PBL Netherlands Environmental Assessment Agency

Integral Circular Economy Report 2021

Assessment for the Netherlands

INTEGRAL CIRCULAR ECONOMY REPORT 2021

Assessment for the Netherlands

Aldert Hanemaaijer and Maikel Kishna (project management), Marjon Kooke (programme secretary), Hester Brink, Julia Koch, Anne Gerdien Prins and Trudy Rood

This Integral Circular Economy Report was produced in the framework of the Work Programme on Monitoring and Directing the Circular Economy, 2019–2023. The Work Programme is a collaborative effort of several knowledge institutes under the direction of PBL Netherlands Environmental Assessment Agency.

The Dutch Government is pursuing to achieve a fully circular economy by 2050. The aim of the Work Programme is to monitor and assess the charted path towards 2050 and to provide the government with the knowledge required to design and adjust policies. Further information on the Work Programme on Monitoring and Directing the Circular Economy can be found at https://www.pbl.nl/monitoring-circulaire-economie.

This report was drawn up with input from the knowledge institutes that take part in the Work Programme on Monitoring and Directing the Circular Economy:

- **Statistics Netherlands (CBS)**
- **CPB Netherlands Bureau for Economic Policy Analysis**
- **Institute of Environmental Sciences (CML)**
- **Netherlands Enterprise Agency (RVO)**
- **National Institute for Public Health and the Environment (RIVM)**
- **Rijkswaterstaat – Ministry of Infrastructure and Water Management (RWS)**
- **Netherlands Organisation for Applied Scientific Research (TNO)**
- **Utrecht University (UU)**

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PBL Netherlands Environmental Assessment Agency is the national institute for strategic policy analysis in the fields of the environment, nature and spatial planning. We contribute to improving the quality of political and administrative decision-making by conducting outlook studies, analyses and evaluations in which an integrated approach is considered paramount. Policy relevance is the prime concern in all of our studies. We conduct solicited and unsolicited research that is both independent and scientifically sound.

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Foreword

The Dutch Government aims to achieve a fully circular economy by 2050 and sees monitoring as an important instrument to assess progress of the transition. For this reason, the government has asked PBL Netherlands Environmental Assessment Agency to collaborate with other knowledge institutes to develop knowledge about the circular economy and to report on progress towards its attainment. This document is an important milestone in the process. This first Integral Circular Economy Report (ICER) describes the current state of affairs of the transition towards a circular economy in the Netherlands and offers tools to policymakers to accelerate the transition, where needed. This ICER report was produced in cooperation with the following organisations: Statistics Netherlands (CBS); CPB Netherlands Bureau for Economic Policy Analysis; Institute of Environmental Sciences (Leiden University); National Institute for Public Health and the Environment (RIVM); Netherlands Enterprise Agency (RVO); Rijkswaterstaat (RWS) (Ministry of Infrastructure and Water Management); Netherlands Organisation for Applied Scientific Research (TNO); and Copernicus Institute (Utrecht University). These organisations all contribute to the multiannual Work Programme on Monitoring and Directing the Circular Economy, which is coordinated by PBL.

The ICER report is to be published every two years and forms the knowledge basis for the policy cycle of the circular economy policies in the Netherlands. It also serves as input for consultations between the parties involved in the Raw Materials Agreement and in the five priority transition themes: Biomass and food, the Construction industry, Consumer goods, Plastics, and Manufacturing. In addition, the report provides information for the debates on circular economy policies between the Dutch Government and House of Representatives.

In a circular economy, the focus is on a more efficient use of material resources and the ensuing reduction in the amount of material that is used. This requires more than just recycling those resources; for example, products need to be designed to last longer. In addition to the fight against climate change and the preservation of biodiversity, a more efficient use of material resources is the third great challenge in finding a better balance between people and nature. These three challenges are closely interrelated, as are the pathways that lead to solutions. The more limited the need for new material resources, the lighter the burden will be on nature, climate and environment. In addition, a circular economy can contribute to reducing the supply risks of material resources that are difficult to obtain. And it also offers opportunities for Dutch companies, such as the competitive advantages to be gained by using material resources in the production chain much more efficiently and by producing in environmentally friendly ways.

This report provides insight into the state of affairs in trends in international and Dutch use of material resources, and shows what environmental and socio-economic impacts arise from it. It also describes the interventions by the Dutch Government to start up and speed up the transition towards a circular economy, such as promoting knowledge development and making voluntary agreements with other parties. The report also describes the actions taken by societal stakeholders, such as business initiatives to market circular products and services or to invest in circular production methods. These operations and actions form what is known as transition indicators; they illustrate how intensively companies, consumers and government authorities are preparing for a circular economy, and what approach they are taking. With this information, it is in principle possible to determine and adjust the direction and pace of the transition towards a circular economy.

Achieving a circular economy requires manufacturers, consumers, NGOs, scientists, administrators and policymakers from all sections of society to make an effort, to innovate and to adapt. Everyone has a role to play, to a greater or lesser degree. While this applies to all tiers of government, the authorities have a special role. With its policies, the government largely determines the rules of the game and, thereby, the playing field in which the transition towards a circular economy is able to develop — for example, through taxation, legal standards and subsidies. The knowledge gathered for this report is meant to offer administrators, politicians and policymakers tools to adjust production and consumption processes 'with policies'. For this reason, in this first ICER report, we also take a closer look at circular economy policies; particularly, those adopted by the national government. I am convinced that the insights brought together here will be of great help. I would like to thank the partners who collaborated in the production of this report and who are continuing to move forward with us on the further development of the underlying knowledge programme.

Professor Hans Mommaas
Director-General

FINDINGS

Findings: Integral Circular Economy Rapport 2021. Assessment for the Netherlands

Main messages

The importance of a circular economy

Many of today's nature- and environment-related problems can be traced back to the wasteful use of natural resources. This leads to pollutants being emitted to air, water and soil, which in turn have undesirable effects such as plastic soup in the sea, ecosystem degradation from mining, large mountains of waste and loss of biodiversity, amongst other things, due to monocultural farming and nitrogen deposition. These problems will become more pressing in the coming decades, due to the increase in global demand and utilisation of material resources (e.g. minerals, metals, fossil fuels, biomass). The increasing use of such resources and the interdependencies in the long international production chains will also increase the risks for supply and price volatility. Considerably more efficient use of the available material resources — using them more often and more intensively and increasing their lifespan — generally reduces the environmental problems and will improve security of supply.

Several trends for material resource use not moving in the right direction

Looking at how material resources are being used in the Netherlands and the effects related to this use, we found that various trends are going in the wrong direction. Although it is true that resource efficiency has increased, this has not led to a sharp reduction in the use of raw materials. Since 2010, the total use has hardly changed in the Netherlands. Moreover, Dutch consumption also requires more and more land in the production chain. In addition, the amount of landfilled waste has increased since 2014, 6 of the 7 overall national targets for waste are not expected to be achieved, and the supply risks for the Dutch economy have also increased. Manufacturers are running the largest supply risks because of their dependence on rare earth metals, cobalt, tungsten, tantalum, tin and indium. These critical metals are used, for example, in machines, in vehicle parts and electronics, and are important for the energy transition.

Together with other parties, the Dutch Government has created a basis and structure for achieving a circular economy in the Netherlands

In recent years, the transition towards a circular economy has been on the agenda of government authorities, businesses, citizens, NGOs and knowledge institutes in the Netherlands. The Dutch Cabinet's ambition to achieve a circular economy by 2050 has since been included in the Dutch Raw Materials Agreement co-signed by over 400 parties and elaborated in 5 transition agendas for the priority themes of Biomass and Food, Construction, Plastics, Manufacturing and Consumer Goods. Cabinet has indicated which clusters of policy instruments it intends to use to accelerate the circular economy transition. These clusters include legislation and regulations, market incentives, monitoring, knowledge and innovation, and producer responsibility. In doing so, a basis and structure has been created for the transition towards a circular economy with a public–private approach.

For many years, recycling and repair have already been part of the Dutch economy which, for the most part, still functions rather linearly

The number of companies focusing on circular activities is increasing. In recent years, substantial financial resources have been used in circular activities or innovations in various support instruments of the national government, such as the Research & Development Tax Credit Act (WBSO) and the Arbitrary depreciation of environmental investments (Regeling Willekeurige afschrijving milieu-investeringen (Vamil)). However, the number of companies using a 'circularity strategy' has grown less rapidly than the total number of companies in the Dutch economy. In addition, the vast majority of these so-called circular companies are focusing on repair, recycling and reuse. This type of activity already existed before there was any talk of a transition towards a circular economy. Examples include garages, waste collection facilities and thrift shops. Most innovative circular companies and circular projects are mainly technological and focus on recycling. There is less attention for innovations that could radically change the use of material resources. As a result, the economy still functions largely according to linear principles. This does not alter the fact that, throughout society, there are experiments and entrepreneurs focused on circular product designs, alternative revenue models and online platforms. These show that radically different methods of production and consumption are possible — as, for example, in the case of Auping's fully recyclable mattresses, LENA the fashion library's clothing and Camptoo's online platform for motorhomes.

More attention needed for socio-economic renewal in combination with conversion and phasing out of existing system

Recycling is an essential part of any circular economy. But recycling alone is not enough to realise the transition towards such an economy. Making production and consumption chains circular requires, for example, new circular business models, online platforms and changes in consumer behaviour. At their core, these are socio-economic innovations for which, to date, there has been little attention from either society or government. This also requires adjustments to or conversion of existing institutions, such as accounting regulations that hinder product-as-a-service companies. In addition to the development of circular production and consumption processes, the transition calls for the phasing out of linear chains and of products with a very short lifespan that place a relatively heavy burden on nature and the environment. Such phasing out could be achieved, for example, by increasing environmental taxes over time or by issuing a ban on disposable products.

The Netherlands, as one of the front runners, has an interest in EU circular economy policy

The Netherlands recycles 80% of its waste. This makes it one of the front runners in Europe, although it should be noted that this 80% often involves low-grade recycling. The use of raw materials for Dutch consumption is also a fifth lower than the EU average. EU circular economy policy is of great importance for the Netherlands, when it comes to taking further steps towards a circular economy. Setting requirements for the use of material resources in product design or the prevention of harmful substances in products particularly requires an EU approach. And if the European Union elaborates its plans for producer responsibility and requirements for product design and repair, this will ensure a more level playing field between Member States. The Netherlands would benefit more than average from this, because of its very open economy and ambitious waste policy of recent decades, which has recently been further developed into a circular economy policy.

Stronger policy is needed to realise ambitions

National policy, to date, has mainly focused on the formation of a broad coalition of stakeholders within society and on facilitating circular initiatives — for example, by promoting knowledge development and bringing parties together on the basis of voluntary agreements such as the Concrete Agreement Netherlands and the Plastics Pact NL. This fits in with the initial phase of circular economy policy. However, voluntary and non-committal approaches will ultimately be insufficient to meet Cabinet's firm ambition to switch to a fully circular economy by 2050. We make the following recommendations for achieving the transition towards a circular economy:

1. *Ensure that environmental damage is factored into the prices of products and services and that legislation and regulations no longer cause disadvantages for circular initiatives compared to the already established linear practices. For example, new raw materials, currently, are cheaper than recyclates, and buyers are wary of circular products for which no quality standards have been set.*
2. *Make more use of coercive measures in circular economy policy, such as taxation and regulation, including standardisation. Important in this respect is the awareness that elaboration and implementation of regulating or guiding economic and legal instruments often take a long time, as shown by the long history of the introduction of a deposit refund system for small bottles. It is therefore important to start the process early.*
3. *Implement stepwise increases in the circularity requirements used in government purchasing and procurement, including those in the context of producer responsibility. Examples include a minimum recycling rate that is subsequently adjusted upwards, over time, and setting preconditions on purchasing and procurement that go beyond recycling. In this way, the quality of recyclates and high-quality reuse of material resources become benchmarks for designing production processes.*
4. *Develop an elaborated vision on the circular economy that is widely supported by companies and civil society organisations, and turn this vision into concrete goals. These goals can differ per transition theme, chain or product group, which calls for a differentiated approach. At the end of 2020, the national government started to develop such differentiated goals.*
5. *Ensure a clear division of roles between the various stakeholder involved in the implementation of circular economy policy. For example, what are the responsibilities and powers of the various transition teams and what is the role of the national government in these teams? These questions are currently being debated.*

Circular economy is relevant to several societal objectives

A circular economy is about making far more efficient use of all the material resources available in the economy, both abiotic (minerals, metals and fossil raw materials) and biobased resources (biomass and food), and contributes to several goals, such as combating climate change, halting biodiversity loss caused, amongst other things, by nitrogen deposits and plastic soup in the sea, and reducing supply risks. Currently, Dutch policy on the circular economy falls under climate policy in the Coalition Agreement of the 3rd Rutte Cabinet (2017–2021). Rather remarkably, the budget includes hardly any additional resources with respect to the circular economy. In addition to the fact that a circular economy could contribute substantially to CO_2 emission reductions, a more efficient use of material resources would also help to address other societal challenges.

A circular economy requires a government-wide approach

A government-wide approach is important for a policy that promotes the circular economy. After all, such policy would cover various production chains, sectors and spatial scales, from agriculture to product design and from global to local levels. In addition to climate policy, for example, this includes policies aimed at improving the security of supply of material resources, green fiscal reform, making international trade more sustainable, promoting environmentally friendly innovations, aligning educational standards with circular production processes, and actively encouraging circular purchasing and procurement. Finally, a circular economy requires different rules that would balance safety, health, environment, economy and innovation. All this is not a matter for one ministry, but requires a government-wide coherent approach in which each ministry has its own role to play. Although several ministries are currently involved in the circular economy policy, their individual packages of policy instruments are not all focused on achieving a more circular economy.

Findings

The Dutch Government intends to achieve a fully circular economy by 2050, and has asked PBL to report on the progress that is being made in this respect, in cooperation with other knowledge institutes. This request has resulted in this first integral circular economy report (ICER). It presents the state of affairs of the transition towards a circular economy in the Netherlands and describes potential starting points and next steps with which this transition could be achieved. This biennial report provides insight into the trends in material resource use and related environmental and socio-economic effects. The report also describes current activities within society, as well as the government's interventions that promote the transition towards a circular economy.

The importance of switching to a circular economy

Industrial processes convert natural resources into materials (steel, concrete, plastics) and finished and semi-finished products, which are used in consumption processes and eventually end up in waste streams. All these phases produce emissions to air, water and soil, resulting in undesirable effects such as plastic soup in the sea, accelerated climate change, large mountains of waste and loss of biodiversity due to nitrogen deposition, open mining and monoculture farming, just to name a few. (IRP, 2019; OECD, 2019).

Without additional policy, this pressure on nature and the environment will continue to increase over the coming decades. The OECD (2019) and the International Resource Panel (2019) expect the use of raw materials to double by 2060, compared to 2017 levels, particularly due to the growing global population and the amount of consumption per world citizen. Under a scenario in which historical trends continue, and taking into account climate policies such as those applied up to 2015, greenhouse gas emissions are expected to increase by 49%, by 2060, compared to 2010 (IIASA, 2018; McCollum et al., 2018; Rao et al., 2017). The increasing demand for food and biomass is also projected to lead to an expansion of the agricultural area. This will be at the expense of natural ecosystems, such as forests and other habitats (Popp et al., 2017; IIASA, 2018; IRP, 2019), in turn leading to biodiversity loss and a further acceleration of climate change.

These nature and environmental problems would decrease if material resources would be used considerably more efficiently. This increased efficiency could consist of repairing products more often to extend their lifespan, rejecting certain types of products, improving both product design and production processes so that fewer raw materials are needed, people sharing things so that fewer products need to be produced, and reusing materials to reduce the amount of waste and reduce the demand for new raw materials. These forms of circular production and consumption, in principle, would reduce the demand for materials and thus also reduce the processing of material resources. The resulting decrease in environmental pressure would be more in keeping with the carrying capacity of the planet.

Although, for now, material resource use is likely to continue to increase, we will not immediately run out of most of the raw materials used. However, the supply risks of certain material resources will increase. This is of particular concern in the case of critical materials — those that are both economically important and have major supply risks — which include rare earth metals, cobalt, tungsten, tantalum, tin and indium. Critical materials are crucial, for example, in producing electronic devices and generating sustainable energy, such as wind turbines and solar panels. In recent years, there has been a growing concern amongst companies and policymakers about the security of supply of specific material resources and the economic vulnerability of long international supply chains. Considerably more efficient use of the available material resources, in principle, would reduce such vulnerability, although this may be not the only solution strategy to follow.

Compared to the current practice of incremental efficiency improvements in the use of material resources, a circular economy means a radically more efficient use of those materials. This is not an end in itself, but a means to achieve the underlying goals of reducing the pressure on the environment and nature associated with resource use and reducing the supply risks of raw materials.

At the core of a circular economy

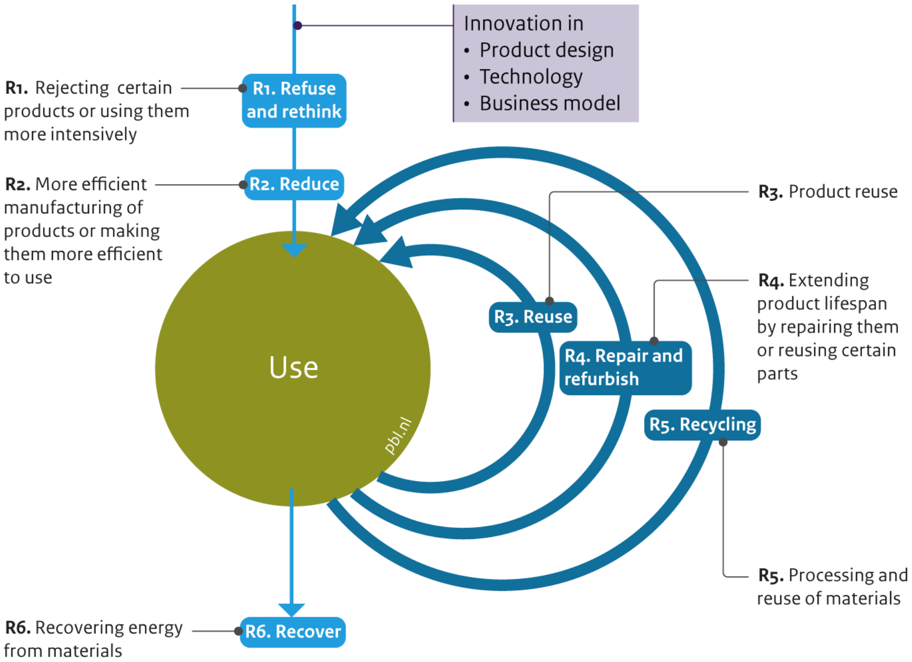
Circularity strategies for a more efficient use of material resources

In essence, a circular economy uses as few material resources as possible and generates as little waste as possible. It is aimed at the optimal use and reuse of such resources, materials and finished and semi-finished products; which means applying them with the highest value for the economy while causing the least damage to the environment (Rood and Hanemaaijer, 2017).

A significantly more efficient use of material resources can be achieved through various circularity strategies, or 'R-strategies'. These strategies include rejecting certain products or using them more intensively by sharing them with others (refuse & rethink), manufacturing products more efficiently (reduce), reusing products (reuse) and repairing them (repair & remanufacture) to extend their lifespan, reusing materials (recycle) so that less waste is generated and fewer new material resources are needed, and recovering energy from materials (recover).

The R-strategies can be combined to form a circularity ladder ('R-ladder'). For several years now, PBL has been using such a ladder with six circular strategies and this was also used for this report (Figure 1). As a rule of thumb, a strategy that is higher up the ladder (and therefore has a lower number), generally, requires fewer material resources or processing steps and therefore causes less environmental pressure. The R-strategies at the top of the ladder (refuse & rethink; reduce) decrease the total use of material resources (narrowing the loop). Those halfway down the ladder (reuse & remanufacturing; repair) postpone the demand for new material resources (slowing the loop). Finally, recycling is aimed at closing the cycle of materials (closing the loop). All R-strategies are needed to achieve a circular economy.

Figure 1
R ladder with circularity strategies



Source: PBL

The rationale for this report

In 2018, the Dutch Cabinet explicitly requested an integral report on the circular economy (ICER) (IenW, 2018). It did so from the conviction that the transition towards a circular economy requires changes throughout society. To enable a more radically efficient use of material resources in the long term, production techniques need to change, requiring new product designs and production methods, as well as different legislation and regulations, tax reforms and new ways of consuming (IenM and EZK, 2016). These coherent and fundamental changes are what the national government refers to as 'the transition towards a circular economy' (IenW et al., 2019).

The integral circular economy reports (ICER) are to provide the knowledge base for government policy to achieve the transition towards a circular economy. The government intends to realise a fully circular economy in the Netherlands by 2050 and, as an intermediate goal, to halve the use of primary abiotic raw materials by 2030 (IenM and EZK, 2016). On the way to achieving these goals, the government is committed to the more efficient use of material resources, increased use of renewable raw materials and new ways of producing and consuming that are appropriate in a circular economy.

PBL has been asked 'to further develop the monitoring system, together with other knowledge institutes, to achieve a fully fledged measurement and control system. The purpose of this system is to monitor government policy and the efforts of parties in society, and to provide insight into the progress made on achieving the circular objectives, to determine whether policy adjustments are necessary' (IenW, 2019). In order to fulfil this role of analyst and manager of knowledge development, PBL will be publishing an integral report on the circular economy (ICER) every two years, with the help of other knowledge institutes.

Purpose and set-up of this report

The aim of the Integral Circular Economy Report (ICER, 2021) is to present the state of affairs of the transition towards a circular economy in the Netherlands and to make recommendations for achieving said transition. Much of the required knowledge is generated from the Work Programme Monitoring and Steering Circular Economy 2019–2023 (PBL, 2019; 2020), which PBL is implementing in collaboration with the following knowledge institutes: Statistics Netherlands (CBS), Leiden University's Institute of Environmental Sciences (CML), CPB Netherlands Bureau for Economic Policy Analysis, Utrecht University's Copernicus Institute of Sustainable Development, the National Institute for Public Health and the Environment (RIVM), the Netherlands Enterprise Agency (RVO), Rijkswaterstaat (the Dutch Government’s service for roads and waterways (RWS)), and the Netherlands Organisation for Applied Scientific Research (TNO). For more information on the organisation and results of this Work Programme, see https://www.pbl.nl/monitoring-circulaire-economie.

This report is part of the cycle of circular economic policy in the Netherlands. This report aims to bring together the best available knowledge on material resource use, activities and policy to accelerate the circular economy in the Netherlands. In this way, the Integral Circular Economy Report will be providing input for consultations between the parties involved in the Dutch Raw Materials Agreement and the five transition teams, as well as offering support for choices to be made on circular economy policy and the debate on these choices in the Dutch House of Representatives.

The Integral Circular Economy Report considers material resource use, its effects and the transition process

The first proposal for monitoring the Dutch transition towards a circular economy by PBL, CBS and RIVM indicates that this requires two elements (Potting et al., 2018). The Integral Circular Economy Report further elaborates on this proposal.

The first element is to provide insight into trends in material resource use and the related impact on nature and the environment as well as on socio-economic processes. Material resource use refers to the amounts of raw materials needed for production and consumption in the Netherlands, and involves insights into the use phase of products, the amount of waste generated and waste treatment processes. Determining the related effects on the environment and nature requires knowledge about, for example, climate change, loss of biodiversity and the presence of toxic substances. Relevant socio-economic effects include the supply risks of materials and the labour market effects of structural changes in the economy as more circular production and consumption become leading. This report is integral in the sense that its scope includes the total use of raw materials in the Netherlands and the related impact. This includes both biobased resources (biomass and food) and abiotic raw materials (minerals, such as sand and gravel, and metal and fossil resources, such as oil, natural gas and coal). Another integral aspect of the report is that it also looks at relevant global and European developments with respect to material resource flows, stocks and uses. After all, the use of material resources in production and consumption processes in the Netherlands cannot be seen in isolation from the international chains within which products are both used and produced.

The second element of the Integral Circular Economy Report concerns the monitoring of the transition process and describes the activities, means and interventions by societal stakeholders and government authorities in the transition towards a circular economy. Think of pilot projects, subsidy measures for circular innovations and removing obstructive legislation on waste. The transition towards a circular economy is a lengthy process, evokes resistance and is hindered by behaviour, regulations and interests, as a result of which the effects of more circular production and consumption will only become visible in due course. This does not alter the fact that a variety of societal stakeholders are already making efforts to make their production and consumption processes more circular. Because the transition process precedes its result, knowledge about the process is indispensable in order to be able to assess, at an early stage, whether the desired effects of more circular production and consumption can be expected in the long term and — if this is not the case or effects lag behind — what the causes may be. Changes, for example, in the behaviour of companies and consumers or in official regulations (European Union, national government, regional government authorities) provide information about the direction of the circular economy and the pace at which it is currently taking shape.

The knowledge base for the circular economy is being constructed

The knowledge base for the circular economy is still under development. Although this report contains the best available, scientifically sound knowledge and the most recent data, this does not preclude further improvements. In the coming years, it is expected that changes in methods, more and better data and new scientific insights will lead to an increasingly better understanding of material resource use and its effects, as well as of the processes that should bring the transition towards a circular economy within reach.

This first Integral Circular Economy Report largely has an inventorying and indicative character. In this way, the report provides insight for accelerating the transition. Although the ambition for this report is to provide an integral picture, the knowledge about a circular economy is still being developed, at least partially, and therefore not yet complete. For example, there is still only limited insight into the effects of possible measures taken by companies to produce more circularly. This is part of the reason why this report evaluates only to a certain extent. However, it does contain conclusions on trends in the use of material resources, on specific developments in society that promote or hinder a more circular economy, and on policy interventions that aim to promote the transition towards a circular economy. The Integral Circular Economy Report also identifies a number of possibilities for adjusting social change processes that can bring a circular economy closer within reach.

Progress on the transition process in the Netherlands

Monitoring the transition process in order to make timely adjustments

Process monitoring enables timely adjustments in the transition towards a circular economy, even before its effects can be registered. However, such monitoring is complex. Businesses, government authorities, citizens, knowledge institutes, networks and NGOs all play a role in the transition, without any of these parties dominating the others. In addition, the transition is not only about new technology, but also about other rules of the game (institutions) and new products, services and knowledge, such as products-as-a-service and online platforms. Finally, the transition towards a circular economy is actually a collection of change processes. This transition covers everything from plant-based proteins in food, to chemical recycling of plastics and appliances-as-a-service. Per theme, the transition process can vary in rate of change and solution direction. In order to monitor this complex whole, this report builds on two long-standing perspectives or frameworks: those of the innovation ecosystem (Hekkert et al., 2007; 2020) and those of transition management

(Loorbach, 2007). Figure 2 and Text box 1 describe the elements that were combined in this report, which focuses on the national level, but where possible also shows insights derived from specific themes.

Text box 1: The perspective on the transition towards a circular economy

The transition combines processes that create circular production and consumption with those that transform or phase out linear production and consumption. The transition goes through several phases, each with dominant dynamics — often presented in a so-called X-curve (Bode et al., 2019). The framework for transition monitoring in this report focuses on various key functions that are crucial to the transition pathway. The cogs in Figure 2 show the various key functions. They are linked to actions that parties can take to speed up the change process and provide direct starting points for monitoring.

This report's monitoring approach looks at various key processes that are crucial for the development and rollout of circular innovations and for the phase-out and transformation of existing linear systems. Think, for example, of entrepreneurs experimenting with circular products, developing and exchanging knowledge, changes in legislation and regulations that remove obstacles to more circular production and consumption, breaking resistance (by creating legitimacy and increasing the pressure to change on the existing linear system) and the coordinating role of government (Figure 2).

A great deal of attention for the transition towards a circular economy

In the Netherlands, there is relatively much attention for the circular economy. Companies, research and educational institutions, citizens, regional government authorities and other parties undertake a variety of actions aimed at circularity. Although this report does not show how far the transition has progressed for all relevant sectors and product chains in the Netherlands, it does provide an overall picture of the efforts made by stakeholders within society. For example, there are more than 100,000 circular companies (i.e. those that apply one or more of the R-strategies in practice (RHDHV, 2020a)). And, in 2019, over 100 conferences on the circular economy were organised (RHDHV, 2020b). At several companies, for example from the textile sector and various branches of the manufacturing industry, the theme of circular economy has been put on the strategic agenda.

Growth can be seen in various elements that are important for a successful transition (Figure 2). For example, the number of circular companies has increased by approximately 8% in the past two years (RHDHV, 2020a). The number of scientific publications on circular economy worldwide has increased from approximately 70 in 2014 to over 1,600 in 2019 (Türkeli, 2020). Since mid 2018, there have been increasing numbers of national and regional initiatives aimed at circular procurement, such as the Green Deal Circular Procurement 2.0, the Green Deal Biobased, the academy for circular procurement and over 200 pilot projects for climate-neutral and circular procurement (Zijp et al., 2020). Educational programmes and courses on the circular economy have also increased in the Netherlands. Almost half of the institutes of higher vocational education (HBO) and 80% of universities are paying attention to circularity in their curricula (RVO, 2021).

Figure 2
Elements of a successful transition to a circular economy

Source: PBL 2013; based on Hekkert et al. 2021

Circular is not 'the new normal' yet

In spite of all these activities and deployment of resources, circularity is still far from mainstream. Circular companies make up only 6% of companies in the Netherlands (RHDHV, 2020a). The vast majority of circular companies already existed before the Dutch circular economy policy was implemented. Think of traditional businesses such as garages, waste collection facilities and bicycle repair shops. Furthermore, a small part of the budget of various policy instruments goes towards circular projects (RVO, 2020). For example, the Research & Development Tax Credit Act (WBSO) supports companies by means of a tax deduction on employers' wage tax. Of the WBSO budget, 3.2% goes to circular economy projects. Consumer attitudes and behaviour also make it clear that the transition towards a circular economy is still in an early stage. Less than 40% of Dutch consumers is open to purchasing products that have been refurbished, and less than 15% to long-term leasing and borrowing via sharing platforms (ABN AMRO, 2018; Kantar, 2019).

Many actions and resources are focused on recycling

Much research and innovation is in line with the current system. For example, the majority (66%) of the 1,900 innovative circular companies in the Netherlands focuses on recycling (RHDHV, 2020a). Over half of Dutch scientific articles mention recycling (or recover) in their subject description, but none of the other circularity strategies (Türkeli, 2020). Many of the innovation projects supported by RVO's instruments also have a technological character and focus on recycling. For example, 60% of projects from the MIT Scheme (SME Innovation Promoting Region and Top sectors) focus on recycling, two thirds of which are biobased projects, and 90% of projects from the public–private partnership allowance focus on secondary raw materials (RVO, 2020). Recycling is a crucial and indispensable part of a circular economy, where many technological challenges still lie ahead. Nevertheless, recycling has been an established and successful industry in the Netherlands for years.

High-grade recycling is a point of attention

The success of the Dutch recycling industry results from decades of waste policy with a strong focus on reducing waste volumes and minimising the amount of landfill. However, a circular economy also requires the application of high-grade recyclate, which means that plastic from bottles is more often reused to make new bottles and not immediately downcycled and processed, for instance, into recycled plastic bollards, and that demolition waste in construction is reused in new housing instead of being used as subgrade in road construction. It is, therefore, important to pay attention to high-grade recycling.

Little attention for socio-economic reform and phasing out of the existing system

Taking significant steps in making production and consumption chains circular, requires circularity strategies that are higher up the R-ladder than recycling. This involves, for example, rejecting products or using products more intensively, such as by sharing them ('narrowing the loop'). In addition, it is also about extending the lifespan of products, for example through second-hand use, repair, remanufacturing or modular design ('slowing the loop').

Such strategies require new circular business models, the organisation of sharing platforms and a change in consumer behaviour. At their core, these are socio-economic reforms for which little attention has yet been paid by either society or government. This also requires adjustments or conversions of existing institutions, such as existing accounting rules that hinder product-as-a-service companies if the assets on their balance sheet (e.g. the washing machines that are leased out) and slow cash flow (rental income) are seen by financiers as an increase in risk compared to the traditional sales model.

In addition to the development of innovative strategies, the transition also requires that attention is paid to the phasing out of linear chains and products that have a very short lifespan and a relatively high impact on nature and the environment. Means to achieve this, for example, include increasing environmental taxes over time and a ban on disposable products, as is already the case for free plastic bags. However, there is currently no broad, fundamental change from the existing linear system to a circular economy.

Transition is still in its initial phase

Overall, these signs indicate that the transition towards a circular economy is still in its initial phase. Although growth can be seen in certain areas, it cannot be concluded that the transition towards a circular economy is spreading across all sections of society and/or is accelerating to any substantial degree. There are also, as yet, few signs that the existing linear system is coming under pressure. This pressure is necessary if the government is to realise its ambition to accelerate and scale up the transition towards a circular economy (IenW, 2019). In Box 2, we examine the difficult question of how to recognise the start of the next phase in this transition.

Text box 2: Indications of the next phase in the transition

There is no instruction manual for what is needed to reach the next phase in the transition towards a circular economy. However, there are signs that would indicate whether the transition is moving into the next phase.
Larger scale innovation is such a sign, with existing circular activities connecting and being scaled up, and a critical mass of those involved is being created. Also consider the emergence of a larger market demand for several types of innovative circular products and services. Such processes of acceleration, scale-ups and connections form a prelude to a phase of institutionalisation, i.e. accepting and establishing new official and unofficial rules of play that are in line with more circular production and consumption.
Another sign of the arrival of the subsequent phase is that of an elaborated vision on and direction of the transition. Such a vision not only relates to the desired developments but particularly also to those elements of the system that no longer fit within a circular economy. This creates a sense of urgency and pressure for change on the part of established parties. It may shake up the current system and create space for the targeted adaptation and phasing out of existing linear practices. At the same time, the established interests may feel increasingly threatened and develop a resistance towards more circular production and consumption. Increasing resistance may be a prelude to fundamental changes in production and consumption processes that are or will be taking place on a large scale, and is therefore also an important indication that the next phase has been reached.

