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Disruptors:
How Circular Start-ups Can Accelerate the Circular Economy Transition

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BACKGROUND

This white paper presents an analysis of the business models of circular start-ups in the Netherlands. It is the product of a research project funded by the Netherlands Organization for Scientific Research (NWO), looking into the roles of circular start-up hubs in the transition to a circular economy (CE); and conducted by Utrecht University's Copernicus Institute of Sustainable Development in partnership with ING, Circle Economy and the Amsterdam Economic Board. It is the companion publication of an academic paper that studies the business models of circular start-ups in Berlin, London and the Randstad region of the Netherlands[10]. For further information on this project, contact: **Julian Kirchherr** (j.kirchherr@uu.nl), principal investigator (PI) of this project.

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CIRCLE ECONOMY

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KEY HIGHLIGHTS

- Circular start-ups are **new entrepreneurial ventures** in the circular economy that have not yet been the focus of extensive research;
- While they are largely under-researched, circular start-ups could contribute significantly to an **accelerated transition** to a more circular economy;
- The business models of **147 circular start-ups** in the Netherlands are here examined and contrasted with those of large, well-established firms engaged in circular economy practices;
- Our findings show that, compared to large established firms, circular start-ups develop **circularity strategies higher** in the waste management hierarchy and engage in circular innovations that are often overlooked.

RECOMMENDATIONS FOR POLICYMAKERS:

- Provide **financial support** in the form of grants, low-interest loans, or business incubators and **training opportunities** to help circular start-ups scale up their operations and increase brand awareness — **patient capital** is especially needed for companies developing **pilot plants** that have yet to prove their technology;
- Assess whether and how regulations that act as a **barrier to adoption of circularity practices** can be eliminated to reduce the regulatory hurdles often faced by circular businesses, without violating the primary objectives of these regulations (as in the case of legislation which impedes the use of food surplus or organic by-products, or accountancy rules that depreciate assets and materials instead of maintaining the value of reused or remanufactured ones);
- Help circular start-ups scale by **boosting market demand** for their products and services through various instruments: **public procurement** which incorporates favorable scoring criteria for tenderers that integrate circular start-ups into their offer; **tax policies** which make circular products relatively more attractive (for instance, through a lower value added tax on reused and repaired products); **performance labels** (aligned with national or European harmonization initiatives) and **consumer information campaigns**;
- Organize **B2B networks** to consolidate collaboration between circular start-ups and established firms.

RECOMMENDATIONS FOR BUSINESSESS:

- Examine circular start-ups' activities and business models to identify **circular solutions** both within and between industries, plus incorporate **best practices** into your own business models;
- Improve the company's **sustainability brand positioning** and effect **social and environmental changes** by engaging in **collaboration** and **strategic partnerships** with circular start-ups, for example by unlocking your network, by acting as off-takers (providing a guaranteed revenue stream for a certain period of time), or as key suppliers (making sure the input side is covered), by delivering production capacity;
- Engage in a **joint venture** with a circular start-up to deliver a circular proposition or service together;
- For circular start-ups, help established companies develop their circular solutions, for example by delivering **specific knowledge** about a material or technology.

Contents

CIRCULAR ECONOMY AND CIRCULAR START-UPS

Transitioning towards a more circular economy calls for disruptive innovation

Swapfiets, a start-up (or, rather, a scale-up) founded in 2014 by three students from Delft, offers bicycles on a subscription model for a fixed monthly fee. This bicycle-as-a-service offering includes the maintenance, repair and eventual replacement of bikes. The concept is simple, but effective: in 2018, this fast-growing company was active in more than 35 cities in the Netherlands, Belgium, Denmark and Germany, with a total of 75,000 bikes in circulation[1]. By retaining ownership of the bicycles, Swapfiets is financially incentivized to make them last as long as possible. It is an economically successful example of a circular scale-up that is disrupting the mobility market.

Business models such as Swapfiets may prove essential to reverse current trends in resource use. Extraction of fossil fuels, ores, minerals and biomass increased 12-fold during the 20th century, amounting to 84.4 billion tons extracted in 2015, with further doubling expected by 2050[2]. Accelerating material use, as well as associated pollution and waste, poses serious threats to the sustainability of economies of industrialized and developing countries, alike. Advocating for a shift away from this tradition, CE proposes an economic system based on business models which replace the 'end-of-life' concept with strategies that aim to minimize the amount of newly extracted resources used in production, distribution and consumption processes[3]. In addition, according to a recent report for the European Commission, transitioning towards a more circular economy could lead to the net creation of about 700,000 jobs in Europe by 2030, through additional labor demand from recycling plants, repair services and other circular activities[4]. It could also contribute to climate change mitigation through more efficient energy and material management[5].

However, progress in transitioning has so far been slow. A recent report stated that in 2015, 9.1% of total material use globally was cycled (reused through recycling or composting, for example), leaving a massive "circularity gap" in the global economy[2]. In the Netherlands, around 93% of all the waste generated was managed effectively in 2016, with 79% being recycled[6]. However, downcycling rather than upcycling remains the rule, resulting in recycled material of lower value than the original.

> Transitioning towards a more circular economy could lead to the net creation of about 700,000 jobs in Europe by 2030, through additional labor demand from recycling plants, repair services and other circular activities

METHODS

To present a comprehensive overview of circular start-ups in the Netherlands, information was collected from different sources, including popular and academic literature, plus several existing databases of information on CE. Additional sources included start-up company websites and LinkedIn profiles, where available, as well as 20 in-depth interviews with founders of circular start-ups, conducted to develop a more fine-grained understanding of their business models. In all, 147 circular start-ups were identified across the country. To put that number in perspective, the Netherlands has approximately 2,980 start-ups or scale-ups that are 6 years old or younger, according to StartupDelta, suggesting that circular start-ups still represent a small part (less than 5%) of the entire Dutch start-up ecosystem.

The adoption of circularity strategies other than recycling — such as reducing the amount of raw material, plus reusing or sharing existing products — also remains marginal[7].

In order to improve the cycling rate of materials and the adoption of smarter circularity strategies, multiple stakeholder groups need to work together. Whilst the contributions of large, well-established firms are undeniably paramount, start-ups or scale-ups such as Swapfiets, with their potential for developing disruptive innovations, could also have a crucial role to play. That said, little has actually been published about circular start-ups, so far. Therefore, this white paper aims to contribute towards the CE transition by illuminating how circular start-ups, in interaction with established firms, could help advance the economy towards higher levels of circularity. In particular, it will analyze the core strategies and business model innovations adopted by circular start-ups.

In order to perform this analysis, it was decided to collect data about circular start-ups in the Netherlands, in particular, because the country has a vibrant movement working towards circularity, driven by both public and private organizations. The Dutch government has the ambition to render the economy fully circular by 2050, with five sectors prioritized: biomass and food, plastics, consumer goods, manufacturing and construction[8]. In May 2015, the Amsterdam Economic Board also launched a resource transition program with the objectives of initiating, connecting and scaling local and regional initiatives in the field of circularity. This led to initiation of a strategic implementation plan on the part of the Amsterdam Metropolitan Area governments in 2017, focused on six major waste/resource streams and areas of circular procurement. In addition, the first 'City Circle Scan' had been completed in Amsterdam, serving to map the current state of environmental impacts and employment in the different economic sectors, plus provide direction in developing a future roadmap and action agenda for the practical implementation of a CE[9].

> Generally, solutions focusing on the strategies higher in the waste management hierarchy also require more fundamental changes in production and consumption models.

