agency (EEA). 2019b. *Textiles in Europe's Circular Economy*. Copenhagen: EEA.

European Environment Agency (EEA). 2021a. *Plastic in Textiles: Potentials for Circularity and Reduced Environmental and Climate Impacts*. Copenhagen: EEA – European Topic Centre on Waste and Materials in a Green Economy.

European Environment Agency (EEA). 2021b. *Business Models in a Circular Economy*. Copenhagen: EEA – European Topic Centre on Waste and Materials in a Green Economy.

Farfetch. 2020. *Understanding the Environmental Savings of Buying Pre-Owned Fashion*. London: Farfetch.

Farrant, L., S. Olsen, and A. Wangel. 2010. "Environmental Benefits from Reusing Clothes." *The International Journal of Life Cycle Assessment* 15 (7): 726–736. doi:10.1007/s11367-010-0197-y.

Ministry of Finance Tax and Customs Department (Finansdepartementet Skatte-och tullavdelningen). 2015. *Skattefrihet För Ideell Second Hand-Försäljning (Tax Exemption for Non-Profit Second-Hand Sales)*. Stockholm: Ministry of Finance Tax and Customs Department.

Freeman, C. 1991. "Networks of Innovators: A Synthesis of Research Issues." *Research Policy* 20 (5): 499–514. doi:10.1016/0048-7333(91)90072-X.

Garcia, R., and R. Calantone. 2002. "A Critical Look at Technological Innovation Typology and Innovativeness Terminology: A Literature Review." *Journal of Product Innovation Management* 19 (2): 110–132. doi:10.1111/1540-5885.1920110.

GEA Waldviertler. 2020. "Home." https://gea-waldviertler.de/unternehmen/werkstaetten.

Global Fashion Agenda (GFA). 2017. *Pulse of the Fashion Industry*. Copenhagen: GFA.

Global Fashion Agenda (GFA). 2020. *Fashion on Climate*. Copenhagen: GFA and McKinsey & Company.

Griffin, A., and L. Page. 1993. "An Interim Report on Measuring Product Development Success and Failure." *Journal of Product Innovation Management* 10 (4): 291–308. doi:10.1111/1540-5885.1040291.

House of Commons Environmental Audit Committee (HCEAC). 2019. *Fixing Fashion: Clothing Consumption and Sustainability*. London: UK Parliament.

Howaldt, J., R. Kopp, and M. Schwarz. 2016. "Social Innovations as Drivers of Social Change – Exploring Tarde's Contribution to Social Innovation Theory Building." In *New Frontiers in Social Innovation Research*, edited by A. Nicholls, J. Simon, and M. Gabriel, 29–51. Cham: Springer.

Islam, S., and G. Bhat. 2019. "Environmentally-Friendly Thermal and Acoustic Insulation Materials from Recycled Textiles." *Journal of Environmental Management* 251: 109536. doi:10.1016/j.jenvman.2019.109536.

Levänen, J., V. Uusitalo, A. Härri, E. Kareinen, and L. Linnanen. 2021. "Innovative Recycling or Extended Use? Comparing the Global Warming Potential of Different Ownership and End-of-Life Scenarios for Textiles." *Environmental Research Letters* 16 (5): 054069. doi:10.1088/1748-9326/abfac3.

Lewandowski, M. 2016. "Designing the Business Models for Circular Economy – Towards the Conceptual Framework." *Sustainability* 8 (1): 43. doi:10.3390/su8010043.

Magretta, J. 2002. "Why Business Models Matter." *Harvard Business Review* 80 (5): 86–92.

Mentink, B. 2014. *Circular Business Model Innovation: A process framework and a tool for business model innovation in a circular economy*. MSc Thesis, Industrial Ecology, Delft University of Technology & Leiden University.

Niinimäki, K., G. Peters, H. Dahlbo, P. Perry, T. Rissanen, and A. Gwilt. 2020. "The Environmental Price of Fast Fashion." *Nature Reviews Earth & Environment* 1 (4): 189–200. doi:10.1038/s43017-020-0039-9.

Nørup, N., K. Pihl, A. Damgaard, and C. Scheutz. 2019. "Quantity and Quality of Clothing and Household Textiles in the Danish Household Waste." *Waste Management* 87: 454–463. doi:10.1016/j.wasman.2019.02.020.

Potting, J., M. Hekkert, E. Worrell, and A. Hanemaaijer. 2017. *Circular Economy: Measuring Innovation in the Product Chain*. The Hague: PBL Netherlands Environmental Assessment Agency.

Pue, K., C. Vandergeest, and D. Breznitz. 2016. *White Paper on Social Innovation. Innovation Policy Lab White Paper*. Toronto: Munk School of Global Affairs, University of Toronto.

Remy, N., E. Speelman, and S. Swartz. 2016. *Style That's Sustainable: A New Fast-Fashion Formula*. London: McKinsey & Company.

Richardson, J. 2008. "The Business Model: An Integrative Framework for Strategy Execution." *Strategic Change* 17 (5–6): 133–144. doi:10.1002/jsc.821.

RREUSE. 2016. "RREUSE Response to the European Commission's Circular Economy Package Proposals." Brussels: RREUSE. https://www.aeress.org/content/download/6348/48245/file/RREUSE-response-to-CEP-FINAL-28.4.2016.pdf.

Runnel, A., K. Raiban, N. Castel, D. Oja, and H. Bhuiya. 2017. *Creating a Digitally Enhanced Circular Economy*. Tallinn: Reverse Resources.

Singh, J., K. Sung, T. Cooper, K. West, and O. Mont. 2019. "Challenges and Opportunities for Scaling up Upcycling Businesses – The Case of Textile and Wood Upcycling Businesses in the UK." *Resources, Conservation and Recycling* 150: 104439. doi:10.1016/j.resconrec.2019.104439.

Tentrée. 2020. "Sustainable Clothing by tentrée." https://www.tentree.com.

ThredUp. 2019. *2019 Resale Report*. London: ThredUp.

United Nations Climate Change (UNCC). 2018. *UN Helps Fashion Industry Shift to Low Carbon*. Bonn: United Nations Framework Convention on Climate Change.

Watson, D., A. Gylling, and P. Thorn. 2017. *Exploring Policy Instrument to Extend the Lifetime of a Garment*. Stockholm: Mistra.

Watson, D., and D. Palm. 2016. *Exports of Nordic Used Textiles: Fate, Benefits and Impacts*. Copenhagen: Nordic Council of Ministers.

Watson, D., P. Miljø, E. Jonas, and S. Tärneberg. 2017. *A Call to Action for a Circular Fashion System*. Copenhagen: Global Fashion Agenda.

WRAP. 2017. *Valuing Our Clothes: The Cost of UK Fashion*. London: WRAP.