Trends in Dutch material resource use and its impact

Measuring the use of material resources and their effects

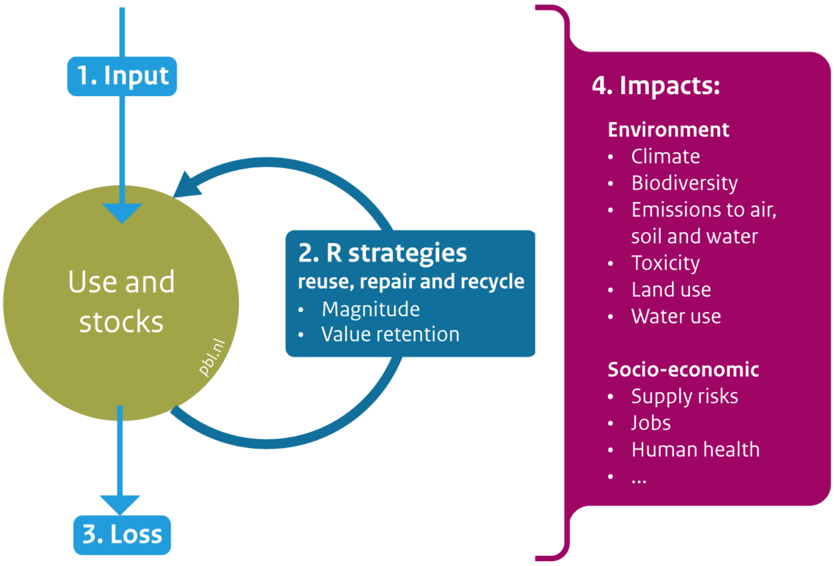
In order to provide insight into the degree of circularity of an economy, indicators are needed to show the development in the use of material resources and the related impact. These indicators cover both the input of materials, their use in finished and semi-finished products, and the output of materials in the form of waste. But the indicators must also provide insight into the effects that a circular economy aims to achieve, namely the reduction in various forms of environmental pressure and the improvement of the security of supply of crucial materials and finished and semi-finished products (Figure 3).

Below, the main trends in the use of material resources and their impact are discussed. Table 1 provides the most up-to-date overview of indicators that are important for a circular economy. These trends and related effects are discussed in more detail, further along the text.

The Netherlands is one of the front runners in Europe

With its 80% waste recycling rate, the Netherlands is one of the front runners in Europe, mainly because, over the past decades, its waste policy has been strongly focused on recycling. In addition, the Netherlands uses fewer material resources for consumption, compared to other EU Member States. These resources are therefore used more efficiently in the Dutch economy. In this respect, the Netherlands benefits from its high population density, which means that the large quantities of raw materials needed for infrastructure (e.g. roads, railroad embankments, pipelines) are used relatively efficiently. In addition, the Netherlands has a service economy that adds much value using relatively few material resources.

Figure 3
Framework for targets and indicators of circular economy monitoring



Source: PBL

Because the Netherlands is already one of Europe's recycling front runners, its circular objective differs from that of most other EU Member States. In Italy and Eastern Europe, for example, substantial progress can still be achieved by reducing landfill and increasing recycling. For the Netherlands, the main challenge is that of applying high-grade quality recyclate in new products and to focus on other circularity strategies, such as reuse, design, refurbishing, sharing, and repair.

Various trends are not moving towards a circular economy

Looking at the entire use of material resources in the Netherlands and the related effects, various trends are not going in the right direction. It is true that, in the Netherlands, resources are used more efficiently than before, but this has not led to a sharp, absolute reduction in use. The total use of material resources in the Netherlands has hardly changed since 2010, with respect to both domestic consumption and the economy as a whole (Table 1). This does not mean that the policy of promoting more circular production and consumption is failing. After all, the government-wide programme was not started until in 2016 and major shifts cannot be expected to be visible this soon. However, the transition towards a circular economy does require a reversal of these trends.

Dutch economy requires many more material resources than are needed for Dutch consumption

In 2018, the Dutch economy used nearly 450 Mt in material resources and, in addition, over 140 Mt in transshipment (Figure 4). These numbers include raw materials as well as parts and products. Over two thirds of these resources are imported. Almost half of all the material resources used in the Netherlands is for domestic use; the other half is exported. This shows that the Dutch economy requires far more materials than are need for domestic use.

Table 1
Overview of material resource use and its impact

Indicator	Magnitude 2010	Magnitude 2016	Magnitude 2018	Trend 2010–2018	Trend 2016–2018	Compared with EU-27 per capita in 2018
Natural resources required						
Material resources for domestic use, DMC[1] (Mt)	195	193	195	0%	1%	-22%
Material resource footprint domestic use, RMC[2] (Mt)**	-	-	-	-	-	-
Resource efficiency (GDP in EUR/kilo DMC)	3	4	4	12%	5%	+125%
Material resources for the economy, DMI[3] (Mt)	401	402	397	-1%	-1%	+95%
Material resource footprint of the economy, RMI[4] (Mt)	597	627	647	8%	3%	+89% (2017)
Share bio-based resources (kilo/DMI, in %)	24	25	26	8%	5%	+5%
Total sustainable renewable material resources (kilo/DMI)	-	-	-	-	-	-
Share secondary materials, CMUR (kilo secondary/DMI, in %)	-	13	14	-	6%	+167% (2017)
Use phase						
Lifespan	-	-	-	-	-	-
Value retention	-	-	-	-	-	-
Waste processing and recovering						
Dutch waste (Mt)	60	60	61	2%	2%	+44% (2016)
Share recycled waste in processed waste (recycled waste/waste, in %)	81 (2012)	79 (2012)	80	-1%*	+1%	+31%
Waste recycled in the Netherlands (Mt)	54 (2012)	52	53	-1%*	3%	+111% (2016)
Incinerated waste in the Netherlands (Mt)	10 (2012)	10	11	11%*	6%	+74% (2016)
Landfilled waste in the Netherlands (Mt)	2	3	3	51%	14%	-81% (2016)
Effects						
Environmental impact						
National greenhouse gas emissions ($MtCO_2$ eq)	214	195	188	-12%	-4%	+33%
Greenhouse gas emission footprint of consumption ($MtCO_2$ eq)	300	252	282	-6%	12%	+35% (2015)
Greenhouse gas emission footprint of production ($MtCO_2$ eq)	462	432	-	-7% (2016)	-	+54% (2015)
Emissions to air, water and soil, such as nitrogen and particulate matter	-	-	-	-	-	-
Land-use footprint of consumption (million ha)	10	-	10 (2017)	3% (2017)	-	-15% (2015)
Land-use footprint of production (million ha)	11	12 (2015)	-	9% (2015)	-	-28% (2015)
Water abstraction	-	-	-	-	-	-
Water footprint consumption (km^3)	52 (2008)	-	-	-	-	+21% (2008)
Biodiversity footprint of consumption (million MSA loss ha/year)	19	-	-	-	-	+1% (2010)
Biodiversity footprint of production (million MSA loss ha/year)	20	-	-	-	-	+2% (2010)
Toxicity	-	-	-	-	-	-
Socio-economic impact						
Supply risks (indicator being developed)	-	-	-	-	-	-
Added value of circular activities (EUR billion)	28	31	34	23%	9%	-
Share circular activities (added value circular / GDP in %)	4	4	4	1%	0%	-
Circular employment (no. of circular jobs in FTEs) (*1,000)	311	318	326	5%	2%	-
Share circular employment (no. of jobs/total no. of jobs in %)	4	4	4	-2%	-2%	-

Legend

Trends
- trend is moving in the right direction (green)
- trend is moving in the wrong direction (orange)
- trend is stable; hardly any differences (up to 5%)

Compared with EU-27
- NL scores better than EU (green)
- NL scores worse than EU (orange)
- hardly any differences (up to 5%)

Deviating years are provided between brackets

* 2012–2018, no data available for 2010
** RMC requires a new calculation
\- No data available

[1] Domestic Material Consumption
[2] Raw Material Consumption
[3] Domestic Material input
[4] Raw Material Input

The sources of the data in this table are listed in Appendix 5.

The amount of material resources used in the Dutch economy is more or less constant

The total use of material resources in the Netherlands has hardly changed since 2010, with respect to both domestic consumption and the economy as a whole. However, the amount of abiotic resources (i.e. minerals, metals and fossil raw materials) has declined, by 0.5% to 1%, annually. Resource efficiency has increased by 12% since 2010, but this improvement has not led to a significant change in the use of these materials in the economy. The material resource footprint of the Dutch economy increased by 8%, between 2010 and 2018 (Table 1). This footprint also includes the resources used in the production processes of materials, parts and products abroad.

More recycling will not substantially increase the share of secondary resources

In 2018, secondary materials made up 14% of the total use of material resources in the Dutch economy. Over the 2016–2018 period, this share increased from 13% to 14%. As much as 80% of the waste is already being recycled. More recycling will therefore only be a limited contribution to further increasing the share of secondary resources. In addition, challenges in the housing sector and the energy transition will require more material resources in the coming years. This increase in demand cannot be met using secondary resources alone. However, gains can still be achieved through a higher quality use of available secondary resources (to which better recycling techniques also contribute). Currently, a large part of the collected plastics is either burned or processed into bollards instead of being turned into new bottles, and not many of the discarded textiles are being reused to make clothing.

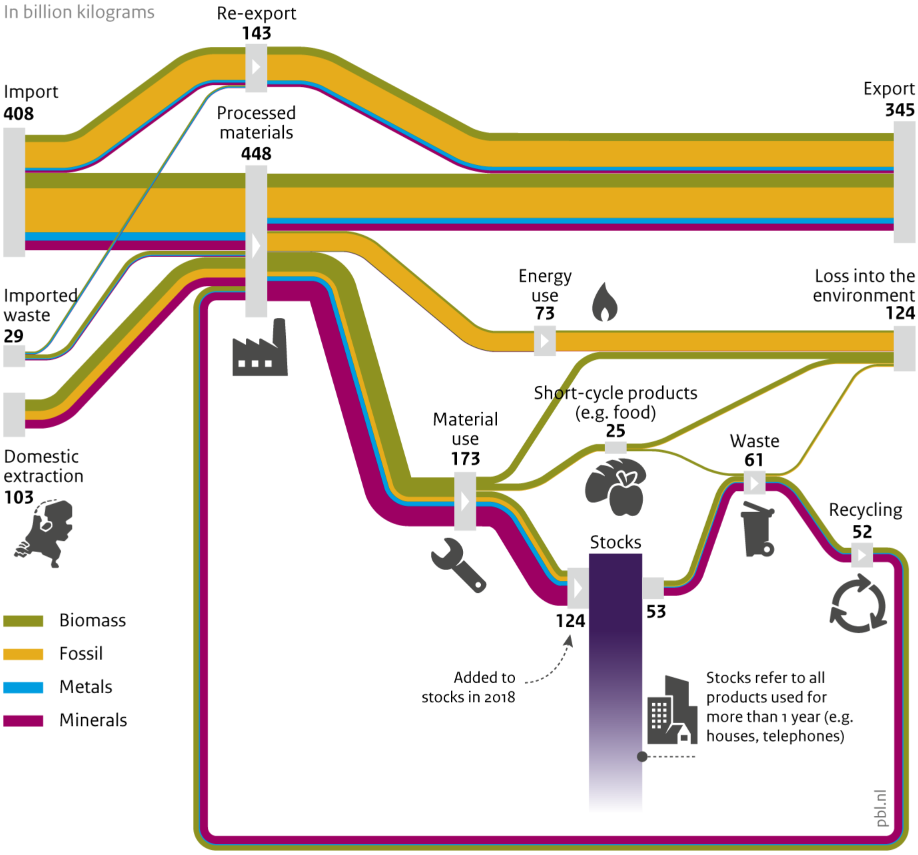
Many general national waste targets will not be achieved

There are many targets related to waste, on both EU and national levels. The Netherlands is achieving most of the EU waste targets and has set additional further-reaching targets for many of its domestic waste streams. However, six of the seven national waste targets of the National Waste Management Plan will not be achieved. These targets relate to the amount of Dutch waste, the total of which is within the target range of no more than 61 Mt by 2023.

The amount of household waste is still 200 kilograms above the target of 400 kilograms per inhabitant by 2020, and the amount of residual waste is even 80% above the target of 100 kilograms per inhabitant by 2020. Furthermore, also the target of halving the amount of waste in incineration and landfill by 2022 is not expected to be achieved. Although the percentage of the household waste that is sorted has increased in recent years (61% in 2018) after years of remaining stable, it is still a long way from the 2020 target of 75%. Furthermore, the amount of residual waste from companies, organisations and government authorities in 2018 was still twice the amount targeted for 2022.

More progress has been made on specific waste streams. The targets for waste from construction and demolition and that for various packaging materials have been achieved, while other targets are within reach. Only in the case of food waste has there, as yet, been no progress on the desired halving by 2030.

Figure 4
Resource flows Dutch economy, 2018
In billion kilograms



Source: CBS 2021

Impact of Dutch use of material resources

The impacts on nature and the environment from material resource use in the Netherlands, to a large extent, take place in certain parts of the production chain outside the Netherlands, especially in Europe, but also in other parts of the world. Nature and environmental effects include greenhouse gases and loss of biodiversity due to land-use change, nitrogen deposition and mining. In order to reduce the environmental impact of Dutch material resource use, it is therefore essential to consider the effects of the entire production chain. Between 2010 and 2016, there was a slight decrease in the footprints of greenhouse gas emissions for both production and consumption. Land use for the Dutch economy (i.e. the production footprint) increased by 9% between 2010 and 2015 (Table 1). This concerns mainly land use outside the Netherlands related to imported products, rather than land use within the Netherlands.

Dutch material resource use leads to both positive and negative socio-economic developments abroad. Employment in the exporting country is one of the positive effects. Negative effects also occur regularly, in the form of poor working conditions, child labour and human rights violations. This happens, for instance, in the mining industry and the production of cacao, coffee, palm oil and soya beans. In order to provide a detailed picture of these effects, it is crucial that companies are transparent about their work processes and their product information.

Supply risks mainly affect the manufacturing industry and are increasing

In the Netherlands, supply risks mainly relate to manufacturing, particularly because many companies depend on rare earth metals, cobalt, tungsten, tantalum, tin and indium. These are the so-called critical metals, because their supply carries the relatively high risk of disruption and because they are of great economic importance. They are used, for example, in machines, machine parts for certain modes of transportation and in electronics. Certain sectors are particularly dependent on them, such as the electronics industry, electrical appliance industry, transport manufacturing industry, the sector 'other industry', metal products and the equipment manufacturing industry. Since 2012, the supply risks for the Dutch economy have increased.

Supply risks are expected to increase further, as a result of the energy transition in the Netherlands. Achieving the energy transition will require an unprecedented acceleration of the increase in the annual production levels of many materials. Some critical metals, such as rare earth metals, silver, cobalt and iridium, are crucial in the production of solar panels, green hydrogen and batteries for electric vehicles. Current global production of a number of critical metals is insufficient to produce all the products needed for the desired energy transition, both for the Netherlands and for other countries. This applies in particular to the envisaged sustainable electrification. Added to this is the fact that the production capacity cannot rapidly be expanded — as opening a new mine, for example, would take at least 10 years.

Information about material resources and products facilitates their reuse

Many material resources are used in products that have a long lifespan, such as buildings, machinery and motorised vehicles. The materials stored in such products are also called stocks for future use or urban mines. In order to be able to reuse products and materials, it is crucial to have more information about the quality of secondary materials, second-hand parts and products. Good insight is needed into their amounts and location, as well as into the time at which they would become available for high-grade reuse, both now and in the future.

If companies and government authorities would have more and better data on the use of material resources, it would become easier to reuse materials, parts and products. At the moment, there is no such overview. First steps are currently being taken under the responsibility of the national government to create the Dutch Raw Materials Information System (GRIS). The development of this system will take a fair amount of time. In addition to the lack of a system that systematically maps material resource flows and stocks, there is also a lack of systematic information about higher circularity strategies, such as sharing, reuse, repair and refurbishing.

Circular economy policy in the Netherlands

The Netherlands has an interest in circular economy policy on an EU level

In order to take further steps towards a circular economy in the Netherlands, EU policy is of great importance. This applies particularly to those areas where the European Union has far-reaching powers, such as in trade, product and waste policies. Setting requirements for the use of raw materials in the design or repairability of products or concerning the presence of harmful substances in products particularly requires an EU approach. The European Union is also working on expanding producer responsibility, whereby producers remain responsible for what happens to their products after they are discarded by consumers. An EU approach would create a more level playing field for the Member States. This is to the benefit of the Netherlands, more so than is the case for other Member States, because the Netherlands has been pursuing an ambitious waste policy for decades and, more recently, a circular economy. As various Dutch companies have already developed innovative products and services, this can strengthen their competitive position on global markets.

The Dutch Government, in cooperation with other parties, has created a structure and basis on which a circular economy can be achieved

The circular economy is prominent on the agenda of government authorities, companies and civil society organisations. The Dutch Government's ambition to achieve a circular economy has now been endorsed by more than 400 parties under the Raw Materials Agreement. One of the things they agreed on is that teams of representatives from businesses, national government, government authorities, NGOs and scientific institutions have drawn up agendas for five priority transition themes: Biomass and food, Construction, Plastics, Manufacturing and Consumer Goods. Since 2018, Cabinet has concentrated policy efforts in 10 intersecting clusters of policy instruments. In doing so, it aims to accelerate the transition towards a circular economy. These clusters are: (1) producer responsibility, (2) legislation and regulations, (3) circular design, (4) circular purchasing, (5) market incentives, (6) financing instruments, (7) monitoring, knowledge and innovation, (8) behaviour and communication, education and the labour market, (9) international commitment and (10) Versnellingshuis Nederland Circulair (organisation to accelerate the Dutch circular economy).

The Circular Economy Implementation Programme 2019–2023 (IenW et al., 2019) elaborates on these intersecting clusters of instruments and includes concrete actions and projects for the five priority transition themes. The Netherlands has a public–private approach to the transition towards a circular economy, and focuses on 5 priority transition themes (societal domains) and 10 clusters of policy instruments. This policy approach, together with social stakeholders, has created a good basis for initiating the transition towards a circular economy.

The transition themes cover most of the environmental impacts

The five transition themes cover most waste flows, the use of material resources, land use and the loss of biodiversity. The transition themes are less focused on greenhouse gas emissions; together, they cover 35% of greenhouse gas emissions in the Netherlands, 42% of the greenhouse gas footprint of consumption and 56% of the greenhouse gas footprint of production. This reason for this lesser focus is that a significant proportion of greenhouse gas emissions originate from refineries, energy supply and transport. These sectors are not directly included in the priority transition themes. In contrast, however, these subjects are given ample attention in the energy transition and in climate policy. Distinguishing what does and does not fall under the priority transition themes is relevant, but calls for certain assumptions. For example, not all sectors clearly fall under a particular transition theme.

National policy so far mainly uses voluntary instruments

In order to stimulate the circular economy, national policy so far has focused on forming a broad social coalition and supporting the initiatives of companies, NGOs and consumers, using communication and facilitation tools. Think of knowledge development, the establishment of Versnellingshuis Nederland Circulair and voluntary agreements, such as the Concrete Agreement Netherlands, Plastics Pact NL and the establishment of the foundation Samen tegen voedselverspilling (together against food waste). In addition, existing financial instruments, such as the ‘Arbitrary depreciation of environmental investments’ (Vamil) and ‘environmental investment rebate’ (MIA), have been made available for circular investments. Such support actions are in line with the start-up phase of the circular economy policy. However, some of the current regulations and standards as well as certain consumer behaviours are not in line with more circular production and consumption, creating all kinds of obstacles for circular initiatives. For example, primary raw materials are cheaper than recyclates, market demand for circular products is often still limited and customers are reluctant to use circular products because there are no quality standards or guarantee schemes for these products. In order to overcome these barriers, the government has a wide range of policy instruments at its disposal.

Regional policy crucial for bringing parties together and exchanging knowledge

In addition to the national government, regional authorities can also support companies and other parties in their search for circular production methods. Local parties are located nearby the material flows and are in close contact with each other, making it relatively easy for them to create the networks or chains that are required for circular initiatives and innovations. Regional authorities, companies and other regional 'accelerators', such as economic boards and environmental federations, are actively developing circular initiatives at various locations in the Netherlands. These regional parties and government authorities can accelerate the transition if they cooperate more and learn from each other's experiences. Analysis shows that front running regional authorities mainly focus on facilitating companies; for example, by stimulating new forms of cooperation and providing them with experts, free of charge, to help further develop their circular initiatives. Many activities are focused on the preparatory phases, pilot projects or testing. Regional government authorities often use their purchasing power to stimulate the circular economy (RHDHV, 2020; Cramer, 2020).

Recommendations for strengthening circular economy policy in the Netherlands

Intensification of policy is needed to realise circular ambitions

In order to accelerate the transition towards a circular economy and realise the Dutch Government’s ambition of a fully circular economy by 2050, policy needs to be intensified. This intensification can be seen as the next phase in the transition. Voluntary and non-committal approaches will not be sufficient to achieve the government’s ambitious objectives. Environmental policy over the past 50 years (PBL, 2013) has shown that ambitious goals and emission reductions of 50% to 90% cannot be achieved through covenants and voluntary agreements alone. In addition to setting the agenda, incentivisation and creating support, more stimulating and coercive measures are needed, as well as the development of a broad-based vision of the desired direction worked out into concrete goals. These can be combined with further actions aimed at strategies higher up the R-ladder. Government may also promote circularity-related innovation; for example, by broadening producer responsibility and increasing circular purchasing and procurement policy. Both instruments are priorities in this Cabinet's approach to the circular economy.

Working towards a shared vision with concrete and measurable goals

As an intermediate goal towards a fully circular economy by 2050, the Dutch Cabinet strives to halve the use of primary abiotic raw materials by 2030. The ultimate objective and intermediate goals have a mobilising effect in the initial phase of the transition. However, acceleration and scaling up of the transition requires a detailed and broad-based vision to provide clarity for businesses, local authorities and social partners about the transition’s development direction and related concrete and measurable goals that this would require.

In 2019, PBL advised policymakers to start working with a set of targets for the input, use and output of material resources, measured in both quantities and euros (Figure 3) (Kishna et al., 2019). Such a set of targets must be aimed at the intended effects of less environmental pressure in the chain and improved security of supply for critical materials. It is important to note that the relevance of the sets of targets may differ per domain or product group. For example, the most important effects in relation to plastics are litter and CO_2. For the manufacturing industry, in addition to CO_2 emissions, there are various public health and environmental effects, such as toxic emissions to air, soil and water, and, for certain materials, there are also supply risks in this domain. Against this background, it is desirable to develop targets for each individual theme, specific product group or region.

Dutch waste policy has already set targets for reducing the outflow of materials in the form of landfill and incineration and for promoting recycling. This can be used as a starting point, with more attention being needed for high-grade recycling and the share of secondary materials in products. For the future, it is relevant to consider the targets and instruments that can be used to stimulate other circularity strategies. This could be targets related to product groups or additional product life cycle requirements and transparency in product design. Further elaboration, here, requires a tailored approach.

The Dutch Government has adopted PBL's earlier recommendations (Kishna et al., 2019) and, in 2020, started to further concretise the 50% reduction target and to set additional targets. A distinction was made between strategic targets and operational targets (IenW Parliamentary Letter, 2020). This enabled the focus on operational targets in addition to those aimed at the effects of material resources use. An example of this is the national target to save 1 Mt CO_2 through circular purchasing. In this way, such operational targets are logically positioned in the policy to stimulate a circular economy and can form part of a roadmap to be developed by the transition teams.

Further elaboration of the division of roles is a step towards the next phase in the transition
In order to be able to implement the concrete goals and agreements differentiated according to the various themes, product groups and regions in the next phase in the transition, a clear division of roles between the various parties involved is important. What, for example, are the authorisations and the mandate of the various transition teams working on realising the transition agendas? And what is the role of the government in these teams? And what is expected of the various ministries directly involved in the transition towards a circular economy? In practice, the focus of the participating ministries is mainly on the transition agenda for which they themselves are primarily responsible, as a result of which the coherence between themes and agendas is insufficiently guaranteed (IenW and MinFin, 2020). Increasing the degree of clarity about the responsibilities of the various stakeholders and the discussion about this is therefore important in order to guide the transition towards a circular economy into the right direction (IenW and MinFin, 2020).

More frequent and earlier application of stronger instruments, such as taxation and regulation
In order to take the next step in the transition towards a circular economy, policy needs to use 'push and pull' mechanisms more often, in the short term. Examples include regulatory taxation, setting standards and placing conditions on the granting of permits. The justification for this is that environmental damage has so far not been sufficiently priced and that the current rules of the game favour linear practices over circular initiatives. The total monetary environmental damage resulting from the emission of harmful substances in the Netherlands is estimated at a minimum of 4.5% of GDP (Drissen and Vollebergh, 2018). And, as indicated, raw material extractions, the

production of materials, finished and semi-finished products, product use and the production and processing of waste, all contribute significantly to these emissions. Product prices currently are often too low, as production decisions do not take sufficient account of the costs of the damage caused by those products to nature and the environment. Consumers also lack this type of important information about the products they are buying.

So far, few legal and economic instruments have been applied in Dutch circular economy policy. And those that are in place still need to be worked out and their implementation formally confirmed. Legal and economic instruments, however, have been implemented in the existing waste policy. Examples include a tax on waste incineration and landfill bans on recyclable waste. The policy aimed at limiting the amount of waste and promoting more recycling has therefore been developed further than the policy aimed at initiating new chains, market formation, new business models, circular design and high-grade recycling. Interventions such as adjustments to legislation and regulation and price incentives usually take time (time needed to create social and political support for the legislative process), as demonstrated by the long time it took to implement deposit schemes for small bottles. It is therefore important to start this process early or accelerate existing processes.

Focusing waste policy on the use and quality of secondary materials
Traditionally, waste policy has been aimed at reducing the amount of waste that leaves the chain, and at promoting recycling as this limits the amount of waste that is incinerated or ends up as landfill. Policy is paying far less attention to the quality of the recyclate and its application in products. This means opportunities are missed for reduced raw material use and for environmental benefits, as the successful application of secondary materials imposes minimum and specific quality requirements on recyclate. The higher the quality, the more high-grade recycling of secondary materials. More circular production and consumption, therefore, requires further development of waste policy that not only focuses on waste volumes but also on the optimal use of the material resources they contain and thus on the quality of the recyclate.

Circular purchasing policy may increase environmental benefits
Government authorities can also stimulate the development of circular products and services by increasing the demand for them themselves; they could directly create a market demand through their purchasing policies. Purchasing policies could focus even more on circularity for various product groups, such as office furniture and road construction. There are still considerable opportunities for increasing the environmental benefits. It is not only the purchasing policy that plays a role in this. If certain products, such as office chairs, are purchased and are intended to last longer than they did before, this must also be embedded in the corporate culture and administrative processes. This is in order to prevent such chairs from being discarded prematurely, in practice, which would undo the envisaged environmental benefits. In addition, it is often possible to apply circular purchasing more ambitiously and to start more innovative procurement processes, rather than just set requirements for recycling. Finally, for some product groups, such as ICT, it makes sense for contracting authorities to enter into joint purchasing. In this way, more far-reaching circular requirements can be placed on suppliers and thus also influence the market, in the process.

Producer responsibility is crucial for environmental benefits
In a system of extended producer responsibility (EPR), producers are responsible for their products also after consumers discarded those products. EPR increases the share of discarded products that

are collected and recycled in the relevant product groups. This also produces a larger and more stable supply to recycling markets. In order to increase the environmental impact of the EPR systems, however, design is crucial. For example, it is effective to use flexible economic instruments, so that producers continue to be stimulated to design their products circularly, at an earlier stage. Think of requirements for waste collection and processing that are tightened over time. A second recommendation is to differentiate return premiums according to, for example, recyclability and the proportion of recycled material (CPB and PBL, 2021). The more recyclable a product is, for example, the higher the reimbursement for its producer. In addition to the share of products that are collected or recycled, the quality of those materials is also important.

Synergy and tension between circular economy and energy transition

Circular economy policy could greatly contribute to achieving energy and climate goals. Conversely, an increase in the use of renewable energy sources, principally, would lead to a decline in the demand for primary fossil energy sources. In addition, the energy transition requires sustainable biomass and critical earth metals for wind and solar power plants. However, sustainable biomass is not infinitely available. Moreover, biomass is preferably used in high-grade applications, such as for food or furniture, in the construction sector and in the chemical industry; using biomass for energy generation is a lower-grade application (SER, 2020). Furthermore, there are supply risks associated with the large-scale use of critical earth metals, partly because of the dependence on China, which has a dominant position in the extraction and refining of several of these raw materials.

An important difference between the two policy areas is their focus. Policy that promotes the Dutch energy transition focuses mainly on greenhouse gases emitted from Dutch chimneys, whereas the focus of circular economic policy includes greenhouse gases emitted throughout the entire chain — also on those that originate and have their impact abroad. This can create a certain degree of tension between these two policy areas. Companies that invest in greenhouse gas reduction outside the Netherlands are not rewarded for this under current Dutch energy and climate policy. This continues to be an issue as long as circular economy policy is part of climate policy, whereby the use of public funds is assessed almost exclusively in terms of reduction potential with respect to Dutch greenhouse gas emissions. The search for possibilities to reward companies for reducing greenhouse gas emissions earlier in the chain (i.e. abroad) is relevant to achieve a more efficient use of material resources as well as global greenhouse gas emission reductions.

Two other conflicting issues between the energy transition and the circular economy relate to the lifespan of products and linking the incineration of waste to heating networks. For example, the continued effort to replace electrical appliance stocks with more energy-efficient appliances may be at odds with the environmental impact of such replacements, as additional raw materials have to be extracted for the production of these new appliances, more products need to be made and more waste is, thus, being generated. The direct link between waste incineration plants and heating networks also leads to friction with circular economy policy and incentivises, because this gives an incentive to waste incineration rather than waste recycling.

The above shows that the energy transition and the transition towards a circular economy are strongly intertwined. To date, policy has mainly focused on the contribution of the circular economy to the energy transition and this is also true for the available government resources for the circular economy. At the same time, limited attention was paid to the possibilities of climate policy to contribute to a more efficient use of material resources. It would therefore be sensible to award greater attention to the coherence, opportunities and risks of both these pathways, so as to ensure that the desired effects along one pathway do not lead to undesired effects along the other.

Circular economy requires a government-wide approach

It is important that the policy to promote a circular economy is addressed government-wide. After all, such policies cover various production chains, sectors and spatial scales; from agriculture to product design and from global to local levels. In addition to climate policy, for example, this includes policies aimed at improving the security of supply of material resources, green fiscal reform, making international trade more sustainable, promoting environmentally friendly innovations, aligning training requirements with circular production processes, and promoting circular purchasing and procurement. Finally, a circular economy requires different rules to ensure there is a balance between safety, health, environment, economy and innovation. All this is not a matter to be addressed by a single ministry, but requires a government-wide approach in which each ministry has its own role and task, forming a coherent whole. Although several ministries are currently involved in the circular economy policy, their individual packages of policy instruments are not all focused on achieving a more circular economy.

Towards another phase of the transition

Policy is able to influence the direction and pace of the transition

The transition towards a circular economy is a process that involves many parties, and cannot be guided by the government alone. But policy does influence the direction and pace of the transition. When policy provides more focus, it can actually accelerate the transition. Entrepreneurs and innovators want to take the next step, but lack clarity about the appropriate direction and concrete goals in which circularity strategies other than recycling will play a major role. Without explicit policy efforts to deploy a broad repertoire of R-strategies, the focus will remain on recycling.

In order to further accelerate the transition, attention for the direction of the transition remains necessary. The currently dominating developments can mainly be described as incremental improvements to the current system (i.e. system optimisation), while system innovation or a significant change in the system is required.

Specification of the direction and its differentiation into the various domains and/or product groups is needed, otherwise waste management and low-grade recycling remain the dominant strategies. Each domain (construction, plastics, manufacturing, transport, food supply) has its specific environmental problems; for example, manufacturing faces the issue of security of supply, but this is hardly an issue in the plastics industry. This makes the transition towards a circular economy a collection of domain-specific transitions — even more so than is the case for the energy transition. And because change processes in sub-domains can differ in the pace and direction of solutions, domain-specific operational goals and strategies will also be needed. The common denominator here is that a reduction in the use of primary resources (to reduce environmental pressure or improve security of supply) will require this use to be radically more efficient. This applies both to the input of new raw materials and to materials that are already available within society.

Guiding the transition is an ongoing process

Guiding any transition requires a clear vision of exactly what this process involves, and how it may develop over time. Such a perspective must be constructed and based on logical expectations and assumptions about human behaviour, events and circumstances. This, for example, relates to the expected roles and behaviour of the various parties in the transition towards a circular economy, new business models and forms of collaboration between companies. It is also about regulations that impede the transition, knowledge that is required, and market demand for circular products that needs to be developed. There may also be resistance from vested interests, and the process also involves identifying the things that would enable and promote breakthroughs towards circular production and consumption.

Such a vision helps to categorise and understand what happens during the transition. Of course, experiences with these processes of change, over time, will lead to new knowledge and insights, thus requiring the perspective on the transition to be adjusted, but without changing the function of such a perspective. This function is to distinguish between main and secondary issues, to identify the roles of the various parties in the change processes, to understand setbacks and obstacles, and to design roadmaps for desired intermediate goals and realising the final ambition. A transition perspective is also useful in the debate with all those involved, and ultimately for support and legitimisation — so that stakeholders all use the same road map to explore new areas, exchanges experiences, speak the same language and use the same knowledge base, whereby the 'map' is improved, over time.