Circularity is more than just recycling

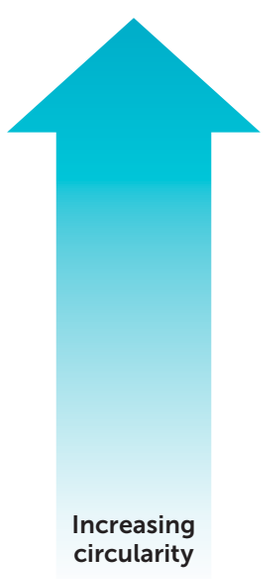
One of the most widely used conceptualizations of circularity strategies is the so-called 4R-framework, which comprises four different 'R-strategies': **Reduce**, **Reuse**, **Recycle** and **Recover** (*Figure 1*)[3,13]. In order to better accommodate the start-ups engaged in the development of nature-based solutions, the authors of this paper have added a further category: **Regenerate**. Nature-based solutions are intended to increase the use of ecosystem services, which provide the benefits humans receive from ecosystems. Examples of ecosystem services include the likes of green roofs or walls, as well as urban green spaces, which rely on a relatively small input of nonrenewable natural capital and invest in renewable natural processes[13].

The R-list establishes a clear hierarchy of priorities for waste management methods: the first R (**Regenerate**) is given priority over the second R (**Reduce**) and so on, with the degree of circularity decreasing progressively down the list.

These strategies can be applied within the two types of material cycles characterizing the CE[14,15]: the biological cycle, which encompasses the flows of food and biologically-based materials (for instance, cotton and wood) that are designed to return to the biosphere through processes such as composting or anaerobic digestion; and the technical cycle, which relates to the flows of inorganic or synthetic materials.

FIGURE 1 | CIRCULARITY STRATEGIES

STRATEGY	DESCRIPTION
Regenerate	Maintain and increase the delivery of ecosystem services (providing the benefits humans receive from ecosystems)
Reduce	Increase efficiency of product design or manufacturing by preventing or minimizing use of specific hazardous materials or any virgin materials, or make product use more intensive via such as product sharing
Reuse	Bring products back into the economy after initial use, or extend the lifespan of products and their parts (through repair, maintenance, secondhand markets, etc.)
Recycle	Process materials via such as shredding or melting to obtain materials of the same quality (upcycling) or lower quality (downcycling)
Recover	Incinerate residual flows and recover embodied energy



Generally, solutions focusing on the strategies higher in the waste management hierarchy also require more fundamental changes in production and consumption models. Take the example of Bundles (*Box Example 1*), an Amsterdam-based start-up selling the use of washing machines instead of the machines themselves, thus embracing a **Reduce** strategy through smarter product use. Bundles developed a subscription model whereby it remains owner of its washing machines and is responsible for their installation, maintenance and repair, as well as replacement if they become outdated or inoperable. The fact that people in the Netherlands are used to having their own washing machines, however, represents a barrier to uptake, with the leasing of consumer goods still relatively uncommon in the country.

The challenge for the Bundles business model becomes even greater if washing machines and dryers would need to be shared by several households — perhaps housed in a communal location within an apartment building, for example. Developing a model of leasing or sharing washing machines therefore calls for profound changes in the mindset of residents, asking them to break with a tradition of privately-owned appliances. Furthermore, in the case of shared equipment, buildings would need to be physically constructed and organized so as to make space for a centralized laundry facility. Ultimately, manufacturers and retailers would also need to switch from selling goods to providing services, so aligning themselves with a model similar to that of Bundles.

EXAMPLE 1

BUNDLES — SMART LAUNDERING

Bundles is a start-up that instead of selling washing machines provides their service on a pay-per-wash basis. The company retains ownership of its appliances and monitors their usage with a device that provides customers with statistics about consumption of energy, water and detergent. Tips are also given on how to optimize use of the machines, which can help reduce economic and environmental costs while also extending the life of the appliance. When a machine is returned to Bundles, it can be repaired or remanufactured and then leased to the next customer.

Established firms focus on strategies of lower circularity

Various leading companies such as Renault, Signify, H&M and Adidas have already committed to implementing the CE concept in their business models, often in partnership with external players. Renault, for example, has implemented a reverse supply chain to collect and remanufacture used spare parts to repair automobiles currently on the road. Signify (formerly Philips Lighting) has developed a light-as-a-service offering, whereby the company retains ownership of lights and luminaires while charging customers monthly fees for contracted illumination levels, as well as maintenance and upkeep of the fixtures, including recycling and other end-of-life procedures. The fashion chain H&M collaborates with the online platform Sellpy to support sales of clothing items that are no longer used by consumers. Adidas has partnered with Parley for the Oceans since 2015 to produce shoes from recycled plastic ocean debris and has recently committed to using only recycled plastics in all its products by 2024.

In general, however, established firms tend to focus on strategies low in the circularity hierarchy, such as recycling, and make changes at the margins instead of shifting their core business models. Based on an analysis of the 2016 corporate sustainability reports published by 46 established firms, recent research suggests that, although CE has started to be integrated into the corporate sustainability agenda, the focus is on end-of-life management strategies, while the adoption of business models incorporating higher levels of circularity is less prevalent[16]. By contrast, as new market entrants, start-ups have the opportunity to immediately adopt strategies with higher degrees of circularity and to monetize design-to-last and maintenance efforts. Embracing such strategies can be achieved, for instance, through a product service system (PSS) model, which entails a conversion from selling a product to offering leasing and sharing services. Providing the use of washing machines, instead of ownership of them, as in the case of Bundles described above, represents an example of a PSS model.

CIRCULAR START-UPS AND SCALE-UPS DEFINED

The OECD distinguishes between young businesses (0-5 years old) and mature firms (6+ years old). Start-ups are a subset of young businesses in their first three years of operation. What characterizes circular start-ups is a business model based on implementing at least one of the CE strategies outlined below: **Reduce**, **Reuse**, **Recycle**, **Recover** and **Regenerate** (see *Figure 1*).

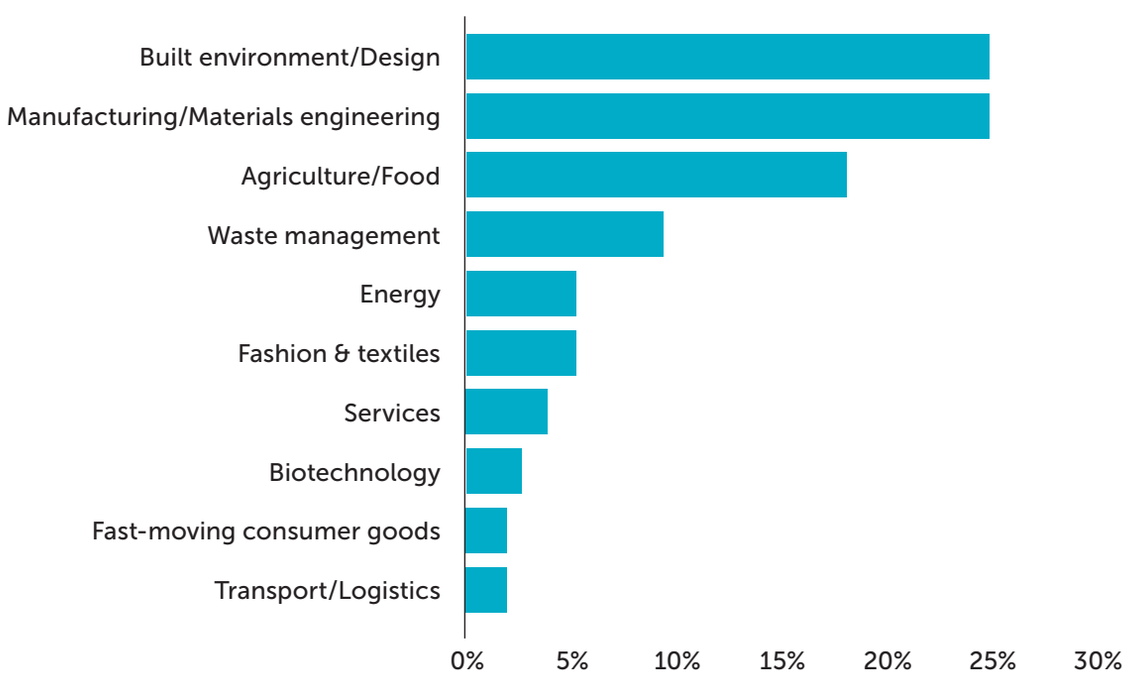
In addition to circular start-ups, our study also covers circular scale-ups. The OECD defines a scale-up as a company with an average annualized return of at least 20% over the past 3 years and at least 10 employees at the beginning of the period[12]. The key difference between a start-up and a scale-up is the nature of the challenges faced. While the main challenge for a start-up is to find a repeatable and scalable business model, for a scale-up, it is to grow that business model successfully, while still maintaining operational controls.

