



CIRCULAR JOBS IN BELGIUM

A baseline analysis of
employment in the circular
economy in Belgium



PREFACE

The Circularity Gap Report 2019 finds that the global economy is only 9% circular. Therefore, a major transition is still needed to achieve a fully circular economy.

Having initiated the action domain 'Sustainable Development' in 2017, the King Baudouin Foundation wishes to support the transition to the circular economy by, amongst other things, making relevant data available on employment in the circular economy.

In cooperation with the Erasmus Research Institute for Happiness Economics, the Dutch social enterprise Circle Economy has developed a methodology to monitor circular employment. The method has been successfully applied in the Netherlands and is standardised and replicable. It therefore produces results that are comparable through time and across national borders. We would like to thank their researchers who have applied this methodology to the Belgian labour market and delivered this report.

This report forms the first publication on the circular economy by the King Baudouin Foundation.

The report presents a baseline measurement on employment in the Belgian circular economy. It provides a starting point for future interpretation, without passing judgement. The measurement is set to be repeated within two to three years, with subsequent measurements allowing for a more comprehensive interpretation of the figures.

We explicitly thank the participants of the working group who, based on their rich experience and knowledge about circular economy and/or the labour market, helped to monitor and advise on the progress of this study. Finally, we would also like to thank data processing companies Inoopa and Graydon for their contributions to this study.

King Baudouin Foundation

EXECUTIVE SUMMARY

The circular economy changes the world of work. As an alternative model for economic and industrial development, it ensures resources are not wasted but kept in circulation for as long as possible. The transition towards a circular economy requires introducing new design strategies, production processes and business models. This reorientation and transformation of activities has a vast impact on the jobs landscape: what work we do and how we do it.

There are core, enabling and indirect circular jobs. Core jobs ensure that raw material cycles are closed, activities include renewable energy, recycling and repair. Enabling jobs support the acceleration and upscaling of core activities, activities include leasing, engineering and digital technology. Indirectly circular jobs provide services to core and enabling activities, activities include education, logistics and public administration.

The employment effects of the circular economy need careful monitoring to maximise positive and minimise harmful effects. Early research points to both the potential benefits and adverse effects on the labour market. A monitoring practice will discern the exact employment opportunities the circular economy offers and uncover potential risks.

This report presents the findings of a baseline measurement of employment in the circular economy in Belgium, the three regions (Brussels Capital Region, Flanders and Wallonia) and two cities (Antwerp and Liège).

BE



7.5%

In Belgium, 262.000 jobs are circular (7,5% of all jobs). The recycling and repair and maintenance sectors together create over 80.000 jobs (30% of all circular jobs). All provinces show a circular share of employment between 5% and 9%.

BXL



8.1%

In the Brussels Capital Region, 58.000 jobs are circular (8,1% of all jobs). Most circular jobs in the region are enabling (44% of all circular jobs) and indirectly circular (38% of all circular jobs).

FL



7.5%

In Flanders, 148.000 jobs are circular (7,5% of all jobs). Most circular jobs in Flanders are indirectly circular (44% of all circular jobs) or core (35% of all circular jobs). Antwerp and Ghent are important clusters for circular economy employment.

WAL



6.8%

In Wallonia, 56.000 jobs are circular (6,8% of all jobs). Most circular jobs in Wallonia are indirectly circular (45% of all circular jobs) or core (40% of all circular jobs). Namur, charleroi and Liège, as well as the Hainaut province are important clusters for circular economy employment.

These numbers might underestimate the amount of circular jobs in the manufacturing sector and are to be interpreted with caution. An additional analysis of this sector shows that almost 25% of all manufacturing companies in Belgium communicate about core circular activities. For these companies, core circular activities can be auxiliary to their primary activities, or the current sector classification system does not allow adequate registration of circular activity.

In transition to the circular economy, technological advancement and changing processes have pervasive consequences on job requirements. Both newly emerging occupations such as the material scout and existing ones such as the recycling operative power the circular transition. New occupations and changing job content affect the skills and knowledge requirements of circular jobs.

In order to maximise positive and minimise harmful effects of the circular economy on the Belgian labour market, there is a need to further develop a monitoring practice for circular jobs, as well as to broaden and deepen the understanding of labour market dynamics in the Belgian circular economy.



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INTRODUCTION

The circular economy is an economic and industrial development model that offers an alternative to the linear 'take-make-waste' economy. It seeks to extract the maximum value from resources in use and keeps materials in circulation for as long as possible. The circular economy keeps resources and materials functioning at their highest potential so that they are not wasted, but re-entered into a system that creates value again and again.

The circular economy ensures the highest level of long-term environmental economic and social value is preserved. The circular economy can reduce our dependence on raw materials inputs by 24% and CO₂ emissions by 48% by 2030.¹ Limiting global warming involves a portfolio of mitigation measures that reduce our reliance on natural resources and carbon, such as the circular economy.² At the same time, the circular transition creates business and economic opportunities by introducing new design strategies, production processes and business models. A changing jobs landscape in the circular economy constitutes one such opportunity.

Circularity changes the world of work, and needs careful monitoring to maximise positive and minimise harmful effects. Early research points to the potential for the circular economy to increase the quality of work and to create jobs for a wide range of workers. Yet, the circular economy is not guaranteed to only have positive effects on the labour market. As the content and structure of work changes, workers' rights need to be continuously safeguarded and the workforce needs to be skilled and reskilled to avoid unemployment.

A monitoring practice of the employment effects of the circular economy will discern what exact employment opportunities the circular economy offers, how these are distributed across society and how we can equip the workforce with the right skills to meet the changing demand.

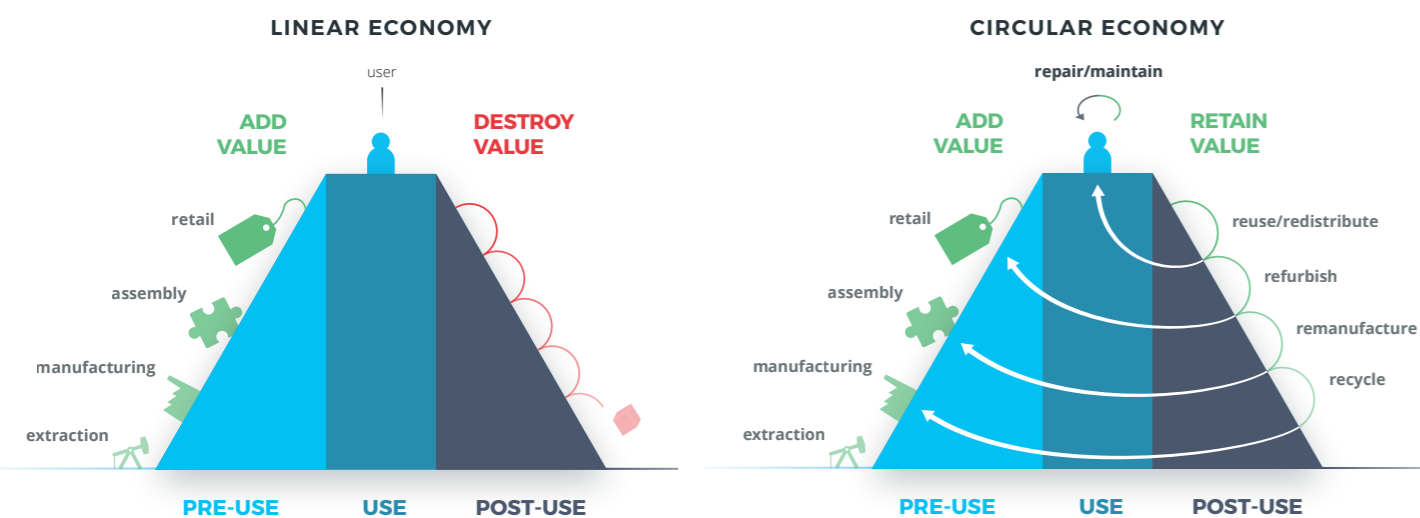
This report presents the findings of a baseline measurement of the circular labour market of Belgium. It provides insight into the nature and amount of jobs in the country's circular economy and constitutes a first iteration of a national monitoring practice of jobs in the Belgian circular economy. As such, the report aims to support governments, employers, social partners and other representatives to pursue effective and inclusive circular labour policy.

The report complements an online monitor, which can be accessed via <https://circle-economy.com/jobs-skills/monitor>

THE CIRCULAR ECONOMY

The circular economy offers an alternative way to the linear 'take-make-waste' economy that is harming people and the environment. It seeks to extract the maximum value from resources in use and keeps materials in circulation for as long as possible. To this end, resources are not consumed and discarded, destroying their value. Rather, their value is retained by reusing, repairing, remanufacturing or recycling, as shown in the figure below.

The circular economy is no end-point, it is rather a process of transformation. By following circular strategies, organisations and businesses can render their processes increasingly circular and attain the highest level of economic and societal value. The DISRUPT model presented on page 12 describes the full breadth of relevant strategies that give direction to this transformative process. There are three core circular strategies (in light blue), which directly intervene in material cycles, and four enabling strategies (in dark blue), which serve to mainstream, accelerate and scale up the core circular strategies.



The value hill model proposes a categorisation based on lifecycle phases of a product in pre-, in- and post-use, and clarifies the systemic differences between the current linear economy and the circular economy that we are striving for. ³



CIRCULAR ECONOMY IN BELGIUM

The circular economy has gained traction in Belgium, much like its surrounding countries. Sector organisation Agoria estimated that the circular economy could create an additional 36.000 jobs between 2017 and 2020, 20.000 of which in the technology sector.⁴ Estimates by PWC indicate a potential of the circular economy of 15.000 up to 100.000 new jobs by 2030.⁵ The circular economy provides an opportunity for the Belgian labour market, with potential benefits in terms of increased purchasing power, reinforced competitiveness and employment opportunities.⁶

Both the Federal and the regional governments support the circular economy. The most recent significant policy interventions in this regard are summarised below.

Belgium

In 2016, the Federal Government has expressed the ambition for Belgium to become one of the circular economy frontrunners and has proposed 21 measures to this end. These measures include informing consumers (about quality assurance, environmental performance and reparability of products), supporting the recycling industry (by promoting demand for recycled plastics, addressing technical and economic barriers and promoting the chemical recycling techniques) and playing an exemplary role by integrating circularity in public procurement practices. At the same time, the Federal Government actively participates in the debate on eco-design and consumer protection on the European level.^{7,8}

Brussels Capital Region

In 2014, the Brussels Regional Government included the circular economy in its coalition agreement as a system for employment creation and opportunity for Brussels' businesses to develop new markets.⁹ Subsequently, the regional government indicated its vision for the circular economy in its Strategy 2025, which contains a Regional Programme for the Circular Economy that kickstarted the circular transition.¹⁰

The Regional Programme on the Circular Economy contains over 100 measures to support the local circular economy and sets three ambitions: to translate environmental ambitions into economic opportunities; to drive local production where possible, optimise land use and added value for the inhabitants of the region; and to contribute to job creation.¹¹ Since its launch, the programme has educated 1.700 people about circularity, financially supported 139 circular SMEs and created over 200 direct jobs.¹² The Brussels Regional Government included the circular economy in its recent coalition agreement 2019-2024.¹³

Flanders

The 2014-2019 Coalition Agreement of the Flemish Government consolidated the past successful efforts of the Flanders Material Programme in the Flanders Vision 2050.¹⁴ This vision aims to work towards a strong, open, resilient and internationally oriented region that provides wellbeing for all in an innovative and sustainable way and proposes the circular economy as one of its seven transition priorities.¹⁵

Currently supporting and guiding this transition is Circular Flanders, a public-private partnership that acts as a central mediator for the circular transition of Flanders and aims to further consolidate and mainstream the circular transition.

It is a partnership of governments, businesses, civil society and knowledge organisations that focuses on the following core activities: network (bringing stakeholders together), lab (personalised guidance for pioneers), knowledge (sharing and creating knowledge), policy (policy support and guidance), innovation (supporting innovation with multiple instruments, anchor (to scale up and anchor circular economy principles and best practices)).¹⁶

Wallonia

The Walloon Government expressed the intention to improve the competitiveness of the region by supporting, amongst others, the transition to the circular economy in 2014.¹⁷ The Walloon 4.0 Marshall Plan for regional development further engages the region in the circular transition. It prioritises energy efficiency and the circular economy with the aim to recover and deploy the Walloon economy.¹⁸ Most recently in May 2019, the Walloon parliament unanimously adopted a resolution on the transition to the circular economy, with the intention to develop a circular economy strategy for the region.^{19,20} The Walloon Government included the circular economy in its recent coalition agreement 2019-2024.²¹

So far, a number of regional programmes recognise the circular economy as a focus area: Win2Wal stimulates strategic research in the circular economy;²² Reverse Metallurgy aims to improve the recovery of scarce metals;²³ and the European Sustainable Chemicals Support Service advises the region to promote a more circular chemical industry.²⁴

JOBS IN THE CIRCULAR ECONOMY

Employment in the circular economy reflects the broad nature of the system, and can equally be defined according to the DISRUPT framework. The circular labour market, much like its linear counterpart, is comprised of all kinds of jobs in different sectors, ranging from manufacturing and creative industries to waste and resource management. Jobs in the circular economy, shortly 'circular jobs', are all jobs that contribute to one of the strategies of the DISRUPT framework.