Managing transitions is therefore an ongoing process of planning, taking action and intervening, followed by monitoring and adjusting the resulting impact. The Integral Circular Economy Report — the current publication as well as every following edition — play an important role in this respect; presenting the best available and current knowledge about circular economy processes, thus offering the possibility for adjustments to be made along the way.

FULL RESULTS

1 Introduction

The Dutch Government aims to achieve a fully circular economy by 2050 and has asked PBL Netherlands Environmental Assessment Agency to report on the progress of its implementation. The response to the request is this first Integral Circular Economy Report (ICER), which describes the state of affairs of the transition towards a circular economy in the Netherlands and contains tools to step up the transition if necessary. This biennial reporting provides insight into trends in material resource use and the environmental and socio-economic effects that arise from it. It also covers the actions and means (e.g. innovation projects and financing) of civil society parties, and government interventions in the transition towards a circular economy.

1.1 Material resource issues and the circular economy

Climate change, the nitrogen problem, deforestation and the plastic soup. These are just a handful of the environmental problems that are currently at issue and appear on the government agenda in both the Netherlands and countries around the world. A significant share of these global environmental problems stems from material resource use. In this report, *material resource use* is a collective term that denotes the *extraction* of primary resources (e.g. iron ore, bauxite and oil), the *processing* of material resources into materials (steel, aluminium, plastics), semi-manufactured products and final products (vehicles, packaging), the *consumption* of these products and the *collection and processing* of the waste that is generated after each step. A wide variety of problems for the environment and for nature are associated with these steps. The extraction of material resources in the mining industry often has serious consequences for local ecosystems, including deforestation and pollution of groundwater and surface water. The processing of material resources, such as iron ore and bauxite into steel and aluminium, requires many other material resources and substantial amounts of energy, which results in CO_2 emissions, amongst other things. The use of electrical appliances, cleaning products and vehicles has all manner of undesired environmental impacts, such as air and water pollution. And, eventually, used materials and products are incinerated, or end up as waste somewhere, for example in a landfill site, or as street litter.

The pressure on the environment and nature stemming from material resource use is high and will continue to grow if no supplementary policies are enacted. This is because the global demand for material resources is expected to keep on rising in the coming decades due to increases in global population and global per capita consumption (Bastein et al., 2013; IRP, 2019). Chapter 2 provides further details on this issue. Pressures on the environment and nature include climate change caused by greenhouse gas emissions, growing waste streams, the accumulation of toxic substances in the environment, loss of biodiversity and soil degradation. Increasing material resource use and the associated environmental impacts are putting pressure on a number of international agreements and ambitions, such as the Sustainable Development Goals and the Planetary Boundaries (IRP, 2019; Steffen et al., 2015). A circular economy is, in essence, about the possibilities to organise material resource use in a significantly or radically more efficient way and is therefore crucial for dealing with the problems described here regarding nature and the environment.

Although material resource use will continue to increase in the short term, most material resources are not going to be instantly depleted. But, the supply risks of certain material resources *will* grow. This is of particular concern with regard to *critical materials* — those which are both economically significant and have huge supply risks. Examples are the rare earth elements and cobalt, tungsten, tantalum, tin and indium. They are crucial for the manufacture of electronic devices and the generation of sustainable energy, amongst other things. It is not so much a question of these critical materials being depleted in an absolute sense, but they might be in short supply because, for example, they are used for geopolitical purposes or they are only found in a few source countries. In recent years, concern has been growing amongst businesses and policymakers about security of supply and the vulnerability of the economy to lengthy international supply chains. The general public too became aware of this vulnerability with the shortages of personal protective equipment for health workers during the outbreak of the Corona pandemic. Significant increases in efficiency in the use of available material resources do, in principle, alleviate vulnerability issues, but this is not the only possible strategy towards a solution.

1.2 The characteristics of a circular economy

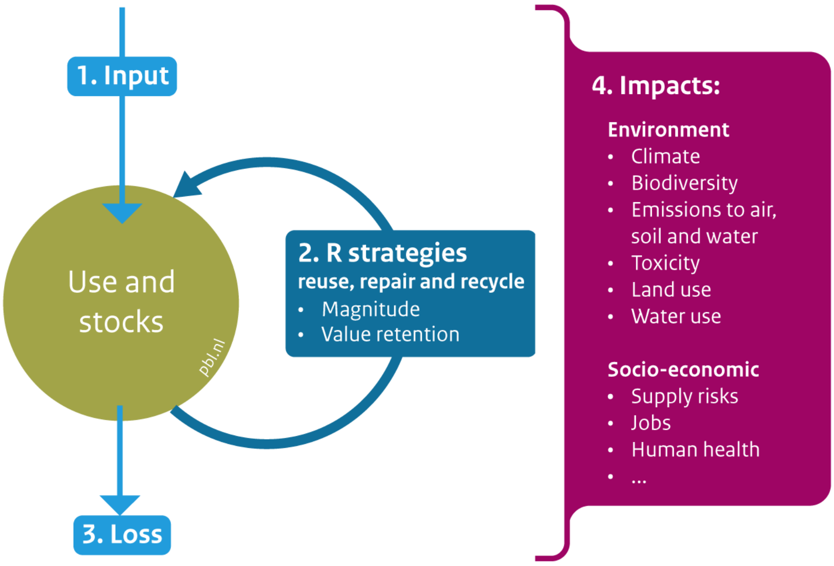
In a circular economy, the focus is on significantly increasing the efficiency of material resource use (PBL, 2018). This is of great importance in efforts to counter environmental issues, such as climate change and biodiversity loss. A circular economy can also contribute to lessening the supply risks of material resources. It can provide opportunities for Dutch companies too: they can save costs by enhancing the efficiency of material resource use in the production chain and by adopting environmentally-friendly production methods. Accordingly, a circular economy can be seen as a means to attain multiple social goals.

A circular economy deals with the overall use of material resources in society. As mentioned above, several phases can be distinguished in this use: material resources entering the economy (input); material resources that remain in the economy and converted into materials, semi-final and final products (consumption and stocks); material resources that leave the economy in the form of waste (output). Taken as a whole, these phases give an indication about the circularity of an economy. This is reflected in the left part of Figure 1.1.

The right part of the figure covers the impacts that stem from use of material resources. By making the economy more circular, the negative impacts can be softened. The relationship between use and impacts is complex: there can be considerable differences amongst material resources in terms of their environmental pressures and supply risks. For example, the extraction, processing and use of one kilogram of sand have fewer negative environmental impacts than those of a kilogram of nickel. In addition, what is important is not only the scale of use of material resources, but also their economic value. For this reason, a central aspect of a circular economy is ensuring that use and reuse of material resources are as high-grade as possible, with an eye to both quality of the environment and economic value.

There are various ways to make material resource use significantly more efficient. Amongst these are the Circularity strategies, also known as R-strategies. They are usually represented in the shape of a ladder, and a rule of thumb holds that strategies placed higher on the ladder generally save more material resources and are therefore better at preventing pressure on the environment. The strategies at the top of the circularity ladder (refuse, rethink, reduce) cut down the total, or absolute, material resource use — narrowing the loop. Those halfway up (reuse, repair) postpone the need for new material resources — slowing the loop. Finally, the one at the bottom (recycle) aims to make the flow of material resources come full circle — closing the loop. To effectively bring about a circular economy, all strategies are needed.

Figure 1.1
Framework for targets and indicators of circular economy monitoring



Source: PBL

1.3 Motivation, subject matter and objectives

In recent years, the government and societal stakeholders in the Netherlands have formulated ambitions and goals for attaining a more circular economy. They are included in the vision laid out in the 'Government-wide programme for a Dutch Circular Economy: A circular economy in the Netherlands by 2050' (IenM and EZ, 2016). This has given rise to:

- the Raw Materials Agreement (Dutch Government, 2017), which to date has been signed by more than 400 parties;
- transition agendas covering the five themes Biomass and Food, the Construction Sector, Consumer Goods, Plastics, and the Manufacturing Industry (Transition Team Biomass and Food [Transitieteam Biomassa en voedsel], 2018; Transition Team for the Construction Sector [Transitieteam Bouw], 2018; Transition Team Consumer Goods [Transitieteam Consumptiegoederen], 2018; Transition Team Plastics [Transitieteam Kunststoffen], 2018; Transition Team for the Manufacturing Industry [Transitieteam Maakindustrie], 2018);
- a government response to those agendas (IenW, 2018) and
- an implementation programme (IenW, 2019; 2020).

These documents contain a wide variety of actions and interventions to promote the transition towards a circular economy. An important tool in overseeing the transition is progress monitoring. One of the challenges is the identification or development of an appropriate set of indicators that serve to provide insight into the degree and the effects of the economy's circularity.

The government response to the transition agendas for a circular economy (IenW, 2018) included a request made to PBL to 'further develop the monitoring system into a fully fledged measurement and controlling system, in collaboration with other knowledge institutes. The purpose of this system is to enable monitoring of government policy and the efforts of societal stakeholders, and to provide insight into the level of attainment of the established circularity goals, making it possible to assess the need for adjustments' (IenW, 2019). Fulfilling its role as coordinator of knowledge development for a circular economy, PBL publishes a biennial integral report on the circular economy (ICER), in collaboration with other knowledge institutes.

Report objectives and target audience

The aim of the reporting is to describe the state of affairs of the transition towards a circular economy in the Netherlands and to formulate recommendations to step up the transition. This ICER 2021 publication is the first edition of the Integral Circular Economy Report. The knowledge gathered here is meant to provide administrators, politicians and policymakers with the means to adjust production and consumption processes, if deemed necessary, through the use of policies. The reporting is part of the annual cycle of circular economy policy in the Netherlands, and serves as input for the rounds of consultations between the parties involved in the Raw Materials Agreement and in the five priority transition themes, and also for the debates on circular economy policies between the government and the House of Representatives.

1.4 Frameworks for monitoring and directing

The report What we want to know and can measure (Potting et al., 2018) describes a framework for monitoring the transition towards a circular economy which comprises two core elements. The first addresses the visualisation of material resource use and the intended environmental and economic impacts of the transition. The second element deals with the transition process, which is made up of various means, actions and efforts of governments and societal stakeholders, and paves the way for attaining the intended impacts. Appendix 2 provides a more detailed description of the underlying methodology.

This ICER 2021 report builds on the monitoring methodology proposed in 2018 and therefore deals with material resource use, the impacts of that use — such as environmental pressures and supply risks — and the transition process that is to lead to a more circular economy. Measuring material resource use and the resulting impacts is relevant because it visualises areas where efforts are to be applied and the transition's ultimate outcomes. The transition will be gradual, which means that quite often the sought-after impacts will only become visible in the monitoring results after several years. For this reason, it is a good idea to also have an understanding of the level of preparedness in society as to more circular forms of production and consumption.

A picture of the progress of the transition towards a circular economy can be sketched with the aid of a broad set of indicators for material resource use, its impacts, and changes in society during the transition. This set can also be used to assess whether the various actors are 'doing the right things' to bring us closer to a circular economy, and whether 'those things are done properly'. This knowledge provides actors in society and the realm of politics and policy with the necessary information to steer the process. It can include, for example, indications of the amounts of material resources being used and the effects that has had on nature and the environment, and indications of actions and interventions made towards more circular production and consumption, and of the results achieved.

The framework for goals and indicators presented in Figure 1.1 is used to monitor material resource use and its impacts, and serves as a structure for Chapter 3, which deals with the state of affairs in the Netherlands. Therefore, this report discusses input of material resources, their use in components and products, and output of material resources which leave the economy as they end up in landfill or are incinerated. The environmental and socio-economic impacts of material resource use are also discussed.

Monitoring provides the opportunity to adjust the transition throughout the process, even before the effects of the shift to a circular economy are observed. The term transition process refers to the activities that businesses, consumers and government authorities carry out, and to the resources and instruments they use to achieve the sought-after effects. The aim of monitoring is to visualise the progress of the transition by registering many large-scale and small-scale actions, estimating their effects and analysing obstacles. The knowledge that the ICER report has to provide about the transition process includes the volume of investments in the circular economy, the number of businesses offering circular products, and the changes to laws and regulations that remove obstacles to increasing circularity of production and consumption. Transition indicators thus offer an image of how intensively companies, consumers and government authorities are preparing for a circular economy, and what approach they are taking. With this information, it is in principle possible to steer the course and adjust the pace of the transition.

The framework for monitoring and directing is dealt with in more detail in Chapter 3, which considers material resource use and its impacts, and in Chapter 4 which deals with the transition process.

1.5 Integral nature of the reporting and available knowledge

The content of this report originates largely from the knowledge acquired in the Work Programme on Monitoring and Directing the Circular Economy, 2019–2023 (PBL, 2019a; 2020a). PBL Netherlands Environmental Assessment Agency runs this programme in cooperation with the following knowledge institutes: Statistics Netherlands (CBS), Institute of Environmental Sciences (CML), CPB Netherlands Bureau for Economic Policy Analysis, Copernicus Institute of Sustainable Development at Utrecht University, National Institute for Public Health and the Environment (RIVM), Netherlands Enterprise Agency (RVO), Rijkswaterstaat - Ministry of Infrastructure and Water Management (RWS), and Netherlands Organisation for Applied Scientific Research (TNO).

For information on the organisation and the outputs of this work programme, please visit the dedicated website https://www.pbl.nl/monitoring-circulaire-economie (in Dutch). This report, of course, also makes reference to other national and international scientific literature and draws on the experience and practical knowledge gained by the parties involved in the Raw Materials Agreement and the transition themes.

Integral monitoring of material resource use, the impacts of use and the transition process

The reporting is integral in the sense that its scope covers the total material resource use in the Netherlands and its impacts in the country and abroad. This applies to both biobased resources (biomass and food) and abiotic resources including minerals (e.g. sand and gravel), metals and fossil fuels (e.g. oil, natural gas and coal). But the reporting is also integral in that it describes relevant developments in flows, stocks and use of material resources in Europe and globally. After all, material resource use in production and consumption processes in the Netherlands cannot be regarded as separate from the international chains in which products are made.

The transition process is also analysed integrally here. The point is to acquire the best possible understanding of progress made in the transition towards a circular economy, or of stumbling blocks encountered, so that the parties involved are able to work in a goal-oriented and coordinated manner. This involves actions in society as a whole, including those to be taken by government authorities. In addition, specific attention needs to be given to the various policy levels. The EU, national and regional levels are all relevant and each plays its own particular role in facilitating, stimulating and implementing the circular economy. The national policy level is the focal point of this ICER report but insights are also provided into developments at the global, EU and regional levels.

The knowledge base for circular economy is still under construction

This ICER report draws on the most readily available knowledge arising from the scientific literature, and from the efforts of and cooperation with the knowledge institutes participating in the Work Programme on Monitoring and Directing the Circular Economy, 2019–2023. It also makes use of knowledge gained through actual practice and experience amongst government authorities and societal stakeholders. However, the knowledge base for the circular economy is still being developed. While it is true that this report includes science-based knowledge and the most recent figures, this does not mean there is no space for improvement. It is expected that, in the coming years, adjustments to methods, more and better data and new scientific insights will lead to increasingly improved understanding of material resource use, its impacts, and the processes that have to bring the circular economy within reach.

Items the ICER 2021 report does and does not include

The nature of this first Integral Circular Economy Report (ICER, 2021) largely has to do with pointing out and taking stock of matters. Through these efforts, the report provides insights into the transition towards a circular economy, and tools for bringing it about. While the ambition of the report may be to paint an integral picture, knowledge about the circular economy is still being developed and therefore incomplete. Since the available empirical knowledge is insufficient, the report is evaluative to a limited extent only. It does contain reflections on trends in material resource use, on specific developments in the society heading towards a circular economy, and on policy interventions that aim to quicken the transition. In addition, several possibilities are identified for adjusting the direction of societal change processes which are to bring a circular economy within closer reach. These include specific policy instruments, such as heightened producer responsibility and circular procurement.

At present, there are gaps in the knowledge and information needed to answer the questions identified earlier. There are, for example, no calculation models that enable quantitative estimates of future material resource use and the impacts it will have on the environment, nature and the economy. In addition, at the time of writing, there is no information system that can visualise the flows and stocks of material resources in the economy, there are no scenarios available for exploring circular economy issues, and there is only limited insight into the costs and impacts of measures that aim to bring the circular economy closer. It should be emphasised that this reporting is based on a build-up model: as the knowledge base becomes broader and stronger in the years to come, subsequent editions of the circular economy report will be able to answer more and more questions.

1.6 Reading guide

Material resource use in the Netherlands cannot be considered in isolation from international developments. For this reason, the report starts, in Chapter 2, with a look at international trends that are relevant to interpreting the importance of the materials issue and the pursuit of a circular economy. What global and European trends in material use are discernible, what trends are expected to emerge, and what effects do they have? Also, why is the material resource issue an urgent matter for Europe?

Chapter 3 focuses on the trends in material resource use in the Netherlands. What amounts of material resources are needed for the economy and for domestic use in the Netherlands? What do we know about material resources which are contained in products, and function as a form of stock? How much waste is released and how is it processed? And what are the effects of material resource use for production and consumption in the Netherlands? This chapter also briefly discusses the consequences of the Corona crisis for material resource use and the associated impacts.

Chapter 4 describes the state of affairs of the transition process. How can the progress of the transition towards a circular economy be measured, and what indicators are available for this? What means and actions have societal stakeholders employed and what have they achieved? Are preparations already being made towards more circular forms of production and consumption?

The developments in EU policies to stimulate a circular economy and the currently available instruments are described in Chapter 5. To conclude, Chapter 6 looks at the present circular economy policies in the Netherlands. What policies have been adopted to bring about a circular economy? What goals have been defined? What approach has the government taken to make the transition happen, and what is the government's own role in it? And what instruments are the national and regional governments working with to encourage the transition towards a circular economy?

2 Global material resource use and its impacts

Main messages

- In recent decades, the global use of material resources has increased substantially, growing more than threefold since 1970. It is expected to double from the present day to 2060. The main drivers behind this growth are a marked increase in population and production in low- and middle-income countries and rising standards of living of the middle classes in those countries.
- The doubling of material resource use poses a problem for the environment. The extraction and processing of biobased and abiotic resources is responsible for 90% of global biodiversity loss, 90% of water scarcity, and 50% of all global greenhouse gas emissions. Based on the projected growth in worldwide use of material resources, greenhouse gas emissions are expected to keep on increasing, natural space will continue to decline, and the generation of waste will intensify. Because of this, ecosystems undergo irreversible change, which leads to biodiversity loss and high costs for individual businesses and for society as a whole.
- Most material resources are not going to run out immediately, but the rise in demand is resulting in fiercer competition. This may cause prices to climb or fluctuate, and supply risks to become larger for material resources that are essential to the economy. The critical metals in particular, such as cobalt, indium and rare earth metals, are of deep concern because of their major economic importance and their use in modern electronics and sustainable energy technologies. European countries, the Netherlands included, are more vulnerable than average to supply risks of material resources and materials because they depend greatly on imports.
- A circular economy can contribute to limiting the undesirable consequences of material resource use for the environment, nature, human beings and the economy by making it more efficient and by closing loops. More efficient use of material resources also involves sharing, reusing and repairing the products containing them, and reducing and recycling waste.
- The globalisation of production chains means that quite often it is the low-wage countries that feel the negative effects, such as greenhouse gas emissions, degradation of nature and landscapes caused by land and water use, and biodiversity impacts. These nations extract material resources for production and consumption in richer countries, or they process, incinerate or dump waste from richer countries, often for a low price, under poor environmental standards and unfavourable working conditions.
- As a major importer and exporter of goods and services, The European Union plays an important role in global material resource use. In addition, CO_2 emissions, water scarcity and biodiversity loss caused by EU consumption are above the per capita world average. The European Union is also a net exporter of environmental impacts — that is to say, imports into the European Union lead to environmental impacts beyond the EU region that are greater than the impacts that arise within the European Union from production meant for export.

2.1 Introduction

The global and European context of material resource use in the Netherlands

The globalisation of production chains and the growth in production over the last century have given rise to long production chains across the world. To give an example, metals from mines in Africa are processed into laptops in China, which are for a large part used in Europe; eventually some of these end up back in Africa or Asia as they are discarded. This means that the negative environmental and socio-economic impacts of extraction and processing of material resources and treatment of discarded products often occur far from the place where products are consumed.

Dutch production and consumption are also strongly intertwined with countries around the world through international trade and global production chains. Material resources, materials, semi-final and final products which are extracted or produced abroad are imported by the Netherlands. Many products, but also waste, are exported. It is important to consider developments at the global and European scale to properly understand and interpret the role of the Netherlands in the transition towards a circular economy, and its scope for action.

This chapter provides an outline of the global and European context of use of material resources and the impact of this use. The Netherlands is part of that context, but the Dutch situation will be discussed in Chapter 3.

Reading guide

This chapter consists of two parts. Section 2.2 considers global material resource use, the expected developments for the next few decades, and the environmental and socio-economic impacts of that use. Section 2.3 looks at material resource use in the European Union and the related impacts. This chapter outlines the international context from a physical perspective: the focus is on material resource use and its environmental impacts. The EU policies dealing with these issues are described in Chapter 5. The Text box below — Material resources, materials, components and products — gives an overview of the main concepts around material resources distinguished in this ICER report.

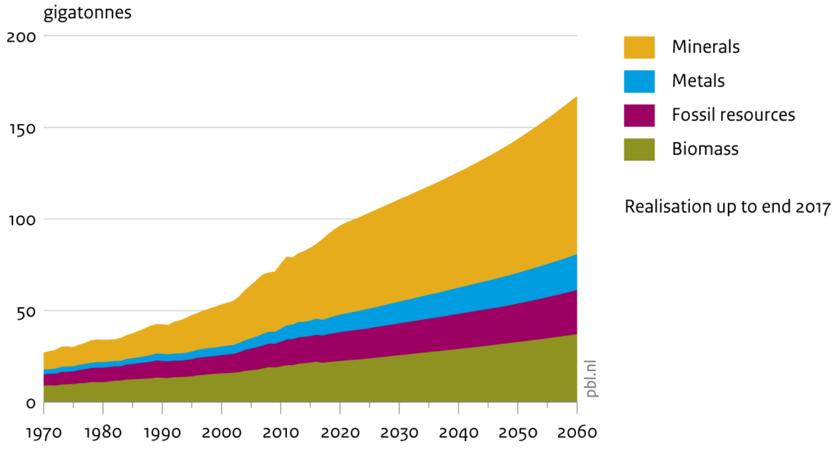
Text box 2.1: Material resources, materials, components and products

Several terms are used frequently in this ICER report. The most important are listed here (also see the Glossary).
The term material resources refers to both primary resources and the resources that have been processed into materials, components and products. The report considers four different types of material resources:

1. Minerals, such as sand, gravel and stone
2. Biomass or biotic resources, such as agricultural crops, wood and animal feed
3. Fossil resources, such as oil, natural gas and coal
4. Metals, such as iron, cobalt and copper

This classification is in line with international research by Eurostat, EEA, OECD and IRP. Water is dealt with to a limited degree in this report and is discussed in this chapter in the section on EU footprints, and in Chapter 3 in the sections on waste water and footprints of the Netherlands.
In addition, the report distinguishes between primary resources and secondary materials. Primary resources are those which are extracted from nature (e.g. petroleum, gold or wheat). Secondary materials are those which enter into the production process again through recycling (e.g. scrap metal or plastic pellets from melted plastic bottles).

Figure 2.1
Global material resource use



Source: Global Material Resources Outlook to 2060, OECD 2019

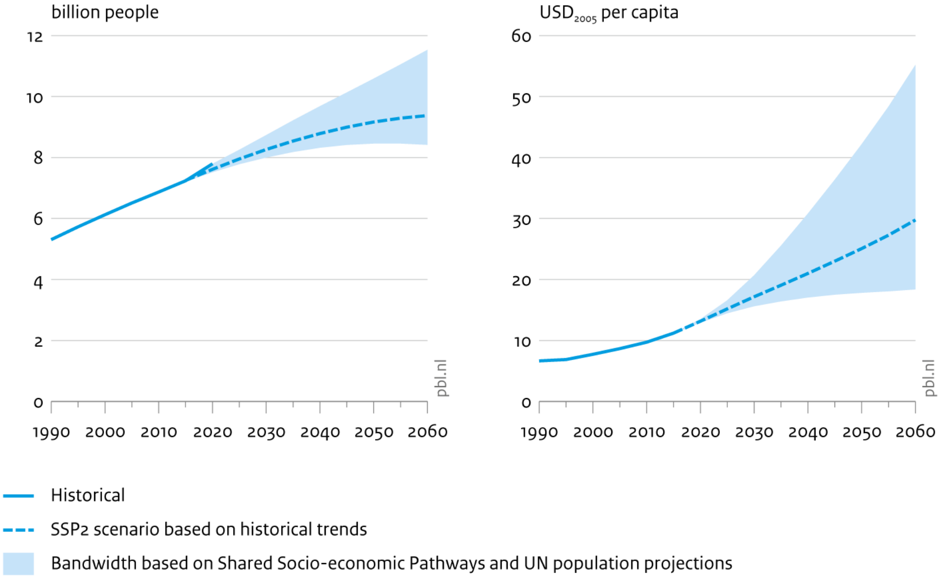
2.2 Material resource use and its effects on a global scale

2.2.1 Global use of material resources

The use of material resources has tripled compared to 50 years ago
The total global material resource use (Figure 2.1) has increased substantially in recent decades, growing more than threefold since 1970 (OECD, 2019b). In 2017, total use stood at 89 gigatonnes, half of which were minerals (44 Gt) and one fourth biomass (22 Gt), with fossil fuels (15 Gt) and metals (9 Gt) making up the rest (OECD, 2019b). The largest increase occurred in the extraction of minerals and ferrous metals, which are used particularly in infrastructure construction in strongly emerging economies, such as China, India, Brazil and South Africa (IRP, 2017). As for biomass, most of the production was used as fodder for livestock (OECD, 2019b). Along with the total use of material resources, global per capita use also increased from 7.2 tonnes in 1970 to 11.8 tonnes in 2017 (IRP, 2017).

If production and consumption patterns do not change, global demand for material resources will double in the coming decades
If there is no fundamental change in the way we use material resources, global use is expected to double by 2060, rising from 89 Gt in 2017 to 167 Gt (OECD, 2019b), or even 190 Gt (IRP, 2019) in 2060 (Figure 2.1). Demand for metals is foreseen to grow the most, according to the OECD (OECD, 2019b). Although metals are the smallest category of material resources in terms of weight, extraction and processing actually have many negative impacts per kilogram (this is discussed in more detail in Section 2.2.2).

Figure 2.2
Drivers of global material resource use



Source: IIASA SSP database 2.0, UN 2019

The increase in the use of material resources is strongly driven by a combination of a growing world population and the corresponding rising production to meet the heightening demand of that population, and also by an increase in per capita consumption resulting from rising standards of living. The projected trends of these drivers are shown in Figure 2.2. In a scenario that assumes that current trends will continue, the global population is set to grow from 7.3 billion persons in 2015 to more than 9 billion in 2060. Under this scenario the average standard of living more than doubles (Dellink et al., 2017), with the greatest gain taking place in the middle class. As a result, average material resource use per capita will also increase over the same period, by around 50% according to the OECD (OECD, 2019b) and IRP (2019) forecasts. If current trends continue, the efficiency of material resource use will not improve fast enough to adequately offset them (OECD, 2019b).

These trends are linked to several other factors that act upon the volume, and also the nature, of the demand for specific material resources. For example, in line with an increasing standard of living, it is estimated that average household size is decreasing globally (Bradbury et al., 2014) and that the size of dwelling space per person is increasing (OECD, 2019b). This leads to a rising demand for material resources, for example minerals and metals needed to build the required living space. Technological developments also play an important role. Technologies are expected to contribute to making designs for materials and products more efficient, making production processes cleaner, and improving waste management. This may make it possible to uncouple production growth, to some extent, from material resource use (OECD, 2019b). At the same time, technological developments may lead to new applications which result in higher demand for energy and specific material resources. For example, the transition from fossil energy technologies to renewable options is expected to generate much higher demand for specific and sometimes scarce material resources (IRP, 2019), such as neodymium for wind turbines and electric vehicles (European Commission (n.d.)).

Material resource extraction and material resource use are unevenly distributed around the world

While most material resources are widely available, the extraction of some resources is concentrated in a small number of countries. The imbalances between supply and demand in different countries eventually come together through international trade. Global trade in material resources has grown four-fold since 1970, from 2.7 to 11.6 gigatonnes in 2017. Half of this trade involves fossil fuels, followed by metals and biomass (IRP, 2019). High-income countries depend especially on imports of material resources, notably fossil fuels and metals, and their dependence is rising. The regions that depend most on material resource imports are East Asia and the Pacific, Europe, and North America (IRP, 2017). These imports are mainly sourced from low- and middle-income regions, such as India or Indonesia, which themselves have low levels of material resource use (IRP, 2017; 2019). As a result, high-income countries, including the Netherlands, exert significant influence on the global extraction and processing of material resources.

Most material resources end up as low-grade processed waste (incineration or landfill) and are not reused

Not much is known about the global total volume of waste streams. Data collection and reporting are insufficient, and there is no internationally uniform categorisation system (UNEP, 2015). Estimates of global generation of waste vary wildly, ranging between 17 and 52 gigatonnes per year (Circle Economy, 2020b; calculation by PBL based on Kaza et al., 2018; UNEP, 2015). The largest part of the waste comes from industry, construction and demolition, and agriculture and mining (Kaza et al., 2018; UNEP, 2015).

Most of the world's waste is incinerated or goes to landfill instead of being reused as secondary materials. According to an estimate by Circle Economy, secondary materials represent only an 8.6% share of total material resource use (Circle Economy, 2020b). A circularity score of 100% is not achievable. This is because the material resources that are stored, for example in buildings, cars and furniture, (i.e. material resource stocks) only become available after a number of years as secondary materials, and also because part of the biomass and fossil resources intended for energy purposes cannot be reused. After use as fuel or food, only a small amount of material resources is left over that can be used again.

According to OECD estimates (OECD, 2019b), from 2030 onwards more secondary materials will become available from the built environment in countries which are now undergoing rapid development, such as India or several African countries. The recycling sector is expected to more than triple between 2017 and 2060. Even so, the OECD expects the share of secondary materials in total material resource use to remain small and to be unable to keep up with further growth in demand for new material resources. In addition, high-grade recycling to produce secondary materials is relatively expensive compared to primary resources, due in part to higher labour costs (OECD, 2019b).

Increase in volume of waste exports and related environmental impacts for low-wage countries

High-income countries, including the Netherlands, export part of their waste to low-wage countries for further processing. In 2016, more than 200 million tonnes of waste were traded — mainly metals, paper, plastic and scrap metal, but also textiles and e-waste. This is 48% more than in 2003 (Yamaguchi, 2018). Incidentally, most of the Dutch waste exports goes to neighbouring countries, though part of it also goes to India, Turkey and Vietnam. The transfer of waste processing from high-income countries to low-wage countries with lower environmental standards raises the risk of the emergence of pollution havens. This also applies to the transfer of goods production that has polluting by-products (Kellenberg, 2012; Kettunen et al., 2019; Yamaguchi, 2018).

2.2.2 Impacts of global material resource use

The described increase in global material resource use has consequences for nature and the environment and may also bring about negative socio-economic impacts. The circular economy is a means to alleviate these undesirable impacts.

Material resource use is coupled with major environmental impacts

The growing use of material resources contributes positively to economic development, but at the same time inflicts significant damage to nature, the environment and landscapes (Figure 2.3). The extraction of resources, their processing into materials, semi-final and final products, their transport and the phases of use and disposal have negative impacts on nature and the environment. Material resource extraction and processing account for 90% of global biodiversity loss in terms of land use, 90% of water scarcity, and 50% of global greenhouse gas emissions (IRP, 2019).

In a scenario that assumes historical trends to continue, and taking into account climate policies introduced up to 2015, greenhouse gas emissions are projected to increase by 49% by 2060 compared to 2010 emissions (IIASA, 2018; McCollum et al., 2018; Rao et al., 2017). The increase, depicted in Figure 2.3, is the result of rising consumption. About two-thirds of the emissions are linked to sectors with substantial use of material resources, such as refineries, energy supply, agriculture and manufacturing. The remainder of the emissions takes place in the services sector, households, and transport. Based on current trends and policies, this proportion is not expected to change much (OECD, 2019b).

In addition, the increasing demand for food and biomass is leading to an expansion of agricultural land, because the expected improvement in yield per hectare is not great enough to make up for that demand. How large the expansion is going to be is unclear. Apart from this uncertainty, an important role is played by the type of climate policy being pursued and the related effects on land use.

In the scenario based on historical trends and without climate policy, the expansion is about 8% compared to 2010 (IIASA, 2018; Popp et al., 2017). The expansion of agricultural land requires the conversion of natural habitats, including forests and grasslands (Figure 2.3). Using a similar scenario based on historical trends for the same period, IRP (2019) infers an increase in agricultural area of more than 20%, which could lead to a decline of about 10% in forests and 20% in other habitats.

The various forms of degradation of nature and the environment are connected with each other. In the tropics, for example, deforestation for agricultural expansion contributes to climate change and changing precipitation patterns (Lawrence and Vandecar, 2015). Overall, human-induced changes in nature and the environment are generating a decline in biodiversity that is threatening one million animal and plant species with extinction (IPBES, 2019).