BUSINESS MODELS OF CIRCULAR START-UPS IN THE NETHERLANDS

Market overview

Almost 35% of the circular start-ups identified as part of this research are located in Amsterdam, with about 10% in Rotterdam. Since Amsterdam and Rotterdam are the two largest economic hubs in the Netherlands, this is hardly surprising. Circular start-ups in the Netherlands thus tend to be concentrated in urban centers. Overall, 61% of circular start-ups are found in the Randstad region (comprising Rotterdam, Amsterdam, Utrecht and The Hague). The sectors in which they are most prevalent are built environment/design and manufacturing/materials engineering (26% each, see *Figure 2*). The latter sector includes all start-ups that convert recycled or virgin materials, components or parts into non-food finished goods such as notebooks or cell phones. The sector that comes next in terms of importance is agriculture/food, followed by waste management. Interestingly, the top three sectors in which start-ups are present roughly correspond to three of the priority sectors that the Dutch government targeted to switch to a CE (manufacturing, construction, and biomass and food) — suggesting a degree of alignment between the entrepreneurial activities in the CE and the objectives of the government.

FIGURE 2 | CIRCULAR START-UPS BY SECTOR



Note: *N* = 147

In addition, 56% of circular start-ups focus on business-to-business (B2B) markets, selling products or services to companies rather than individual consumers. Some 25% of start-ups have a business-to-consumer (B2C) focus, delivering products or services directly to the final consumers. Finally, 18% combine both B2B and B2C models. The lesser focus on B2C markets may in part be due to consumer resistance to circular innovations (see *Challenges faced by circular start-ups* below). Another barrier mentioned by our interviewees is that conventional products remain relatively inexpensive — an issue faced by KarTent (*Box Example 2*), for instance, a company selling tents made of cardboard at music festivals and other events. As co-founder of KarTent Timo Krenn shared with us that "Plastic is so cheap these days, it's quite hard to enter the [retail] market. It's just a huge challenge product-wise, design-wise, and price-wise to compete with these retail products."

In addition, given increasing public attention shown towards the records of established firms on matters of social and environmental responsibility, companies are ever-more willing to go green in order to comply with legal standards, improve brand reputation or save money. They often look, therefore, for businesses that can help them achieve their sustainability goals, with circular start-ups sometimes an option. This, in turn, may explain the greater focus of circular start-ups on B2B markets. For instance, certain sustainability certification programs require all organizations in a supply chain to be accredited. Since it is not always easy for a company to change the practices of its suppliers, one solution is to source an alternative product with better sustainability credentials, for example, one developed by a circular start-up that complies with the certification requirements. For established companies, this creates "a direct connection between the product they buy, the ingredient they buy, and sustainability in the chain — so, that's for them way more transparent and interesting from a certification point-of-view," explains Rudi Dieleman, director of Pectcof, a start-up that has developed bio-based materials from coffee-pulp biomass. Fear of missing out, commercially speaking, could also motivate established firms to partner with circular start-ups, so as to reduce the risk of being surpassed by competitors or simply failing to spot a market trend.

EXAMPLE 2

KARTENT — CAMPING IN A BOX

If you have ever attended a multi-day music festival, you were probably confronted with the problem that, due to the inexpensiveness of the product, one in four people visiting campsites worldwide leave their plastic tent behind, more often than not after a single use. This plastic then ends up in landfill or is incinerated. KarTent sought to address this issue by developing a tent made of high-quality waterproof cardboard, adopting a **Reduce** strategy. Today, KarTent works with festivals in more than 19 countries to offer music fans the option to buy a cardboard tent when purchasing their tickets. So far, the start-up is responsible for the replacement of 48,000 plastic tents. After each event, the tents are collected and transformed into cardboard boxes (**Recycle** strategy), which are then sold into the B2B market. In the future, KarTent also plans to enter the retail market to sell its product directly to consumers.

KarTent sells easily recyclable cardboard tents as a more sustainable alternative to plastic ones

Circular start-ups feature more in the biological cycle than established firms

A relatively high proportion (36%) of circular start-ups operate in the biological cycle, while the remaining 64% are active in the technical cycle. By contrast, a study on the CE-related practices of 46 established firms found that whilst 57% of these companies focused on the technical cycle, only 4% were solely concerned with the biological cycle (with around one third of the sample reporting activities in both cycles)[16]. This strong presence of start-ups in the biological cycle can be explained by the large percentage of loss and waste found in food and drink supply chains. According to the Food and Agriculture Organization (FAO), roughly one third of the food produced globally for human consumption is lost or wasted every year — which provides plenty of opportunities for turning such waste into valuable products.

This strong presence in the biological cycle is important to highlight because of multiple value models — where sequential cashflows can be generated from the use of waste from one process as a resource in another — which tend predominantly to be adopted by start-ups. For instance, a coffee company which generates income from the coffee, its core business, can also generate revenue from the mushrooms farmed on the waste, and whatever is left over after harvesting the fungi can be used as animal feed. Established firms seldom adopt such novel ways of creating value[17], since they tend to remain focused on their core product. As one of our interviewees involved in the processing of green coffee beans explained, "the [established companies] all said, 'we focus on the green beans that we buy, that we roast and that we get the quality from, and we don't focus on anything apart from that'". Rotterzwam, a company that grows mushrooms from coffee grounds, is an example of a circular start-up involved in the biological cycle (see *Box Example 3*).

EXAMPLE 3

ROTTERZWAM — FROM COFFEE WASTE TO FOOD

Rotterzwam is a circular start-up that produces oyster mushrooms from coffee waste. While its circularity strategy is essentially **Recycle**, it combines multiple revenue streams, thereby distinguishing itself from more conventional companies. As Rotterzwam's founder and CEO explained, "The business model is complex, since we have multiple cashflows, which also differentiates us from 'old economy' companies, as we do not have a core business model." First, the company sells to local restaurants edible mushrooms grown from coffee grounds. Secondly, it picks up coffee waste from coffee-producing companies. Then, thirdly, through e-learning and online courses it trains entrepreneurs in other cities to create and run the same business model of growing mushrooms from coffee waste. Thanks to this replication strategy, several similar companies have 'mushroomed' all over the Netherlands: Fungi Factory in Utrecht, Westerzwam in Giethoorn and ZuiderZwam in Tilburg, amongst others. Finally, as a fourth revenue stream, the start-up carries out projects and holds speeches at events and conferences, for which it gets paid.