- **Core circular jobs.** These jobs ensure that raw material cycles are closed and thus form the core of the circular economy. They include jobs in renewable energy, repair and waste and resource management sectors. Examples of core circular jobs are displayed in light blue in the framework on the right.
- **Enabling circular jobs.** These jobs enable the acceleration and upscaling of core circular activities and thus form the supporting shell of the circular economy. They include jobs in leasing, engineering and digital technology - albeit only those that actually contribute to circularity. Examples of enabling circular jobs are displayed in dark blue in the framework on the right.
- **Indirect circular jobs.** These jobs provide services to the primary circular activities above and thus form the activities that indirectly uphold the circular economy. They include, for example, jobs in education, logistics and the public sector. Examples of indirect circular jobs are displayed in grey in the framework on the right.

DEFINITION CIRCULAR JOBS

A **circular job** is any occupation that directly involves one of the elements of the circular economy or indirect supports such activities.

A **direct circular job** includes jobs that follow **core** and **enabling** circular economy strategies.

An **indirect circular job** includes jobs that support the directly circular jobs.



DESIGN FOR THE FUTURE

Adopt a systemic perspective during the design process, to employ the right materials for appropriate lifetime and extended future use.

The **architect** designs buildings to enable resource recovery after the building's use phase and so designs for the future.



INCORPORATE DIGITAL TECHNOLOGY

Track and optimise resource use and strengthen connections between supply-chain actors through digital, online platforms and technologies.

The **data analyst** makes sense of large amounts of information to connect supply and demand of secondary materials by means of digital technology.



SUSTAIN & PRESERVE WHAT'S ALREADY THERE

Track and optimise resource use and strengthen connections between supply-chain actors through digital, online platforms and technologies.

The **appliance technician** repairs appliances, machines or vehicles and so extends the lifetime of things already made.



RETHINK THE BUSINESS MODEL

Consider opportunities to create greater value and align incentives through business models that build on the interaction between products and services.

The **leasing process manager** coordinates service providers across market segments to enable the new business model.



USE WASTE AS A RESOURCE

Utilise waste streams as a source of secondary resources and recover waste for reuse and recycling.

The **recycling operative** separates waste into materials that can and cannot be recovered, allowing for waste to be used as a resource.



PRIORITISE REGENERATIVE RESOURCES

Ensure renewable, reusable, non-toxic resources are utilised as materials and energy in an efficient way.

The **solar panel installer** builds solar panels and so contributes to the use of solar energy as a regenerative resource.



TEAM UP TO CREATE JOINT VALUE

Work together throughout the supply chain, internally within the organisation and with the public sector to increase transparency and create shared value.

The **director of a trade organisation** manages the membership organisation that facilitates collaboration for joint value creation.

INDIRECT CIRCULAR JOBS

These jobs provide services to the primary circular activities above and thus form the activities that indirectly uphold the circular economy.

The **courier** brings packages to and from consumers as part of a reverse logistics scheme that enable new business models.

The **teacher** transfers knowledge and skills to the (future) workforce so as to equip workers with the skills for all circular economy strategies.

Recent estimates have highlighted the potential of the circular economy to generate a net employment increase of about 700.000 jobs in the European Union by 2030.²⁵ Especially the initial phases of the transition to the circular economy are predicted to be labour intensive.

This report examines the nature and magnitude of employment in the circular economy in Belgium. The intention is to better understand the current situation, discern the meaning of predictions for the country and its regions.

The following sections give an overview of current circular economy employment in Belgium, the three regions (Brussels Capital Region, Flanders and Wallonia) and two cities (Antwerp and Liège).

Method

The methodology that was applied to calculate the amount of circular jobs follows a sector-focused approach. The data is organised following the NACE Rev. 2 statistical classification system of economic activities, a standardised system employed in the European Union.²⁶

Based on the DISRUPT framework, almost 2.000 sectors are differentiated and classified as core, enabling or indirect circular. It is assumed that all jobs within core circular sectors are circular. For enabling circular and indirect circular sectors, however, this assumption does not hold. Not all activity within these sectors is circular. Here, the economic cross-interaction between indirect, enabling and core circular sectors and their trickle-down effects are used to estimate the number of enabling and indirect circular jobs.

The approach holds advantages and limitations:

- The method employs up to date, reliable and existing data to calculate the amount of jobs in the circular economy. There is no need to collect new data, a time intensive and costly process.
- The method employs data that is structured in internationally standardised classification system. This allows for replication and comparison of results over time and across borders.
- The method employs a proxy to calculate the circular share of jobs in enabling and indirect circular sectors. This proxy is derived from economic interaction between sectors (input-output analysis) and can therefore lead to an under- or overestimation of circular jobs in enabling and indirect circular sectors.

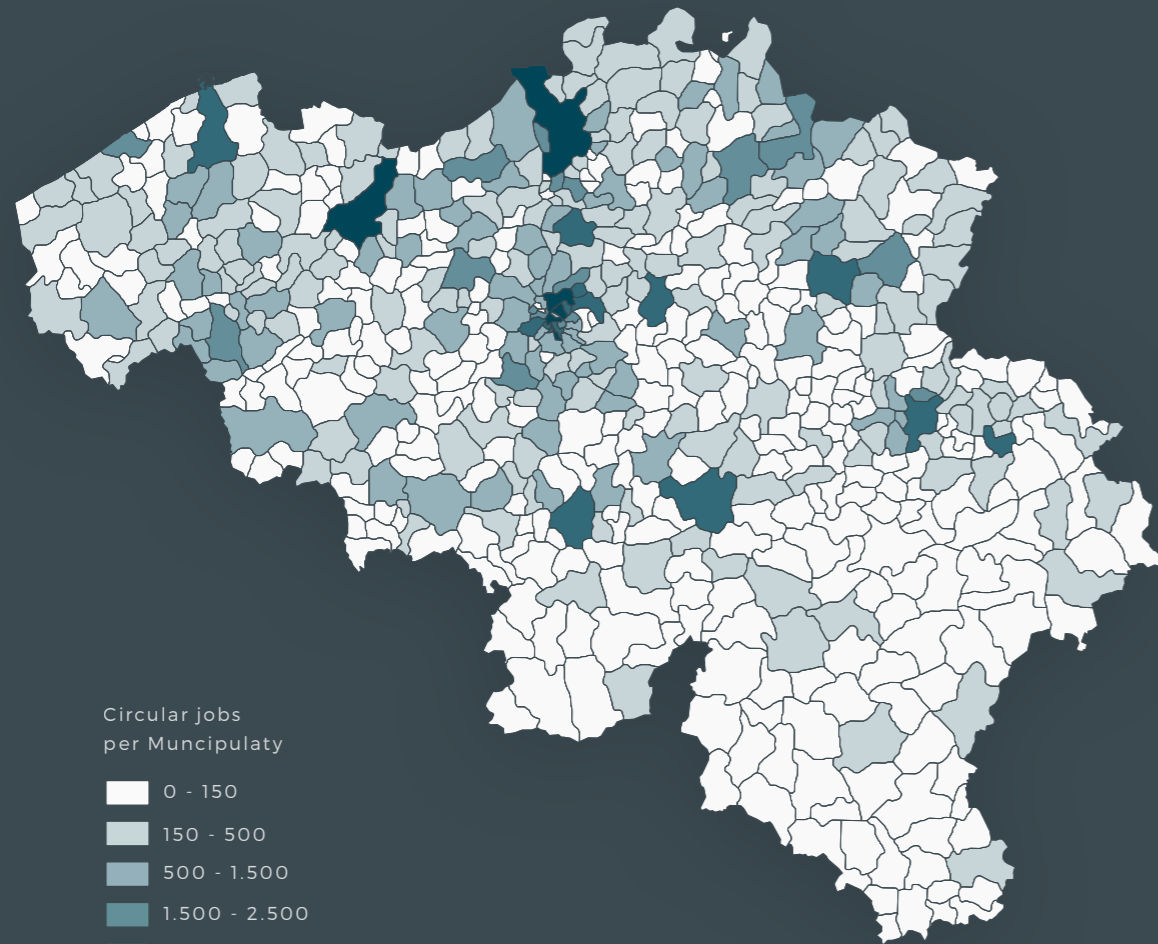
Considering both the opportunities and limitations, the method employed for this monitor forms the basis - and first iteration - of a monitoring practice for employment in the circular economy in Belgium.

See Annex I for a full overview of the methodology.



7.5%

OF ALL JOBS IN BELGIUM ARE CIRCULAR



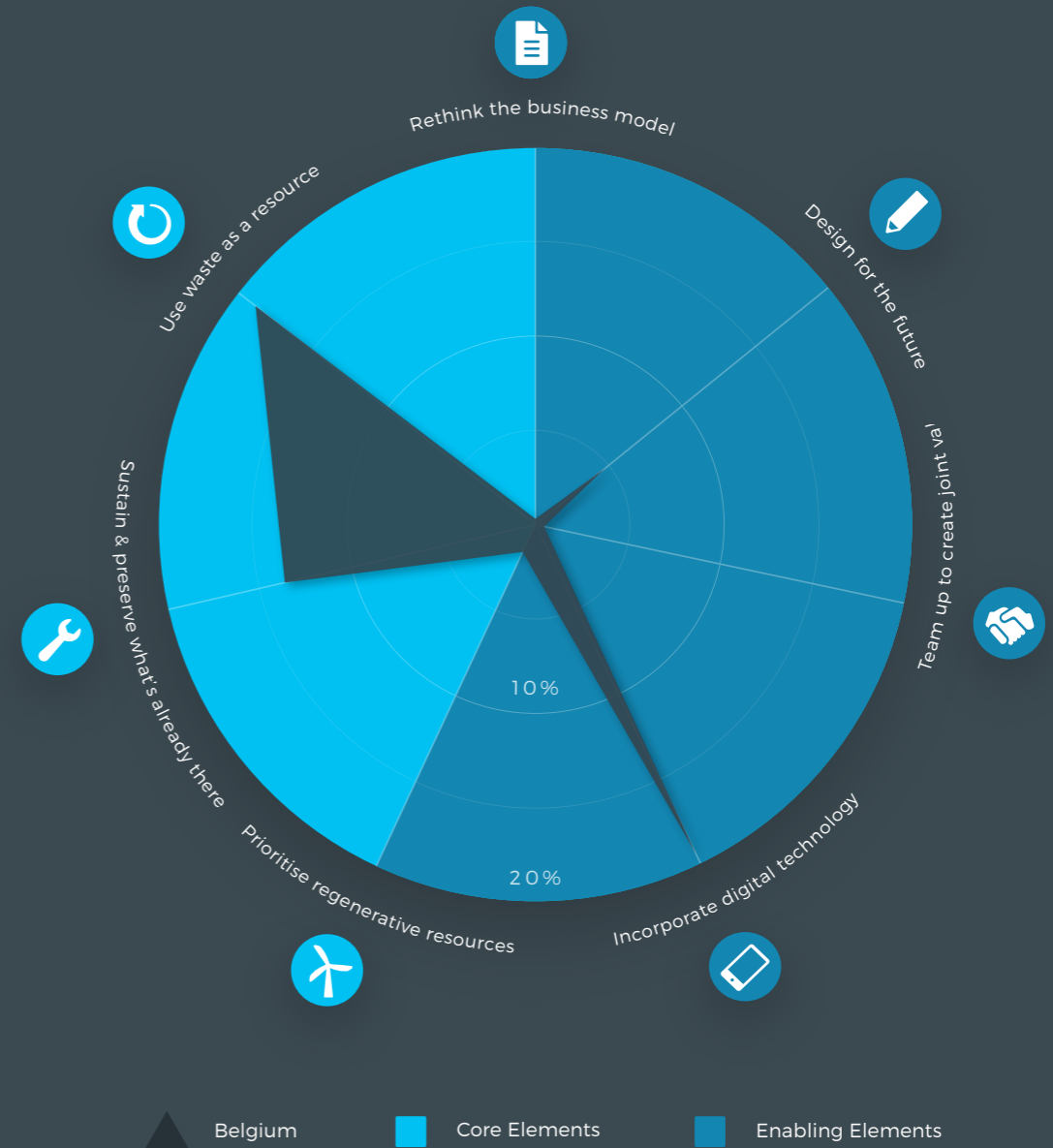
Circular jobs per Municipality

- 0 - 150
- 150 - 500
- 500 - 1.500
- 1.500 - 2.500
- 2.500 - 7.500
- 7.500 - 20.000

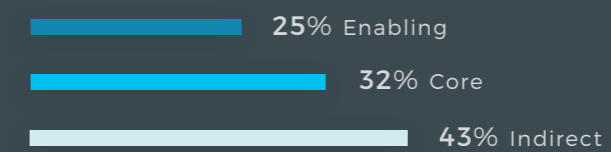
AREA	30.688 km ²
POPULATION	11.322.088
GDP	€ 439.052 million
GDP PER CAPITA	€ 38.700

all data for 2017 ^{27,28}

DIRECT CIRCULAR JOBS



CIRCULAR JOBS



Circular jobs in Belgium

In Belgium, 262.000 jobs are circular (7,5% of all jobs). These jobs are distributed across core, enabling and indirectly circular sectors, which respectively create 85.000, 66.000 and 112.000 circular jobs (32%, 25% and 43% of all circular jobs).