Figure 2.3
Global greenhouse gas emissions and land use

SSP2 scenario based on historical trends
Bandwidth based on Shared Socio-economic Pathways

Source: IIASA SSP database 2.0, UN 2019

These developments are putting pressure on several international agreements and ambitions, such as the Paris Climate Agreement, several Sustainable Development Goals (SDGs)[1] and the Convention on Biological Diversity (CBD). Research shows that there are no signs that these trends will be reversed in the foreseeable future (Parrique, 2019).

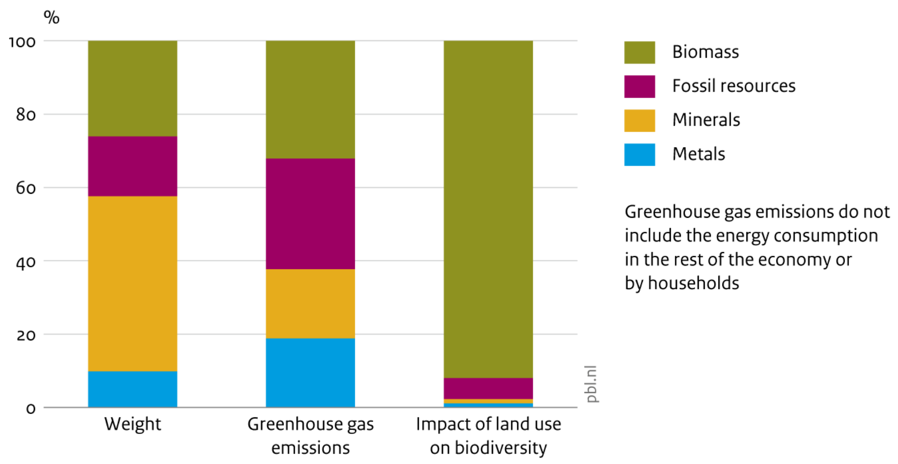
Ultimately, environmental impacts also lead to health risks and high costs for society and the economy. The number of extreme weather events, such as floods, erosion, heat waves and long droughts, is expected to rise. They cause yield losses in agriculture and damage to infrastructure, which in turn make it necessary to invest in climate adaptation (European Commission (n.d.); IRP, 2019).

Environmental pressures vary amongst different categories of material resources

Variations in environmental pressures occur depending on the category of material resources. Biomass production has a particularly strong impact on land use, water use and biodiversity. Use of fossil fuels leads to emissions of greenhouse gases and other pollutants, such as nitrogen oxides and particulate matter. Mining activity often causes serious environmental damage at the local level (OECD, 2019b). While for minerals the environmental impact per kilogram may be low, the volume of extraction is so high that considerable negative environmental impacts occur, particularly in the form of receding nature, biodiversity loss and greenhouse gas emissions. The opposite is the case with metals, where significant negative environmental impacts are created because the environmental pressure per kilogram is very high (Figure 2.4).

[1] A circular economy has a bearing on, for example, SDG 12 on responsible consumption and production, SDG 13 on climate action, and SDG 14 on life below water.

Figure 2.4
Shares of global material resources in extraction and processing, 2017



Source: IRP 2019

In recent decades, the globalisation of production chains has brought about a geographic shift amongst environmental impacts, from the place where material resources are consumed in the form of final products, to the place where the final products are manufactured. This means that, in practice, there has been a shift of environmental impacts (e.g. greenhouse gas emissions, impacts on land use, water use and biodiversity) to low-wage countries. For example, between 4% and 8% of the air pollution in China in 2006 alone can be attributed to exports of products to the United States (Wiedmann and Lenzen, 2018).

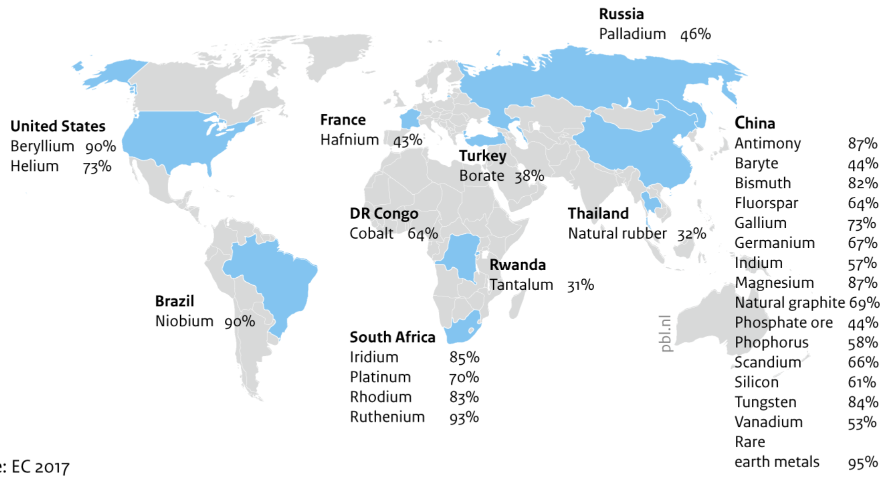
The rising demand for material resources can lead to supply risks

Most resources are not going to be instantly depleted, but due to increasing demand supply risks will pose a threat to material resources with high economic significance. These resources are therefore often labelled as critical materials. Supply risks do not normally arise from actual shortages, but from a combination of physical, economic and political circumstances. For example, they can arise when there is a marked increase in demand, or because only a few countries extract or process certain material resources, because there are few substitutes for some material resources, or the recycling rate of other resources is low. Limited availability of critical materials poses a risk to the economy and the standard of living in importing countries (OECD, 2019b; PBL, 2011).

A few countries are dominant in the extraction of one or more critical materials for global demand (Figure 2.5). Brazil, for example, extracts 90% of the world's supply of niobium — a metal used to make steel lighter and stronger. It is widely applied in nuclear power generation, for defence purposes, in natural gas distribution and the electronics industry, but also in surgical implants and MRI scanners. South Africa mines 85% of the supply of iridium — a metal that is important for the manufacturing of LCD and touchscreen monitors of laptops and smartphones, amongst other things. China is, by far, the most important global supplier of critical materials: 70% of all critical materials are extracted there (European Commission, 2017a). The concentration of mineral and metal extraction over certain countries has not changed significantly since 2012, although in other countries new, small-scale sites have been developed for the extraction of rare earth metals. The proportion between reserves and production has not changed either (USGS, 2020). Since 2012, the level of criticality of some metals, particularly cobalt, germanium, gallium and beryllium, has increased more than that of others (TNO, 2020).

Figure 2.5

Countries that dominate the extraction of critical resources, 2010 – 2014



Source: EC 2017

Many critical materials are extracted in just a few countries. Some are only extracted as by-products of other resources, because it is the only way to make extraction financially interesting. When the demand for the by-product increases, extraction of the main resource usually cannot respond within a year. This is because opening a new mine is a process that comes with many issues and takes at least 10 years (Rietveld et al., 2019). An example of a critical metal is indium, a by-product in zinc extraction which is used in the production of LCD screens, tin solder and electronics.

Increasing material resource use leads to rising prices

The availability of material resources is also reflected in their price. Up until the late 1990s, prices were falling. Between 2000 and 2008, steep increases were observed, particularly in the price of metals and fossil energy carriers. After a slump during the 2008 credit crisis and a temporary decline between 2011 and 2016 due to the removal of some trade restrictions, and the negotiations on continental trade treaties, the prices of fossil fuels, metals and minerals picked up a little after 2016 (World Bank, 2020a). This stemmed in part from trade disputes within the WTO and the breaking off of negotiations on trade treaties (OECD, 2019a). The Corona crisis brought about a sharp drop in prices, particularly those of energy carriers. Although the price of metals, minerals and agricultural products declined slightly due to the crisis, they recovered in the period up to October 2020, reaching levels higher than at the end of 2019, and they are expected to continue to rise (World Bank, 2020a; 2020b). The International Resource Panel (IRP, 2017) has estimated that the growing demand for material resources will drive prices up further in the coming years. Supply will be adapted to increasing demand, for example by opening new mining sites, but this usually takes a long time and therefore price fluctuations may arise (PBL, 2011).

A circular economy can contribute to greater security of supply and more stable prices by increasing the efficiency of material resource management and intensifying the use of secondary materials. Efficiency of material resource use can also be improved by enhancing reuse, repair and the sharing of products.

Negative impacts in production chains mainly affect the poorest part of the global population

Although the circular economy is generally looked upon as a way of dealing with environmental problems and supply risks, the transition towards a circular economy could also be coupled with pathways for tackling social problems. The fact is, global material resource chains are often also characterised by social abuses, such as violations of labour rights.

The international trade in materials and products offers opportunities for economic development to many, while the social costs are not always evenly distributed. Certain international chains, such as soya production in Brazil, cause a great deal of environmental damage and incur a high risk of social injustice. This is particularly the case in low-wage countries, in the areas of material resource extraction, primary production and waste processing. This is partly due to the lower environmental standards in those countries, along with their poor working conditions and dismal terms of employment. For example, the extraction of minerals and metals in low-wage countries often goes hand in hand with severe local environmental pollution and a high risk of labour rights violations, while local communities benefit little from the activity. The mining sector can also create serious disruption to local communities, especially in countries marked by political instability and corruption. In some cases, this can also add to long-term friction, such as the conflict in the Democratic Republic of the Congo since the 1990s or the civil war on Bougainville Island in Papua New Guinea between 1988 and 1998 (Adamo, 2018; IRP, 2020).

In many countries, environmental damage also has a direct and serious negative impact on local communities. Low-income households in particular are heavily hit, since poverty makes people vulnerable and less able to respond rapidly to negative impacts. This is apparent in, for example, the cultivation of certain agricultural crops, such as cotton or sugar cane, for which large amounts of water are used (IRP, 2019). These crops are often grown for consumption in other countries. If water stress sets in or increases in these areas due to water use in agriculture or climate change, the local population may feel a huge impact. For example, shortages of unpolluted water and safe drinking water often mean that people either spend a large part of their disposable income on water, or dedicate a large amount of time to collecting water from elsewhere in the region (Damania et al., 2017; Johansson et al., 2016; Tadesse et al., 2018).

Text box 2.2: Global E-waste Monitor 2020

According to the most recent Global E-waste Monitor (GEM), published in 2020, the amount of electronic waste, or e-waste, generated worldwide continues to grow, with relatively little being recycled. In 2019, nearly 53.6 megatonnes of e-waste were generated globally, and about 17.4% of that was recycled in ways that were safe for humans and the environment. The global creation of e-waste is expected to reach 74.7 megatonnes per year by 2030. As reported in the GEM 2020, it is unclear exactly what happens to the greater part of this e-waste. The possibility exists that it goes to landfill or is traded or recycled under poor conditions, especially if it ends up in middle- and low-income countries (Forti et al., 2020). Research from 2015 shows that in 2012, about 1.3 megatonnes of e-waste left the European Union as unregistered exports. Most of these often-illegal shipments are intended for reuse and repair in other countries. About 30% is waste made up of unusable or broken items (Huisman et al., 2015). The GEM 2020 also observes that in countries without legislation and regulations on e-waste, there is a high risk that the hazardous substances in the waste products are not processed properly, and that the e-waste is recycled under poor conditions. This leads to serious environmental pollution, contributes to climate change and carries serious health risks (Forti et al., 2020).

A final issue is that there is trade in end-of-life materials and products, both within and beyond the European Union. Part of this trade is not legal. Discarded materials and products can be a source of material resources or affordable second-hand products in low-income countries. But if sorting, repair or recycling of these products is not carried out safely, there is a high risk of serious pollution and damage to health (EEA, 2019b; Forti et al., 2020). Further information is provided in the text box 'Global E-waste Monitor 2020'.

2.3 Material resource use in the European Union and its impacts

2.3.1 Material resource use in the European Union

This section takes a closer look at material resource use in the European Union and its impacts. Given its position as a major exporter and importer of goods and services, the European Union plays an important role in global material resource use and the global environmental impacts that arise from it. At the same time, the European Union also depends heavily on certain materials from other countries. The position of the European Union in the world and the way it is intertwined with the world form the context in which the Netherlands acts, and represent the starting point for policies related to a circular economy in the European Union (Chapter 5) and in the Netherlands (Chapter 6).

The European Union plays an important role in global material resource use

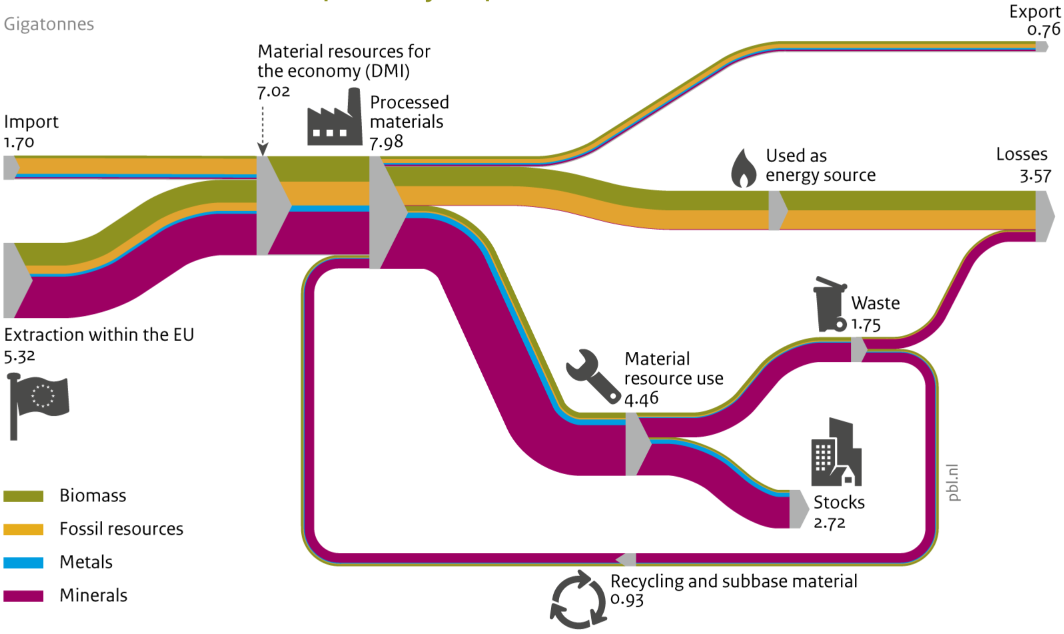
In 2019, around 7.1 gigatonnes of material resources were used in the EU-27 economy (Eurostat, 2020c). Material resources are either consumed as final products within the European Union or exported for further processing or consumption. The amount of material resources used in the EU economy (direct material input, DMI) is slightly larger than that in the United States and India, and much smaller than in the economy of international leader China, where 40% of the global supply of material resources is used (OECD, 2020). Worldwide, the European Union is the largest exporter of goods and services, in terms of weight. With regard to services and processed products in particular, it is a major exporter (European Commission, 2019a), most specifically of machinery, vehicles, chemicals and food. Most of these products are exported to the United States, China and Switzerland (Eurostat, 2020d; 2020e).

But the European Union is also closely intertwined with the rest of the world through its imports: about 25% of the material resources used in the EU economy is imported (Eurostat, 2019a). Because of its key position in trade, the European Union can exert far-reaching influence on global resource use.

The amount of material resources needed in the European Union is greater than the world average

Figure 2.6 shows the flows of material resources that are processed in the EU economy. After processing, the European Union itself consumes 90% of the total flow, and the rest is exported. In 2019, the domestic material consumption (DMC) of the EU-27 stood at about 6.3 gigatonnes of material resources, materials, semi-final and final products (Eurostat, 2020c). About two thirds of this was consumed in the form of products, and one third was used as fuel (Eurostat, 2019a).

Figure 2.6
Material resources in the EU-27 economy, 2017
Gigatonnes



Source: Eurostat 2019

The 2017 figure of 14 tonnes per person (Eurostat, 2020g) shows that amount of material resources consumed in the European Union is less than that in other developed countries, such as Qatar, Australia, the United States, Canada, Russia or China (OECD, 2020), but more than the world average of 11.8 tonnes (IRP, 2017).

It is important to also consider the material resource footprint

The material resource flows in Figure 2.6 do not include resources used in the production chain outside the European Union. For example, for an imported car, the weight is counted of all of the material resources it contains, but not of those used earlier in the chain to produce the car, such as iron ore for the production of steel parts or the energy carriers used during the production process. The material resource footprint for the EU-27 economy does include the resources used in the chain (raw material input, RMI); in 2017, it stood at 8.8 gigatonnes, which is 20% higher than the direct material input (DMI) for the EU economy.[2] With regard to material resources for domestic use, the difference between domestic material consumption (DMC) and the material resource footprint (raw material consumption, RMC, 6.3 gigatonnes) is small at less than 1% (Eurostat, 2020h).

For every tonne of material resources that is physically imported into the European Union, about one tonne of resources has been used earlier in the chain. Metals represent a large share of this amount (Eurostat, 2020c; 2020h). Even though those material resources do not physically enter the European Union, they are extracted and processed to satisfy EU needs. To cut down the use of material resources and its impacts, it is important to visualise the full material resource footprint.

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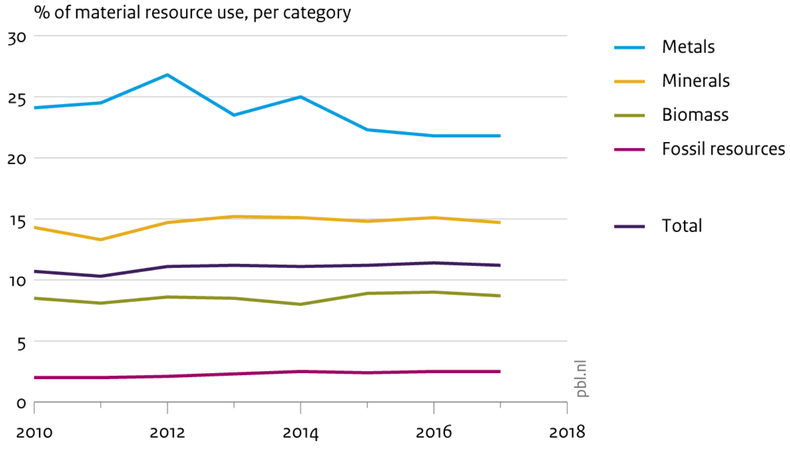
[2] It is measured in raw material equivalents (RME), that is to say, the material resource equivalents that are needed in the chain to produce materials, semi-final and final products. Conversion of direct use to RME enables mapping of the materials in the chain.

Figure 2.7
Share of secondary material use in the EU27



Source: Eurostat 2020

Material resource use will continue to increase in Europe too

According to estimates by Eurostat (2020j), the population of the EU-27 Member States will increase from 447 million in 2019 to 449 million in 2025, and then start to drop, reaching 432 million in 2060. Presumably, efficiency in material use in the EU economy will improve thanks to innovation and new technologies (meaning that fewer material resources are needed to create a given added value), but for now the OECD (OECD, 2019) expects that total material resource use in the European Union (OECD EU-17) will increase by 50% until 2060 compared to 2017. This is partly explained by a strong rise in the use of building materials.

Supply of secondary materials barely increases

The share of secondary materials released and recycled in the European Union has been wavering around 11% for many years (Figure 2.7). It is the proportion of the total amount of material resources used in the European Union that is recycled and reused in the European Union or elsewhere (circular material use rate, CMUR).[3] The EU figure of 11% is higher than the global average of 8.6% (Circle Economy, 2020b). Further details are provided in Section 2.2.1.

The use of secondary materials varies widely amongst categories of material resources: while a quarter of the metals used in production comes from secondary processing, for minerals the figure is about a sixth. For biomass, the proportion is lower because part of it cannot be reused, such as food eaten by humans and animals, or wood that has been burned. The same applies to fossil energy: a large share is burned and can therefore not be reused. But, even though a 100% reuse score is not achievable for these resources, it is possible to significantly improve efficiency of use by, for example, wasting less food, recycling textile fabrics or replacing fossil energy carriers with renewable energy sources such as solar and wind (Circle Economy, 2019; Eurostat, 2020i; Van Berkel et al., 2019).

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[3] This differs from the calculation used by Statistics Netherlands (CBS) and Circle Economy to determine the CMUR for the Netherlands (Section 3.3), and can therefore not be compared with Dutch figure (Koch et al. 2020).

Half of all waste is incinerated or goes to landfill instead of being reused

In the European Union, a total of about 5 tonnes of waste is released, per person, every year (Eurostat, 2020a). About half of this is recycled. The rest cannot be reused as secondary materials in the production system and undergoes low-grade processing: it is incinerated or goes to landfill (Eurostat, 2019a). In addition, the European Union exports about 2% of its total waste production for processing outside the region, mainly to Turkey, China and India. Although exports to China halved following the country's ban on plastic waste imports in 2018, it is still the second-largest recipient of EU waste (Eurostat, 2019b). Since waste export chains are not transparent, it is not possible to paint a clear picture of how exported waste is actually processed, or what the related risk is of negative environmental impacts, and what loss of value this brings about (Kettunen et al., 2019). Research on waste streams also assumes the existence of unreported, illegal waste exports, as is the case for a share of electronic waste (Huisman et al., 2015; Yamaguchi, 2018).

2.3.2 Impacts of material resource use in the European Union

European Union is a net exporter of environmental impacts

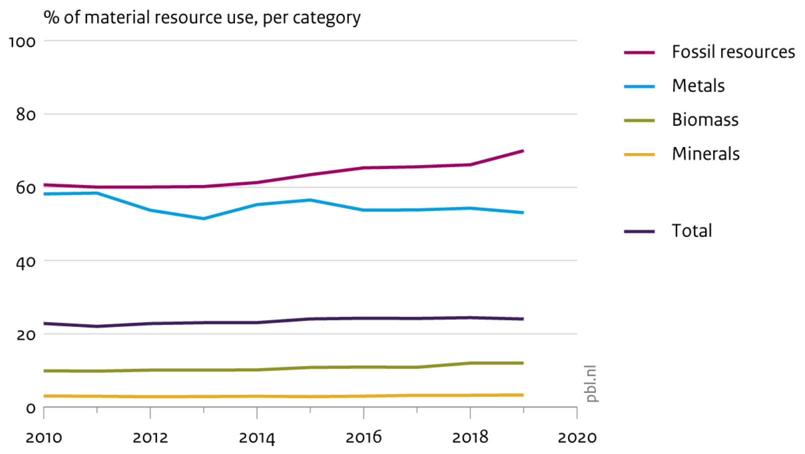
As mentioned in Section 2.2.2, the extraction of material resources and the production of materials, semi-final and final products, both within Europe and in global chains, exert negative impacts on nature and the environment. A number of the impacts caused by EU consumption, such as CO_2 emissions, water scarcity and biodiversity loss, are above the global per capita averages (IRP, 2019). With regard to CO_2 emissions, nitrogen and phosphorus losses from soil, land use and biodiversity loss, Europe even oversteps the 'fair share' which, based on the number of inhabitants, could be applied without exceeding the ecological limits of the planet (EEA, 2019c; Häyhä et al., 2018; Lucas et al., 2020b; Sala and Castellani, 2019).

As a result of the large amount of material resources imported (directly, but also indirectly through resources used along the chain), the European Union is a net exporter of environmental impacts. This means that imports exert environmental impacts beyond the European Union which are greater than the impacts in the European Union stemming from its production for exports (IRP, 2019; Sala and Castellani, 2019). Impacts that are related to EU consumption but are felt outside the region occur in several areas in the following proportions: around 31% refers to land-use change (Fischer et al., 2017; Steen-Olsen et al., 2012; Wilting, 2021), 80% to scarce water use (Lutter et al., 2016), between 28% and 31% to greenhouse gas emissions (Steen-Olsen et al., 2012; Wilting, 2021) and 29% to biodiversity loss (Wilting, 2021). Most of these impacts stem from the production of food and feed for EU consumption, taking place in regions such as South America, Sub-Saharan Africa and Southeast Asia. EU consumption is the second largest contributor, after that of North America, to global biodiversity loss caused by, for example, the clearing of forests to grow animal feed for meat production (Le Polain de Waroux et al., 2019).

The high dependency of the European Union on imports can lead to supply risks

As mentioned earlier, about 25% of material resources used in the EU economy comes from imports. While biomass and minerals are largely produced and extracted within its borders, for fossil fuels and metals Europe depends mostly on imports (Figure 2.8). Because of this dependence, EU Member States are faced with higher-than-average supply risks for certain materials (EEA, 2015; IRP, 2017). Moreover, the energy transition and electrification efforts in the mobility and transport and housing sectors mean that Europe needs large amounts of specific metals, such as lithium, cobalt and neodymium. These materials are needed in products for the energy transition, such as solar panels, green hydrogen batteries, electric vehicles and consumer electronics.

Figure 2.8
Share of material resource imports in the EU27



Source: Eurostat 2020

In the coming years, these materials will hardly be released as secondary materials, because most critical materials are locked up in goods and infrastructure, and there are no cost-effective processing options yet (European Commission, 2018a; Rietveld et al., 2019). Added to this is the fact that no proper substitutes are available yet. As a result, recycling cannot keep up with growth in demand for these materials, and the demand for primary resources increases — which might lead to higher prices and bigger supply risks (IRP, 2017; La Porta Arrobas et al., 2017; Rietveld et al., 2019).

At present, 27 materials have been classified as critical by the European Union; most of these are metals (European Commission 2017a). Critical materials are mainly used in industrial production processes and are particularly indispensable in electrical devices, such as mobile phones, and in technologies for the energy transition, such as solar panels, wind turbines, electric vehicles and low-energy lighting. Only a few critical materials are mined in Europe, particularly cobalt, silicon and hafnium. The rest is imported from countries outside Europe. The largest EU supplier is China, which covers 62% of the demand. Other important suppliers are Turkey, Brazil, the United States and Russia. The level of EU dependence is also high because it is not just the extraction of metals that is limited to only a few countries, but also the operations of processing, smelting and refining. These producing countries control exports and may apply restrictions to serve their own industrial interests, which means the importing countries could face reduced availability and increased prices (Deloitte Sustainability et al., 2017; European Commission, 2020c).

2.4 Summary and conclusions

Pressing need to change material resource use to reduce environmental impacts

The global use of material resources has been growing steadily since 1970 and is expected to double by 2060 compared to the 2017 level (IRP, 2019). Although the efficiency of use is increasing in many parts of the world, such as Europe, the demand for material resources is expected to rise and go hand in hand with growth in the generation of waste.

Most material resources are not going to be instantly depleted. However, the pressure on the environment and nature caused by material resource use is high and will continue to intensify if no additional policies are implemented. As a result of increasing consumption, and taking into account the climate policies introduced up to 2015, a 49% increase in greenhouse gas emissions is expected by 2060 compared to 2010 levels (IIASA, 2018; McCollum et al., 2018; Rao et al., 2017). In addition, reductions are expected to occur in forest cover and other habitats, as they must give in to an expansion of agricultural land (IIASA, 2018; IRP, 2019; Popp et al., 2017). This comes with biodiversity loss and a further acceleration of climate change.

The increasing demand for material resources and materials is also leading to rising prices and a further heightening of supply risks. This is of particular concern for critical materials — materials that have great importance for the economy, have high supply risks, and are also crucial for technological developments in areas such as the energy transition.

The growing global material resource use and the related impacts ultimately entail health risks and high costs for society, and also contravene international goals, such as the Paris Climate Agreement and the Sustainable Development Goals. The intensity and form of today's material resource use for global production and consumption do not only bring positive economic effects and a higher standard of living, but are also a great burden on nature and the environment. A circular economy is a means of limiting the negative impact of the increasing use of material resources. A circular economy is geared towards sparing and efficient use of material resources and keeping them in use for as long as possible.

Global impacts are unevenly distributed
Global trade in material resources has grown four-fold since 1970. High-income countries, such as those in Europe, depend particularly on imports of material resources, especially fossil fuels and metals, and their dependence is increasing. However, the globalisation of production chains has also led to the situation where many negative impacts occur in other places than where the material resources are ultimately consumed in the form of final products. Negative environmental, economic and socio-economic impacts are concentrated in low-wage countries, which extract large shares of the material resources for consumption and use in the economy in richer countries, and which also process waste from richer countries. While this may generate local employment and income, it occurs under low environmental standards and poor working conditions (IRP, 2017; Wiedmann and Lenzen, 2018).

The European Union depends heavily on imports, particularly of metals and fossil resources
Internationally, the European Union holds an important position in the trade of material resources: measured by weight, the European Union has the highest volume of exports worldwide, especially of machinery, vehicles, chemicals and food (Eurostat, 2020d; 2020e). Europe is also intertwined with the rest of the world through its imports: about 25% of the material resources used in the EU economy are imported (Eurostat, 2019a). The negative aspects of the great breadth of these connections and interdependencies have been highlighted by recent disruptive developments, such as the global spread of the coronavirus or the credit crisis. Due to its high import dependence, particularly with regard to fossil fuels and metals, the European Union is vulnerable to rising prices and growing supply risks for critical materials and other materials that are important for European industry and the energy transition.

The European Union is a net exporter of environmental impacts

Due to the large quantities of imports, the European Union is also a net exporter of environmental impacts: imports into the European Union create environmental impacts in other countries that are greater than those in the region itself, due to the production for export (IRP, 2019; Sala and Castellani, 2019). A proportion of the impacts caused by EU consumption occurs outside the European Union, in regions such as in South America, Sub-Saharan Africa or Southeast Asia: 28% to 31% of greenhouse gas emissions, 31% to 32% of the land-use footprint, 80% of the scarce water consumption and 29% of the biodiversity loss (Fischer et al., 2017; Lutter et al., 2016; Steen-Olsen et al., 2012; Wilting, 2021). In several respects, the contribution of EU consumption to environmental pressures is greater than the global per capita average, for example in terms of generating CO_2 emissions, water scarcity and biodiversity loss (IRP, 2019; Sala and Castellani, 2019). EU material resource use is expected to grow further until 2060 (OECD, 2019b).

3 Dutch material resource use and its impacts

Main messages

- In 2018, the Dutch economy used almost 450 megatonnes of material resources. Part of this was primary resources, but it also included components and products. In addition, over 140 megatonnes of material resources were imported and exported without having undergone substantial industrial processing. Almost half of the 450 megatonnes was used for domestic consumption in the Netherlands. The other half was exported after having been processed by Dutch companies. This means that far more material resources are needed for the Dutch economy than for Dutch domestic use.
- The total consumption of material resources in the Netherlands has hardly changed since 2010. However, the use of abiotic resources (minerals, including metals, and fossil resources) has decreased by 0.5% to 1% per year. But this will not bring about the substantial drop in future abiotic resource use that policies hope to achieve. In addition, the Dutch economy's footprint of material resource use increased by 8% between 2010 and 2018. This footprint also factors in the material resources that were used abroad for the production of materials, components and products that the Netherlands imported.
- Likewise, several other trends are not moving toward a circular economy yet. To give an example, the Dutch economy requires increasing amounts of land. Moreover, since 2014, more Dutch waste has been going to landfill. With regard to waste, it is expected that six of the seven overarching national goals will not be met without implementing additional policies. These goals include halving landfilled and incinerated Dutch waste, and reducing the amount of residual household waste to 100 kilograms per person per year. In addition, the Dutch economy has seen its supply risks increasing and has become more and more dependent on imports.
- The use of primary abiotic resources can be limited by, for example, employing more sustainable biobased resources and secondary materials. Use of biobased resources increased by 5% in the period 2016 to 2018 and today represents about a quarter of the total material resource use in the Dutch economy. However, not all of these biobased resources are sustainable. The substitution of abiotic resources with sustainable biobased resources is competing with other applications, including food, so this may only be part of the solution. Secondary materials make up 14% of material resource use in the Dutch economy. This share increased by 1% in the period 2016 to 2018.
- In the domain of circular economy, the Netherlands is amongst the front runners in the European Union. Its 80% recycling rate, for example, is one of the highest, material resource efficiency is relatively high, and relatively little waste is landfilled. The challenge for the Netherlands is to improve the quality of recyclates to such a degree that they can be processed as secondary materials into new products. The use of material resources can be further reduced by cutting back the need for new products (e.g. by sharing or renting products) and by extending the lifespan of products (through reuse, repair or refurbishing).
- Material resource use in the Netherlands exerts major impacts abroad on nature and the environment. More than half of the greenhouse gas emissions and most of the land-use changes related to material resource use take place in other countries.

3.1 Introduction

This chapter studies the Dutch trends in material resource use and the associated impacts. The term material resources refers to both primary resources and those that are incorporated in materials, components and products (also see Chapter 1, Text box Material resources, materials, components and products). The impacts of material resource use may occur locally, nationally and globally. For example, greenhouse gas emissions bring about global changes to the climate, while conversion of a forest to agricultural land mainly has local effects.

The aimed-for effects of a circular economy in the Netherlands, listed in Figure 3.1, range from limiting climate change, preventing the spread of toxic substances and impeding biodiversity loss (environmental effects) to ensuring there will be fewer supply risks and more jobs (socio-economic effects).

These intended effects are important motives for government authorities, businesses, and other societal stakeholders to make efforts towards attaining a circular economy. Government authorities, for example, want to comply with the Climate Agreement by focusing on a circular economy, amongst other things, and some businesses see new opportunities in more circular production methods and goods.

Progress towards goals

Several goals exist for material resource use, including targets for total material resource use, and for greater volumes of secondary materials and renewable material resources. There are also several goals for waste produced in the Netherlands, directed at issues such as waste reduction, recycling or food waste. This chapter therefore identifies, where possible, relevant developments in material resource use with regard to the goals.