Rotterzwam commercializes mushroom-growing kits to promote cultivation at home

Use by circular start-ups of the five R-strategies

The **Regenerate** strategy is used by circular start-ups whose goal is to retain and restore the health of ecosystems. The distinctive feature of these companies is that they try not only to avoid environmental harm but also to enhance the delivery of ecosystem services to humans through nature-based solutions. This strategy is quite novel, which may explain why companies embracing it are still rare (5% of our sample, see *Figure 3*). Examples of such start-ups include De DakDokters, Makers of Sustainable Spaces (MOSS) and MetroPolder — three companies that transform unused rooftops into multifunctional spaces to provide opportunities for biodiversity, urban farming, water-retention systems and renewable energy production.

In total, 49% of circular start-ups in our sample have adopted the **Reduce** strategy. An example of a start-up in this category is the Rotterdam-based CONCR3DE, which has developed 3-D printer technology to produce complex components for the construction industry. For the printing, CONCR3DE uses inorganic polymers as an alternative to Portland cement, the main component of concrete, resulting in an 85% reduction in carbon dioxide emissions. Also included in this category are start-ups based on PSS models, such as Swapfiets and Bundles, as showcased above.

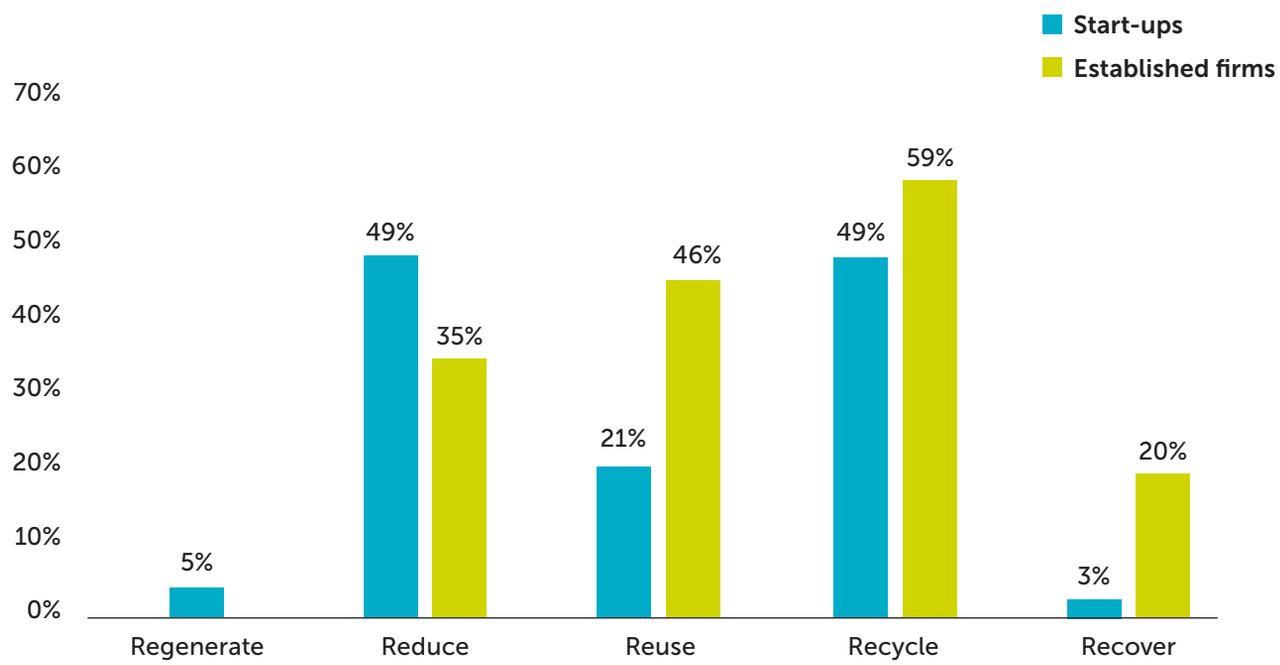
Some 21% of the organizations in our sample have implemented the **Reuse** strategy. For instance, Roetz Bikes remanufactures bicycles discarded by the OV-fiets, a bike rental service of the Dutch railway Nationale Spoorwegen (NS), and transforms them into new vehicles, reusing 70% of the original bicycle materials.

Up to 49% of circular start-ups examined have adopted the **Recycle** circularity strategy. Examples in this category include Tusti, a high-tech recycling company that cleans greasy plastics and sells plastic regrinds (plastics that have been shredded into small flakes) to manufacturers, also New Marble, which manufactures tiles from old plastic bottles.

Finally, a small fraction of circular start-ups also employ the **Recover** strategy, including, for example, The Waste Transformers, which converts residual waste streams into energy, and Broodnodig, which converts bread waste into biogas via fermentation.

Overall, the findings suggest that a large majority of circular start-ups embrace strategies that correspond to relatively high levels of circularity (**Regenerate, Reduce** and **Reuse**). For balance, this output should be assessed against the efforts made by established firms. To do this, our results were compared to the R-strategies, analyzed in a previous study[16], of 46 established firms engaged in CE activities in household goods and textiles, food and beverages, and packaging. Overall, the results show that compared to established firms, start-ups tend to pursue strategies higher in the circularity hierarchy. Of the higher strategies, only **Reuse** is more strongly embraced by established firms than by circular start-ups. This can be explained by the fact that reverse logistics processes (facilitating the management of returned parts, materials and products from the consumer back to the producer) are very complex, with established firms tending to have better resources to set up adequate take-back management.

FIGURE 3 | COMPARISON OF CIRCULARITY STRATEGIES USED



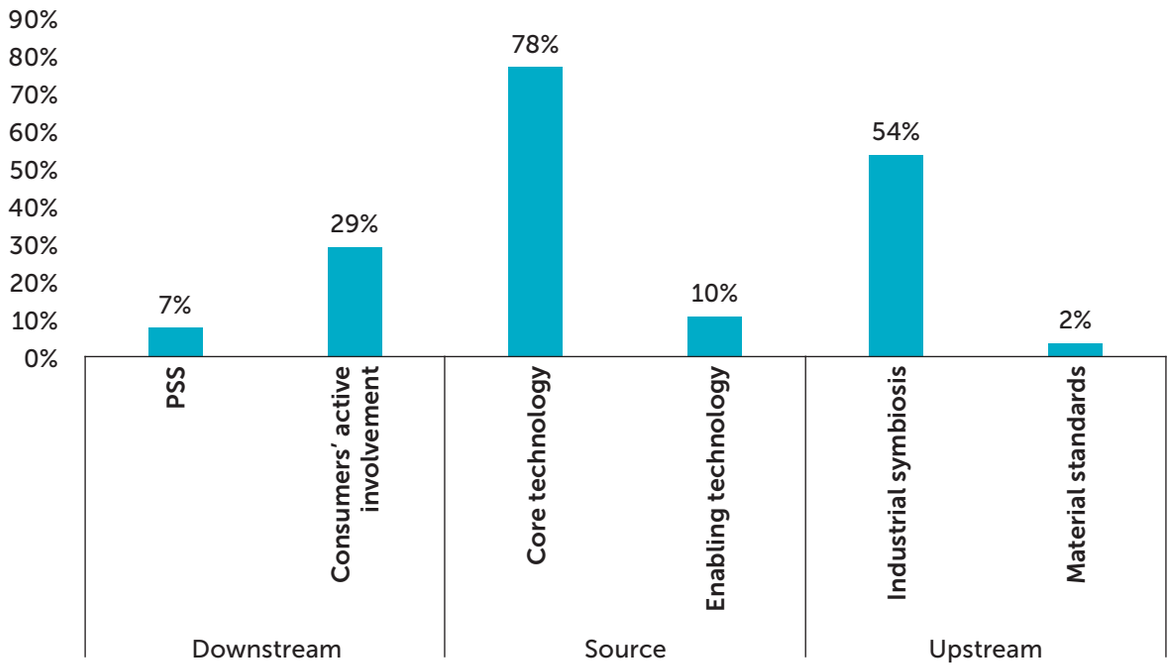
Note: *N* = 147 for circular start-ups and *N* = 46 for established firms. The total does not amount to 100% as a single organization can pursue multiple R-strategies. Source of the data on established firms: Stewart & Niero (2018).