The recycling and repair and maintenance sectors together create over 80.000 jobs (30% of all circular jobs), mostly located in the Antwerp, East-Flanders, West-Flanders and Liège provinces.

In absolute numbers, most circular jobs are located in Flanders and Brussels. There are 58.000 circular jobs in the Brussels Capital Region and 50.000 in the Antwerp province (23% and 19% of all circular jobs). The Brussels Capital Region creates the most enabling and the Antwerp province the most core circular jobs.

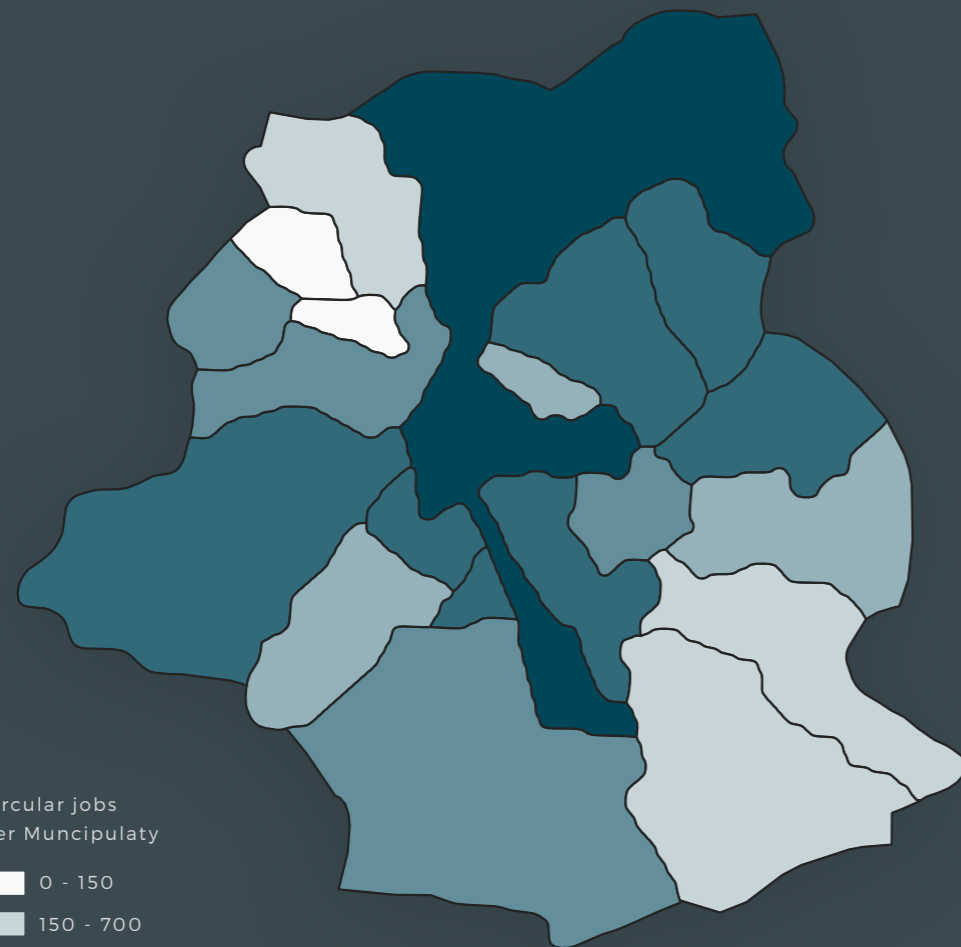
Yet, in relative terms, all provinces show a circular share of employment between 5% and 9%. Only the Brussels Capital Region consistently shows a higher share of circular employment than Flanders and Wallonia.

The circular economy is a system that takes place on different systemic levels, from the local, to the regional and global level. Belgium is the home to circular initiatives on each of these levels, from local sharing initiatives, to regional waste management systems and a global network that circulates secondary cars and car parts. The following sections zoom into the three regions of Belgium: Brussels Capital Region, Flanders and Wallonia to further discern the results of this baseline measurement. Subsequently, two sections isolate the characteristic cases of Antwerp and Liège - Antwerp as a city with a seaport that operates on a global scale and Liège as an industrial legacy city.

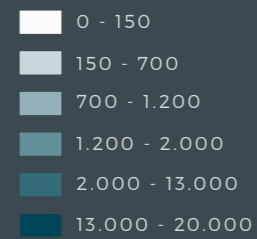


8.1%

OF ALL JOBS IN
BRUSSELS CAPITAL REGION
ARE CIRCULAR



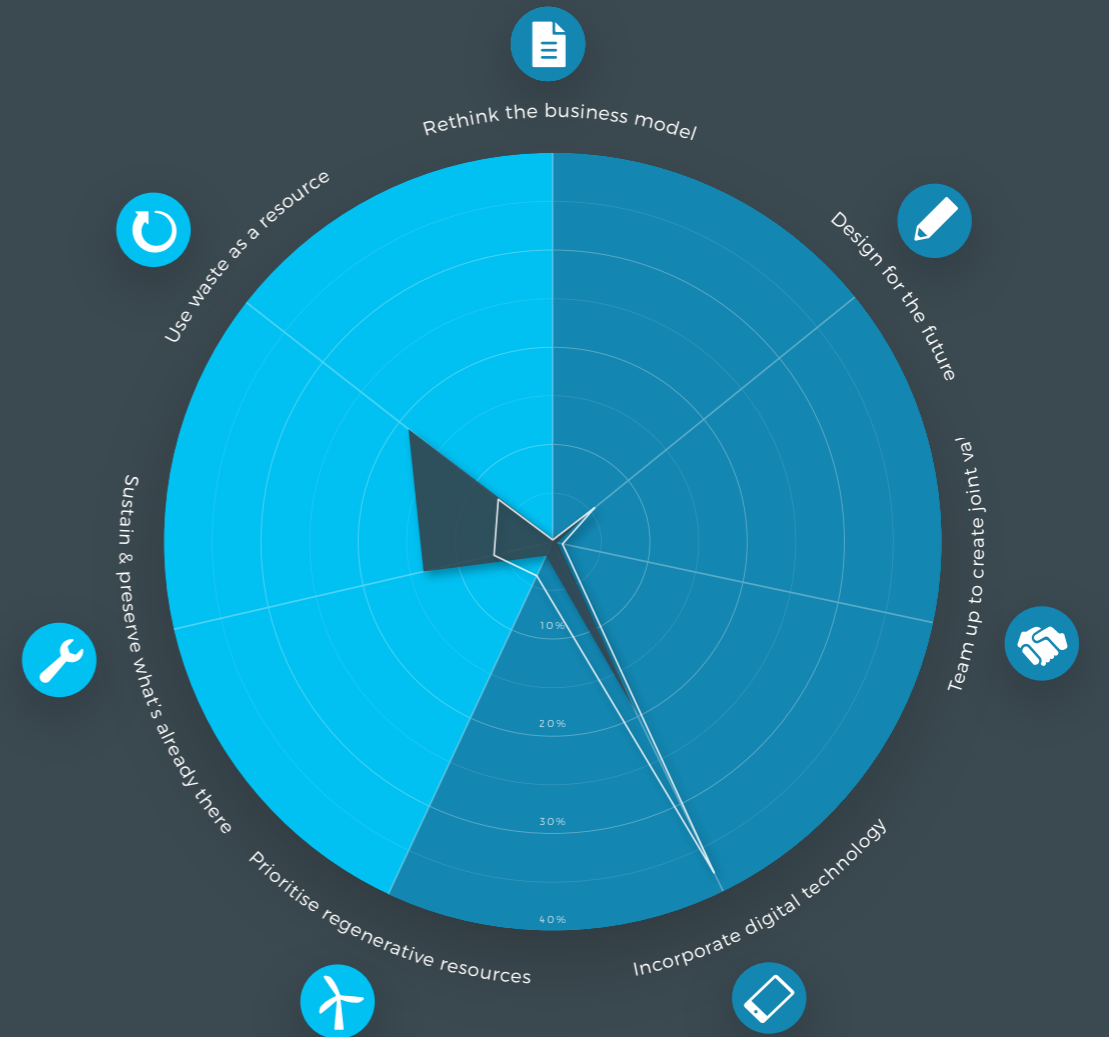
Circular jobs per Municipality



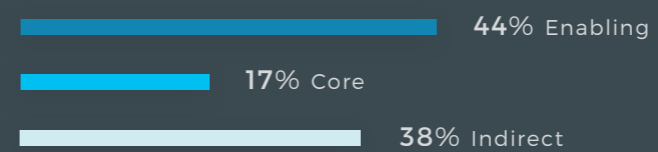
AREA	161 km ² (0.2% of Belgium)
POPULATION	1.191.604
GDP	€ 77.694 million (18% of Belgium)
GDP PER CAPITA	€ 65.000

all data for 2017 ^{29,30}

DIRECT CIRCULAR JOBS



CIRCULAR JOBS



Circular jobs in Brussels Capital Region

In the Brussels Capital Region, 58.000 jobs are circular (8,1% of all jobs). Unlike the Flanders and Wallonia regions, almost half of these jobs are created by enabling circular activities, with a mere 9.500 jobs in core circular sectors (17% of all circular jobs).

The waste and resource management sector creates over 4.000 jobs (7% of all circular jobs). Next to traditional waste management, the Brussels Capital Region contains innovative initiatives that recover value from waste.

Over 3.500 people are employed in the repair and maintenance sector (6% of all circular jobs). Unlike the jobs in waste management, jobs in repair and maintenance are spread more or less evenly across Brussels and the surrounding municipalities.

It stands out that, with over 22.000 jobs, the digital technology sector creates the lion's share of circular employment in the Brussels Capital Region (38% of all circular jobs). This is a much higher proportion than the Belgian average. This can be related to the registration of company data, which is accounted under each company's Belgian headquarters. In the digital technology sector, these headquarters are often located and therefore registered in the capital.

The circular economy indirectly creates over 22.000 jobs in the Brussels Capital Region (38% of all circular jobs). Indirect circular jobs are created mainly in the trade, administrative and construction sectors. Almost 2.000 jobs in construction can be considered circular (7% of all construction jobs).

Circular employment in the Brussels' construction sector closely relates to circular economy practices in the engineering and design sectors as a part of the same innovation system. There are 3.200 circular jobs in design and engineering in the Brussels Capital Region (6% of all circular jobs). This is, just like digital technology, a larger proportion than the other two regions.

Lastly, it is interesting to note that the Brussels Capital Region is the home of a large number and wide variety of small-scale circular activities. Whereas these have a small impact in terms of absolute job creation, they can be very powerful in raising the profile of the Brussels' circular economy as they are in direct contact with the region's inhabitants.