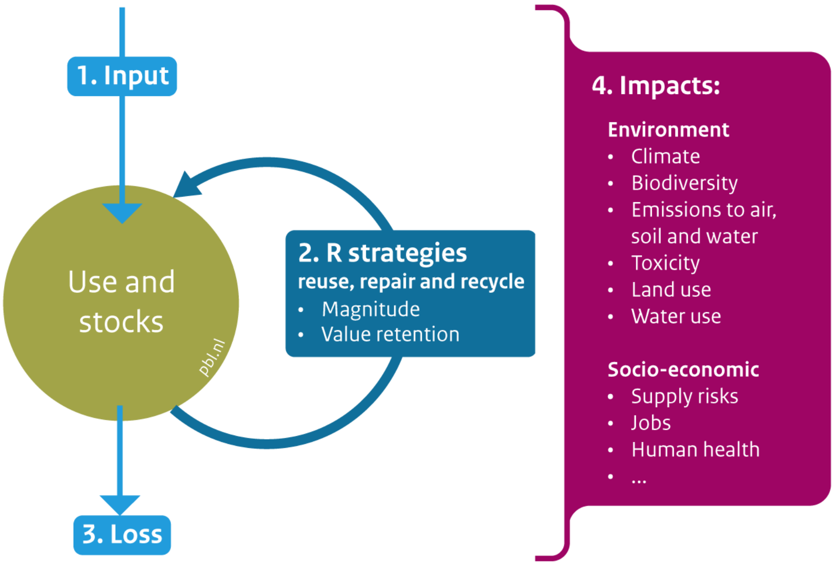
3.1.1 Important concepts

The use of material resources can be mapped in various ways. They are all relevant because they use different perspectives to offer policymakers starting points for directing actions.

Difference between material resources for domestic use and those for the economy

There are two ways to visualise the material resources needed in the Netherlands. The first is by looking at those needed for the Dutch economy. This is also called use for the economy. These are the material resources that companies use during production, together with those contained in imported products for use by Dutch consumers, companies and government authorities.

Figure 3.1
Framework for targets and indicators of circular economy monitoring



Source: PBL

It is the aggregate of primary resources extracted in the Netherlands (minerals, harvested crops) and imports of primary resources (e.g. crude oil), materials (e.g. steel or animal feed), components (e.g. microchips) and products (e.g. cars). This is illustrated in Figure 3.2. A share of the material resources used in the Netherlands is exported in the form of materials, components and products, such as steel, machine parts and cheese. Recycled materials are not part of this definition of material resource use.

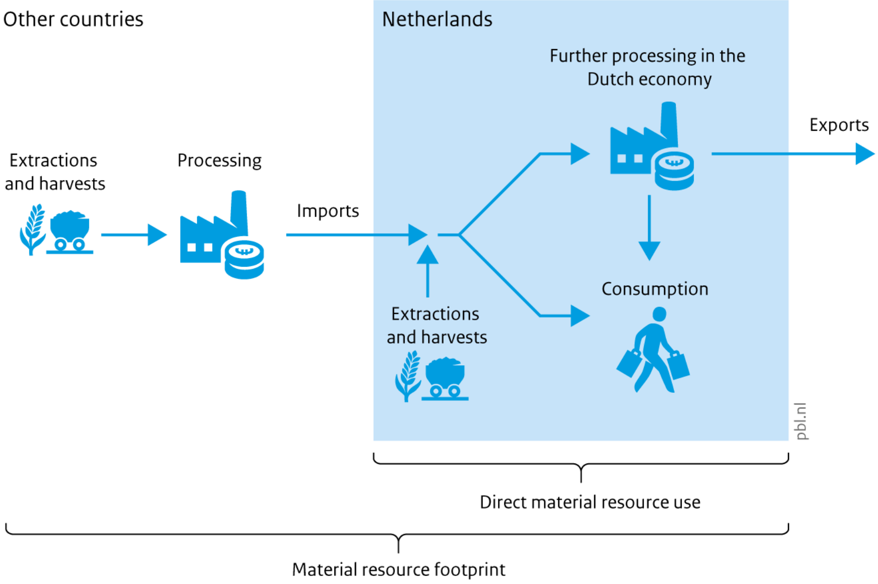
The second way to visualise the material resources needed in the Netherlands is by considering the material resources needed for use by Dutch consumers, companies and government authorities. This is also referred to as domestic use. A share of these products originates from Dutch companies, such as pork from Dutch livestock farmers, and the other share is imported and delivered to Dutch consumers, for example, bananas sold in Dutch supermarkets. Unlike in use for the economy, exported material resources are not included in domestic use.

The difference between material resource use in the Netherlands and material resource footprints

Material resource use not only takes into account the use in the Netherlands (also called direct use of material resources) but also the material resource footprints. This is because a share of the Dutch material resource use is not contained in the product. This is the case with, for example, the use of fuels in other countries to run machines that make products for the Netherlands. Material resource footprints also include those material resources. The material resource footprint differs from the direct material use in the Netherlands, in that the former also includes the resources used for the production of the imported products or components (Figure 3.2).

The material resource use in the Netherlands and the material resource footprints both make a distinction between material resources for domestic use and for the economy as a whole; this therefore yields a total of four indicators.

Figure 3.2
Difference between direct use of material resources and material resource footprint



Source: PBL

This chapter uses footprint analyses as a basis for an examination of the impacts exerted by the entire production chain in the Netherlands and abroad. Clues about changes in resource use domestically and abroad as well as the impact thereof can be derived from these footprints.

Distinguishing between national impacts and international impacts of production and consumption

When considering impacts, another distinction is made: national impacts, a production footprint and a consumption footprint. National impacts are those felt on Dutch territory; for example, the greenhouse gases emitted in the Netherlands by companies and consumers. This should not be confused with the material resource use in the Netherlands, because this use also includes imports.

The consequences of imports do not come into the picture until impact footprints are considered. Imports have effects in production chains elsewhere in the world that can be traced back to decisions made in the Netherlands on production and consumption. For example, the Netherlands imports clothing produced in other countries, and during production various environmental impacts occur there, such as emissions to air, water and soil, and water use. These effects become visible in the consumption footprint, which shows the environmental impacts of Dutch consumption in the Netherlands and abroad.

The production footprint shows the impacts that occur in the Netherlands and abroad as a result of production by Dutch companies. The Netherlands imports material resources that are needed for domestic production, such as fodder for the Dutch livestock sector. To produce this fodder, tropical rainforest may have been converted into arable land for soya cultivation, which results in adverse effects on nature. Domestic production is also partly intended for export. Another difference between production and consumption footprints is that imported goods, such as clothing, are not included in the former, since they are not produced in the Netherlands.

3.1.2 Required data

Development of monitoring data on material resource use and its impacts

The monitoring of material resource use and its impacts is still under development. In 2018, the multiannual Work Programme on Monitoring and Evaluation Circular Economy was set up to achieve this (PBL, 2020). The programme is to provide the best possible overview of the circular economy, and offer tools to policymakers to accelerate the transition towards a circular economy. An important part of this effort is gaining insight into material resource flows and the impacts that occur during their extraction, production, use and disposal. To map those insights, this first report draws on the best currently available data (Table 3.1). These data originate from the consortium of knowledge institutes in charge of implementing the work programme (see Section 1.5). Data and indicators are already available for various subjects, and must be updated regularly. For other subjects, such as value retention and substances of very high concern, indicators still need to be developed and specified in detail. This means that a growth model is used, through which the knowledge base will become broader and more solid in the years to come.

The importance of an integral picture

It is necessary to acquire an integral picture of material resource use. The importance of this can be illustrated with a simple example about discarded plastics. These plastics are recorded in five different registration systems. A certain amount of plastic is collected for recycling (collection system). Part of this is offered for recycling (processing). A share of the processed plastic is actually used as secondary material for a new product (recycling). The rejected amounts are then burned (incineration). Incineration then creates a residual stream that is dumped (landfill). If these registration systems are not coordinated with each other, there is a high likelihood of double counts and confusion will arise over the interpretation of the data. Therefore, what is needed is an integral insight into the processing of plastic.

At present, various registration systems, methods and databases exist, each throwing light on a different aspect of the circular economy; they are in use at Statistics Netherlands (CBS), government authorities, consulting agencies, businesses and other organisations. New ones are being developed, for example with an eye on gaining insight into material resource flows and stocks in a certain region. It is important that the relationships between the various monitoring systems are consistent, to ensure that debates centre as much as possible on the choices to be made, and as little as possible on the underlying monitoring data.

Missing data

There are also important aspects of the circular economy for which data are still missing or which require data integration and harmonisation between companies, government authorities and other organisations. For example, a crucial condition for the reuse of material resources is that more and better information is obtained on the quality and availability of secondary materials and residual streams. It is also necessary to have an idea of the volume, quality, location and time of release of these material resources and stocks, so that high-grade use becomes possible, today and in the future.

Moreover, policymakers will obtain information on whether additional interventions are desirable or necessary to step up the transition thanks to improved insight into the use of material resources in all phases (e.g. volume and quality of the required material resources, product life cycles, R-strategies during the usage phase of products, and volume and quality of waste). The first steps are currently being made to achieve a national Raw Materials Information System (PBL, 2020c, work package 3) but development will still require quite some time.

Reading guide

This chapter provides insight into material resource use in the Netherlands and its impacts at home and abroad. An overview is provided in Table 3.1 below. Material resource use in the Netherlands is described in Section 3.3 and several social developments that act upon that use are outlined in Section 3.4. Section 3.5 deals with the impacts of material resource use on nature and the environment, and with economic and socio-economic impacts. Section 3.6 closes this chapter with policy-oriented conclusions for realising the transition towards a circular economy.

3.2 Overview of material resource use and its impacts

The results of this chapter are summarised in Table 3.1, which presents an overview of indicators that are relevant to the circular economy. The table builds on the survey from the report Op weg naar een robuuste monitoring van de circulaire economie [towards robust monitoring of the circular economy (in Dutch)] (Prins and Rood, 2020); information on the sources is provided in Appendix 5. The table is based on the most recent available data for each indicator, and also shows developments that have been taking place since 2010, and since the introduction in 2016 of the Government-wide programme for a Circular Dutch Economy (see Chapter 6 for more information on policies). The terms used in the table are explained below. The following sections discuss the indicators presented in the table in more detail.

The report uses, to the greatest extent possible, data from the Material Monitor developed by Statistics Netherlands (CBS). To enable comparisons with other countries, this information has been complemented with other data, such as those on Dutch waste, on footprints and data from Eurostat. Where this is the case, it is pointed out in the text. The Text box on Key indicators provides explanations on a few important indicators from Table 3.1 (for further details, see the Glossary).

3.3 Material resource use

This section discusses the many facets of material resource use. Section 3.3.1 describes the total domestic use and use for the economy. Special attention is paid to the use of abiotic resources (Section 3.3.1), renewable biobased resources (Section 3.3.2) and secondary materials (Section 3.3.3). The Netherlands trades in material resources (see Text box The Netherlands as a trading nation). Therefore, these sections also consider imports and exports of material resources. Section 3.3.4 deals with the resources that are stocked in long-cycle products, and Section 3.3.5 with strategies to extend the lifespan of products (reuse, repair and refurbishing), and ensure that the material resources contained in those products can be used in a considerably more efficient way. Finally, Section 3.3.6 describes the supply and treatment of waste, including recycling.

Table 3.1
Overview of material resource use and its impact

Indicator	Magnitude			Trend		Compared with EU-27
	2010	2016	2018	2010–2018	2016–2018	per capita in 2018
Natural resources required						
Material resources for domestic use, DMC[1] (Mt)	195	193	195	0%	1%	-22%
Material resource footprint domestic use, RMC[2] (Mt)**	-	-	-	-	-	-
Resource efficiency (GDP in EUR/kilo DMC)	3	4	4	12%	5%	+125%
Material resources for the economy, DMI[3] (Mt)	401	402	397	-1%	-1%	+95%
Material resource footprint of the economy, RMI[4] (Mt)	597	627	647	8%	3%	+89% (2017)
Share bio-based resources (kilo/DMI, in %)	24	25	26	8%	5%	+5%
Total sustainable renewable material resources (kilo/DMI)	-	-	-	-	-	-
Share secondary materials, CMUR (kilo secondary/DMI, in %)	-	13	14	-	6%	+167% (2017)
Use phase						
Lifespan	-	-	-	-	-	-
Value retention	-	-	-	-	-	-
Waste processing and recovering						
Dutch waste (Mt)	60	60	61	2%	2%	+44% (2016)
Share recycled waste in processed waste (recycled waste/waste, in %)	81 (2012)	79 (2012)	80	-1%*	+1%	+31%
Waste recycled in the Netherlands (Mt)	54 (2012)	52	53	-1%*	3%	+111% (2016)
Incinerated waste in the Netherlands (Mt)	10 (2012)	10	11	11%*	6%	+74% (2016)
Landfilled waste in the Netherlands (Mt)	2	3	3	51%	14%	-81% (2016)
Effects						
Environmental impact						
National greenhouse gas emissions ($MtCO_2$ eq)	214	195	188	-12%	-4%	+33%
Greenhouse gas emission footprint of consumption ($MtCO_2$ eq)	300	252	282	-6%	12%	+35% (2015)
Greenhouse gas emission footprint of production ($MtCO_2$ eq)	462	432	-	-7% (2016)	-	+54% (2015)
Emissions to air, water and soil, such as nitrogen and particulate matter	-	-	-	-	-	-
Land-use footprint of consumption (million ha)	10	-	10 (2017)	3% (2017)	-	-15% (2015)
Land-use footprint of production (million ha)	11	12 (2015)	-	9% (2015)	-	-28% (2015)
Water abstraction	-	-	-	-	-	-
Water footprint consumption (km^3)	52 (2008)	-	-	-	-	+21% (2008)
Biodiversity footprint of consumption (million MSA loss ha/year)	19	-	-	-	-	+1% (2010)
Biodiversity footprint of production (million MSA loss ha/year)	20	-	-	-	-	+2% (2010)
Toxicity	-	-	-	-	-	-
Socio-economic impact						
Supply risks (indicator being developed)	-	-	-	-	-	-
Added value of circular activities (EUR billion)	28	31	34	23%	9%	-
Share circular activities (added value circular / GDP in %)	4	4	4	1%	0%	-
Circular employment (no. of circular jobs in FTEs) (*1,000)	311	318	326	5%	2%	-
Share circular employment (no. of jobs/total no. of jobs in %)	4	4	4	-2%	-2%	-

Trends
- (green) trend is moving in the right direction
- (orange) trend is moving in the wrong direction
- (white) trend is stable; hardly any differences (up to 5%)

Compared with EU-27
- (green) NL scores better than EU
- (orange) NL scores worse than EU
- (white) hardly any differences (up to 5%)

Deviating years are provided between brackets
* 2012–2018, no data available for 2010
** RMC requires a new calculation
- No data available

[1] Domestic Material Consumption
[2] Raw Material Consumption
[3] Domestic Material input
[4] Raw Material Input

The related data sources are listed in Appendix 5.

Text box 3.1: Key indicators

Recycling refers to putting materials of an old product to new use after it has been decomposed, for example by a shredder or by melting. New use of a product as a whole, or of its components, is referred to as reuse. The environmental impacts of reuse are often far more limited than those of recycling because the materials are processed less, or not at all.
DMI (direct material input) concerns the direct use of material resources for the economy. This indicator measures the total amount of primary resources extracted in the Netherlands (extraction of minerals and harvesting of forest and agricultural products) and the volume of imported primary resources (e.g. oil), materials (e.g. steel), components (e.g. microchip) and products (e.g. car). This is illustrated in Figure 3.2. Subtracting exports from this direct use of material resources gives the amount of material resources for domestic use, or DMC (domestic material consumption).
RMI (raw material input) refers to the material resource footprint of the economy. It is the amount of material resources needed to sustain the Dutch economy. This footprint comprises the direct use of material resources (DMI) and the resources that are needed for production abroad but are not contained in the product, such as fossil fuels to run the machines that make the imported products.
RMC (raw material consumption) concerns the material resource footprint of domestic use, which is not included in this report. DMC is required when calculating RMC. This report uses a DMC that is determined in a robust manner, contrasting a wider range of statistics than has been usual until now. However, reports on RMC to the European Union, as prescribed by Eurostat, are based on a less robust calculation method for DMC (as discussed in Van Berkel and Schoenaker, 2020). Statistics Netherlands (CBS) is to investigate the possibilities of applying the more robust DMC to determine RMC.

3.3.1 Material resources for the economy and for domestic use

A large share of the used material resources is for export

In 2018, the Netherlands used almost 450 billion kilograms of material resources (CBS, 2021). Part of this concerned materials which became available through recycling (Figure 3.3). In addition, 397 billion kilograms of primary resources were used (e.g. iron ore and petroleum) and also material resources contained in materials, components and products (DMI). A quarter of the used material resources came from domestic extraction; examples include the extraction of natural gas and gravel on Dutch territory, but also harvests of sugar beets and potatoes. Three quarters of the material resources came from abroad (Figure 3.3). This involved resources such as petroleum, natural gas and coal, and also imported materials, components and products.

In addition to material resources imported for processing by Dutch companies, the Netherlands also imports large amounts of material resources that are forwarded to other countries almost without any processing. Known as re-export, in 2018 this totalled 143 billion kilograms. This means that the material resources that are used in the Netherlands or are in transit through the Netherlands total almost 600 billion kilograms (CBS, 2021).

About half of the material resources processed in the Netherlands are exported in the form of final and semi-final products (Figure 3.3). Examples are fodder that is eventually transformed into meat destined for export, or metals that are processed into machine parts. The other half is for domestic use. This requires 195 billion kilograms of material resources. Use in the Dutch economy, including re-export, therefore requires almost three times as many material resources as domestic use.

Material resource use in the Netherlands is hardly changing, except for a slight drop in abiotic resource use

The required volume of material resources has hardly changed since 2010. This applies to both domestic use and use in the economy as a whole. Even since the introduction, in 2016, of the Government-wide programme for a Circular Dutch Economy, the use of material resources has not changed noticeably. The use of abiotic resources — metals, minerals and fossil resources — is showing a slight decline. Since 2010, both domestic use and exports of abiotic resources have fallen by 4%. Since 2016, the annual decline has been 0.3% for domestic use and 1.4% for use in the economy as a whole (CBS, 2021). If these trends continue, the policy goal of halving abiotic resources by 2030 will not be attained.

Material resource footprint has grown bigger

The material resource footprint of the economy (RMI) increased by 8% between 2010 and 2018 (CBS, 2021; Van Berkel and Schoenaker, 2020). This is illustrated in Figure 3.4. The fact that direct material resource use in the economy (DMI) hardly changed over that period means that the change occurred in the composition of imports. In 2018, imports into the Netherlands had undergone more processing in other countries than in 2010. This is because, for example, a processed material was imported instead of the required primary resources. This means that elsewhere material resources were used which are not contained in the product itself, such as fuels to run the machines that process materials.

Volume of material resources for domestic use is lower than in other EU Member States

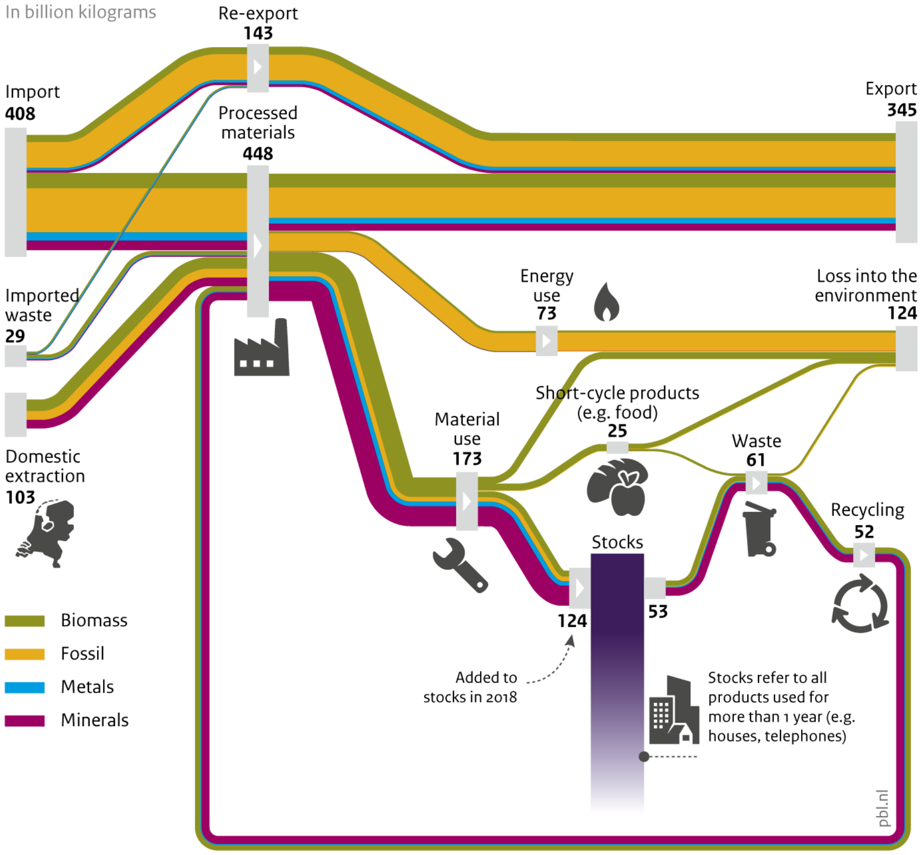
Table 3.1 shows that the material resource use per capita is lower in the Netherlands than the EU average (CBS, 2021). This relatively low level of domestic use can be explained primarily by the high population density in the Netherlands. This high density results in above-average efficiency in the use of buildings and infrastructures, whose new construction, use, renovation and maintenance generally require large amounts of material resources.

In contrast, volume of material resources needed for the Dutch economy is relatively high

The amount of material resources used in the Dutch economy (DMI) is higher than the average of other EU Member States (CBS, 2021). The data are presented in Table 3.1. As can be seen in Figure 3.4, the amount of material resources used in the entire chain (material resource footprint, RMI) is also relatively high (CBS, 2021). The per-capita material resource use in the economy of the Netherlands is almost double the European average, because the Netherlands exports a great deal. Moreover, re-exports are also taken into account in the European comparison. The Netherlands has a high level of re-exports, which is unique in the European Union. Many material resources enter the European Union through the Netherlands, for example through the port of Rotterdam or Schiphol airport. These material resources leave the country almost without any processing. In addition, the Netherlands produces a great deal for other countries, and this too is reflected in the relatively large quantities of materials used in the Dutch economy.

Figure 3.3
Resource flows Dutch economy, 2018

In billion kilograms



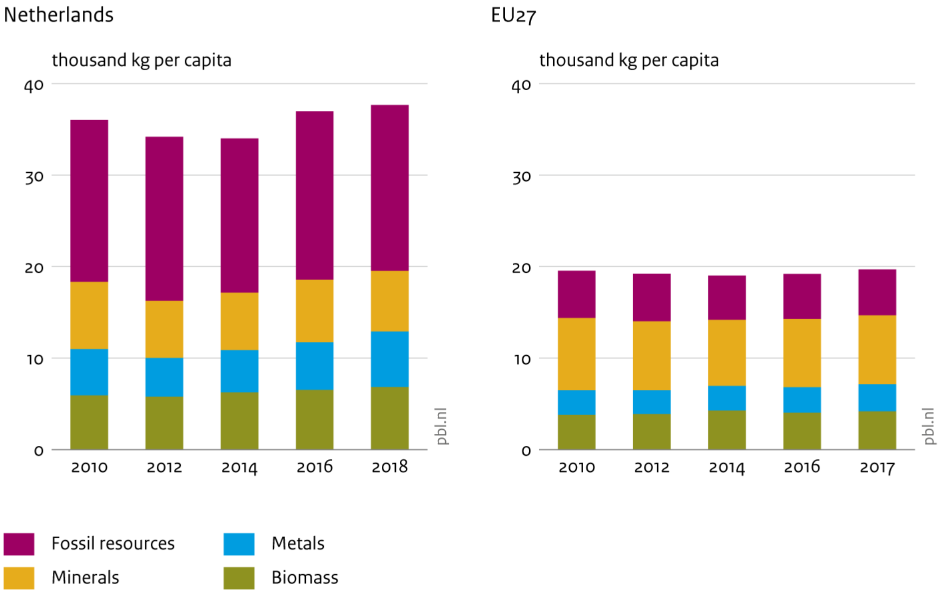
Source: CBS 2021

Both within the Netherlands and in the production chain as a whole, relatively large amounts of fossil energy carriers are used. In contrast to other EU Member States, fossil energy carriers make up almost half of the material resource use (Figure 3.4). This is a result of the relatively large size of the chemical industry, steel industry, refineries and greenhouse cultivation in the Netherlands, which produce abundantly for export.

Material resource use in the Netherlands is more efficient than in other EU Member States

The material resources that are processed in the Netherlands generate a higher GDP per kilogram than the EU-27 average. The Netherlands earns almost twice the average per kilogram of material resources. Between 2010 and 2018, material resource efficiency (or material resource productivity) increased by 12% (CBS, 2021). This means that increasingly fewer material resources are needed to generate a given added value, or that greater added value is generated with the use of a given amount of material resources. This high efficiency is mainly due to the fact that the Netherlands has a service economy — and service provision generally requires fewer material resources than industrial production. As a result, the Netherlands needs relatively few material resources per euro of GDP and therefore has a relatively efficient use of material resources.

Figure 3.4
Footprint of material resource use in the economy of the Netherlands and the EU27



Source: CBS 2021, Eurostat

Text box 3.2: The Netherlands as a trading nation

Important role of the Netherlands as a trading nation
The Netherlands trades widely in material resources, materials, components and products. This means that the impacts of material resource use are not limited to the Netherlands but that the country also has an impact on the physical environment of other countries. In 2017, the Netherlands ranked sixth globally for exports of goods and tenth for imports (Central Intelligence Agency, 2017). Some of the imports are directly forwarded on to other countries (re-export). Adjusting the figures for re-exports, the position of the Netherlands as a trading country drops significantly (Lankhuizen and Thissen, 2019). This is because about half of Dutch trade consists of re-exports, mainly to other European countries (CBS, 2019e). In the 20 years up to 2015, re-exports grew significantly: in 2015, the value of re-exports was more than four times higher than in 1995 (CBS, 2016).

The Netherlands is a major trading country in material resources for agriculture
Of all Dutch exports, 71% goes to other EU Member States (including the United Kingdom). The remaining exports go mainly to China and the United States. As for Dutch imports, most of the material resources, materials, semi-final and final products also come from the European Union (53%). The rest of the imports come mainly from China, the United States, Russia and Norway (CBS, 2019e).
The Netherlands is the second largest exporter of agricultural products in the world after the United States, with shipments worth EUR 90.3 billion. Agricultural products account for almost one-fifth of all Dutch exports (18% in 2018). Of these, 72% is produced domestically; that is to say, the goods are exported after production or considerable processing. The Netherlands also imports large amounts of palm oil, soya beans and coffee. It is the largest importer of cacao beans worldwide; it is the third-largest importer of palm oil, and ranks fourth for soya beans and fifth for coffee (CBS, 2019e). Because of its important position in international trade of agricultural products, the Netherlands can, in principle, exert a great deal of influence on foreign production chains.

3.3.2 Use of renewable material resources

More biobased resources are being used

One government ambition is to use more renewable resources to decrease the use of primary abiotic resources. Renewable resources are primary resources originating from a stock that can be renewed continuously, and biobased resources fall into this category. Between 2010 and 2018, their use increased by 7% (Table 3.1). As a result, their share of total material resource use increased slightly, from 24% in 2010 to 26% in 2018 (CBS, 2021).

Choices need to be made around use of biobased resources

Most biobased resources are used in agriculture for the production of food, wood and paper. In addition, in recent years, their use in the energy supply has increased, contributing to the realisation of the Climate Agreement (Hekkenberg and Notenboom, 2019). On top of the demand from food and energy generation, the chemistry (e.g. for bioplastics) and construction sectors (e.g. timber frame construction) also have a need for biobased resources (Social and Economic Council of the Netherlands, 2020).

There is still a great deal of uncertainty about how the need for biobased resources will evolve. Estimates by research and consultancy organisation CE Delft (2020b) assume a growth up to 2030 by a factor of between 1.5 and 6. Growth will depend primarily on developments in the mobility and transport sector and on the requirements for heating in the built environment and in greenhouse cultivation. The questions of the amount of sustainable biobased resources available in the future and which applications are regarded as sensible options depend very much on the perspective that is adopted (Strengers and Elzenga, 2020). For instance, ideas on what resources from agriculture and forestry are considered sustainable, and whether they may be burned in biomass power plants.

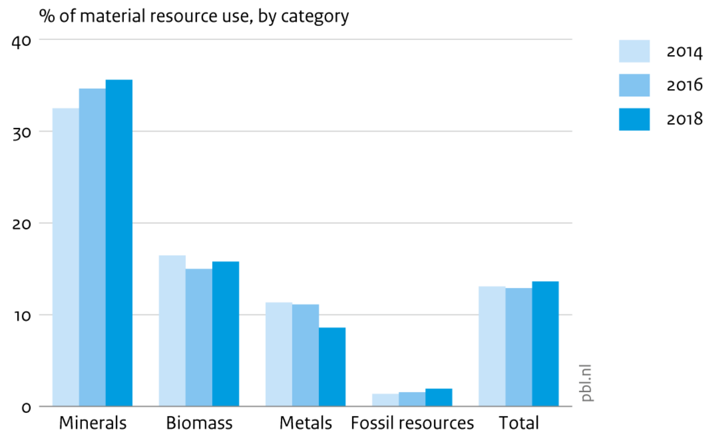
Looking at future developments, biobased resources will be able to replace some of the abiotic resources, but the possibilities of this happening seem to be determined primarily by the limited amount of sustainable biobased resources available.

Sustainability framework needed

The risk of overexploitation, which means that the supply of biobased resources cannot be restored and the danger of depletion is created, requires that the biobased resources are cultivated sustainably, soil fertility is maintained and nutrient cycles are closed (Rood et al., 2016). Examples include restricting nutrient losses from agriculture and using struvite extracted from waste water as a fertiliser. It is also important that the use of biobased resources is as high grade as possible, for example first as paper and then — when recycling is no longer an option — as fuel (also see Figure 3.7). The government has given the initial impetus to a widely supported sustainability framework (Van Veldhoven and Wiebes, 2020).

Some abiotic material resources can also be renewable (Dutch Government, n.d. (a; b)). In the case of clay, for example, there has long been a balance between the deposition and use of sediments (SBK, 2020; Van der Meulen et al., 2009). An important question for circular economy policy-making is that of which conditions need to be met for such abiotic material resources to be renewable.

Figure 3.5
Share of secondary material use in the Netherlands



Source: CBS 2019, CBS 2021

3.3.3 Secondary materials

Share of secondary materials has remained the same in recent years

Secondary materials can replace primary resources, and thereby reduce demand for those resources. Secondary materials are materials which are used anew in the economy, after being recycled. As a result, the environmental impact of extracting and processing an equivalent amount of primary resources is avoided. Although secondary materials are also processed before they are used, this generally results in a smaller environmental impact than the extraction and processing of primary resources.

In 2018, the use of secondary materials in the Dutch economy was on average 14% of the overall material resource use. The share varied widely amongst the types of secondary material (Figure 3.5). For example, recycled metals made up 9% of used metal, but for other minerals the share was 36%. In recent years, more secondary materials have been used, but total material resource use has also increased. As a result, between 2016 and 2018, the share of secondary materials used in the Dutch economy increased by only 1 percentage point, from 13% to 14% (CBS, 2021). In Dutch consumption, the share is markedly higher at 25% to 30% (see Text box Secondary material use).

The Netherlands is the EU front runner in use of secondary materials

According to Eurostat, in 2017, the Netherlands had the highest share of secondary material use in the European Union (Eurostat, 2020f). It should be noted though, that there are various ways of determining the figure. For example, Eurostat and Statistics Netherlands (CBS) use different methods (see Text box on Secondary material use).

Total replacement of primary resources with secondary materials is not feasible

The volume of secondary materials has increased slightly in recent years, but the total demand for material resources for the Dutch economy is still seven times greater. It is not easy to bridge the gap between supply and demand. For example, the Netherlands exports many products, which means material resources leave the country (Figure 3.3). In addition, a share of material resources is incinerated to produce energy. This involves mainly fossil resources, but a part of the biobased resources is also used for energy supply. Another substantial part of the biobased resources is used as food for humans and animals. Here too, it is necessary to make many more steps to achieve things such as more perfectly closed mineral cycles and carbon cycles (also see Section 3.3.2 on renewable resources). Furthermore, some products are designed in ways that make recycling difficult, for example if they have mixed materials or materials that are glued together. Due to these factors, satisfying the demand for material resources with secondary materials only is at present not achievable.

Text box 3.3: Secondary material use

The *circular material use rate* (CMUR) — *or secondary-material use indicator* — shows the amount of reused materials in proportion to overall material resource use. Depending on the calculation method, in the Netherlands the share of secondary materials varies between 14% and 30% (Table 3.2). This is because the indicator can be determined with reference to use in the economy or to consumption. As for use in the Dutch economy, in 2018, the share of secondary materials in total material resource use stood at 14% (CBS, 2021). It is also possible to consider the share of secondary materials in the consumption of goods and services. Various ways exist to do this. Statistics Netherlands (CBS), for example, looks at the share of secondary materials used in Dutch consumption, whereas Circle Economy bases its calculations on the material resource footprint. This means that it also factors in those material resources that are used in the foreign part of the production chains but do not end up in the imported final product — for example, the energy carriers used to enable production of materials for a car. However, the Circle Economy indicator is less reliable, because data on secondary material use in specific production chains abroad are more uncertain. Finally, Eurostat considers the amount of secondary material released in the Netherlands, rather than what is used in the Netherlands. While those materials may also end up in other countries, they are assigned to the Dutch CMUR. Since the Netherlands produces a relatively large amount of secondary materials and needs a relatively small amount of material resources for consumption, this calculation of secondary material used produces a slightly higher figure.