Circular business model innovations

So, why exactly do circular start-ups embrace strategies higher in circularity? Is it due to a particular skill they possess? To answer these questions, it is interesting to look at the type of circular business model innovations these start-ups actually develop. Innovation can take place at different points along the value chain. A distinction can be made between innovation led internally by the organization (source), occurring due to interaction with suppliers (upstream) and occurring due to interaction with customers (downstream). The downstream and upstream activities are considered to be those driving social innovations (by modifying the relationships with other actors in the value chain), while innovations taking place internally are mainly technological.

Within source activities, a distinction is made between the development of core and enabling technologies. The difference between the two is that the former is specific to a product, while the latter has a generic character — that is to say, it can be applied to many industries and is not unique to a given supply chain. Typical examples of enabling technologies are information technologies, such as platforms facilitating the sharing or trading of products and materials. Downstream activities comprise innovations related to the adoption of the PSS model and innovations linked to consumers' active involvement in CE-related activities. The major difference between these two lies in the ownership structure: with a PSS model the start-ups are the owners of the product; while in the case of consumers' active involvement, the start-ups only facilitate consumers' CE-related activities in respect of products owned by an external actor (for instance, when returning products to the producer and conducting maintenance activities). Finally, upstream activities reflect relationships with suppliers and comprise both collaborations to create value from residual resource streams and the establishment of circular processes or material standards along the value chain.

FIGURE 4 | TYPES OF CIRCULAR BUSINESS MODEL INNOVATION



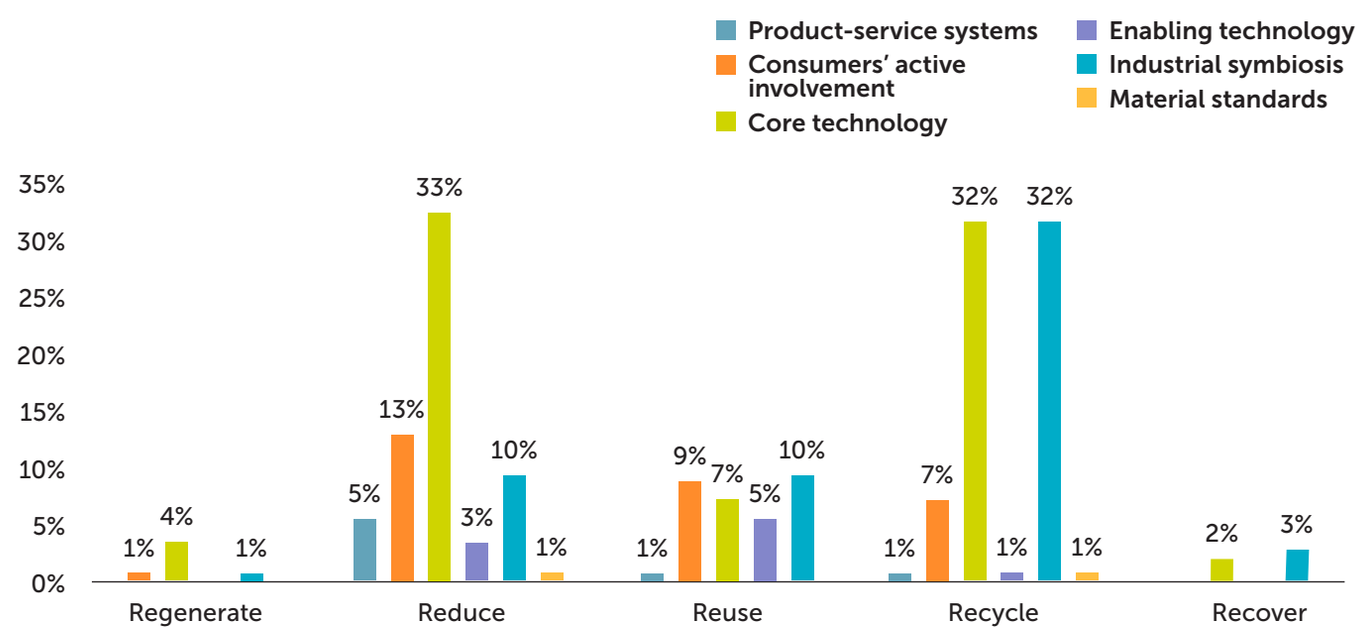
Note: *N* = 147. The total does not amount to 100% as a single start-up can develop multiple types of innovations.

When the sample is deconstructed according to the types of circular business model developed (*Figure 4)*, innovations in core technology clearly emerge as the most frequently developed type (78% of the sample). Many innovations in core technologies take place in companies that develop novel production methods, new source materials (such as CONCR3DE, presented above), or high-tech recycling processes (such as Tusti). Another type of innovation that stands out is that developed by start-ups engaged in industrial symbiosis and in the valorization of other companies' residual waste streams (54% of the sample). A large proportion of start-ups (29%) seek to involve consumers more actively, mostly by developing educational activities and raising awareness around circular practices. Only a small fraction of start-ups (7%) have adopted the PSS model. This may be because this model is particularly asset heavy (as explained below in the section *Challenges faced by circular start-ups*). Similarly, only 10% of start-ups have developed enabling technologies — such as trade platforms connecting consumers and producers of used products or blockchain-based technologies aimed at tracking materials — possibly because of the relative novelty of these technologies, in general.

Overall, half of the sample of circular start-ups is engaged in developing technological advances (represented by source activities), while the other half brings about social innovation changes (represented here by upstream and downstream activities). The relatively high proportion of start-ups focused on social innovations is remarkable. These changes are usually much harder to bring about than technological advances, as they require shifts in customs, norms and beliefs, which typically prove more difficult to change than the technologies themselves.

According to a report by the Dutch Environmental Assessment Agency (in Dutch: *Planbureau voor de Leefomgeving*, PBL), high-level circularity strategies more often require social innovations throughout the product chain, whereas low-level strategies rely on technological innovations[6]. Take the example of Bundles: by selling packages of washing cycles instead of washing machines, the company does not use radically new technology, but it does effect profound changes in the revenue model, in the ownership structure of goods and in actors' social practices. Conversely, recycling may involve the development of a technological innovation to transform materials into new products, or to convert biomass waste for useful applications, but it generally does not lead to substantial changes in products that would require important social innovations. To assess the extent to which this holds true for circular start-ups, it is instructive to look at the relationship between the circularity strategies they adopt and the types of circular business model innovation they develop (*see Figure 5*).

FIGURE 5 | TYPES OF INNOVATION ACCORDING TO CIRCULARITY STRATEGY



Note: *N* = 147

> Many circular design companies collect discarded goods or components to be used, often with another function, in a new life cycle. This may require changes in consumer preferences. towards reused products.