Travie is developing a project where they collaborate with large supermarkets to recuperate unsold food products and reprocess them to high value food products such as soup and juice. The organisation employs over 400 people, and is geared towards offering jobs to people with a distance to the labour market.³¹



Yuman Village eases the way to circular every day shopping by bringing together shops that sell circular products in one centre.³²

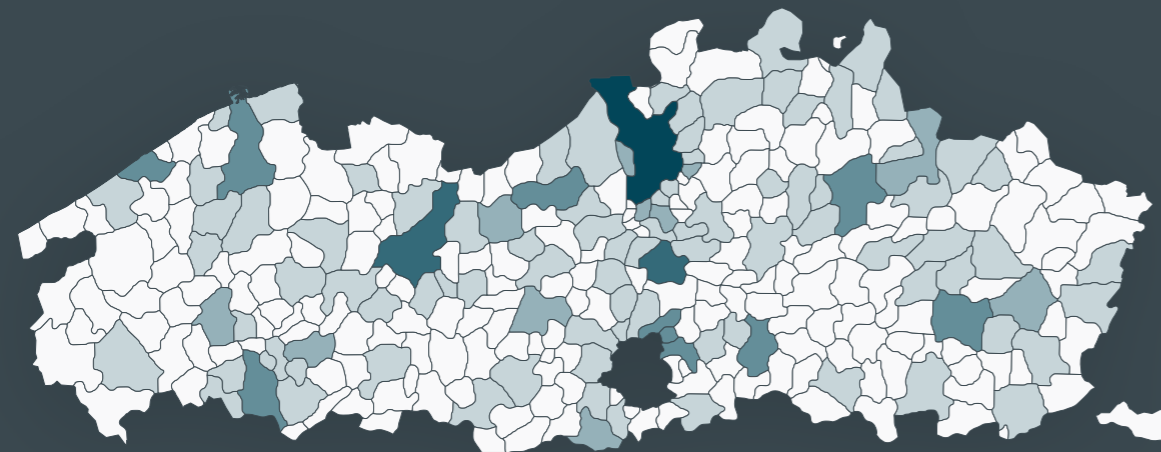


MCB Atelier specialises in designing and printing wooden structures that are sustainably sourced and modular - and therefore personalisable, adaptable and ultimately reusable.³³

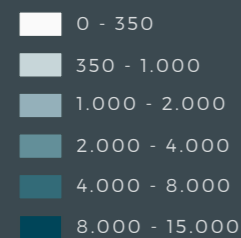


7.5%

OF ALL JOBS IN FLANDERS ARE CIRCULAR



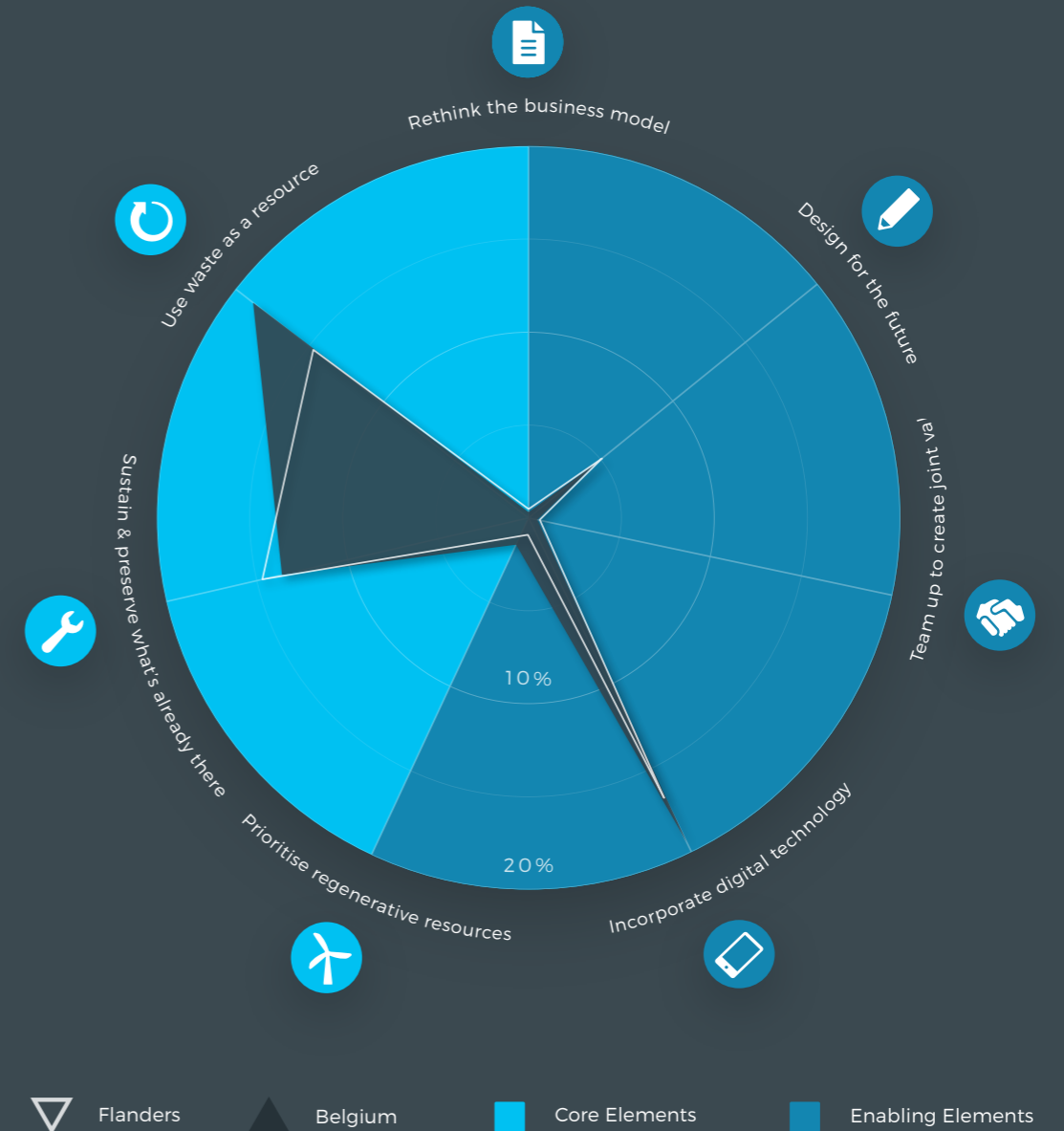
Circular jobs
per Municipality



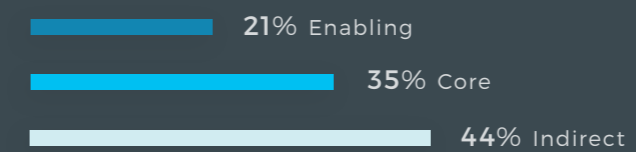
AREA	13.522 km ² (45% of Belgium)
POPULATION	6.516.011
GDP	€ 259.786 million (59% of Belgium)
GDP PER CAPITA	€ 39.800

all data for 2017^{34,35,36,37}

DIRECT CIRCULAR JOBS



CIRCULAR JOBS



Circular jobs in Flanders

In Flanders, 148.000 jobs are circular (7,5% of all jobs). Typically for a region its size, Flanders circular jobs are mainly generated in core and indirectly circular sectors. Still, with over 30.000 jobs generated by enabling circular activities (21% of all circular jobs), Flanders performs strongly in the more service-oriented circular sectors as well. Antwerp and Ghent are important clusters for circular economy employment.

Almost 30.000 are employed in waste and resource management (20% of all circular jobs). Next to Antwerp and Ghent, Mol and Geel each create over 1.000 jobs in waste management too, respectively 13% and 7% of total employment in these municipalities.

Over 20.000 people are employed in repair activities (15% of all circular jobs), the majority of which in the repair of motor vehicles. However, over 6.000 jobs are created in the repair and maintenance of other goods, from household appliances to industrial equipment. Over 1.000 of these last repair jobs are located in Antwerp (the case of Antwerp explored in more detail below).

The Flemish circular economy produces over 23.000 jobs in digital technology and almost 7.000 in design (16% and 5% of all circular jobs). Whereas most digital technology jobs are created within established, large technology companies, some digital technology companies are created with the sole purpose of supporting the circular economy.

Indirectly circular jobs, then, are mostly created in the professional services, trade, logistics and construction sector (44% of all circular jobs).



Top-Mix processes residual materials from construction and infrastructure projects such as concrete into secondary granulates for road construction.³⁸



Recyca buys and collects used printer cartridges, repairs and cleans them and resells them to manufacturers for refilling. In doing so, Recyca avoids old cartridges from going to chemical waste and extends the lifetime of cartridges in use.³⁹

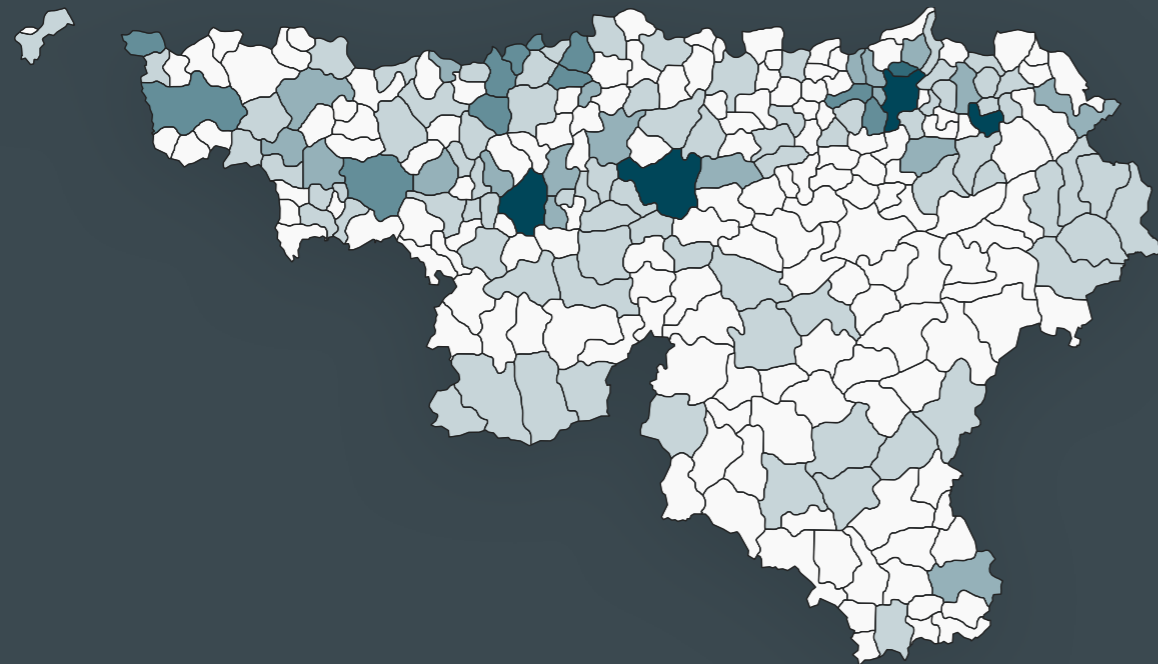


Werflink connects supply and demand in secondary construction materials. By means of an online platform, it allows stakeholders in the construction chain to advertise or search for unused or secondary construction materials.⁴⁰