Table 3.2
Comparison of figures on secondary material use in the Netherlands, in 2016 and 2018

	Share of secondary material use for Dutch consumption		Share of secondary material use in the Dutch economy	
	2016	**2017**	**2016**	**2018**
CBS	24%	-	13%	14%
Eurostat	29%*	30%*	-	
Circle Economy	25%	-	-	

* The DMC used in this Eurostat calculation differs from the DMC for the Netherlands as presented in this publication. As a result, the actual CMUR for the Netherlands will be a bit lower, but still higher than in other European countries.

Sources: CBS, 2021; Circle Economy, 2020c; Eurostat, 2018; formerly unpublished figures compiled by CBS and Circle Economy in Koch et al., 2020; Van Berkel et al., 2019b

The various calculation methods illustrate the different aspects that are important for policy decisions. For this reason, a complete picture can only be obtained by using multiple, complementary indicators (Koch et al., 2020).

3.3.4 Use of the resource stocks in the economy

Urban mining instead of extraction

A large amount of material resources is currently in use and stored in all manner of products, such as buildings, machines and cars. These resources are released after a certain time and could be used as secondary materials. Properly considered, the material stocks are so-called 'urban mines' of resources that can be used in the future. With regard to future use, it is necessary to obtain an idea of the stocks and the quality of the material resources. This is illustrated with a look at four stocks and the possibilities of using them as a material resource: the electricity system, electronics, vehicles and buildings.

Metals in the electricity system not used

The electricity system contains notable quantities of copper, aluminium and critical metals. For example, the quantities of copper and aluminium in the electricity system are comparable to stocks in transport and construction (Van Oorschot et al., 2020). Copper and aluminium are found mainly in power lines. Many disused cables are still underground, because digging them up is at present not economically feasible. Therefore, a sizeable stock of copper and aluminium is still lying unused underground.

Critical metals from discarded electronics not used

Electronics is a group of products whose lifespans are often short, such as laptops and mobile phones. It is a complex group in which a variety of metals is used (Figure 3.6). Compared to the electricity system, the amounts of metals in electronics are small, but due to the short lifespan of the products, they are released relatively quickly (Van Oorschot and Van der Zaag, 2020). Every year, tonnes of electronics are discarded. However, approximately half of this is not collected separately and is therefore incinerated (see Section 3.3.6); this means the critical metals in these electronic devices are not recycled.

Cars, ships, planes and bicycles are also sources of metals

Means of transport, including cars and ships, contain many metals, such as copper and steel (Van Oorschot et al., 2020). The stock of iron and steel in vehicles is about 30 billion kilograms. This is 16 times that of the electricity system. Vehicles also contain considerable amounts of aluminium and copper: over 1 billion kilograms of aluminium and over half a billion kilograms of copper. This is more than three times as much as in the electricity system. Electric cars and electric bicycles contain large quantities of copper. Since these product categories are from growth markets, they might also become interesting sources of copper in the future.

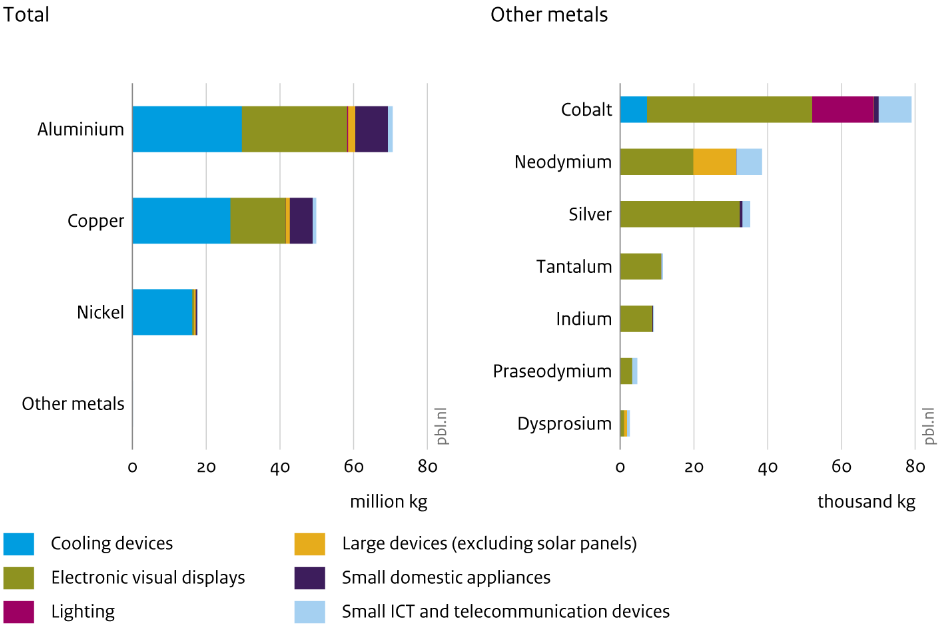
End-of-life vessels are a major source of steel that the Netherlands does not take advantage of

Ships contain about 80% of the steel supply in all means of transport and can therefore be an important source of steel. However, at present, end-of-life ships are exported for scrapping. The large quantity of steel and other metals they contain might be other interesting sources of metals for the Dutch economy.

The built environment contains many material resources but the construction sector is not self-sufficient

Buildings contain predominantly large amounts of concrete, steel and timber. Material resources are locked in buildings for long periods. Therefore, in the construction sector, the demand for material resources and the supply of secondary materials has its own dynamics. As for the provision

Figure 3.6
Material resources in electronics, per type of device, 2016 – 2018



Source: CML/CBS 2020

of housing up to 2030, the volume of secondary materials available in the coming years will not be enough to build the required number of dwellings (Arnoldussen et al., 2020). Other solutions will also be needed, such as greater amounts of renewable material resources, the use of residual flows from other sectors and different designs for homes and buildings that require significantly smaller amounts of material resources.

More attention must be paid to using existing material resource stocks in society

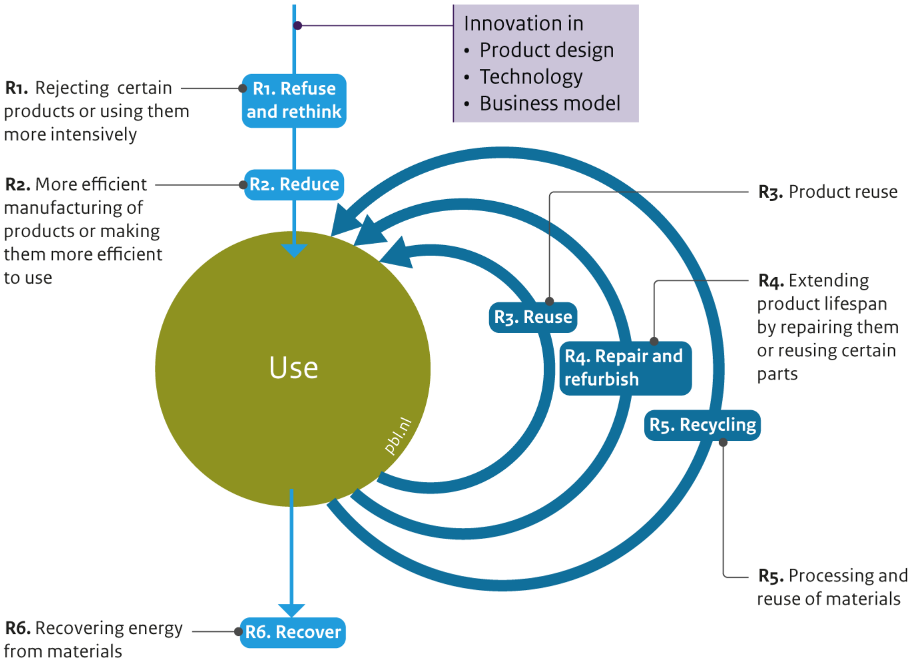
The potential stocks of the material resources mentioned above are, as yet, not being used as actual stocks. For example, disused cables are disregarded, electronic devices containing critical metals are incinerated, and scrapped ships are exported, even though they contain large amounts of metals.

High-grade recycling of critical metals recovered from structures such as wind turbines and solar panels is still in its infancy, but recycling technologies are developing rapidly (Van Oorschot and Van der Voet, 2020; Versnellingshuis Nederland circulair 2020). It is important for these technologies to become cost-effective. Different designs may make recycling or repair easier. The same applies to other products such as electronic devices and vehicles, where, for example, metals are incorporated in alloys, and components are glued together or made of mixes of synthetic materials. This makes recycling and repair more difficult. To ensure the possibility of high-grade recycling of material resources, more attention needs to be paid to the potential of stocks of material resources contained in products.

3.3.5 Resource use via product use

There are several approaches to dealing with products in a different way and thereby reducing material resource use and the related impacts (Figure 3.7). They are also called circularity strategies or R-strategies. Rethink, reduce and refuse are strategies that play a role at the beginning of the production chain or in a consumption decision. With rethink, products are used more intensively.

Figure 3.7
R ladder with circularity strategies



Source: PBL

One way of doing this is through a sharing platform, where people can borrow things such as a drill instead of buying one, which means use of the tool is intensified and fewer need to be produced. The strategies reuse, repair, refurbish and recycle ensure that products and components last longer, or that material resources are used longer in the economy. These kinds of strategies aspire to preserve the value of material resources during the use phase, with the aim of limiting environmental impacts and enhancing security of supply (PBL, 2019b).

Put together, the R-strategies form a 'ladder' that is applied to various products, such as electrical appliances, clothing and furniture. Earlier research has made a few adjustments to the ladder for biobased resources and food, but similar strategies emerge there (PBL, 2019b; Rood et al., 2016). For example, reducing food waste is a strategy under 'R2 reduce', and the residual flows of biobased resources can be used in animal feed or in industrial processes, that is, as a strategy under 'R5 recycle'.

There is as yet no integral insight into the savings that the various circularity strategies produce in material resource use (and the related environmental gains) for certain product groups or sectors. In addition, an indicator for value retention is still being developed (CE Delft, 2020a). Even so, for certain areas, information on the strategies is available. This information has been gathered below for the strategies rethink, reuse, repair and refurbish. Section 3.3.6 will discuss recycle and recover.

The sharing economy is growing but represents a small proportion of the economy as a whole
The sharing economy is about using products in exchange for payment, rather than buying and owning products (an example of rethink). According to research by Newcom, the sharing economy in the Netherlands is growing (Hoekstra, 2018). Of the Dutch population aged 15 or older, 15% uses one or several sharing platforms where consumers share goods with each other. Examples of such platforms are SnappCar, Hurenvanburen and Peerby. In 2014, tools, houses and cars were most

often shared via sharing platforms. The volume of activity in 2014 was estimated at, in monetary terms, between EUR 40 and 60 million. The estimate also included home sharing via Airbnb, which represented about half of the financial total (ING Economisch Bureau, 2015).

The number of shared-use cars is also increasing, although currently they still only represent 0.6% of the total number of cars in the Netherlands (CBS, 2020a; Kennisplatform CROW, 2019). At present, the total size of the sharing economy amounts to less than 0.01% of national GDP, and is therefore still rather small (CBS, 2020c).

Lifespan of electrical appliances is decreasing
Products with longer lifespans prevent the purchase of new products, and therefore environmental pressures. However, the lifespan of products such as furniture and clothing is decreasing (KplusV, 2020). In the period 2000 to 2013, there has also been a decline in the lifespan of electrical appliances, such as washing machines, tumble dryers, refrigerators and laptops (Bakker et al., 2014; Prakash, 2016). This is partly due to a rise in technical problems (e.g. decreasing battery life of smartphones and laptops or defective hinges of washing machines) and partly to the fact that consumers want a newer model more quickly, even though their device is still working (Prakash, 2016).

Reuse, repair and refurbish have small share in current economy
Strategies meant to extend the lifespan of products are reuse, repair and refurbish. In 2018, the added value of second-hand shops was 0.01% of total GDP (CBS, 2020c). In addition, in 2017 second-hand shops collected a total of 139,000 tonnes of goods (Witteveen+Bos, 2019). Products are also traded on Marktplaats — one of the major online platforms for second-hand sales in the Netherlands. The research and consultancy organisation CE Delft estimates that reselling on Marktplaats extends the lifespan of products by half (CE Delft, 2019). In 2018, consumers used Marktplaats to sell about 1.2 million electrical appliances, 1 million pieces of furniture, about 0.5 million products for babies and children, and about 1.6 million pieces of clothing. A comparison of the 1.6 million second-hand garments traded on Marktplaats with the figure of around 1 billion newly purchased items reveals that the second-hand market for clothing is still small (KplusV, 2020).

The added value of repair activities is 1.4% of total GDP (CBS, 2020c). This comprises, for example, the activity of vehicle repair shops. The added value is, relative to the economy as a whole, still rather low (also see Chapter 4).

Refurbishing is mainly applied to electronic devices, such as mobile phones, laptops or medical equipment. Over 2018 and 2019, the retailers Forza Refurbished, leapp and Renewd refurbished and resold 369,000 iPhones, 64,000 laptops and 62,000 tablets per year in the Netherlands (Techniek Nederland, 2019). According to BigSpark (BigSpark, 2018), the percentage of Dutch people owning a refurbished smartphone has increased in recent years. Nevertheless, at around 1.8% to 6%, this is still only a small proportion of all smartphone owners in the Netherlands (BigSpark, 2018; Techniek Nederland, 2019).

3.3.6 Waste and recycling

This section starts by looking at waste processing in the Netherlands. This concerns waste which is mostly generated in the Netherlands by citizens and businesses, with a smaller fraction coming from abroad. Following that is a discussion of the government's targets for waste generated in the Netherlands, including the share that is exported.

Waste processing in the Netherlands

Volume of waste remaining fairly stable
As can be seen in Figure 3.8, in 2018, the amount of waste processed in the Netherlands was 66 megatonnes and the figure has remained stable in recent years (Afvalrekeningen; CBS, 2020). Of that amount, over 40% was imported waste (29 Mt, of which 9 Mt were re-exported). The rest of the waste was produced in the Netherlands (CBS, 2019g).

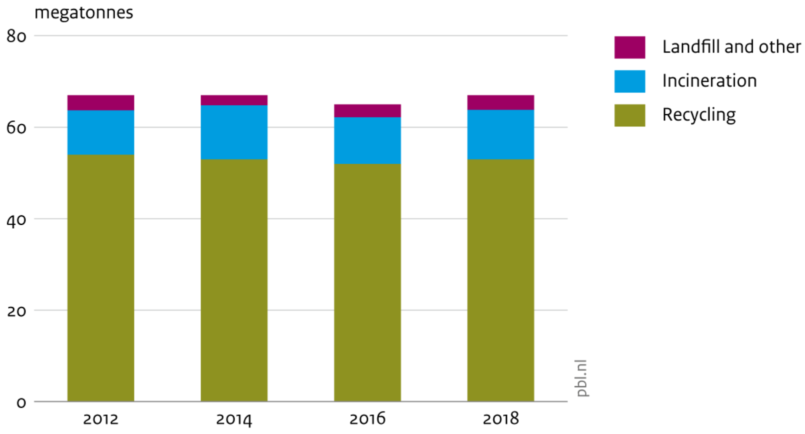
The share that is recycled is large and stable, but not always high-grade
Of the 66 megatonnes of waste processed in the Netherlands in 2018, 80% was recycled (53 Mt), including the volume that was composted. Figure 3.8 shows how the volume of recycled waste has remained fairly stable since 2012 (CBS, 2020i). At present, there are still many low-grade applications of secondary materials. For example, used plastic bottles are partly recycled into roadside posts and not into new bottles (CPB, 2019). More high-grade recycling is possible by improving the quality of recycling and waste collection (Rood and Hanemaaijer, 2017). Through more high-grade recycling — such as producing plastic bottles out of recyclate — environmental gains can be reaped.

One-fifth of the waste in incineration plants comes from abroad
Besides the share that is recycled, 17% of the waste in the Netherlands is incinerated (11 Mt in 2018). Figure 3.8 shows the amount of incinerated waste, which has been fixed since 2012 (CBS, 2020i; Rijkswaterstaat, 2020a). A large part of it (7.5 Mt in 2018) is processed in waste incineration plants (Rijkswaterstaat, 2020a). The remainder goes to installations such as cement kilns, biomass plants and power stations.

Between 2010 and 2016, the amount of waste processed in incineration plants increased, but since then it has been shrinking slightly (Rijkswaterstaat, 2020a). At present, sizeable investments are being considered or actually made to connect incineration plants or other incineration or fermentation facilities to the energy supply system. An example in question is the linking of district heating networks to incineration facilities, as has been done in Amsterdam. Waste burned in incineration plants produces energy that is used in industrial processes, district heating and greenhouse agriculture. Waste is also imported for these purposes. One fifth of the waste that goes to incinerators comes from abroad. Between 2010 and 2017, the volume increased substantially, from 55 kilotonnes to 1.9 megatonnes, and then declined slightly, reaching 1.5 megatonnes in 2019 (Rijkswaterstaat, 2020a; RWS, 2020).

Landfilling of waste is increasing
Since landfilling means that material resources leave the economic cycle and are not reused, the practice is only desirable for hazardous materials, such as asbestos. Landfilling has declined significantly since 1995, dropping from 10 megatonnes to around 2 megatonnes in 2014, as a result of implemented policies (landfill bans, landfill tax and expansion of separate waste collection). Between 2014 and 2018, the volume of waste gone to landfill increased again to 3 megatonnes (Figure 3.8). This increase was largely due to fluctuations in specific flows, such as soil, asbestos and sewage sludge (Rijkswaterstaat, 2020a).

Figure 3.8
Waste processing in the Netherlands



Source: CBS, RWS

Exports of recyclable waste

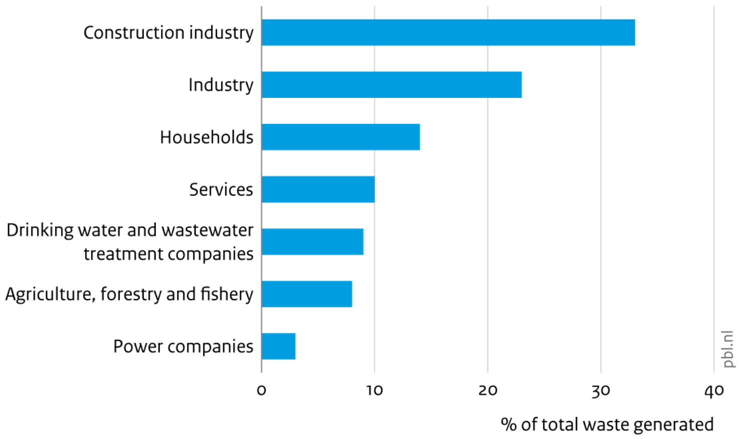
Total exports of waste amounted to 22.4 million tonnes in 2016. Just over a third of this was re-exports, that is to say, waste that had not been generated in the Netherlands (CBS, 2019g). Between 2010 and 2018, the volume of recyclable waste that was exported decreased sharply. Recyclable waste exported by the Netherlands includes recyclable plastics, minerals from the construction sector and refuse from the food industry. In 2018, exports largely went to other European countries. The decrease in exports was mainly due to the decline in the volumes of paper and plastic. Sharp drops occurred particularly in exports to China. In 2010, the Netherlands processed 58% of the supply of plastic waste and exported the rest — almost half of it to China. In 2018, this dropped to 3%. This sharp fall has everything to do with China's import ban on waste that is harmful to the environment, which has been in force since 2018. As a result, since that moment, more plastic waste has been going to other countries, including Germany, Indonesia and Vietnam (CBS, 2019f). Given the lack of traceability and the limited capability for enforcement, it is not possible to guarantee that exported recyclable plastic is actually recycled at its final destination (Interpol, 2020).

Recovering water and material resources from sewage

Besides solid waste, households and businesses also produce waste water. In the case of waste water too, there is potential for reuse and recycling. Along with stormwater that washes into the sewer via catch basins and roof gutters, waste water ends up in sewage treatment plants where biodegradable pollutants, phosphorus and nitrogen are removed (CBS, 2019a). In 2019, sewage treatment plants in the Netherlands processed over 1.9 billion cubic metres of sewage water (Association of Dutch Water Authorities, 2020). A large portion of the treated sewage is discharged to surface waters (CBS, 2019), part of it used for water table management and irrigation. In addition, the water can be reused by businesses, for example as cooling water. In 2018, this reuse (excluding water table management and irrigation) amounted to approximately 0.3% of the treated sewage water, or 6.3 million cubic metres of water (Association of Dutch Water Authorities, 2020).[4]

[4] This is an underestimate, as not all water companies are included yet.

Figure 3.9
Origin of waste generated in the Netherlands, 2018



Source: CBS 2020, Materiaalmonitor

It is also possible to recover material resources from sewage, including phosphate — which is processed into artificial fertiliser and serves as an alternative to primary phosphate extracted from mines — critical metals and other metals (De Buijzer et al., 2015; Geertjes et al., 2016), softening lime used as raw material for cosmetics, and biocomposites for the production of furniture, sheet piles or rain barrels (Waternet, 2019).

Targets around Dutch waste

For decades, the Netherlands has been enacting policies aimed at reducing waste produced in the country. Policy results since the 1990s include, amongst other things, a considerable cutback in the amount of waste being landfilled and an increase in the share of recycling. This section provides an overview of the current targets around waste and indicates which of these are expected to be attained and which are not.

The largest share of waste comes from the construction sector, industry and households

Figure 3.9 shows where most of the waste generated in the Netherlands comes from; 33% originates in the construction sector, 23% in industry (particularly the food, drink and tobacco industry) and 14% in households (CBS, 2020i). Since these are the largest waste streams, the government has set national targets for them. There are, in addition, overarching targets for the overall waste supply and for specific streams, such as packaging and food waste (see Text box Environmental gains attainable from specific waste streams).

Most overarching waste targets will not be met

To encourage both the prevention of waste generation and the practice of higher-grade waste processing, the policy framework of the National Waste Management Plan (Ministry of IenW, 2019) has established concrete targets for the overall supply of waste in the Netherlands, for household waste and for waste generated by businesses, organisations and public authorities (Table 3.3).

These targets apply to waste generated in the Netherlands (primary waste generated), excluding contaminated soil, dredging sludge, manure and radioactive waste. This category does not include imported waste, but does include Dutch waste that is exported.

Table 3.3
Overarching national objectives for waste

Themes	Sub-themes	Objectives
Waste total	Waste supply (total primary waste generated)	No more than 61 Mt in 2023 and no more than 63 Mt in 2029
Waste total	Incineration and landfill	Halve between 2012 and 2022
Waste total	Preparation for reuse and recycling	At least 85% in 2023
Household waste	Waste supply	No more than 400 kg/cap/yr in 2020
Household waste	Residual waste supply	No more than 100 kg/cap/yr in 2020 and no more than 30 kg/cap/yr in 2025
Household waste	Separation	At least 75% separation in 2020
Waste from businesses, organisations and government authorities	Residual waste supply comparable to household waste	Halve between 2012 and 2022

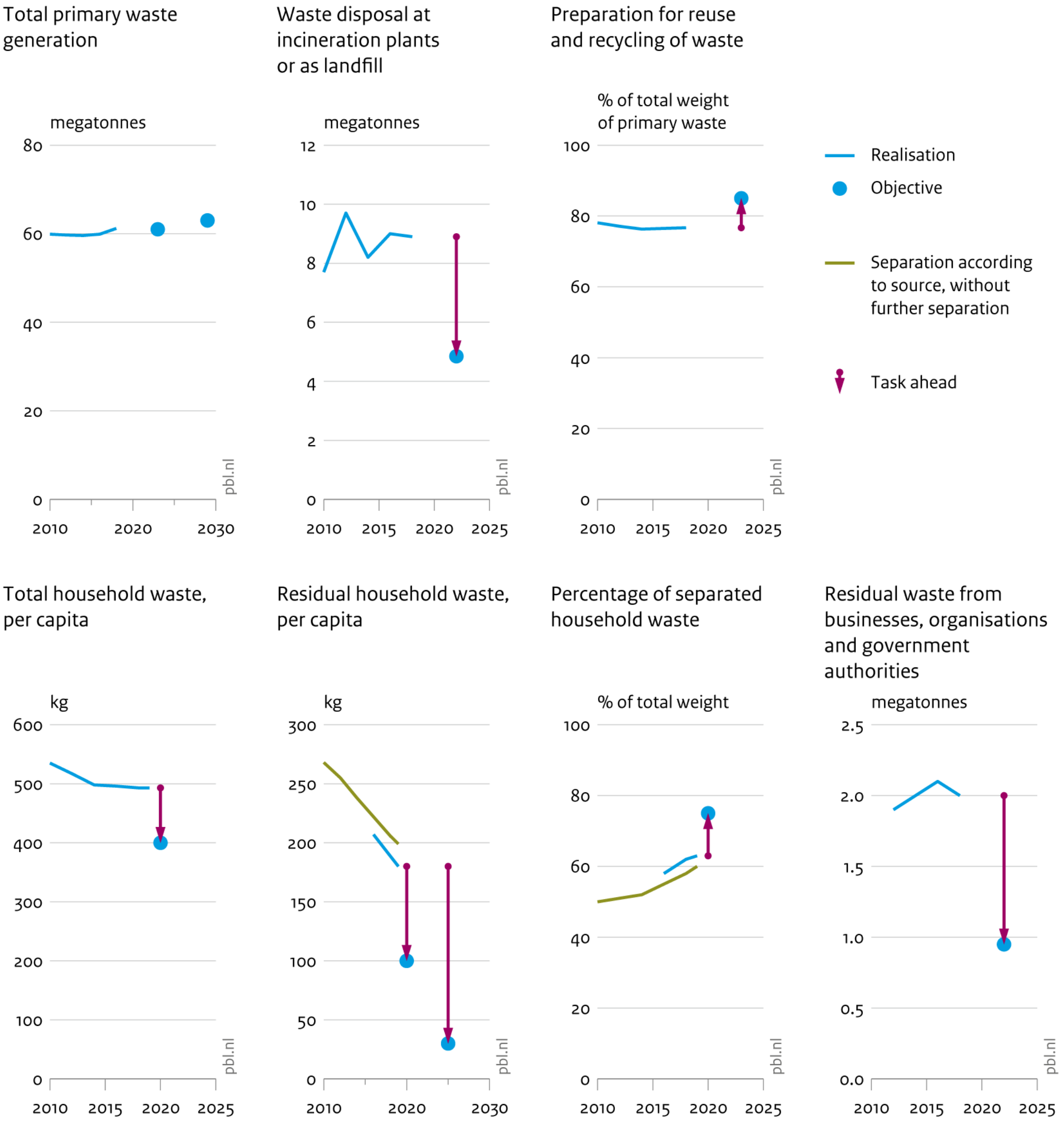
Source: National Waste Management Plan (Ministry of Infrastructure and Water Management, 2019)

Figure 3.10 provides an overview of recent developments and the targets. Substantial policy efforts are still required to achieve most of those targets. The aim to reduce waste generated in the Netherlands in 2023 is likely to be attained. In 2018, the volume of Dutch waste was, at 61.2 megatonnes, almost within target (Rijkswaterstaat, 2020b). However, the volume has shown a slight increase in recent years, and therefore it is necessary to remain attentive to ensure the 2023 target of 61 megatonnes is achieved.

The target for preparation of waste for reuse and recycling might be met if policy efforts are intensified (PBL, 2020b). For the past 10 years, the share of Dutch waste that is recycled has fluctuated around the same percentage; in 2018 it stood at 77%, but the target is 85% (Rijkswaterstaat, 2020b).

Expectations are that the other five targets will not be met (PBL, 2020b). In the first place, the amount of Dutch waste that went to incineration plants or to landfill in 2018 totalled almost 9 megatonnes. While this is about 8% less than in 2012, it is still far from the target of halving the volume between 2012 and 2022. Secondly, the amount of household waste did decrease to 493 kg per capita in 2019, but the decrease rate has remained unchanged since 2014. It therefore does not seem likely that the 2020 target of 400 kg will be achieved. Thirdly, the amount of residual household waste (after separation at source and post-collection sorting) fell to 180 kg per capita in 2019. This is a substantial reduction compared to 2010 (from 268 kg to 199 kg after separation at source; data on post-collection sorting are not available for 2010), but it is still far above the 2020 target of 100 kg per capita (Rijkswaterstaat, 2020b). It is expected that this target will not be met in 2020 (NVRD and Rijkswaterstaat, 2019), but that it will be met in 2024. This also implies that the tougher 2025 target of 30 kg per capita will not be achieved. In the fourth place, there is the share of household waste that is separated at the source; after years of remaining stable, it has risen steadily since 2014, but the 63% figure (after post-collection sorting) for 2019 is still far from the 2020 target of 75%. Finally, the waste from businesses, organisations and government authorities was in 2018 still double the 2022 target. Halving the amount within four years does not seem feasible (PBL, 2020b; Rijkswaterstaat, 2020b). A more detailed explanation of the attainability of the targets can be found in the digital publication of the assessment of the physical environment (Balans voor de Leefomgeving) (PBL, 2020b).

Figure 3.10
Objectives around Dutch waste



Source: RWS

Many targets for specific waste streams are being met

In addition to those presented in Table 3.3, the Netherlands has targets for specific waste streams (also see Table B4.1 in Appendix 4). The National Waste Management Plan, for example, has set further targets for preparation for reuse and recycling of 95% of construction and demolition waste and 85% of industrial waste by 2023. As for food — along the entire chain from farm to fork — the ambition is to halve waste by 2030 compared to 2015.

Targets have also been set for various packaging materials. Many of these have already been met or are about to be met. All the packaging targets for 2017 have been reached, with the exception of those for glass. In 2020, the European Commission introduced new targets and measuring methods (European Commission, 2019f). The new targets applying to 2021 had already been achieved in 2017 with regard to the whole of packaging, and with regard to wood, glass, and paper and cardboard packaging. The target set for 2023 for preparation for reuse and recycling of 95% of construction and demolition waste was achieved ahead of schedule, with 98% in 2016 (Rijkswaterstaat, 2020c).

For food waste, however, considerable efforts still need to be made. As the volume of food waste remained more or less stable between 2015 and 2018, progress towards the corresponding target is insufficient (Soethoudt and Vollebregt, 2020). Further details on this point are provided in the Text box Environmental gains attainable from specific waste streams, and in Appendix 4, Table B4.1).

Inferior quality of collected waste impedes high-grade recycling

At present, the targets for household waste focus on volume or weight, which means the quality of the collected material receives less attention. Enhancing the quality of collected waste, whether separate or not, makes more high-grade recycling possible (Rood and Hanemaaijer, 2017). For example, today, textile waste often cannot be used for high-grade applications because a portion of the collected textiles is wet or contaminated with other materials. Other examples are the contamination of collected biodegradable household waste (Vereniging Afvalbedrijven et al., 2020) and mixing of collected plastics which are processed into low-grade applications (Verrips et al., 2019). If recycling is more high-grade, environmental gains can be reaped.

The Netherlands generates more waste than the EU average and recycles more

The Netherlands generates per capita 43% more waste than the EU-28 average (Van Berkel et al., 2019). Only seven Member States in the EU-28, amongst which are Finland, Estonia and Luxembourg, generate more waste per capita (Eurostat, 2020a). The main reason for this is the amount of industrial waste generated in the extensive export sectors of the Dutch economy, particularly the food, drink and tobacco industry (Van Berkel et al., 2019; Van Berkel and Schoenaker, 2020).

The Netherlands generates a large amount of waste, but it also recycles a large part of this waste. The country performs well in the international comparison of waste processing: it is in the top three for recycling, in terms of kilograms per capita (Van Berkel and Schoenaker, 2020). The percentage of household waste that goes to landfill in the Netherlands is one of the lowest of the European Union.

Many EU targets achieved ahead of schedule

The European Union has set waste targets which focus on, amongst other things, reuse and recycling of household waste, municipal waste, construction and demolition waste, electrical appliances and packaging (Table B4.2 in Appendix 4). The Netherlands has already achieved many of those targets before the deadline. For example, in 2018, the country met the 2025 target for municipal waste recycling; it is ahead of schedule with regard to the target for recycling and recovery of construction and demolition waste; and in 2017, it met the 2030 targets for wood packaging, paper and cardboard packaging, and packaging as a whole. The Netherlands has set its own targets for certain waste streams, such as construction and demolition waste, wood packaging, paper and cardboard packaging, and packaging as a whole, which are more stringent than those of the European Union.

Text box 3.4: Environmental gains feasible in specific waste streams

This Text box provides a brief, more detailed look at three waste streams which at present are drawing a great deal of interest and offer opportunities to achieve environmental gains: food, textiles and electronics.

Food and food waste: Food waste occurs along the entire chain from production to consumption: in agriculture, in the food industry, in the catering industry and in households. Reducing food waste is important because the food supply chain generates many environmental impacts during production, transport, packaging and preparation. The overall volume of food waste has hardly changed since 2009. In 2018, it totalled between 1,649 and 2,568 kilotonnes, or between 96 and 149 kilograms per capita. About one third of this amount was incinerated (Soethoudt and Vollebregt, 2020). According to the independent food information organisation Voedingscentrum (2019), between 2010 and 2019, household food waste decreased by approximately 30% to an average of 34 kilograms per person. This represents one third to one fourth of food waste in the chain as a whole. Since measuring of food waste in households is subject to substantial uncertainties, there is a possibility that the absolute volume of food waste in households actually remained stable, but appeared to go down in percentage terms because the total amount of household waste decreased (PBL, 2020b).