The graph in *Figure 5* shows that for the **Reduce** strategy — which, along with **Recycle**, is the most widespread among circular start-ups — the dominant types of innovation take place in the core technology (mainly through the development of new source materials or a new product design). For **Recycle**, the dominant types of innovation are in core technology (in the form of new recycling processes) and in the development of industrial symbiosis (as extracting value from waste streams entails interorganizational collaborations), but innovations also occur due to consumers' active involvement (for instance, in reverse logistics). These figures illustrate that innovations in core technology are dominant for the **Reduce** strategy, while industrial symbiosis, which mainly involves social innovations, is important for the **Recycle** strategy. They therefore appear somewhat at odds with the main proposition of the PBL's report, that high-level circularity strategies typically require more social innovations, while low-level strategies mainly involve technological innovations.

Companies, such as CONCR3DE, involved in the production of new, more sustainable materials are a good example of businesses embracing a **Reduce** strategy and simultaneously developing innovations in core technology. By contrast, Dutch aWEARness is an example of a company that has adopted **Recycle** as a dominant strategy but has developed innovations in the revenue model and through actively involving consumers rather than through technology (see *Box Example 4*). When it comes to companies involved in the **Reuse** strategy, their dominant innovations occur in industrial symbiosis and consumers' active involvement. For example, many circular design companies collect discarded goods or components to be used, often with another function, in a new life cycle. This may require changes in consumer preferences towards reused products.

EXAMPLE 4

DUTCH AWEARNESS — CIRCULAR WORKWEAR

Dutch aWEARness is a textile company that produces workwear from 100% recycled polyester (recycled up to eight times). The company remains owner of the garments and all items are returned to it. A track-and-trace system has been implemented to monitor the company's entire product chain and to ensure that all actors comply with circularity principles. Hence, while the company's dominant strategy is **Recycle**, the innovations it develops include using a PSS model, implementing enabling technology (asset tracking), encouraging customers' active involvement (via the return system) and setting circularity standards along its value chain.

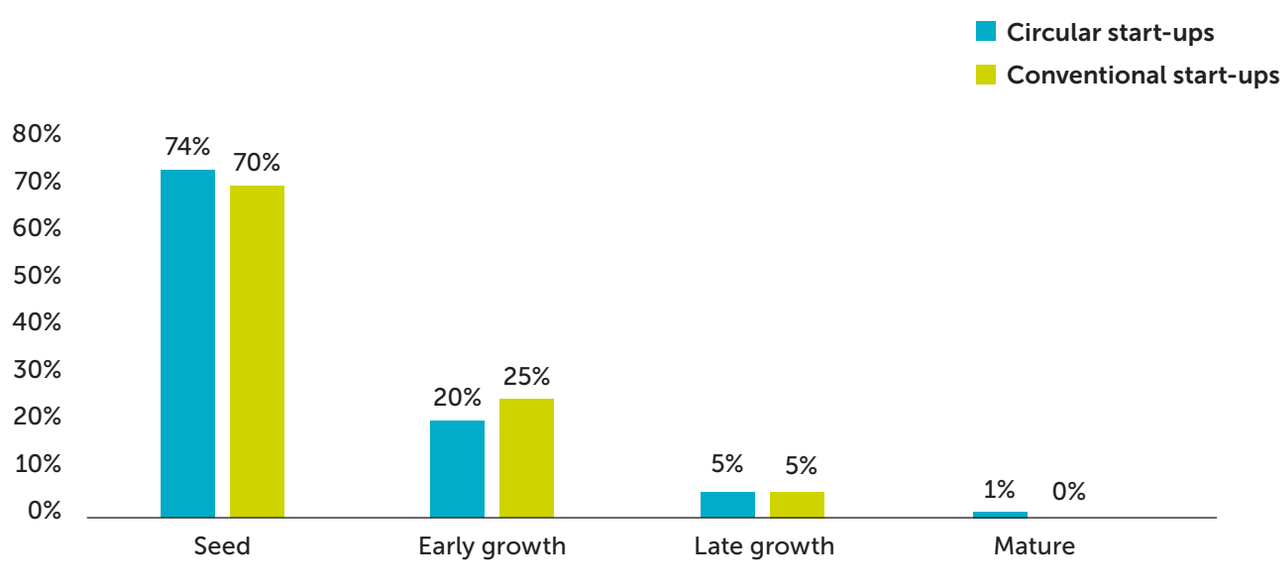
Circular and conventional start-ups' development stages

We now turn to the stages of development in circular start-ups, here delineated according to the stages of venture capital financing. The first, seed stage, involves raising the capital necessary to start the company and to try to find product-market fit. *Figure 6* illustrates that most of the circular start-ups examined in this study are in an early development stage, with 94% at the seed stage (having less than €1 million in funding) or the early growth stage (€1–10 million in funding). This is also reflected in the number of people the circular start-ups employ: over 80% of them have between one and 10 employees. This could mean either that many circular start-ups fail before they become large or that they need more time to realize their growth potential.

However, *Figure 6* also shows that the majority of conventional, non-circular start-ups of the same age (6 years old or younger) are in an early development stage as well. The differences observed between the distribution of circular start-ups and conventional start-ups in the early development stages are not statistically significant — that is to say, it cannot be shown that they are not due to chance. Therefore, contrary to the findings of previous qualitative studies comparing conventional and green start-ups — which suggest that the latter need a somewhat longer investment horizon than the former due to a more protracted period of product development[18],[19] (with circular start-ups being a specific subset of green start-ups) — there seems to be no difference between circular and conventional start-ups when it comes to the percentages in each stage of development.

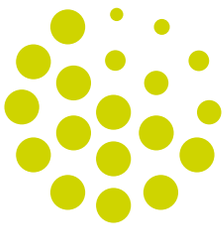
Although venture capital funding information was available for only 11% of the start-ups included in our sample, these companies had raised a total of €50,940,000, indicating that at least some of these organizations have a successful proof-of-concept that validates their scalability and profit potential.

FIGURE 6 | DEVELOPMENT STAGES



Note: *N* = 95 for circular start-ups and *N* = 2,440 for conventional start-ups. The seed, early growth and late growth stages correspond respectively to less than €1 million in funding, €1–10 million in funding or post-Series A, and over €10 million in funding.

Source: StartupDelta.



Four companies in our sample have reached late growth or mature stages: Swapfiets (showcased above); Fairphone; Niaga; and United Wardrobe, a Utrecht-based company, founded in 2014, which is the fastest-growing online marketplace for secondhand fashion items in the Netherlands. Fairphone is an Amsterdam-based company, created in 2013, which aims to design and produce smartphones with minimal environmental harm. As at December 2018, Fairphone had sold about 143,000 smartphones, and its goal is to sell 500,000 by 2020. It also wants to launch Fairphone-as-a-service, a PSS model in which Fairphone retains ownership of its devices. The company's explicit objective is to be a leader in the smartphone industry's transition towards greener electronics. Founded in 2010, Niaga has developed a reversible glue that makes it easy to separate materials after use, thereby improving the business case for recycling. In 2014, the scale-up announced a joint venture with DSM, a Dutch multinational company active in health, nutrition and materials, to develop a technology for manufacturing a 100%-recyclable polyester carpet. In early 2017, DSM-Niaga teamed up with Mohawk, the second-largest flooring maker in the United States and the first company to incorporate DSM-Niaga's system into its own. DSM-Niaga's director explained, "Our technology was so new that nobody believed it works. And now you see that the industry looks at it differently"[20]. As its technology can be used in fabricating all types of tufted carpets, DSM-Niaga expects other manufacturers to join the movement towards manufacturing fully recyclable carpeting.