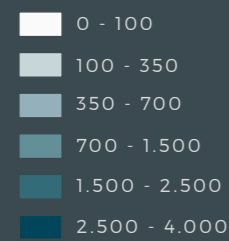


6.8%

OF ALL JOBS IN WALLONIA ARE CIRCULAR



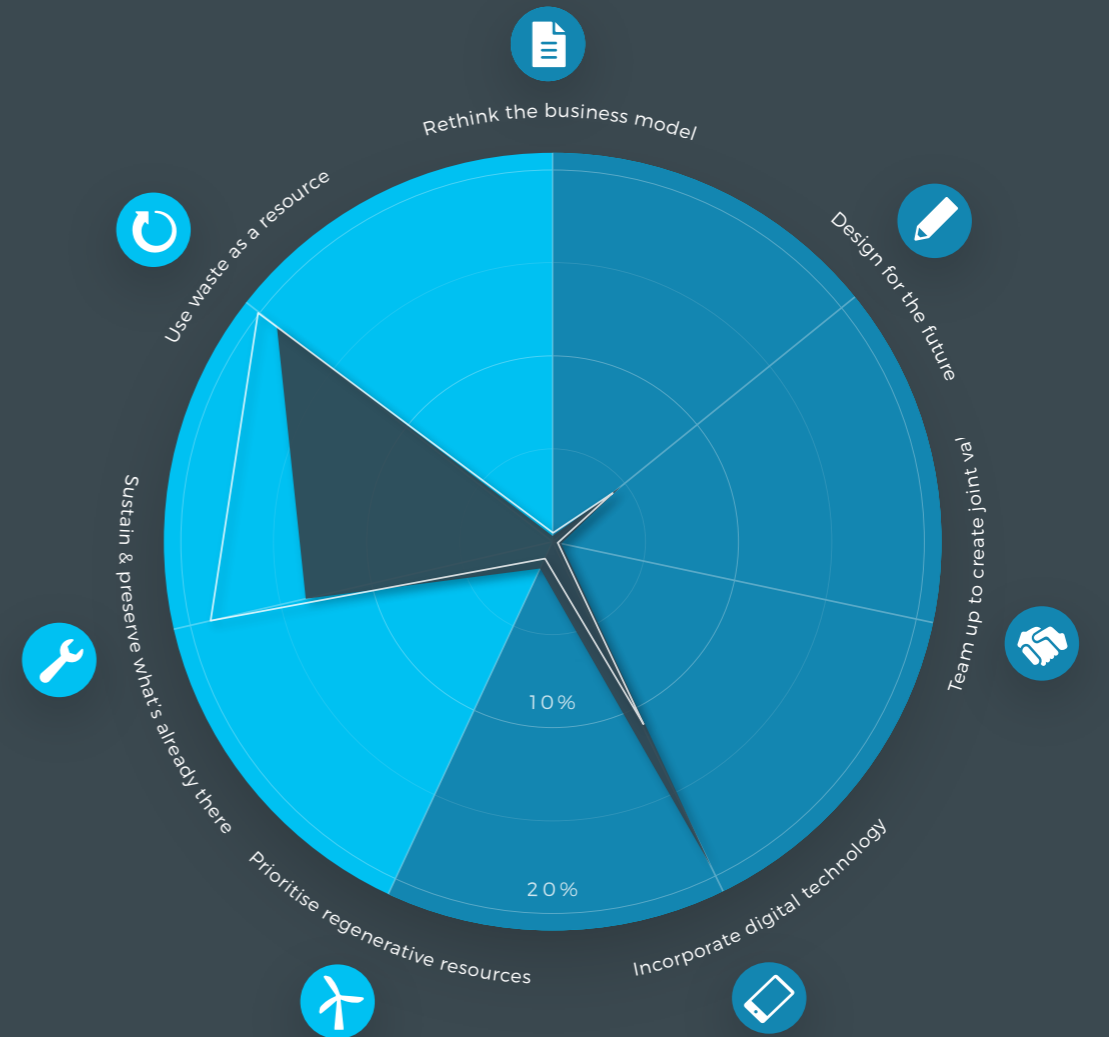
Circular jobs per Municipality



AREA	16.844 km ² (55% of Belgium)
POPULATION	3.633.795
GDP	€ 101.378 million (23% of Belgium)
GDP PER CAPITA	€ 28.000

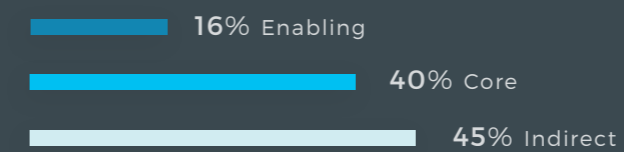
all data for 2017^{41,42}

DIRECT CIRCULAR JOBS



Wallonia Belgium Core Elements Enabling Elements

CIRCULAR JOBS



Circular jobs in Wallonia

In Wallonia, 56.000 jobs are circular (6,8% of all jobs). A large majority of these circular jobs are located in the core of the circular economy and in the sectors indirectly supporting the circular economy (40% and 45% of all circular jobs). This is roughly in line with employment in the Flemish circular economy.

The cities of Namur, Charleroi and Liège form the economic centres of the region. When it comes to core circular jobs, the Hainaut province equally provides circular employment opportunities.

Each creating about 11.000 jobs, the recycling and repair and maintenance sectors create a large share of all circular employment in Wallonia (together 39% of all circular jobs). The jobs in repair and maintenance are distributed more or less evenly across the entire region, more so than all other circular jobs. These core circular jobs are created by social initiatives, as well as on an industrial scale.

Much like the rest of the country, the digital technology and design sectors are the key enabling sectors generating jobs in the circular economy in Wallonia. The digital technology sector creates 6.000 and the design and engineering 2.500 circular jobs (10% and 4% of all circular jobs). Whereas digital technology jobs mainly gravitate towards Brussels, design jobs tend to concentrate in Namur, Charleroi and Liège.

Digital technology jobs are created by large digital service providers, as well as by more disruptive start- and scale-ups, committed to advancing the circular economy through digital technology.

Indirectly circular jobs in Wallonia constitute almost half of all circular jobs and are mostly generated by the trade, construction and manufacturing sectors.



Vanheede Biomass Solutions has four branches in Hainaut that specialise in revalorising bio-based waste streams by means of composting, biodigestion and unpacking of organic products such as food for processing.⁴³



Ressourcerie du Val de Sambre recovers, repairs and resells household objects and creates jobs for people with a distance to the labour market.⁴⁴



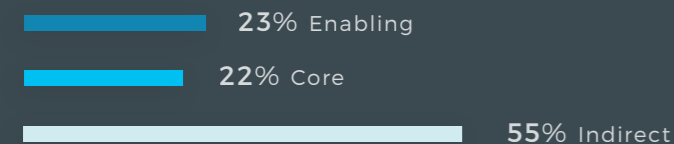
Connect2Move is a Liège based start-up that develops digital mobility solutions to enable real-time and efficient smart logistics systems which are crucial for the success of the circular economy.⁴⁵



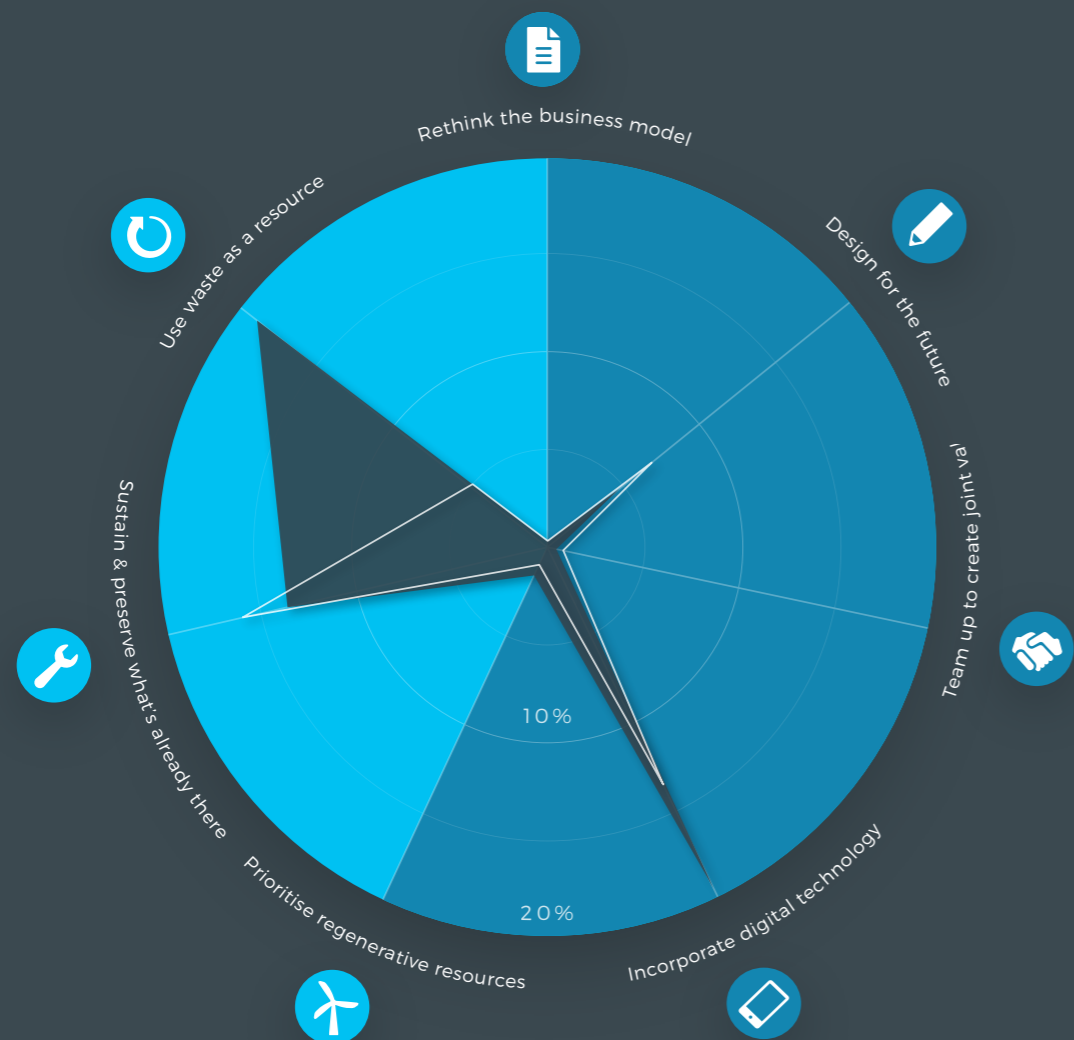
6.4%

OF ALL JOBS IN ANTWERP ARE CIRCULAR

CIRCULAR JOBS



DIRECT CIRCULAR JOBS



▽ Antwerp
 ▲ Belgium
 ■ Core Elements
 ■ Enabling Elements

Circular jobs in Antwerp

In Antwerp, 14.500 jobs are circular (6,4% of all jobs).⁴⁶ There are roughly equal shares of core and enabling circular jobs (22% and 23% of all circular jobs). The circular economy creates 8.000 indirectly circular jobs in Antwerp (55% of all circular jobs).

The majority of core circular jobs in Antwerp can be traced back to the Port of Antwerp. The repair and maintenance sector creates 2.400 jobs in Antwerp (16% of all circular jobs). This is unique to Antwerp compared to Liège or the regions studied here. These jobs can be traced back to the repair and maintenance sector in the Port of Antwerp. The most recent Sustainability Report of the port shows that employment in repair, maintenance and recycling activities in the port have been on the rise since 2010.⁴⁷

Although currently housing traditional industries such as the Antwerp petrochemical cluster, seaports hold potential for the circular economy. Circular ports act as logistical nodes to facilitate the growth of circular product distribution and redistribution in a system of reverse logistics. The industry related to the port can also transition to a more circular one that uses the availability of secondary resources and knowledge infrastructure already in place.

Next to the more traditional circular economy, the port also widens its scope of activities, creating opportunities for renewable energy and remanufacturing (or added value logistics). There are currently over 200 circular jobs in the renewable energy and manufacturing sectors adjacent to the circular economy (1% of all circular jobs). As such, the future circular economy of Antwerp will see more diversified labour in the port.

There are 2.000 circular jobs in the digital technology sector and 1.000 circular jobs in the design and engineering sector in Antwerp (14% and 7% of all circular jobs), proliferating both in

the port and the city centre. Enhanced interaction between the knowledge intensive activities in the centre and the space intensive industries in the port can further drive the circular transition of the area.

Indirectly circular jobs are mainly created in the trade, public administration and professional services sectors. The circular economy also creates 700 indirect jobs in the transport and storage sector (2,4% of the transport and storage sector).

The **Carloop** project encompasses the recycling and remanufacturing of car parts which are shipped back from Benin to Belgium to be processed by specialist partner companies in the port of Antwerp.⁴⁸

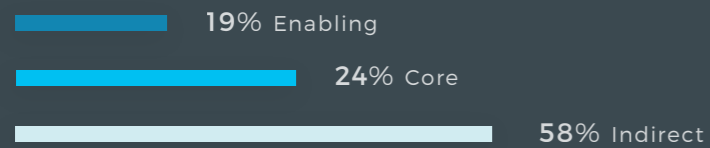
BlueChem is an incubator and accelerator for sustainable companies in the chemical sector. The incubator support entrepreneurs and partners by connecting companies with governments and knowledge institutions. BlueChem is directed towards the valorisation of waste and by-product flows of biomass, energy and water.⁴⁹

The **Energy-Neutral Lock** uses the water passing through the locks that ensure steady water levels in the docks to generate electricity.⁵⁰