Textiles: Although the amount of collected textiles has increased over the past 10 years, between 60% and 70% still ends up in residual waste, which eventually is incinerated (CBS, 2019b; KplusV, 2020; Van der Wal and Verrips, 2019). The problems are that a share of the collected textiles is contaminated by other materials or by water, and that the collected textiles are of poor quality (Vereniging Herwinning Textiel, 2019). However, at least half of the textiles that are incinerated would still be suitable for reuse or recycling (Rijkswaterstaat, 2019). Of the portion that is recovered, two thirds are reused on the national or international second-hand markets and one third is recycled (KplusV, 2020). The production of textiles creates many environmental impacts, such as high-intensity water use in areas where water is often already scarce, and impacts stemming from the use of toxic substances (Khan and Malik, 2013). Therefore, a longer lifespan of clothing will, in principle, have a positive effect on the living environment.

Electronics: In 2018, a total of 366 million kilograms of electrical and electronic equipment was discarded. One third of this was large appliances, such as washing machines and ovens, and the rest consisted mainly of small devices, such as vacuum cleaners, cameras, mobile phones and laptops (Baldé et al., 2020). The volume of electronic waste is growing rapidly: in 1995, it totalled 161 million kilograms (Dutch Government, 2020) and in 2010 it stood at 324 million kilograms (Baldé et al., 2020). Proper collection and processing of electronic waste is essential to minimise environmental deterioration and to recover scarce and valuable materials. In 2018, about half of the electronic waste was collected and recycled — an increase of 39% compared to 2010. About one tenth of electronic waste is exported for reuse abroad. A quarter of electronic waste is collected but not processed properly (i.e. not recycled), and there are no records on what happens to 6% of the waste. Furthermore, one tenth ends up in the waste bin and is incinerated (Baldé et al., 2020). The incinerated appliances have a material resource value of approximately EUR 57 million, because they contain valuable metals such as gold (Dutch Government, 2020). Part of the metals is recovered from the bottom ash in the incinerators; the rest is not recycled.

3.4 Social developments

This section describes a few important social developments that will affect material resource use in the Netherlands, such as population trends and changing consumption patterns. The Corona crisis also appears to have an influence on a number of trends, at least temporarily. This will be considered separately. The section finishes with a discussion of the role of the Netherlands as a trading nation. The country plays an important pivotal role in international production chains, because a relatively large number of material resource flows passes through it.

3.4.1 Developments in population and consumption patterns

Population and number of households continue to increase

The population in the Netherlands is increasing due to rising immigration, while the rate of natural population increase is declining (CBS, 2020b). Statistics Netherlands (CBS) expects the population in the Netherlands to increase to more than 18 or 19 million people in 2030 and then to stagnate or grow only slightly to between 18 and 21 million people in 2060 (CBS, 2019d). For every additional person and every additional household there will be an increase in the demand for material resources. According to an estimate by CPB Netherlands Bureau for Economic Policy Analysis and PBL Netherlands Environmental Assessment Agency (CPB and PBL, 2015), average household size will continue to fall in the future. This will lead to an increase in the number of households from over 7.5 million in 2015 to between 8 and 9.5 million in 2050. This means more homes will be needed, but also more refrigerators, furniture, curtains, and so on.

Lifestyle changes do not lead to decrease in material resource use

The demand for material resources is also affected by the consumption pattern in the Netherlands. This includes various aspects of daily life such as mobility and transport, food and the use of consumer goods. Many historical developments (up to the start of the Corona crisis) point to an increase in material resource use. For example, the Dutch are travelling more and more kilometres by car and by plane (Verrips and Hilbers, 2020), which is leading to growing consumption of fossil resources. The number of electrical appliances per household has also risen sharply since 2000. In the area of food, the per capita consumption of meat is increasing again, following a decline between 2010 and 2017 (Wageningen University & Research, 2019) and the number of plastic food containers is rising (PWC, 2019b; RetailTrends, 2019; Dutch Government, 2019). The use of consumer goods is another area where no changes are observed that could lead to a decrease in material resource use. For example, at present, Dutch households spend more on clothing than they did in 2002, while clothing has become increasingly cheaper (Milieucentraal, 2018), and, as pointed out in Section 3.3.5, the period of use of electrical appliances is decreasing (Bakker et al., 2014; Prakash, 2016). In addition, more and more people are buying products online (Deloitte, 2019; PWC, 2019a), and also increasingly from foreign web shops (CBS, 2020f), which generates a rise in shipments and use of packaging materials.

3.4.2 Consequences of the Corona crisis

The Corona crisis has consequences for the use of material resources. It is useful to distinguish between the short-term effects and consequences to be expected in the medium and long term. The short-term effects can be outlined roughly with the quarterly figures of Statistics Netherlands (CBS). More structural impacts felt in the longer term are still difficult to predict.

In the short term less use of material resources and less environmental pressure

The Dutch economy is expected to contract considerably in 2020 (CPB, 2020). Figures show that industry shrank by 2.7% in the first quarter, and by as much as 16.6% in the second quarter (CBS, 2020d, e). Turnover declined particularly in the transport, chemicals, refinery, textile, clothing and leather sectors. In contrast, the production of tobacco goods, pharmaceutical products and machinery showed growth over the same period (CBS, 2020d). In the first two quarters of 2020, sharp drops were recorded particularly in the demand for fossil resources and the demand for metals. On the other hand, the amount of biobased resources used for food and building materials increased. People have started to spend more time gardening, renovating their homes, and cooking at home.

It is expected that the total use of material resources will decrease in the short term, because fossil resources and metals account for a large proportion of material resource use. Since reduced activity leads to a drop in emissions, the environmental pressure in 2020 will also be lower than in the past few years. Greenhouse gas emissions in particular are expected to be significantly lower due to reduced activity in the chemical industry, refineries and transport.

It is difficult to indicate by how much the total amount of waste will decrease, if it decreases at all. It is true that waste generation in industry, construction and SMEs was significantly lower in 2020 than in previous years, but households are expected to produce more waste (Suez, 2020). The waste stream from households increased particularly during the lockdown period, which many people took advantage of to clear out their attics and renovate their homes and gardens (NVRD, 2020).

In addition to all of this, the Corona crisis has clearly shown how, in a global economy with high levels of interdependence between countries, a rapidly rising demand for specific material resources (laboratory test liquids) and products (medicines and personal protective equipment) can lead to geopolitical tensions (also see Section 3.5.2).

Medium- and long-term consequences uncertain

The question on the table is whether the Netherlands can use the crisis to green the economy and realise circular ambitions by, for example, laying down sustainability requirements on companies if they want to qualify for government support. The Corona crisis could fuel the need for a large step forward, especially amongst companies in the industrial sector: taking action on circular production and consumption now may reduce supply risks and, limit, under certain conditions, environmental pressure. An impulse could also come from the European Union, which is working on its Green Deal. The European Union's level of vulnerability is, after all, higher than average due to its great dependence on imports of material resources (see Section 2.3.1). There is a growing general awareness that long international production chains are vulnerable and that this entails a risk that certain material resources may no longer be supplied. Amongst the options for improving security of supply are shorter and less complex chains (production located more closely to consumption) which can be achieved by extracting more material resources within the European Union or by keeping strategic stocks. This does, however, come at a price in terms of the higher costs of stock management or the search for alternative suppliers in nearby locations. In addition, sometimes there is no point to resource stockpiling, as the processing into materials (refining) often takes place elsewhere (frequently in China).

It is not yet possible to evaluate the extent to which the Corona crisis will lead to structural changes in consumption patterns. However, it seems probable that working from home has expanded structurally and that online shopping has grown at an accelerated pace. While online shopping leads to a reduction in customer journeys to brick-and-mortar shops, it also leads to increased goods transports to and from households for deliveries and returned items. This also implies more waste, such as more packaging materials and returned pieces of clothing. At present, returned garments are often destroyed (European Commission, 2017b; Pavillon, 2020). Two large online retailers will now offer these clothes second-hand. In principle, this improves the efficiency of material resource use, but it is uncertain how big the improvement will be.

3.5 Impacts of Dutch material resource use

3.5.1 Environmental impacts

The use of material resources is coupled to various environmental impacts. This section discusses greenhouse gases, changes in land use, biodiversity loss, water use and the use of Substances of Very High Concern (see Text box on Substances of Very High Concern). Not all of the impacts occur in the Netherlands. Greenhouse gas emissions, for example, have consequences on a global scale through the accelerated pace of climate change. Changes in land use, such as the conversion of tropical rain forest into agricultural land, and biodiversity loss are processes that initially have local impacts and, after build-up, exert global effects, such as the extinction of species. Water use and the use of hazardous substances lead to impacts that are felt particularly on a regional scale, such as a decline in soil fertility or damage to human health (Lucas and Wilting, 2018b).

Both impacts in the Netherlands and footprints of production and consumption are relevant for policies

The environmental impacts of material resource use can be measured in various ways. One way is to record the environmental pressure on Dutch territory. This concerns all emissions caused within the Netherlands by businesses, organisations and households (therefore, including agriculture, transport and housing). Another way to measure environmental impacts is through footprints. These show the environmental pressure linked to entire production chains that arises from the use of material resources, the production of materials and the manufacture of components and products that are eventually used in the Netherlands. Habitually, two variants are distinguished in this approach. First of all, the consumption footprint: this reveals the impacts created by the manufacture of all products used in the Netherlands by consumers and government authorities, and those used for investments by businesses. It includes both products made in the Netherlands and imported products. Secondly, the production footprint: this concerns the impacts in the production chains of all the material resources, materials, components and final products used in Dutch production. Examples are the environmental pressure arising in the production chain from the use of iron ore from Australia in the Dutch metal industry, and the environmental impacts occurring throughout the processing chain of soya from Brazil, which ends up in feed for Dutch dairy cows. It makes no difference whether the metal products or the milk are ultimately consumed in the Netherlands or exported.

The production and consumption footprints overlap in part, specifically where products are processed within the Netherlands into final products that are used by Dutch consumers, businesses or government authorities (such as the portion that is not exported of iron from the Dutch steel industry or of milk from Dutch cows). The production footprint does not include imported final products, such as bananas from Costa Rica, cheese from France or clothing and toys produced abroad. In 2016, these imported final products contained almost a quarter of all the material resources in the consumption footprint (CBS, 2020g).

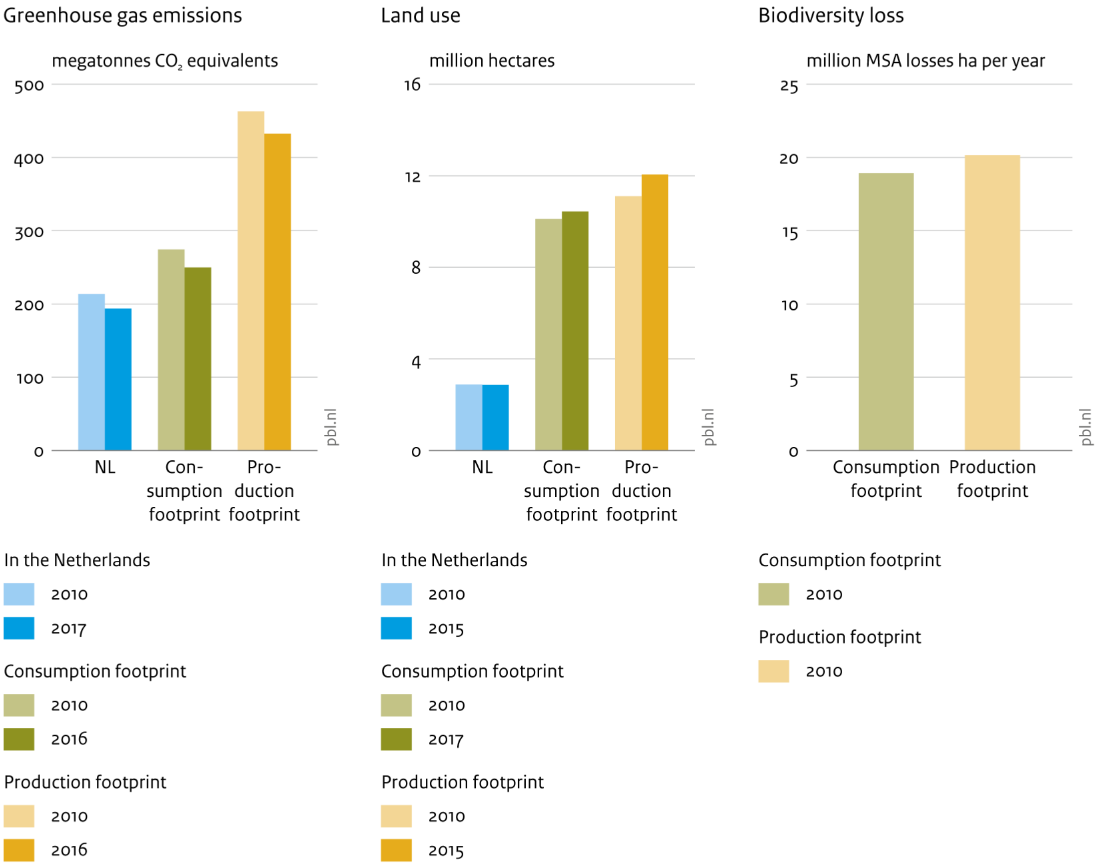
The consumption and production footprints complement each other. While the consumption footprint provides insight into the environmental impacts that arise from consumption in the Netherlands, the production footprint reveals the environmental impacts the Netherlands creates as a producer for national and foreign markets.

Greenhouse gas emissions

More than half of greenhouse gas emissions occur abroad

Between 2010 and 2016, there was a slight decline in greenhouse gas emissions in the Netherlands (i.e. emissions by Dutch companies and consumers). The same holds for the production and consumption footprints between 2010 and 2017 (Figure 3.11).[5]

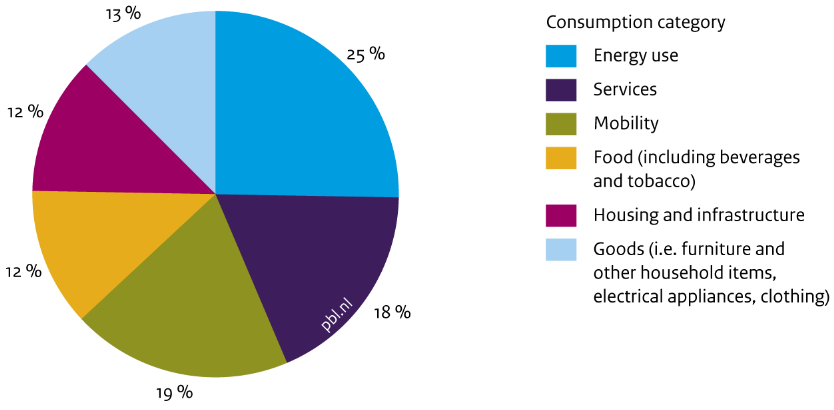
Figure 3.11
Environmental impact of Dutch material resource use



Source: PBL, CBS

[5] The consumption footprint for greenhouse gas emissions presented here deviates slightly from the figure in Table 3.1. This is due to a difference in the calculation method that was chosen for reasons of consistency and the aimed-for level of detail.

Figure 3.12
Shares in greenhouse gas emission footprint of Dutch consumption, 2016



Source: CBS 2020

The total volume of greenhouse gas emissions in the Netherlands is substantially lower than both footprints. This is because more than half the emissions for Dutch consumption (56%) are produced abroad — mainly in other European countries and in Russia, China and the United States, from where the Netherlands imports fossil resources, machinery and other goods (CBS, 2020g; Cremers et al., 2019).

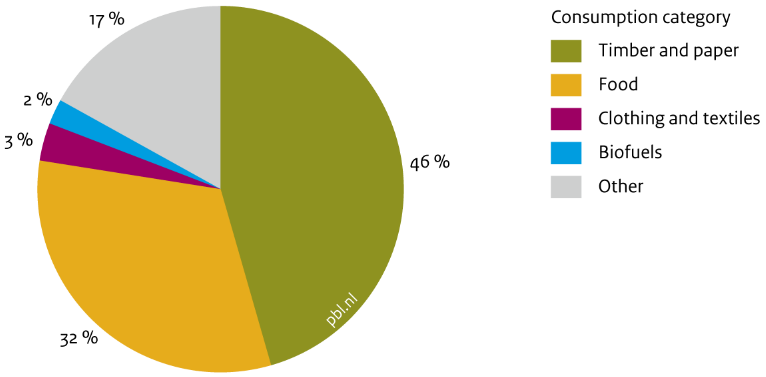
The fact that the consumption footprint is higher than the greenhouse gas emissions in the Netherlands means that the emissions generated abroad for Dutch consumption are greater than the emissions generated in the Netherlands in the production of goods and services destined for export.

Products represent considerable share of consumption footprint for greenhouse gases
Greenhouse gas emissions do not only arise from the obvious activity categories of energy supply and transport, but also from the consumption of food and goods, because emissions are released during their production (e.g. in the manufacture and transport of electrical appliances, clothing, furniture and other household items). Another activity leading to emissions is the use of buildings and infrastructure, which requires the extraction and processing of large quantities of material resources. These categories account for 37% of the consumption footprint for greenhouse gases (Figure 3.12).

Land use

Surface area needed for consumption is three times the Dutch land area
Figure 3.11 shows that land use within the Netherlands has remained stable for years and covers around 2.9 million hectares, excluding water, forest and nature areas (CBS, 2018). But the amount of land required to meet the needs of Dutch consumption and production is much larger. For consumption, it is three times the total land area of the Netherlands. A large part of this (82%) lies outside the country. The largest shares of consumption-based land footprints are found in Western Europe, where wood and paper in particular are sourced, and in South America (especially Brazil) due to the production of wood and meat (PBL, 2020d). The latter may take the form of imports of beef, but also of soya as cattle feed.

Figure 3.13
Shares in land-use footprint of Dutch consumption, 2017



Source: PBL 2020

The Netherlands is using more and more land abroad
In contrast to greenhouse gas footprints, land footprints are following an increasing trend. Between 2010 and 2015, land use for Dutch production (production footprint) grew by 9%, and between 2010 and 2017, land use for consumption grew by 3% (Figure 3.11). Over the same period, land use within the Netherlands remained the same. The country is therefore using more and more land abroad for production and consumption. This means that it is importing increasing amounts of products that require large extensions of land. The rise in consumption is mainly the result of population growth and the increase in the use of wood for construction (PBL, 2020d).

Most land is used for the production of food, wood and paper
The production of food for Dutch consumption is responsible for a large share (32%) of the land footprint of the Netherlands (Figure 3.13). Meat and dairy production, in particular, requires large areas of land per kilogram of produced output (Westhoek, 2019). The consumption of wood and paper also represents a large share of land use. In addition, land is needed for the production of clothing and other goods. The production of biofuels for transport and electricity generation has a smaller impact on land use than on greenhouse gas emissions. All the same, this impact will become greater if the share of biofuels in the energy supply increases (PBL, 2020d).

Biodiversity loss

More than half of the biodiversity loss arising from Dutch consumption is produced abroad
Biodiversity loss stems mainly from the use of arable land, pastures and forests. It leads to the disappearance of the natural plants and animals that used to live in these spaces and nature areas. Moreover, the emission of greenhouse gases causes additional biodiversity loss through accelerated global climate change. While land use has a short-term impact on biodiversity loss, greenhouse gas emissions have a longer-term effect. To take this into account, the impact of the emissions in 1 year has been calculated for a time horizon of 100 years, and factored into the biodiversity footprint. Biodiversity loss also has local causes, such as the extraction of material resources, emissions of nitrogen and phosphate to soil and water, the fragmentation of habitats,

and traffic noise (Rood et al., 2004; Rood and Alkemade, 2005; Wilting et al., 2017).[6]

The biodiversity footprints for consumption and production are almost the same. In 2010, the Dutch per capita consumption footprint was well above the world average. Of the biodiversity loss stemming from Dutch consumption, 57% is caused abroad — 14% in the European Union, and the remaining 43% outside the European Union, mainly in Central and South America (Wilting, 2021). It should be noted that these are the countries where land-use and greenhouse gas emissions occur, but that does not mean that the actual biodiversity loss ultimately occurs there too.

Production of food and other biobased resources mainly responsible for biodiversity loss

The impacts of land use on biodiversity are greatest under intensive forms of use, such as agriculture. The production of plant-based and animal-based food accounts for a large share of biodiversity loss (Figure 3.14). Another large share corresponds to housing and infrastructures (Wilting, 2021). This is mainly the result of the use of wood that is associated with land use for forestry (PBL, 2015). In contrast, transport and energy use bring about biodiversity loss mainly through the release of greenhouse gases.

Text box 3.5: Substances of Very High Concern

Number of Substances of Very High Concern and their concentrations are increasing

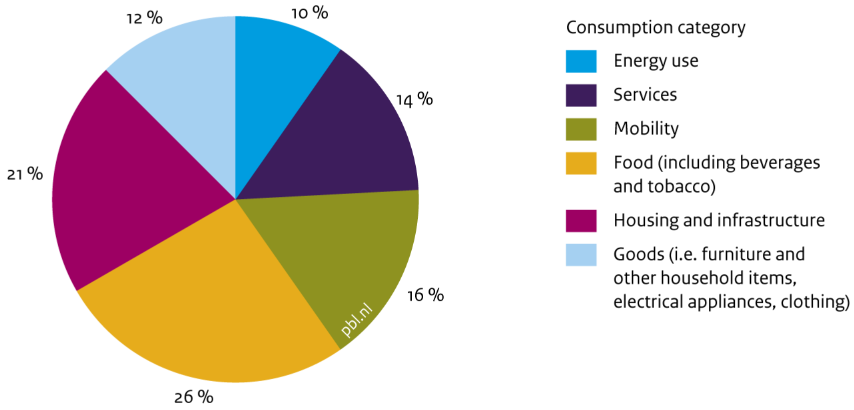
In the past 30 years, the number of registered chemical substances has increased tenfold to 159 million (Rli, 2020). They are used in, for example, the production of metal alloys, fuels, detergents and lubricants, and also in the chemical industry (Beekman et al., 2019). Some are classified as Substances of Very High Concern (SVHC) because they are dangerous to humans; this may be because they are carcinogenic or impede reproduction, or because they can have a negative impact on the quality of the environment. In recent years, there has been an increase in the concentrations of certain SVHC in the environment, such as crop protection products, plasticisers, and PFAS substances, which are used in products such as pans, clothing and cosmetics (Rli, 2020).

Transparency is crucial for circular economy

The dispersion of SVHC is still insufficiently controlled and poses unforeseen risks (Beekman et al., 2019; Rli, 2020). During reuse and recycling, SVHC can be released or accumulate in products. This may also happen with banned substances that are still contained in older products. New risks may also arise from the use of new combinations of substances (Beekman et al., 2019; Rijkswaterstaat, n.d.; Rli, 2020). These issues call for more knowledge about the associated risks (Rli, 2020).
To ensure safe practices, the use of SVHC should only be allowed in materials and products if no alternative (i.e. safe substitute) exists, and if they are not released during reuse of materials and products. In addition, it is important that information is shared throughout the production chain about the substances present and their safety, that a corresponding directive on producer responsibility is drawn up, and that safe handling is ensured of materials and products containing SVHC which cannot, or can no longer, be phased out or replaced. A monitoring framework of the National Institute for Public Health and the Environment is to map this out (Beekman et al., 2019).

[6] Emissions to soil and water are not included in the biodiversity footprint calculated here.

Figure 3.14
Shares in the biodiversity loss footprint of Dutch consumption, 2010



Source: PBL 2021

Water use

Consumption of meat and dairy products has a large impact on water use

In 2018, the water consumption in Dutch households added up to 48,500 litres per person (CBS, 2020h). This seems quite a lot, but compared to the total water consumption footprint it is a small amount. Most of the water is used in the manufacture of products. For example, producing a T-shirt requires as much water as showering 42 times (Chapagain et al., 2005; Waternet, n.d.). Dutch consumption requires between 1.5 and 3.6 million litres of water per capita per year (Arto et al., 2012; Lenzen et al., 2013; Mekonnen and Hoekstra, 2011; One Planet Economy Network, 2011; Tukker et al., 2014; Van Oel, 2008; Wilting et al., 2015). Agricultural products — particularly meat and dairy — represent by far the largest share of the water footprint because their production requires huge amounts of water (Van Oel et al., 2009). Rainwater that is absorbed by agricultural crops (green water) makes up a large part of that (Schyns et al., 2019). Leaving aside rainwater, and only considering surface water and groundwater, which are used particularly for irrigation (blue water), then beverages, fruit and meat represent the largest shares of the water footprint for food (Vellinga et al., 2019). Industrial products too require a great deal of water. These are either products destined for businesses, such as materials and components for further processing into products, or material resources and products needed in the production process, such as energy carriers and machines. This industrial use mainly concerns water that is needed to dilute polluted waste water from a production process (grey water). The level of dilution should be sufficient to achieve a water quality that remains above the established standards (Van Oel et al., 2009).

Almost 90% of the water footprint from Dutch consumption occurs in other countries, particularly in the rest of Europe, Africa and Latin America (Van Oel et al., 2009). A share of the water comes from regions affected by water scarcity such as India, China, Pakistan and Turkey, where cotton is grown for textile production, or from South Africa and Spain, where part of the fruit consumed in the Netherlands is sourced (Van Oel et al., 2009; Van Oel, 2008). The greatest level of water stress caused by Dutch consumption takes place in Egypt, mainly as a result of the vegetables, fruit and nuts which are grown there and are imported by the Netherlands (Cabernard and Pfister, 2020).

3.5.2 Economic and socio-economic impacts

Dependence on other countries leads to supply risks

The Dutch economy functions largely on the basis of foreign material resources (Figure 3.3). The only exceptions are biobased resources and non-metallic minerals, of which almost three quarters are extracted or harvested domestically. This means that the Netherlands produces most of those material resources itself. With regard to domestic use, the country has to import almost half of the material resources it requires. With regard to the economy as whole, 75% of the material resources comes from abroad (CBS, 2021). This comprises not only primary resources, but also components and products.

For all metals, the Netherlands is fully dependent on other countries. And for fossil resources too, the Netherlands is highly dependent on imports; in 2018, more than 60% of what was needed for domestic consumption was imported (CBS, 2021).

The dependence on other countries has been rising since 2010. For decades, the Netherlands extracted large amounts of natural gas from the province of Groningen, but between 2000 and 2018 it became for the greater part dependent on imports of fossil energy carriers (PBL et al., 2020). In addition, the Netherlands is producing less and less biobased resources. As a result, between 2010 and 2018, the country's self-sufficiency as to material resources fell by 24% (CBS, 2021).

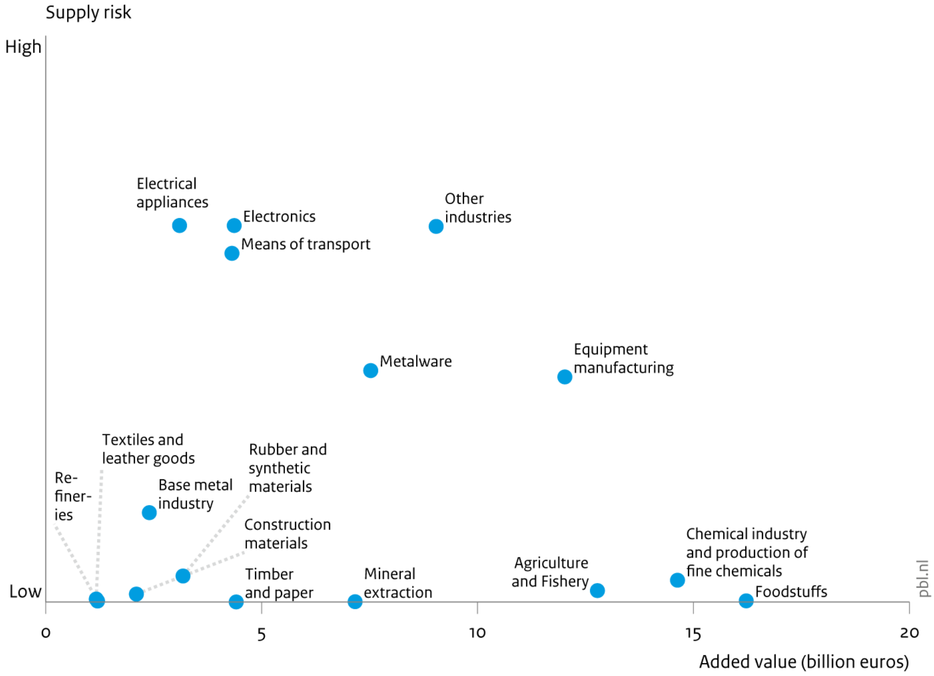
In 2020, the Corona crisis clearly exhibited how, in a global economy with high levels of interdependence between countries, a rapidly rising demand can cause tensions to build up around prompt availability of specific material resources (e.g. test liquids for laboratories) and products (e.g. medicines, medical personal protective equipment). Sometimes, long international production chains prove vulnerable due to protectionist reflexes of individual countries. This does not only apply to products related to the coronavirus, but also to material resources that are critical for the Dutch economy.

Supply risks of critical metals

The dependence on imports of critical metals poses a risk to the Dutch economy

Material resources are not going to run out instantly, but supply risks do exist for some of them. Supply risks arise from a combination of factors, such as geopolitical forces, low recycling rates, the lack of a suitable substitute for a specific material resource, and situations where material resources can only be extracted in a limited number of countries. Restricted availability of crucial material resources that the Netherlands imports poses a risk to its economy and standard of living (also see Chapter 2). For example, agriculture depends on the import of phosphate. There are no phosphate mines in the European Union, so it must be sourced outside the European Union or recovered by extracting struvite from waste water (also see Section 6.6 on regional initiatives). Also, many industries depend on metals, for use in, for example, catalytic converters, nanotechnology and machines. The Netherlands needs to import these metals, and the components that contain these metals. A share of these imported metals are so-called critical raw materials. Many of these are characterised by the fact that they are, compared to other material resources, low in weight but essential for the function they fulfil in various products.

Figure 3.15
Relationship between supply risk and added value, per sector of the Dutch economy, 2018



Source: TNO 2020

A few countries are dominant in the extraction of a number of critical raw materials, which means there is a risk of monopolistic practices. China, for example, extracts 70% of all critical raw materials (Deloitte Sustainability et al., 2017). In addition, it can prove difficult to speed up the production of some critical raw materials, such as indium, which is used for LCD screens, tin solder and electronics (also see Chapter 2). Supply risks are also affected by OECD export restrictions, existing possibilities for recycling, and the quality of government in source countries. As a result, several production sectors, such as the manufacturing industry, face a risk of not receiving supplies of these critical raw materials (Figure 3.15). Given that the Dutch economy depends on these sectors, it is necessary to remain attentive.

Supply risks of critical raw materials mostly affect the manufacturing industry
The companies most affected by the supply risks of critical raw material resources are those that use germanium, platinum group metals, rare earth metals, gallium, cobalt and tungsten. Companies in the manufacturing industry run the largest risks due to their dependence on rare earth metals, cobalt, tungsten, tantalum, tin and indium (Bastein et al., 2020). These critical metals have applications in, for example, machinery, vehicles and electronics. Specific sectors which depend on these metals are the electronics and electrical equipment industries, the vehicle industry, other industries, metal production and machine construction (Figure 3.15).

Increase in supply risks for the Dutch economy
Between 2012 and 2018, the supply risks increased for cobalt, germanium, gallium and beryllium. While security of supply improved for a number of other critical raw materials — rare earth metals, for example — a supply risk continues to exist. While for some sectors the risks have gone down slightly, they have gone up for the vehicle and electronic products sectors. Considering the Dutch economy as a whole, the risks have increased (Bastein et al., 2020).

New supply risks resulting from the energy transition
In the coming decades, electrification of the automotive industry and growth in the production of renewable energy in the Netherlands will bring about an increasing demand for critical metals (Bastein et al., 2020; Schoots and Hammingh, 2019). The reason is that critical metals are needed for the production of, for example, electric cars, wind turbines and solar panels (Bosch et al., 2019; Rietveld et al., 2019; Van Exter et al., 2018). It is expected that the energy transition in the Netherlands will lead to new supply risks, because it requires an unprecedented acceleration of the annual growth of the production of numerous material resources (Rietveld et al., 2019). Some critical metals, such as rare earth metals, silver, cobalt and iridium, are necessary in products for the energy transition, including solar panels, green hydrogen and batteries for electric vehicles. The demand for metals for the energy transition is many times greater than what the Netherlands uses today for the economy as a whole (Van Exter et al., 2018). If the rest of the world starts to electrify along similar lines, severe shortages of some metals will arise, or considerable price rises will occur.

Socio-economic effects in the Netherlands
Below is a discussion of the socio-economic effects of circular activities in the Netherlands and abroad. For example, to what degree do circular activities represent added value for the economy? What is the impact on the labour market when companies start producing in a more circular fashion, and what health effects arise from handling other materials?

Economic impact of circular economy in the Netherlands has not become greater
As yet, circular business activities — such as recycling, repair and reuse — only cover a small part of the economy. In 2018, circular business activities added 4% of value to the economy, and 4% of employment is coupled to circular activities.[7] Between 2010 and 2018, employment in circular activities increased by 5% and the added value of those activities by 23%. The changes are comparable to the Dutch economy as a whole, which saw a 7% increase in the number of jobs and a 21% increase in GDP over the same period (CBS, 2020c). This means that in terms of effects on the economy, a shift towards a circular economy cannot yet be observed.

It is expected that the nature and quality of jobs will change during the transition towards a circular economy (Circle Economy, 2020a; ILO, 2019). However, no data are available on this issue. The fact that there is hardly any change in effects on the economy does not mean that no changes are taking place in society, such as the use of new revenue models or innovations. These changes already exist before their effects can be measured. Chapter 4 focuses on the monitoring of social changes that occur before there is an observable shift to a circular economy.