Boosting impact through collaborations

These four companies are examples of successful scale-ups that may potentially grow at the expense of non-circular firms within their industries. However, there are other, more indirect ways for circular start-ups to contribute to an industry's shift towards more circularity[21]. In particular, established firms can copy and/or modify entire business models or individual characteristics of circular start-ups, as they recognize the early market success of such start-ups to be both evidence of potential that they could develop themselves and a growing competitive pressure. This is all the more relevant since, as was shown above, a majority of circular start-ups operate in B2B markets. An example of such influence exerted by circular start-ups on established firms is the collaboration between DSM-Niaga and Mohawk. As Jurrian Knijtijzer, the director of Finch Buildings, a start-up active in the circular construction sector, explained: "I always see this as the tanker and the pilot boat. We are obviously the pilot boat, as we don't have the mass, we don't have the money to [steer the market], but we can help adjust [big companies'] course.... They learn from us and we learn a lot from them." The interviewee then offered an example of such a learning process: "We see that the market is coming our way. For example, we've built without fossil fuels since 2014; everybody said that was crazy, but now there is a law for it.... So [big companies] also see that there is something to what we say."

Finch Buildings develops sustainable and modular buildings.

Finally, collaborations and learning may occur not only between circular start-ups and established firms, but also between different circular start-ups. This happens, for example, when the creation of a circular start-up by a pioneer motivates other entrepreneurs to follow and replicate the model. This replication process may even be encouraged by the pioneering actor concerned. An example of this is Rotterzwam, which, through training and online courses, helps other entrepreneurs employ its business model to launch start-ups in other locations. When start-ups share and collaborate in this way, they seek to increase their impact through opensource sharing and dissemination of best practice, rather than organizational growth within a single entity. Although this scaling approach gives the original innovator less control over the intellectual property and how it is used, it does enable them to potentially have a much greater impact. As a co-founder of the Fungi Factory, another mushroom-growing company, explained: "throughout the Netherlands, I think there are now about 10 to 15 of these small businesses, and we try to work together. So, if other businesses come to us and say they have an interesting opportunity in Rotterdam, we will send them to Rotterzwam. That way you can maintain your local [anchorage] and you help each other." These cooperations with potential competitors — so-called co-opetitions — are common amongst small innovative companies that wish to work together to leverage resources, mitigate risks and achieve economies of scale.

Collaborations and learning may occur not only between circular start-ups and established firms, but also between different circular start-ups.

CHALLENGES FACED BY CIRCULAR START-UPS

Circular start-ups also face challenges, however. On the one hand, they are confronted with obstacles common to any start-up. In particular, they may struggle to access external financing because, for example, their business idea is new and lacks market history or a track record of commercial performance, their credit history is unknown or non-existent, or they lack collateral. As a result, it is difficult for potential external funders to reliably assess the risks involved and the potential value of the venture. As one of our interviewees said, "we found that when we started reaching out to venture capital, it is hard to strike deals for a start-up because you don't have a valuation". Here, collaborations with established firms may prove essential. Indeed, it may reassure funding providers if larger (and creditworthy) companies act as off-takers (providers of a guaranteed revenue stream for a certain period of time), or as key suppliers (making sure the input side is covered), or by delivering guarantees (for instance, at end of life by taking back assets). This may help mitigate some of the risks. In addition, circular businesses may require multiple forms of capital, from seed money, loans, bonds and equity to crowdfunding and peer-to-peer lending, depending on their stage of development and risk profile[22]. While the amount of available capital matters, deploying the right type for a specific initiative can also prove a challenge.

In addition, it may be hard for a start-up lacking capital, access to distribution channels and economies of scale to enter a market that is already occupied by large players. Again, collaborations with other actors seem crucial to overcome this barrier. As one of our interviewees puts it, "the best way to start an innovation is to try to get other players in the ecosystem to work with you instead of competing with all of them, and use their assets and your own innovation power and flexibility to have a great proposition with other partners in the teams".

On the other hand, circular start-ups may be confronted with challenges specific to circular products and business models. For instance, the PSS model may be difficult for a start-up to implement since it has cost and cashflow structures that are very different from those in the conventional pay-for-ownership model. Here, again, the example of Bundles is illuminating. As Bundles retains ownership of its washing machines, this means that until the asset base is large enough to circulate machines that are fully paid-off, each new customer necessitates an investment of approximately €1,000 for a new machine. However, this upfront investment entails a longer payback period (five to six years) than if the machines were sold, which puts pressure on cashflow[23]. The financial risk of this model could be reduced by shortening the payback period through charging higher fees in the first years of the service.

It may be hard for a start-up lacking capital, access to distribution channels and economies of scale to enter a market that is already occupied by large players.

Another barrier relates to consumer resistance to circular innovations and/or reluctance to pay a higher price for them[24,25]. Convincing potential users of the superiority of circular options and creating a demand for them can be challenging. This is an issue with any product innovation. However, some cultural barriers may be specific to the CE, such as customers' preference for owning products, as discussed above in the example of sharing washing machines and dryers, or their preference for buying new products rather than reusing old ones.

Finally, current regulations or laws may obstruct the development of circular solutions. For instance, waste regulations can impede circular initiatives to use by-products of a production process as an input for product development, because such resources are classified as waste. As one of our interviewees said, "Waste-material sourcing requires specific licenses, and the tax on it is too high, in my opinion". Another example is provided by accountancy rules that are tailored to a linear model that depreciates assets and materials instead of maintaining the value of reused or remanufactured ones.

THE DISRUPTIVE POTENTIAL OF CIRCULAR START-UPS, IN SUMMARY

This white paper provides evidence of circular start-ups' potential contributions to fostering a transition to a CE in the Netherlands. First, it shows that compared to large established firms, circular start-ups embrace strategies higher in circularity: 54% of circular start-ups are engaged in the **Regenerate** and **Reduce** strategies, as compared to 35% of established firms. Circular start-ups also often operate in the biological cycle, generating sequential cashflows from the processing of organic nutrients, a practice that remains rare amongst established firms. Overall, this indicates that circular start-ups can indeed make a major contribution to supporting the transition to a CE by helping large companies innovate, engaging in circular activities often overlooked by them, and leading the way to the next level of circularity.

In terms of business growth, most circular start-ups are still at an early stage of development, but this is not especially due to their circular nature, since most conventional start-ups are also at an early stage. In addition, circular start-ups may pursue a diverse range of strategies in order to maximize their contribution to help effect a transition to a CE. Some, such as Swapfiets and KarTent, choose to pursue growth within a single organization, expanding their activities internationally. Others focus more on the value chain, seeking to encourage their business partners to embrace more circular practices. In certain cases, this may even lead to mergers and acquisitions — the legal, organizational and/or financial integration of circular start-ups into established firms' own organizations by means of friendly or hostile takeovers, or joint ventures. An example of this is the joint venture between Niaga and DSM. Finally, others, such as Rotterzwam, favor impact expansion through opensource sharing and dissemination of best practices.

From a policy perspective, although our findings suggest that only a limited number of new, small circular companies become large companies, this does not mean that the government's policies should cease to promote new circular start-ups and instead focus all its resources on high growth potential businesses. Firstly, without new business start-ups there would be no pipeline for companies to become future disruptive enterprises. Secondly, as was shown in this white paper, organizational growth is only one way for circular start-ups to maximize their impact. An initial, straightforward step for policymakers to support circular start-ups would be to better accommodate them within the existing policies aimed at supporting start-ups in general.

Policymakers play a critical role in creating a favorable environment for circular start-ups in various ways, thereby also contributing to the realization of the broader CE agenda:

- Firstly, training opportunities and financial support (in the form of grants, low-interest loans or business incubators) could help circular entrepreneurs create new designs and products and gain access to financing to scale up their operations and increase brand awareness. Patient capital is especially needed for companies developing pilot plants that have yet to prove their technology.
- Secondly, the regulatory hurdles often faced by circular entrepreneurs and large established firms alike can be reduced by the elimination of regulations that impede adoption of CE practices, without necessarily violating the primary objectives of these regulations (as in the case of hygiene legislation which discourages the use of food surplus, or organic by-products).