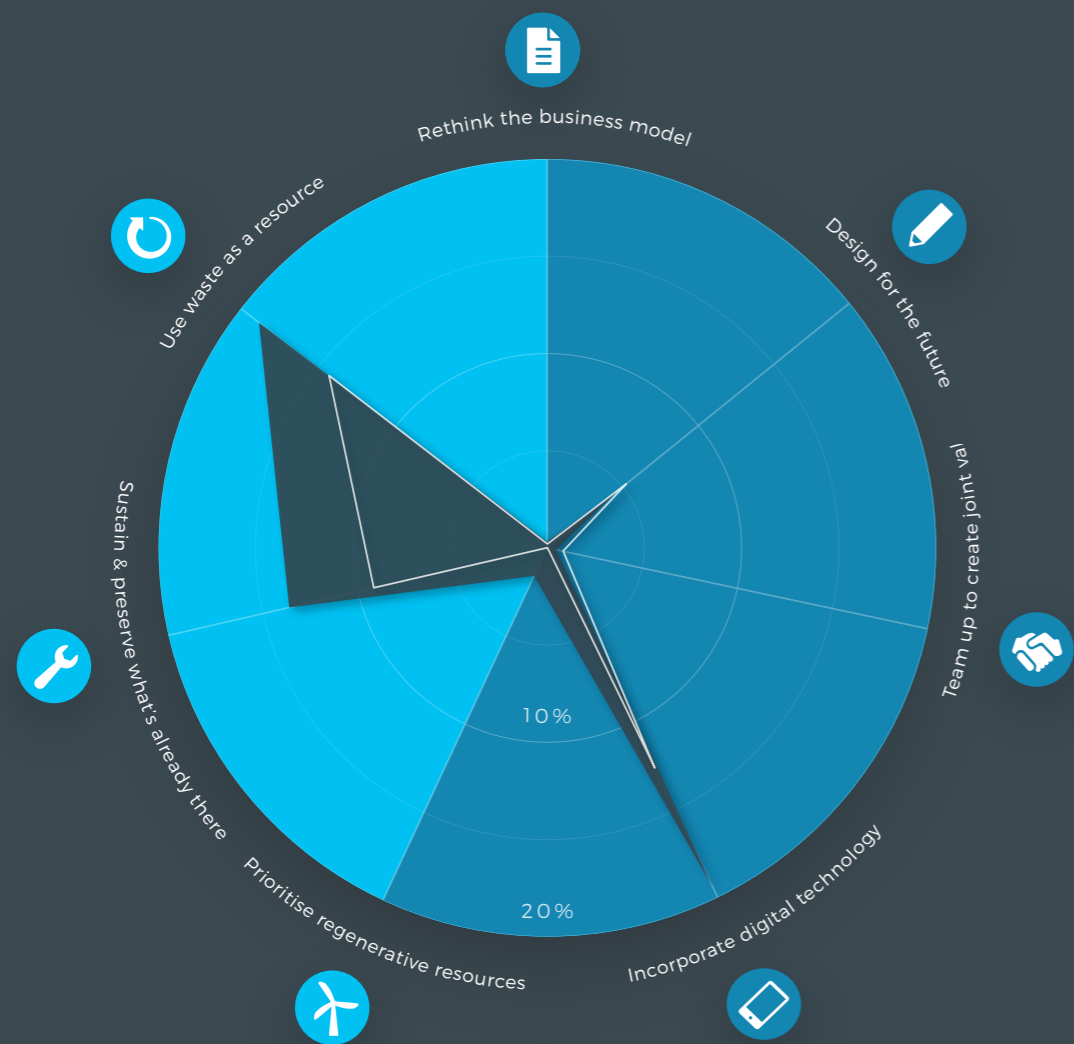
6.3%

OF ALL JOBS IN LIÈGE ARE CIRCULAR

CIRCULAR JOBS



DIRECT CIRCULAR JOBS



Liège
 Belgium
 Core Elements
 Enabling Elements

Circular jobs in Liège

In Liège, 3.800 jobs are circular (6,3% of all jobs).⁵¹ Of these circular jobs, 900 are core, 700 enabling and 2.000 indirectly circular (24%, 19% and 58% of all circular jobs).

The majority of core circular jobs are created in the recycling and the repair and maintenance sectors (14% and 9% of all circular jobs). The recycling, maintenance and repair sectors are closely related to the manufacturing sector as they provide recycling of byproducts and secondary materials and remanufacturing services to the manufacturing industry. A share of these processes can be internalised by the manufacturing sector itself. This is further explored in the chapter 'Circularity in the Manufacturing Sector' on page 38.

The majority of circular jobs in Liège enable or indirectly support these core circular activities (19% and 58% of all circular jobs). Enabling circular jobs are created in the digital technology and engineering and design sectors (13% and 5% of all circular jobs) and indirectly circular jobs are created in the trade, construction and administrative sectors.



Sofie collects, sorts, dismantles, recycles and reuses waste electrical and electronic equipment (WEEE). As a social enterprise, they provide training and job opportunities to people with a distance to the labour market.⁵²



Reverse Metallurgy, a Walloon public-private partnership, creates a platform for industrial, technological and scientific excellence in metal recycling and how it results in value creation, job creation and international recognition of the Walloon economy.⁵³



OCCUPATIONS AND SKILLS

In order to supply the right labour for the circular jobs in Belgium discussed in the previous sections, there is a need for insights into what occupations these jobs are, and what their skills and knowledge requirements are. This section gives a brief overview of the dynamics shaping work in the circular economy and the consequences this has on the job requirements of this work.

There are two trends that have a significant impact on occupations and skills in the circular economy. Firstly, technological advancement shakes up the landscape of skill requirements and job profiles.⁵⁴ Secondly, as a consequence of a cascading process of remanufacturing, repair and recycling, stakeholders and processes are more interconnected, with pervasive consequences on job content and tasks of workers in the circular economy.⁵⁵

Occupations in the circular economy

New jobs appear in developing and operating new machinery and equipment and from changing processes in a circular economy. These latter jobs are specifically circular professions that, as yet, do not exist. Qualitative analysis points to potentially newly emerging professions such as the material scout (who proactively searches for opportunities to develop feedstock from secondary and residual material flows), the environmental steward (who guards circularity during the design process) and the system mediator (who maintains contacts with the entire value chain and up to date with the cutting edge of circular process, material and design innovations).⁵⁶ Some of these professions can emerge within existing companies, while others can create entire new ones. All will operate across core, enabling and indirect circular activities.

The circular economy is powered by newly emerging occupations, but equally so by occupations that already exist. The results of a survey amongst entrepreneurs active in the circular economy point towards three types of professions particular to the

circular economy: jobs in waste management with the specific aim of high value retention; existing jobs, but with an awareness and knowledge of circular economy principles to apply these in day to day business; and supporting and coordinating roles that bring stakeholders together to realise circular projects.⁵⁷

Skill requirements in the circular economy

Both new professions and changing job content affect the skills and knowledge requirements of jobs in the circular economy. Just like in all other jobs, the need for technical skills increases as technological advancement innovates the tools and equipment used in the circular economy.⁵⁸ In a circular economy, different steps in the value chain collaborate more closely and even blend together. This results in vertical diversification of tasks and a general increase in complexity of tasks, which requires a general upskilling of the workforce.⁵⁹

It is however, tricky to make general claims about skills requirements of the circular economy, as the diverse range of circular activities requires a heterogeneous skill base. While job requirements for core circular jobs involve more manual and technological skills,⁶⁰ enabling circular jobs require more complex and cognitive skills. More research is required for indirect circular jobs.

Technology and circular jobs

The risk of technological advancement destroying low and mid-skilled jobs is to be interpreted with caution. Whereas estimates of almost half of all jobs being at risk of automation sparked widespread concern, the OECD estimates the share of jobs at risk of automation in Belgium to be 7%.^{61 62} This discrepancy can be explained by the diversity of tasks of workers - which is set to increase in a circular economy. By combining technical and behavioural tasks and skills, technology and people remain complementary in the labour market.⁶³

The circular economy has the potential to address people ending up in unemployment, a risk that is highest for low-skilled workers.⁶⁴ Evidence from Flanders suggests that the labour index for core circular sectors is growing faster than the regional average, with an expected increase of repair activities in the circular economy.⁶⁵ These are jobs that require low to mid-skilled workers.

CIRCULARITY IN THE MANUFACTURING SECTOR

This section further explores circular activity in the manufacturing sector.

As explained on page 14, the method employed for this monitor can over and underestimate certain circular economy employment. This is a consequence of employing a proxy to calculate the circular share of sector employment based on the economic interaction of these sectors with circular sectors.

As the analysis is based on sector classifications of companies, it classifies all workers under the main activity their company is registered as. This means that the method does not take secondary activities into account. In the manufacturing sector, for instance, companies often internalise recycling or maintenance, and as such create core circular employment. This employment is, however, not represented in this monitor.

In order to address these challenges, an extra analysis was carried out, looking into the online communications of the Belgian manufacturing companies about circular economy strategies.

Method

The method that was employed to provide more insight about circular activity in the manufacturing sector was applied to the 40.000 companies registered in the manufacturing sector (NACE codes 10.00 to 32.99) and consists of four steps:

1. Understand what companies do, based on their online communication. Open data (from universities, public institutions), public data (from company websites, social media networks) and private data (from Trends Business Information, Graydon, SimilarWeb) is used to this end. From the 40.000 companies in the sample, roughly 10.000 had sufficient visibility to perform the analysis on.

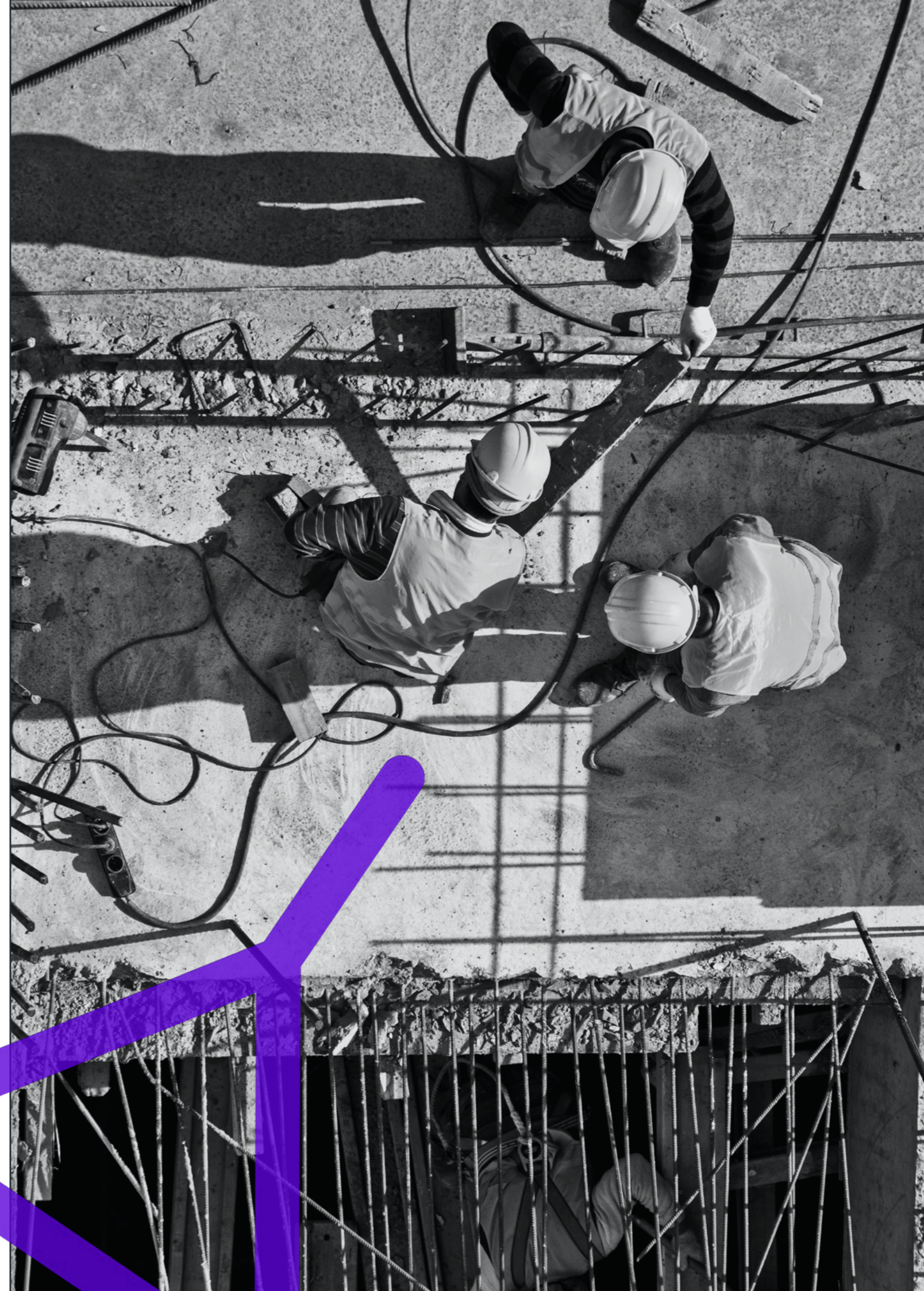
2. Understand the circular economy for this sector. The core elements of the DISRUPT framework are used for this, enriched with content from other sources and retrieved with an artificial intelligence script.
3. Attribute a matching score for every company to the circular economy. This is based on the overlap between the information from step 1 and step 2 respectively, and divides companies into buckets with similar matching scores.
4. Calculate probability of companies to communicate about the circular economy for each bucket.