> Further research is needed to better understand how circular start-ups build their business ecosystems and develop collaborations with other actors, including supply-chain partners as well as incubators, financial actors, knowledge centers, governmental institutions, NGOs and consumers.

- Thirdly, policymakers can use different instruments to boost market demand for circular start-ups' products and services, thereby helping such companies scale up and benefit from economies of scale. For example, they can incorporate into public procurement some favorable scoring criteria for tenderers that integrate circular start-ups into their offer. They can also use tax policies to make circular products relatively more attractive (for instance through a lower value added tax on reused and repaired products), or performance labels (aligned with national or European harmonization initiatives) and consumer information campaigns to enhance consumer awareness.
- As a fourth option, the organization of B2B networks can help consolidate collaboration between circular start-ups and established firms.

As shown by numerous examples above, circular business models do not typically occur within a single company, but, involve new forms of collaboration and transaction between parties along and even outside existing supply chains:

- On the one hand, start-ups can help larger companies speed up the development of circular solutions, for instance by delivering specific knowledge about a technology.
- On the other hand, managers at large established firms who are willing to increase the level of circularity of their businesses should examine circular start-ups' practices to identify promising circular opportunities both within and between industries. They could then develop circular solutions in their own business models, thereby improving their companies' sustainability brand positioning and social and environmental impacts.
- In addition, they can reach out to help circular start-ups, for example by unlocking their network, by acting as off-takers or as key suppliers, or by delivering production capacity.
- Going one step further would be to engage in a joint venture to deliver a circular proposition or service, together.

In terms of future research perspectives, for circular start-ups to sustain their business models, it appears crucial for them to develop collaborations with other actors. Therefore, further research is needed to better understand how circular start-ups build their business ecosystems and develop collaborations with other actors, including supply-chain partners as well as incubators, financial actors, knowledge centers, governmental institutions, NGOs and consumers. Another promising avenue for further research is studying how a CE will actually operate in the consumer society and business world of tomorrow, plus what roles circular start-ups, amongst other types of actors, may ultimately play in these circular futures.

THE CIRCULARITY STRATEGIES AND BUSINESS MODEL INNOVATIONS OF CIRCULAR START-UPS

54%

of circular start-ups are engaged in the strategies of higher circularity **Regenerate** and **Reduce**.

49%

of circular start-ups are engaged in the circularity strategy **Recycle**.

21%

of circular start-ups are engaged in the circularity strategy **Reuse**.

78%

of circular start-ups develop innovations in core technology, such as novel production methods, new source materials and high-tech recycling processes.

54%

of circular start-ups develop industrial symbiosis to extract value from waste streams of other companies.

29%

of circular start-ups seek to involve consumers more actively in circular activities.

10%

of circular start-ups develop innovations in enabling technology, including trade and sharing platforms and asset tracking systems.

7%

of circular start-ups are engaged in the development of product-service systems.

ENDNOTES

1. Swapfiets - Altijd een werkende fiets. Available at: https://swapfiets.nl/en/. (Accessed: 21st November 2018)

2. Circle Economy. *The Circularity Gap Report: An analysis of the circular state of the global economy*. (2018).

3. Kirchherr, J., Reike, D. & Hekkert, M. Conceptualizing the circular economy: An analysis of 114 definitions. *Resources, Conservation and Recycling* **127**, 221–232 (2017). doi: 10.1016/j.resconrec.2017.09.005

4. Cambridge Econometrics, Trinomics & ICF. *Impacts of circular economy policies on the labour market*. (European Commission, Directorate-General for Environment, 2018).

5. Wijkman, A. & Skanberg, K. *The Circular Economy and Benefits for Society: Jobs and Climate Clear Winners in an Economy Based on Renewable Energy and Resource Efficiency*. (Club of Rome, 2016).

6. Potting, J., Hekkert, M., Worrell, E. & Hanemaaijer, *A. Circular Economy: Measuring Innovation in the Product Chain*. (PBL Netherlands Environmental Assessment Agency, 2017).

7. Rood, T. *et al. Circulaire economie in kaart*. 68 (PBL Planbureau voor de Leefomgeving, 2019).

8. Ministry of Infrastructure and the Environment and the Ministry of Economic Affairs. *A Circular Economy in the Netherlands by 2050: Government-wide Programme for a Circular Economy*. (Ministry of Infrastructure and the Environment and the Ministry of Economic Affairs, 2016).

9. Circle Economy & TNO. *Circular Amsterdam. A vision and action agenda for the city and metropolitan area*. (2016).

10. Henry, M., Bauwens, T., Hekkert, M. & Kirchherr, J. A Typology of Circular Start-Ups – An Empirical analysis of 128 Circular Business Models. *Journal of Cleaner Production* (2019). doi: 10.1016/j.jclepro.2019.118528

11. *EUROSTAT - OECD manual on business demography statistics: 2007*. (Eurostat-OECD, 2007).

12. European Comission. *Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on Waste and Repealing Certain Directives*. (2008).

13. Maes, J. & Jacobs, S. Nature-Based Solutions for Europe's Sustainable Development. *Conservation Letters* **10**, 121–124 (2017). doi: 10.1111/conl.12216

14. Ellen MacArthur Foundation. *Towards the Circular Economy: Economic and Business Rationale for an Accelerated Transition*. (Ellen MacArthur Foundation, 2012).

15. McDonough, W. & Braungart, M. *Remaking the Way We Make Things: Cradle to Cradle*. (North Point Press, 2002).

16. Stewart, R. & Niero, M. Circular economy in corporate sustainability strategies: A review of corporate sustainability reports in the fast-moving consumer goods sector. *Business Strategy and the Environment* **27**, 1005–1022 (2018). doi: 10.1002/bse.2048

17. Bocken, N. M. P., Ritala, P. & Huotari, P. The Circular Economy: Exploring the Introduction of the Concept Among S&P 500 Firms. *Journal of Industrial Ecology* **21**, 487–490 (2017). doi: 10.1111/jiec.12605

18. Randjelovic, J., O'Rourke, A. R. & Orsato, R. J. The emergence of green venture capital. *Business Strategy and the Environment* **12**, 240–253 (2003). doi: 10.1002/bse.361

19. Linnanen, L. An Insider's Experiences with Environmental Entrepreneurship. *Greener Management International* **2002**, 71–80 (2002). doi: 10.9774/GLEAF.3062.2002.su.00008

20. De Thouar, J. ECOR & DSM-Niaga: Two Scale-Ups Reaching New Heights Together. ECOR Europe by *Noble Enviromental Technologies*

21. Schaltegger, S., Lüdeke-Freund, F. & Hansen, E. G. Business Models for Sustainability: A Co-Evolutionary Analysis of Sustainable Entrepreneurship, Innovation, and Transformation. *Organization & Environment* **29**, 264–289 (2016). doi: 10.1016/S1096-7508(02)00069-1

22. Hieminga, G. *Rethinking finance in a circular economy: Financial implications of circular business models*. (ING Economics Department, 2015).

23. Working Group finanCE. *Money makes the world go round (and will it help to make the economy circular as well?)*. (Working Group FinanCE, 2016).

24. Pastakia, A. Grassroots ecopreneurs: change agents for a sustainable society. *Journal of OrgChange Mgmt* **11**, 157–173 (1998). doi: 10.1108/09534819810212142

25. Kirchherr, J. *et al*. Barriers to the Circular Economy: Evidence From the European Union (EU). *Ecological Economics* **150**, 264–272 (2018). doi: 10.1016/j.ecolecon.2018.04.028

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