This method has enormous potential to bring clarity about activity in the circular economy as it employs company level information regardless of registration under NACE codes and so manages to overcome the shortcomings of this sectoral registration of companies.

On the other hand, interpretation of the results should happen carefully. The method is reliant on information as communicated by the companies themselves, and therefore susceptible to greenwashing of companies. Moreover, the insights only tell something about companies communicating about circular strategies, not to what extent these strategies are applied.

As such, this analysis provides insights in the external positioning of companies in the circular economy, not about the amount of people working in it.

See Annex II for a full overview of the methodology.



Almost 25% of manufacturing companies position themselves as active in the circular economy, with an overwhelming 20% of manufacturing companies communicating about lifetime extension strategies such as maintenance and repair. Around 3% of manufacturing companies communicate about regenerative resources and recycling. Brussels and Walloon companies communicate less about circular strategies than Flemish ones. Overall, the pattern of communicating about circular economy strategies is consistent across the three regions, with lifetime extension being the most commonly applied strategy, followed by renewable resources and recycling.

Prioritise regenerative resources

Around 3% of Belgian manufacturing companies position themselves as applying regenerative resources. These companies are mainly registered under NACE codes 28.2 Manufacture of other general-purpose machinery; 27.1 Manufacture of electric motors, generators, transformers and electricity distribution and control apparatus; and 25.2 Manufacture of tanks, reservoirs and containers of metal.

The relevant companies are involved in manufacturing or installing equipment for the generation, distribution or use of renewable energy, such as heat pumps or solar panels.

Sustain & preserve what's already made

Close to 20% of Belgian manufacturing companies position themselves as applying lifetime extension strategies such as maintenance and repair. These companies are mainly registered under NACE codes 28.2 Manufacture of other general-purpose machinery; 25.1: Manufacture of structural metal products; 25.6: Treatment and coating of metals, machining; 27.1 Manufacture of electric motors, generators, transformers and electricity distribution and control apparatus; and 28.1 Manufacture of general-purpose machinery.

The relevant companies are involved in the maintenance and repair of all kinds, either as core or part of their service offering. A small number of these companies manufacture products that enable maintenance and repair of other products. An example of this is Resus, which manufactures sensors for predictive maintenance systems.⁶⁶

Use waste as a resource

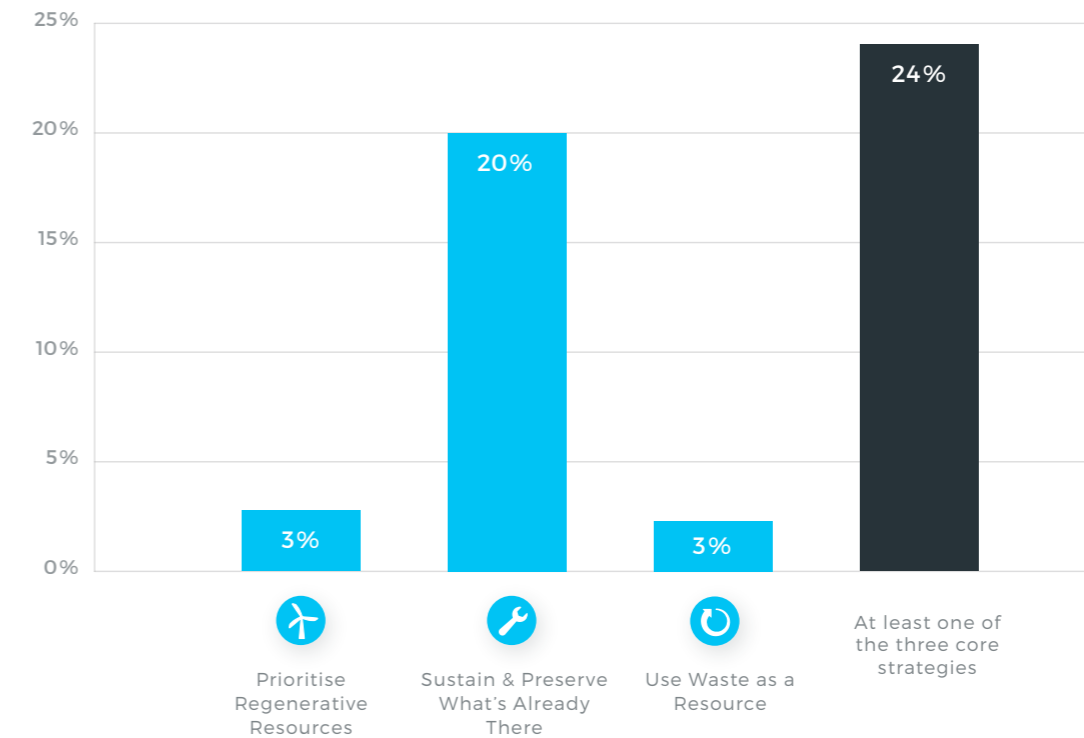
Almost 3% of Belgian manufacturing companies position themselves as applying recycling strategies. These companies are mainly registered under NACE codes 22.2 Manufacture of plastics products; 25.6 Treatment and coating of metals, machining; and 20.1 Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms.

The relevant companies are involved in the recycling of metals, plastics and construction materials, or produce bio-based materials. When recycling, the companies concerned either use recycled content in manufacturing processes, incorporate recycling as an integral part into their manufacturing process; or recycle their own by-products.

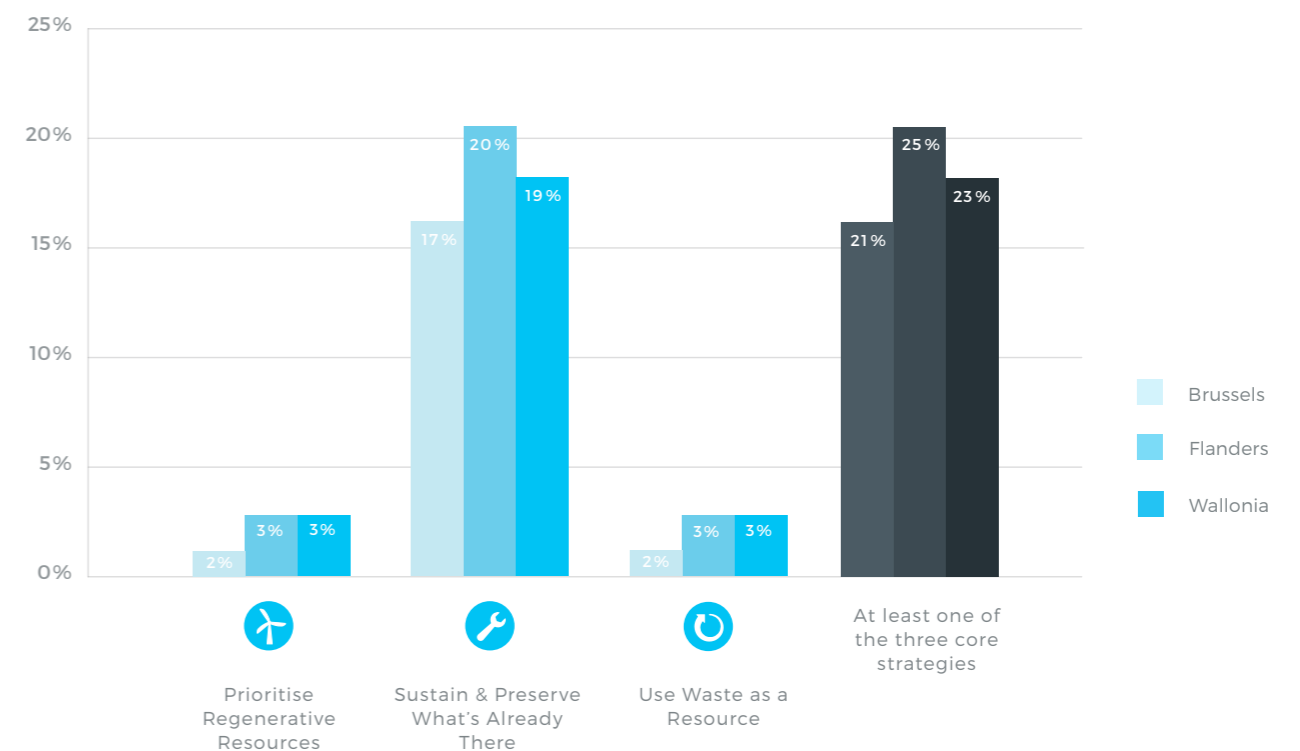
The results of the circular jobs monitor underestimate the amount of circular jobs created by the manufacturing sector, which, on the one hand internalises circular strategies such as recycling of byproducts and on the other hand play an important role in the circular economy by developing, installing and maintaining circular solutions such as renewable energy installations.

How much exactly the monitor underestimates these circular jobs in the manufacturing sector is unclear, as the current method cannot provide insight into employment related to these activities.

GRAPH 1 - 24% of manufacturing companies in Belgium communicate core circular strategies



GRAPH 2 - Manufacturing companies in Brussels Capital Region, Flanders and Wallonia communicate about core circular strategies.



CONCLUSION

This report presents the findings of a baseline analysis of the employment in the Belgian circular economy. The report took a holistic perspective on circular economy employment, including all jobs contributing to the circular economy through activities in renewable energy, repair and maintenance, recycling, digital technology, design, new business models and collaboration. As such, it was able to give a holistic understanding of the amount and nature of jobs in the circular economy in Belgium.

The analysis has shown that 7,5% of all jobs in Belgium are circular - that is 8,1% of jobs in the Brussels Capital Region; 7,5% of jobs in Flanders; and 6,8% of jobs in Wallonia.

The circular economy opportunity for the Belgian labour market. The country is facing challenges in matching people in unemployment with existing and future job opportunities. The circular economy creates employment with a wide variety of job requirements and therefore has the potential to create opportunities in all levels of the labour market. There is room for small-scale and social initiatives; low to mid-skilled jobs in repair are expected to increase overall, with a large share running a low risk of being automated; and newly emerging jobs can attract and employ highly skilled and creative talent.

This report presents a first iteration of a monitor for employment in the circular economy in Belgium. Developing a fully fledged monitoring practice for employment effects of the circular economy helps to discern the employment opportunities the circular economy creates and how these are distributed across society.

At the same time, there is a need to broaden and deepen the understanding of labour market dynamics in the Belgian circular economy.

The overview of jobs in the circular economy begs the question of the skill requirements for these jobs and how these will evolve in the future. Further research into the development of circular job requirements as a result of sector development, technological advancement and employer and business needs is needed in order to align education and training offering with it.

The insights in the jobs the circular economy creates in recycling, repair, maintenance and manufacturing leads to questions about the qualitative aspects of work in the circular economy. Developing actionable insights on quality and inclusion of circular jobs will enable social partners to ensure circular jobs are decent jobs in Belgium.

The monitor presented here is likely to underestimate the amount of circular jobs in the manufacturing sector. An additional analysis of the manufacturing sector showed that 25% of Belgian manufacturing companies communicate about circular economy strategies, and are therefore likely to incorporate such strategies as side processes. Further development of the method to measure circular jobs should provide more insight into the occurrence and nature of circular activities in non-circular sectors and so address and aim to resolve such issues.

Lastly, and related to the previous point, the monitor highlighted the shortcomings of the NACE sector divisions in understanding and guiding the circular economy. Although it is an internationally established and standardised registration practice, the system imposes limitations on monitoring therefore guiding and supporting the transition to

the circular economy. Further research to how the NACE classification system can reflect the reality of the circular economy is needed.

In order to address the social and environmental challenges we are facing on a local and global level, governments, businesses and social partners can embrace the circular economy as a solution. Stakeholders across the board can seize the opportunity of the circular economy to create a balanced labour market, with opportunities for both the most vulnerable and high-skilled workers.



ANNEX 1 - METHOD CIRCULAR JOBS IN BELGIUM

1. Definition of a Circular Job

Qualitative research into similar studies indicates an initial understanding of which sectors contain circular jobs, however these studies incorporate only end-of-life aspects of the circular economy as it relates to waste management, and additional aspects of the circular economy need to be considered.⁶⁷

A piece of work by Circle Economy, Making Sense of the Circular Economy: The 7 Key Elements⁶⁸ conducted a literature review and mapped the various terms and definitions used by over 20 organisations - NGOs, government agencies, academia, consultancies, etc. - working on the circular economy. From this work emerged a framework for the circular economy - the DISRUPT Framework, and from this framework the description of a circular job was formulated.

The DISRUPT framework defines three core strategies, intervening directly in material stocks and flows, and four enabling elements which relate to technology, collaboration, design and business models to support, scale up and mainstream the core strategies.

A circular job is any occupation that directly involves one of the elements of the circular economy or indirect supports such activities. A directly circular job includes jobs that follow core and enabling circular economy elements. An indirect circular job includes jobs within all other sectors of the economy that support the directly circular jobs.

Using this definition, the sectors of economic activity as defined by NACE (level 5) are classified as core circular, enabling circular, or indirect circular, based on how well the sectors are connected to the DISRUPT Framework. An indication is provided in the table below, followed by a full extract of NACE Level 5 sectors mapped to the DISRUPT Framework.

TABLE 1 - An indication of how sectors are mapped to the DISRUPT Framework.








CIRCULAR JOBS	ECONOMIC SECTOR	CIRCULAR ECONOMY ELEMENT	EXAMPLE SECTORS AND ACTIVITIES
DIRECT CIRCULAR JOBS	CORE SECTORS	 Sustain and Preserve What's Already There  Use Waste as a Re-source  Prioritise Regenerative Resources	Repair Services Recycling Renewable Energy
	ENABLING SECTOR	 Design for the Future  Incorporate Digital Technology  Rethink the Business Model  Team up to Create joint Value	Industrial Design and Architecture Digital Technology Renting or Leasing Activities Professional and Networking Associations
INDIRECT CIRCULAR JOBS	INDIRECT CIRCULAR SECTORS		Education Government Services Professional Services

TABLE 2 - NACE Codes mapped to the DISRUPT Framework

DISRUPT ELEMENT	CORRESPONDING NACE REV 2.1 CODES
 Sustain and Preserve What's Already There	33100; 33110; 33111; 33112; 33120; 33121; 33130; 33131; 33140; 33141; 33150; 33151; 33160; 33161; 33170; 33171; 33190; 33191; 45112; 45192; 45201; 45202; 45204; 45205; 45206; 45402; 47790; 47791; 47792; 47793; 95000; 95100; 95110; 95111; 95120; 95121; 95200; 95210; 95211; 95220; 95221; 95230; 95231; 95240; 95241; 95250; 95251; 95290; 95291; 95292; 95299
 Use Waste as a Resource	36000; 36001; 36002; 36003; 37000; 37001; 37002; 37003; 38000; 38100; 38110; 38111; 38112; 38120; 38121; 38200; 38210; 38211; 38212; 38213; 38219; 38220; 38221; 38222; 38300; 38310; 38311; 38312; 38320; 38321; 38322; 38323; 38329; 39002; 43110; 43111; 46770; 46771; 46772; 46779
 Prioritise Regenerative Resources	3511X ⁶⁹
 Design for the Future	71110; 71111; 71112; 71120; 71121; 71129; 74100; 74100; 74101; 74102; 74103; 74104; 74105; 74109
 Incorporate Digital Technology	61000; 61100; 61101; 61200; 61201; 61202; 61300; 61301; 61900; 61901; 62000; 62010; 62011; 62020; 62021; 62030; 62031; 62090; 62091; 63100; 63110; 63111; 63120; 63121; 63900
 Rethink the Business Model	43996; 77200; 77210; 77211; 77212; 77213; 77220; 77221; 77290; 77291; 77292; 77293; 77294; 77295; 77296; 77299; 77300; 77310; 77311; 77320; 77321; 77330; 77331; 77340; 77341; 77350; 77351; 77390; 77391; 77392; 77393; 77394; 77399; 96010; 96011; 96012; 96013; 96014; 96015
 Team up to Create joint Value	94100; 94110; 94111; 94120; 94121; 94200; 94201

2. Employment in Belgium

2017 Employment data for Belgium, was obtained from Graydon.⁷⁰ It details the number of companies in a certain personnel size class (range for number of employees), for a given postcode, and a given sector (NACE, level 5). We applied the average across the range for each size class, but for the maximum class (1000+ employees), we applied the actual numbers of the companies.

The employment data was mapped to our core and enabling circular sector definitions as described above. Data at this level allows us to calculate and display the circular jobs across Belgium at a granular level.

3. Quantifying Circularity

For the core circular sectors, it is assumed that 100% of the jobs are circular. For the enabling circular and indirect circular sectors; however, not all jobs are circular and it was necessary to analyse what percentage of the jobs within these sectors can be considered circular. This analysis is done through the use of input-output (IO) tables. IO tables describe the flow of economic activity between different sectors in the economy, with rows representing the 'source' of activity and columns representing the 'destination'.

The sectors in the rows and columns are classified using the NACE mapping indicated above.

However, the sectors in IO tables are specified at NACE, level 2, as opposed to NACE, level 5 as per the classification table. Because NACE, level 2 is often a combination of core, enabling and indirect sectors, corresponding proportions must be applied to every row and every column. We calculate the proportions using the granular employment figures and apply it to each NACE Level 2 sector. This effectively distributes the value of one cell, into 9 cells and more clearly specifies the relationships between core, enabling and indirect sectors. This transformation is displayed in the image below: Table 3 is transformed into Table 4.

TABLE 3 - Subset of Original IO Table

	SECTOR B
SECTOR A	100

TABLE 4 - Subset of Original IO Table with Circular proportions applied

	SECTOR B - CORE	SECTOR B - ENABLING	SECTOR B - INDIRECT
SECTOR A - CORE	10	5	0
SECTOR A - ENABLING	5	50	20
SECTOR A - INDIRECT	0	10	0

In order to determine the share of circular activity within a particular enabling circular sector, we take the monetary value of core and enabling circular sectors supplying that enabling circular sector, and the monetary value of that enabling circular sector supplying core and enabling sectors, all as

a proportion of the total input and output activity in that sector. With reference to the below table, mathematically, the following calculation was performed:

$$\frac{\{(C+D) + (B+D)\}}{\{K + Y\}} = \% \text{ enabling circular activity}$$

TABLE 5 - : Illustration of the Enabling and Indirectly Circular Jobs

	CORE SECTOR	ENABLING SECTOR	INDIRECT SECTOR	TOTAL ROWS
CORE SECTOR	A	B		J
ENABLING SECTOR	C	D		K
INDIRECT SECTOR	E	F		L
TOTAL COLUMNS	X	Y		

In order to determine the percentage of circular activity within a particular indirect circular sector, the monetary value of indirect circular sector products used by core circular sectors and by enabling circular sectors was taken into consideration. With reference to the above table, mathematically, the following calculation was performed:

$$\frac{\{(E+F) / (X+Y)\}}{\{X+Y\}} = \% \text{ indirect circular activity}$$

In order to then accurately represent circular jobs, we must consider the intermediate supply of services through the sectors that is not directly represented in the input output table. We calculate final 'circular' demand by summing the core, enabling and indirect proportions of circular activity per row in the adjusted input-output table, and then dot multiply this onto the Leontief Inverse of the input-output table. This is mathematically represented by:

$$d \cdot (I-A)^{-1}$$

Here, d represents circular final demand, A represents the input-output table, and I represents the identity matrix. This result is the final circular input which is our indirect adjustment to each sector code.

At this point, we know for each sector the share of core circular jobs, enabling circular jobs and indirect circular jobs, and we are able to apply these proportions onto the original employment data at postcode level.

For this calculation, IO data for Belgium 2014 was sourced from the World Input-Output Database (WIOD).⁷¹ In the absence of regional IO data, national IO data is scaled using regional employment data. The calculation is done for each province and the numbers are aggregated to the national level.

4. Adjustments to Electricity Employment Data
Core strategy 'Prioritise Regenerative Resources' refers to all direct employment in the Production of Renewable Energy, however the raw employment data provided data only at an aggregate level for the whole sector 'Production of Electricity', NACE code 35110.

We sourced data of all the companies listed under NACE code 35110, and then sourced the websites of these companies. We checked the website(s) of each company to establish whether the plants associated with the company produced renewable energy or non-renewable energy, both or neither. We were then able to aggregate the data bottom up into the total number of employed persons in the renewable sector, and the total number of employed persons in the non-renewable sector. We transformed all the data into either renewable, and therefore circular, or non-renewable, and therefore indirect or not circular, and arrived at the following results.

TABLE 6 - Original employment data

NACE LEVEL 5	SECTOR NAME	PRO-PORTION
35110	Production of Electricity	100%

TABLE 7 - Employment split into renewable and non-renewable proportions

NACE LEVEL 5	SECTOR NAME	PROPORTION
35110*	Production of Non Renewable Electricity	69%
35112*	Production of Renewable Electricity	31%

* This table uses unofficial sector codes.

ANNEX 2 - METHOD CIRCULAR PROFILING MANUFACTURING SECTOR

Inoopa defines company activities by using Artificial Intelligence advanced technologies. Today, it has become a great challenge to obtain the correct activities of companies for profiling, marketing, barometers or internal data. Thanks to its expertise and tools such as barometers, keyword search, web scraping and data enrichment, Inoopa is able to provide reliable information about companies and their sector of activity.

Method

The objective of the analysis was to provide geographical statistics of Belgian companies in the manufacturing sector based on their online communication. In an effort to obtain accurate results, the manufacturing sector was matched with 3 circular economy activities, namely regenerative resources, lifetime extension and recycling. The method took place in 4 distinct steps.

1. Understanding what companies do

The first step was to understand what companies do in order to classify them accurately. More than 200 sources of data were used, and they fall under 3 categories: open data from universities and public administrations, public data from websites and social networks and private data from specialized platforms like for instance Trends Business Information or Graydon.

Natural Language Processing (NLP) algorithms matched the obtained data with a company number and summarised it in a "company vector". A company vector is a semantic representation of the online textual and visual content of a company and it is created based on the terms describing its activity. It should be interpreted as the "company activity DNA".

2. Understanding Circular Economy's core activities

Once the activity DNA's were defined, companies needed to be matched with circular economy activities. To do so, 3 topic vectors were generated for the 3 circular economy activities cited above. Those 3 activities were renamed "topics":
Topic 1 (T1) Regenerative resources
Topic 2 (T2) Lifetime extension
Topic 3 (T3) Recycling

As for companies, each topic was matched with relevant content selected by NLP algorithms and researchers. This allowed us to create a unique semantic representation of each Topic, i.e. a "topic vector".

3. Scoring of a company similarity with a topic

The first two steps allowed us to create a semantical representation of what we search (topics), and possible candidates (companies). In step 3 we calculate a distance between those vectors for every company in our data-set. This alignment is useful for ranking companies with regard to their positioning on core circular economy strategies. Alignment between topics and companies solely serves to create this ranking, it does not reflect a probability yet.

4. Estimation of the probabilities to apply circular strategy

The aim of step 4 was to mathematically determine the probability of a company being positioned on a particular topic, based on their matching scores and the manual creation of a randomly selected validation sample for each topic.

To do so companies were classified in groups based on their matching score and their similarity with each topic. A total of 5 groups were established, Group 1 being the best match with a given topic and Group 5 the worst match. In each group, a random sample of companies was taken and classified by our researchers into two classes (true/false), depending on whether the company's main website clearly indicates a positioning on the topic. After more than 1000 checks, this validation set allowed us to estimate a probability for a company belonging to a certain group to be positioned on the topic.

Companies of Group 1 typically have a probability of 60%-80% to belong to the related topic, while the same probability ranges between 0 and 8% for companies of Group 5. Although there is further research needed to improve this model's results, this validates that most companies are successfully categorized by the algorithms.

5. Estimation of the probability to apply at least one circular strategy

The final step was to calculate the total probability of a company to be positioned on at least one core circular economy strategy. In order to determine this probability, it is assumed that the application of the 3 strategies T1, T2 and T3 is independent. The probability can be mathematically calculated as follows:

$$\begin{aligned} P(T1 | T2 | T3) = & P(T1) + P(T2) + P(T3) \\ & - P(T1) \times P(T2) \\ & - P(T2) \times P(T3) \\ & - P(T1) \times P(T3) \\ & + P(T1) \times P(T2) \times P(T3) \end{aligned}$$

Finally, we aggregate all the company-level probabilities geographically (at zip-code, province, region or country level) or per sector (at NACE code level) to obtain the regional and sectoral results presented in this report.

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ACKNOWLEDGEMENTS

Circle Economy would like to thank the working group for their contribution to this circular jobs monitor for Belgium.

CIRCULAR JOBS IN BELGIUM - A baseline analysis of employment in the circular economy in Belgium

This publication is also available in Dutch and in French as:

CIRCULAIRE TEWERKSTELLING IN BELGIË - Een nulmeting van de werkgelegenheid in de circulaire economie in België

L'EMPLOI CIRCULAIRE EN BELGIQUE - Analyse de référence de l'emploi dans l'économie circulaire en Belgique

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Legal deposit D/2893/2019/19

September 2019