Socio-economic effects abroad
Production and consumption in the Netherlands cannot be considered in isolation from effects abroad, which are both positive and negative (Alliance87, 2019; IRP, 2020). They differ per production chain and also according to production location and method (see Chapter 2).

[7] Here, observed employment growth is lower than that detailed in a study by Royal HaskoningDHV (2020a). The source for this report is Statistics Netherlands (CBS), which considers employment growth in a broader group of circular activities.

Socio-economic effects in agricultural chains in low-wage countries
The Netherlands plays an important role in agricultural chains. For low-wage countries that produce agricultural resources, exports to the Netherlands are important for economic development and employment. Negative effects can also occur in those countries, such as violations of labour rights in the production of cacao beans and coffee, or extensive deforestation for the production of palm oil and soya beans. As mentioned in Chapter 2, production can also exert negative environmental impacts for local communities (ILO, 2016; ILO et al., 2019; Milieucentraal, n.d.; Vijay et al., 2016).

Sustainability requirements reduce risks of negative impacts
In recent years, Dutch businesses have taken steps to deal with the negative impacts in their supply chains (CBS, 2017; SER, 2019). For example, several market parties have committed themselves, through treaties and initiatives, to concrete agreements on the use of larger amounts of sustainably produced agricultural resources (SER, 2019). The use of palm oil, cacao, soya and soya-based products with a sustainability certification label has increased in recent years. In 2016, of all the palm oil used to produce food for the Dutch market, 90% was certified. As for the production of meat, dairy products and eggs, since 2016 only animal feeds with sustainably produced soya have been used (CBS, 2017). It should be noted though, that certification does not constitute a guarantee that no negative effects will occur. There are many types of certification which set widely varying requirements for products and production methods. Many certification schemes are also facing criticism, because, amongst other things, they cannot offer guarantees on improvements in the chain (Van der Wal, 2018; Brad et al., 2018).

Some imported products are not covered by sustainability requirements
In addition to products for the Dutch market, huge amounts of agricultural resources are imported and then instantly re-exported (CBS, 2017, 2019c). For example, most of the imported soya products (67%) are re-exported to other European countries without further processing. In addition, it is not known whether the sustainability criteria are met for soya that Dutch refiners use in products destined for export (IDH and IUCN NL, 2019). Certified palm oil only comprises volumes for the Dutch market that are to be used for foodstuff and animal feed (CBS, 2017). As a result, applications such as biofuels or processing into soap and paint are not governed by the sustainability requirements. A more extensive approach is needed to ensure all production chains become sustainable. The Dutch business world is taking steps to reduce sustainability risks, but not nearly all risks have been addressed yet.

3.6 Summary and conclusions

A large share of the material resources imported and extracted in the Netherlands is destined for export
In 2018, businesses and citizens in the Dutch economy used a total amount of almost 450 megatonnes of material resources. This included primary resources and also materials, components and products. Approximately half of this was for domestic use by Dutch consumers and businesses, for example houses, cars and food for Dutch consumers, or machines for companies. The other half was processed by Dutch companies and then exported.

In addition, more than 140 megatonnes of material resources were imported and exported without significant industrial processing. Such re-exports have increased considerably over the past 20 years. This means the Netherlands trades widely in raw materials, materials, components and products. Overall, the country imports and extracts almost 600 megatonnes of material resources, of which 65% is destined for other countries. The Dutch economy therefore needs much larger amounts of material resources than for domestic use alone.

Further improvement in material resource efficiency has not led to decrease in use
Between 2010 and 2018, material resource efficiency increased by 12%. Efficiency is determined by looking at how much money (GDP) the Netherlands earns per kilogram of domestically used material resources. Between 2016 and 2018, efficiency increased at the faster rate of 5%. However, this improvement in efficiency is not a sign that important steps towards a circular economy have been made. This is because the improvement has not led to a fall in demand for material resources. The overall amount of material resources needed for the Dutch economy or for domestic consumption has barely changed since 2010.

Use of material resources abroad for the Dutch economy has increased
Since 2010, the Netherlands has been importing more materials, components and products which have already undergone a certain amount of processing abroad. Examples are imports of materials instead of primary resources, or imports of products instead of the materials from which they can be made locally. As a result, larger amounts of material resources have been needed in the foreign parts of the production chains, such as fuel to run machines.

Slight decrease in the use of abiotic resources
An examination of the composition of the required material resources shows that, since 2010, the Netherlands has been using more biobased resources, which means the country has needed smaller amounts of minerals (including metals) and fossil resources. The decrease is about 0.5% per year for domestic use and 1% for the economy. A projection of these trends does not show the use of primary abiotic resources will have halved by 2030.

Not enough secondary materials to take over from current demand for material resources
The required amount of minerals and fossil resources could be reduced by using more secondary materials. At present, secondary materials fulfil 14% of the overall material resource demand in the Dutch economy, and about a quarter of the demand for domestic use. Over the period from 2016 to 2018, this share barely increased (1%). The amount of secondary materials can only grow to a limited degree, because the Netherlands already recycles 80% of its waste. Moreover, at present, some materials cannot be reused because many material resources are stored in products such as houses, electronics and vehicles. These products are, in principle, points of supply for material resources to be used in the future (urban mining). However, this potential is still receiving little attention and situations can arise where, for example, ships containing large quantities of material resources are sent to other countries for scrapping, or materials in products are glued together or mixed in ways that make recycling complicated and expensive. In addition, resources that are eaten by humans or animals, and resources that are burned to produce energy are currently for the greater part lost. Directing attention to closing these loops helps to reuse all, or part of, these material resources.

Biobased resources can only be part of the solution
The use of abiotic resources can also be pushed back by replacing them with renewable biobased resources. Sustainable biobased resources are in principle renewable, provided certain sustainability criteria are met, including preservation of soil fertility and closing nutrient cycles. Use of biobased resources increased by 5% in the period 2016 to 2018, and at present they represent about a quarter of the material resources used in the economy. However, this amount is not entirely made up of sustainable resources. Only limited quantities of sustainable biobased resources are available and in addition to new applications — in bioplastics or in biomass power plants, for example — they are also needed for uses such as the food supply. Land for cultivation of these resources is also limited, and space is also needed around the world for things such as housing, roads and nature. With the help of innovations, the available volume of sustainable biobased resources can still increase, and thereby replace part of the current use of abiotic resources.

Many overarching waste targets not met
It is expected that six of the seven overarching targets for waste will not be met, or will require additional policies. For example, the volume of residual household waste and comparable waste from businesses and organisations is still almost twice the levels established for 2020 and 2022. The volume of Dutch waste that is incinerated or landfilled decreased by 8% between 2012 and 2018, but is still far from the target of being halved in 2022. The only overarching target that is expected to be met is the decrease in the overall waste supply in 2021. More progress has been made with regard to the targets for specific waste streams. Targets for construction and demolition waste and for several packaging materials have been met, and other targets are within reach. Food waste is the only stream where the shift towards the aimed-for reduction by half by 2030 is still unsatisfactory.

The Netherlands is amongst the EU front runners with regard to recycling and landfill
With a recycling rate of 80% of all waste, the Netherlands is amongst the front runners in the European Union. Material resource efficiency is also high and the level of landfilling is low. In recent decades, the country has achieved great progress in waste processing. As a result, it has met numerous EU targets before the set deadlines. Cases in point are the recycling of construction and demolition waste, household waste and various packaging materials.

While other countries can still take further steps by recycling more, the challenge for the Netherlands lies mainly in reducing material resource use, for example by sharing or renting products, extending the lifespan of products through reuse, repair or refurbishing, and ensuring that recyclates find high-grade applications in new products.

Share of waste still undergoing low-grade recycling
In addition to the recycling rate, it is also important to direct attention to the quality of the recyclate. Quite often, levels of recycling are not yet high-grade, in part because no targets exist for it. For instance, concrete that has become available is used for road bases instead of in existing or new buildings, and a share of plastic bottles is used to make low-grade roadside posts instead of being processed into new bottles. Several obstacles stand in the way of high-grade recycling. The use of mixes of plastics in items such as packaging or cables makes recycling complicated and expensive. Textiles get contaminated relatively often during collection or are not collected separately. Through more high-grade recycling — such as producing plastic bottles out of recyclate — environmental gains can be reaped. High-grade collection and recycling are crucial because they

determine the types of new products that can be made from the secondary material, and how often the secondary material can be reused. The situation calls for improvements in the quality of waste collection and sorting, and of applications of waste in new materials and products.

Higher R-strategies represent a small economic share and require more attention

The Netherlands is already carrying out a relatively large number of actions in the field of waste processing and recycling. To bring a circular economy closer, steps can be taken in the use stage of products too. However, no targets have been set yet to this end, and the trends are not very positive. A case in point is the fact that the lifespan of clothing, washing machines and laptops has been dropping in recent years. Initiatives that ensure that the lifespan of products increases or that products are used more intensively — such as sharing, reusing, repairing and refurbishing — are barely getting under way. The sharing economy and the second-hand, repair and refurbishing markets still only make up a small part of the economy as a whole. Taken together, these kinds of circular business activities account for about 4% of employment and added value in the Netherlands.

Increase in supply risks for the Dutch economy

The companies facing the largest supply risks for critical raw materials are those that use germanium, platinum group metals, rare earth metals, gallium, cobalt and tungsten. Since 2012, the supply risks have increased of resources such as cobalt, germanium, gallium and beryllium, affecting the manufacturing industry in particular. These critical metals are used in the production of machinery, vehicles and electronics. In general terms, the supply risks for the Dutch economy as a whole have increased.

In addition, the Dutch economy has become more and more dependent on imports of material resources. At present, the Netherlands imports 75% of the material resources it needs. This includes not only primary resources, but also components and complete products. This dependence can pose a risk, as became clear with the shortages on the world market of items such as face masks and test equipment for laboratories during the Corona crisis.

Increase in supply risks due to energy transition

Supply risks are expected to increase due to the electrification of passenger transport and the energy transition, particularly the construction of greater generation capacity of renewable energy (wind turbines, solar panels). This is because critical metals are crucial for the production of solar panels, green hydrogen and batteries for electric vehicles. As a result, the importance is growing of recycling critical raw materials from, for example, discarded electrical appliances or unused cables.

The linking of district heating networks to waste incineration plants can lead to a risk in energy supply or create tension over the pursuit of a circular economy. Further-reaching measures for a circular economy will reduce the amount of waste for incineration and thereby reduce the supply of energy by incineration plants.

Impacts of Dutch material resource use are created mainly in other countries

Three quarters of the material resources used in the Dutch economy are imported. Examples include petroleum, coal and soya beans, and also components and products for further processing. The extraction of material resources, the production of components and goods, the use of products, and the disposal of products as waste are all coupled to impacts on nature and the environment, and also have socio-economic impacts. These impacts largely occur abroad.

Consider, for instance, land used and emissions generated in soya cultivation in Brazil for the purposes of livestock farming in the Netherlands. The foreign parts of the production chains of consumer products for the Netherlands are the places where 56% of the greenhouse gas emissions and 57% of the biodiversity loss occur. Also, of the land needed for Dutch consumption, 82% is located abroad and used mainly for the production of food, paper and wood. Moreover, Dutch production requires more and more land elsewhere. Since a large part of the impacts on nature and the environment takes place in other countries, reducing the effects of material resource use also requires making efforts in the foreign parts of the production chains.

In various production chains, material resource extraction and production activity take place in low-wage countries. Examples are the extraction of metals and the cultivation of agricultural products, such as coffee. It is important to keep in mind not only the positive effects, such as employment for the local population, but also the possible risks, such as local environmental impacts and child labour. To enable decision-making that gives thoughtful consideration to all impacts along the entire production chain, a necessary step is the creation of more transparency, including in the foreign parts of the chain.

Data from businesses and government authorities on material resources facilitate transition

To enable the reuse of material resources, it is crucial that more information be made available on the volume and the quality of secondary materials or residual flows. Insight is needed into the size and the condition of these material flows and into the location and time of their release so that they can be used in high-grade applications, now and in the future. Efforts are being made to set up a suitable registration system for this purpose, the Dutch Raw Materials Information System. If businesses and government authorities have more and better data about the use, quality and release of material resources from buildings, capital goods, infrastructures and consumer goods, it will become easier to reuse those resources. Moreover, heightened insight into the use of material resources during all phases (e.g. volume and quality of the material resources needed, lifespan of products, and volume and quality of waste) provides information for policymakers about measures or additional policy interventions that are desirable or necessary to speed up the transition towards a circular economy.

Accelerating the transition is a challenge and a great opportunity

All in all, stepping up the transition towards a circular economy by 2030 and 2050 still poses a tough challenge. Compared internationally, the Netherlands is already on the right track for several aspects. The amount of material resources for domestic use is below the European average; they are used more efficiently than in other countries, and the recycling rate is high. This offers the Netherlands the opportunity to play a pioneering role in accelerating the transition towards a circular economy. The challenge for the Netherlands is to encourage innovations and market formation that lead to an increase in high-grade recycling, to normalisation of repair, refurbishing and sharing (renting and leasing) and to ongoing reduction in stocks of products.

4 Progress of the transition process

Main messages

- The transition towards a circular economy is on the agenda of many societal stakeholders. Progress of the transition is discernible in, amongst other things, the growing number of 'circular' businesses, scientific publications, study programmes that focus attention on circularity issues, and financial resources that have been used for circular activities through government instruments, such as the Research & Development Tax Credit Act (WBSO) to promote research and development.
- Despite this progress, the transition is still in an initial phase. At around 6%, the share of circular businesses in the Netherlands is still small and the great majority are dedicated to traditional activities, such as vehicle repair and thrift shop retailing. In addition, the current economy still functions for the most part according to linear principles. The implementation of circular design or circular business models is still next to non-existent.
- If no additional actions are carried out, recycling will remain the dominant direction in the transition towards a circular economy. Recycling is essential in a circular economy, but the greatest environmental gains are expected to be achieved through strategies aimed at reducing the total material resource use (narrowing the loop) and extending the lifespan of products and components (slowing the loop). So far, these strategies have hardly received any attention.
- The transition towards a circular economy is not only about new technologies, but also about different rules (institutions), different behaviour, and new products, services and knowledge, and alternative business models. These features still receive little attention. The upscaling of circular activities faces various obstacles, such as a lack of standards for circular products, the reluctant attitude of consumers with regard to circular products, and environmental deterioration that is not factored into the price of material resources and products. To reach the next phase in the transition process, it is important to create more market incentives and more explicitly steer the transition into the right direction.
- Realising the transition is an important goal of government policy. It requires efforts from government authorities, producers, consumers, NGOs, scientists and administrators. After all, the transition cannot be directed and realised by the government alone. At the same time, the government performs a special role, because its policies will affect the direction and the pace of the transition towards a circular economy.

4.1 Introduction

The Dutch Government expressed its ambition to achieve a fully circular economy in the Netherlands by 2050 in its first government-wide programme for the circular economy Nederland Circulair in 2050 (IenM and EZ, 2016). To increase the pace of the transformation of the Dutch economy into a circular economy, the government is concentrating on three strategic goals. The first and second focus on high-grade use of material resources and on replacing material resources which are not produced sustainably. These goals deal mainly with material flows. The third strategic goal is the development of new production methods and new product designs, and the promotion of new forms of consumption. With this goal, the government is making it clear that attaining national goals will require sweeping changes in society through technical, social and system innovations — in other words, a transition.

To track the progress of the transition, monitoring is necessary. The transition process is intractable and lengthy, and at the outset it is slow, which means that the impacts (as discussed in the previous chapter) which societal stakeholders are now aiming for will only become visible in the longer term. Monitoring the transition process offers, in principle, the possibility of making gradual adjustments to it, even before the effects of the changeover to a circular economy can be registered.

Reading guide

This chapter presents an analysis of the progress of the transition process to a circular economy, aiming to identify the stage the transition is currently in, the predominating paths towards solutions, and the possibilities that exist to make adjustments. This is not a conventional evaluation. This chapter also discusses options to take the transition to the next phase. Obstacles to such options and ways of overcoming them are dealt with in various sections. Section 4.2 looks at the approach taken to monitoring the transition process, which involves identifying the parts of the process that are important for monitoring. Section 4.3 contains a national-level description of the activities that various societal stakeholders are carrying out and resources they are putting up for the transition towards a circular economy. In Section 4.4, a closer look is provided at several cases for which the various parts of the transition process have been analysed in connection with each other. The chapter finalises with a reflection on the progress of the transition process.

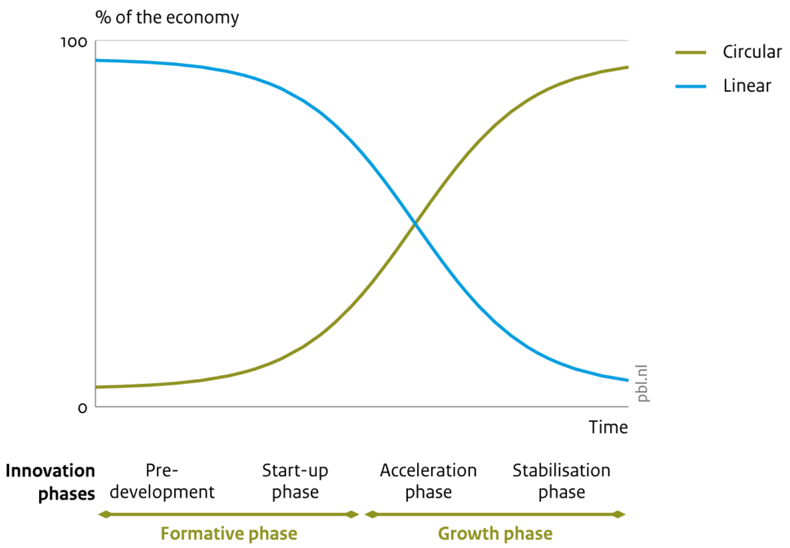
4.2 How the transition process is monitored

In the publication What we want to know and can measure (Potting et al., 2018), the knowledge institutes taking part in the Work Programme on Monitoring and Directing the Circular Economy laid the basis for monitoring of the transition process. Measuring the progress of transitions is a relatively new field of activity (Potting et al., 2018) for which there is no manual. The monitoring put forward in this ICER report builds on insights from science and actual practice.

4.2.1 Transition frameworks as a basis for monitoring

Plant-based proteins in food, chemical recycling of plastics, an electric drill as-a-service, mobile homes and refurbished office furniture. They form a small selection from the broad field of the transition towards a circular economy. In addition, the transition is not only about new technology, but also about different rules (institutions), different behaviour, and new products, services and knowledge, and alternative business models. The transition is therefore a complex bundle of widely varying processes which ultimately lead to a fundamental change in established and predominantly linear systems of production and consumption (Bode et al., 2019). The examples mentioned above show that all kinds of sectors and parties are involved in the transition. Businesses and government authorities, and certainly also citizens, knowledge institutes and NGOs, all have a role to play, while no single party wholly determines the transition (Bode et al., 2019).

Figure 4.1
Degree of circularity of an economy



Source: DRIFT; adaptation by PBL

Transition monitoring in ICER report builds on existing frameworks

To structure this complex whole and enable its monitoring, this report builds on two leading transition theories that are applied in the context of Dutch policies. The text box below (Characteristics of and analysis frameworks for a transition) provides a brief overview of several well-known transition frameworks and the points they have in common. The first is the X-curve model developed by DRIFT (Figure 4.1). This model regards transition processes as developments in which, on the one hand, innovation emerges and is institutionalised, and on the other hand, highly institutionalised, unsustainable existing structures and practices are broken down. The second theory is the innovation ecosystem model developed at Utrecht University. The model focuses especially on understanding innovation. Innovations are not developed in isolation, but in symbiosis and in iteration with a specific environment, with the whole, then, forming the innovation ecosystem. It consists of organisations and rules which exert their influence on the innovation process. The functioning of innovation ecosystems strongly determines whether innovations actually arise or not. This functioning can be measured by means of a number of key processes (details on these are provided below) and it is therefore well suited for monitoring the progress of a transition process. With this framework, it is possible to identify systemic problems that can be managed with policies and strategic actions. Solving systemic problems increases the likelihood of a transition developing successfully.

These two theoretical frameworks have been merged into the theoretical model known as mission-driven innovation system (Elzinga et al., 2020a; Hekkert, 2020). The model consists of the actors and rules that jointly contribute to the realisation of a societal mission (e.g. the transition towards a circular economy) by developing all sorts of innovations (technological innovations, new business models, social innovations), and also by phasing out existing practices that stand in the way of completing the mission. With the mission-driven innovation system too, it is possible to assess the quality, and therefore the chances of realising the mission, on the basis of a number of key processes (Hekkert et al., 2007; Hekkert, 2020). These key processes can be regarded as preconditions for realising the social mission. If certain key processes are carried out incompletely, or not all, this will lead to a delay in the transition process.

Text box 4.1: Characteristics of and analysis frameworks for a transition

Several transition frameworks have been put forward in the scientific literature. Well-known ones include transition management (Loorbach, Rotmans), strategic niche management (Kemp, Raven and Geels), the multi-level perspective (Geels, Schot), the innovation (eco)system (Bergek, Jacbonsson, Hekkert) and small wins (Termeer). Each framework has its own application and scope. Below is a brief overview, based partly on Köhler et al. (2019).

Transition management is a policy-oriented transition framework. It outlines a transition management cycle made up of four steps that policymakers can take: (1) participatory problem structuring and vision development in a transition arena; (2) developing a transition agenda and transition paths in networks; (3) designing and executing transition experiments; (4) monitoring, evaluating and learning from transition experiments.
Strategic niche management focuses mainly on emerging, radical innovations in protected environments. Examples of these include subsidised demonstration projects and specific, dedicated users such as the Ministry of Defence. In these protected environments, innovations are not exposed to the pressures that are normally seen in competitive markets.
Multi-level perspective presents transitions as processes on three different and interacting levels: (1) protected environments in which innovations, radical or otherwise, emerge — niches; (2) the established system of actors and rules — regimes; (3) exogenous developments that can put regimes under pressure — the landscape level. Radical innovations taking place in niches can cut across to the regime if developments at the landscape level provide windows of opportunity. The systemic nature of transitions and the tension between stability and change are central features of this framework.
Innovation system focuses especially on understanding innovation. Innovations are developed in the context of an innovation ecosystem made up of organisations and rules that exert an influence on the innovation process. The functioning of innovation ecosystems strongly determines the successful emergence of innovations. This functioning can be measured by means of a number of key processes. With this perspective, it is possible to identify systemic problems which can be eliminated by policies and strategies, thereby improving the chance that the innovation will be developed and applied successfully. The framework of the mission-driven innovation system is to a great extent based on this approach.
Small wins looks at handling transition challenges in ways that motivate societal stakeholders. The underlying idea is that a transition can be the result of small steps which together add up to major changes. Three actions are central to this: identifying and valuing small wins, analysing whether the conditions for successful transformation are in place, and ensuring the outcome of implemented actions is fed back into policies.

These transition frameworks differ from each other and all have their own application options, but they also complement each other. Some shared elements or common themes have been distinguished (Köhler et al., 2019).

In transitions:

- ...processes of building up and phasing out are important; there is both synergy and tension between stability and change;
- ...the element of time is important; a transition goes through various phases; actions in the here and now affect the transition process in later phases;
- ...it is not possible to directly steer the process or manage it through policy; but government authorities do play an important role; they can use policy to influence the pace and direction of the transition;

- ...a huge number of different parties are involved; it is important to take into account this complex group in which everyone is moving the transition process in a certain way, but no one is able to control it completely;
- ...it is necessary to look with greater detail at subsystems, such as sectors or product groups; a transition is quite often a bundle of processes of change; the circumstances, direction and pace can differ per domain, subdomain or product group;
- ...development is unpredictable, non-linear and uncertain.

In addition to these overarching frameworks, there are others which focus more on specific roles or levels. For example, the role of intermediaries which connect parties to each other at the regional or municipal level (Campbell-Johnston et al., 2019; Cramer, 2020). Other levels are highly relevant to the unfolding of the transition. In this first ICER report, the focus is on the overarching level, because it is the most suited to the data available.

Monitoring the transition by means of eight key processes

Figure 4.2 depicts the transition framework as a set of gears. It contains eight components — cogwheels — that are used in this report to monitor and analyse the transition process (this framework has been worked out in more detail in Elzinga et al. 2020a). The components are crucial to the transition and are therefore also referred to as key processes:

- entrepreneurship (experimenting and scaling up innovations);
- developing knowledge;
- exchanging knowledge;
- guiding the search process (by stating goals and solutions);
- creating markets;
- mobilising resources;
- counteracting resistance to change (by creating legitimacy and intensifying the pressure for change on the established system);
- and finally, coordinating the complex bundle of different change processes that exist in the transition.

Partial picture of indicators per component

Based on the literature, indicators have been set up for each cogwheel in Figure 4.2. Ideally, the cogs are studied in connection with each other to establish the obstacles the transition is encountering. At present, structured and validated data are not available for each indicator. Therefore, this ICER report gives a partial description of one or two indicators for each cogwheel, based on the best available knowledge. The indicators are presented in the discussion of the results in Section 4.3. The key processes guiding the search process and coordinating are dealt with in more detail in Chapter 6, which focuses on the role of the government. The government can influence the direction and pace of the transition towards a circular economy, but this is not to say that the transition can be managed by the government alone.

Figure 4.2
Elements of a successful transition to a circular economy

Source: PBL 2013; based on Hekkert et al. 2021

4.2.2 Direction and pace of the transition process

In a set of gears, the cogwheels interlock; together they form a system. If something changes in one cogwheel, this will have an effect on the other ones. This means that it is beneficial to not only monitor individual parts, but also look at the relationship between the parts to draw lessons about the development of the transition. Below, the individual cogwheels are analysed first. To be able to say something about the direction and pace of the transition process, two criteria or ‘yardsticks’ are used — one corresponding to the R-strategies and the other to the transition phases. Then, Sections 4.4 and 4.5 examine the cogwheels in conjunction in order to interpret the state of affairs of the entire transition.

R-strategies to interpret the direction of the transition

The R-ladder offers various options for reducing material resource use. At the top of the ladder are strategies to reduce overall material resource use (narrowing the loop through refuse, rethink, reduce); further down are ways to postpone the need to obtain new material resources (slowing the loop through reuse and repair); and, finally, there are ways to make the flow of material resources come full circle (closing the loop through recycle).

To be able to give an indication of the direction of the transition, an analysis is performed of the extent to which actions and resources are deployed in line with the various R-strategies. All R-strategies are necessary to bring about a circular economy, but each one faces its own specific challenges. Strategies which are higher on the ladder, such as reusing and sharing products, usually require more numerous and more fundamental socio-institutional adjustments (PBL, 2019b; Potting et al., 2016). This will be discussed in more detail later in this chapter.

Characteristics of transition phases

In the literature on innovation and transition, progress of a transition is often represented by means of a series of phases. These may concern the development of innovations and the emergence of a new system, but also the extent to which an established system is being adapted or replaced. Figure 4.1 presents a stylised illustration of the development of a transition process through different phases. In the image, a circular economy is a new system that is emerging, and gradually replacing the established linear system.

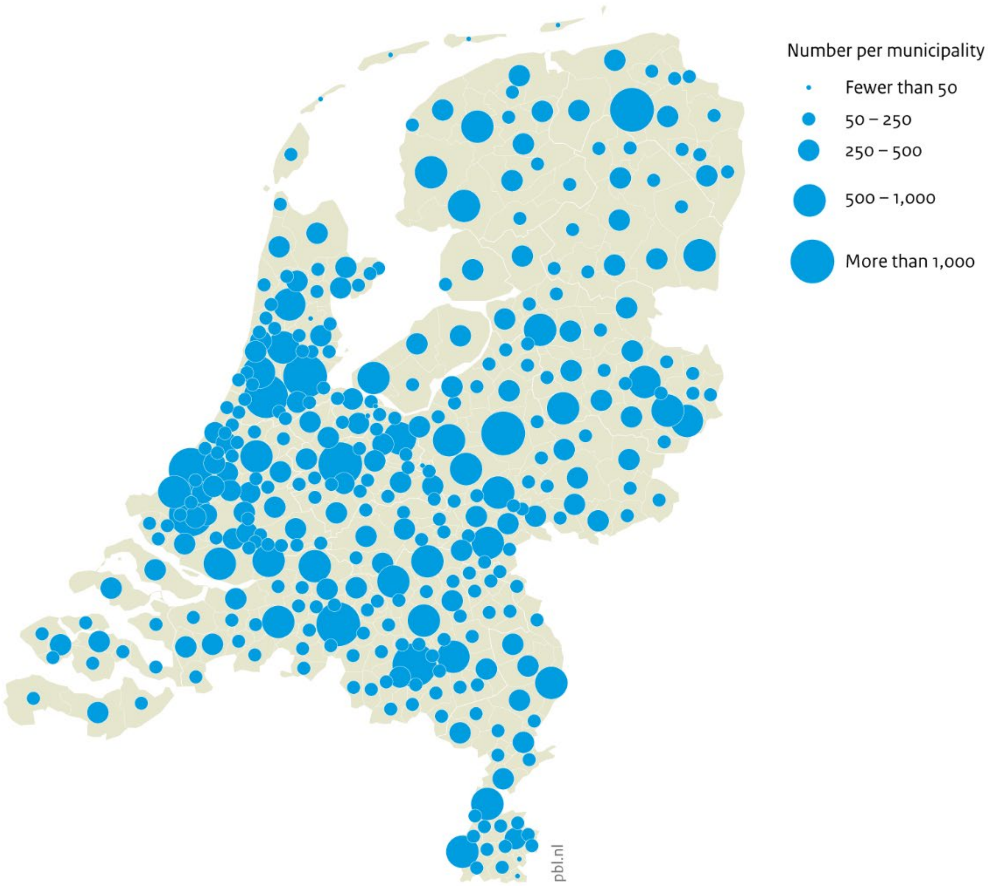
Table 4.1
Characteristics of each transition phase

Pre-development	Start up	Acceleration	Stabilisation
Many questions on knowledge, and much knowledge development	Entrepreneurs start commercial activities	Substantial market demand arises	Circular is the new normal
Entrepreneurs begin to experiment, sometimes radically.	Initiators start moving together and are visible	New rules and course are determined (institutionalisation)	Optimise the new normal
Renewal focuses on incremental innovation	The need to act becomes more pressing	Fierce resistance is mounted	Resistance has abated
The established system continues to function the traditional way	Fundamental debates about vision of and path towards the future	Contradictions and uncertainties	Dealing with disadvantaged parties

Typical features of the formative phase of the transition are experimentation with circular products and services, development of visions, creation of new networks and relationships in product chains, and new parties getting on board. It is not to be expected that this phase will already see major changes in material resource use and the related impacts. That will be different in the growth phase, when more and more effects will become visible of decreasing and changing material resource use. Examples are falling CO_2 emissions, and socio-economic progress stemming from growing added value from circular activities.

In practice, transitions will almost never go through the various phases in neat, linear progression. Each phase does have some characteristic features, the most important of which are listed in Table 4.1 (based on Bode et al. 2019; Hekkert et al. 2007; Hekkert 2020). Recognising the phase that the transition is in serves to visualise general and complementary starting points which both policymakers and other societal stakeholders can use to promote the transition to the next phase. It is important to realise that, depending on the sub-domains being considered, the transition may be going though different phases, for example because the transition in one particular domain started earlier than in others.

Figure 4.3
Circular businesses, 2020



Source: RHDHV 2020

4.3 Monitoring the transition process at the national level

4.3.1 Entrepreneurship

Entrepreneurs, both SMEs and large companies, are of crucial importance when it comes to introducing and scaling up innovations. They put new technologies, products and business models into practice. The transition towards a circular economy requires a sufficiently large number of ambitious entrepreneurs to scale up innovations and breakthrough novel methods. This ICER report looks at the number of circular businesses, whether innovative or not, and the number of innovation projects.

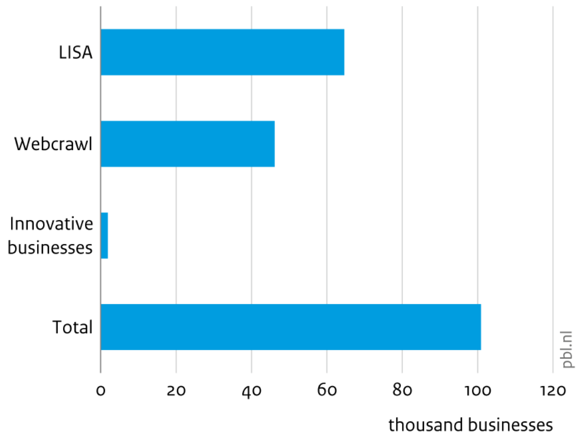
Number of circular businesses is growing

In 2018, there were more than 100,000 circular businesses in the Netherlands (Royal HaskoningDHV, 2020a). This amounts to almost 6% of the total number of businesses for that year. A circular business is any business that applies one or several R-strategies in practice (for further details, see Royal HaskoningDHV, 2020a). Figure 4.3 shows their regional distribution.

Text box 4.2: Counting circular businesses

Three inventories were used to determine the number of circular businesses (a full explanation can be found in Royal HaskoningDHV, 2020a). These were: (1) existing statistical data included in the LISA companies database, which identified about 65,000 circular businesses; (2) the results of a web crawl which located about 46,200 circular businesses; (3) the results of a detailed search exercise which found almost 1,900 innovative circular businesses.

Figure 4.4
Sources for the inventory of circular businesses, 2020



Source: RHDHV 2020

The total number of circular businesses is smaller than the sum of the three sets, because an organisation can appear in more than one inventory. After using Chamber of Commerce registration numbers to check for double counts, the identified circular businesses were combined into a single file.
It is not possible to make a direct comparison with the 2016 calculation of circular companies. That effort resulted in an inventory of 85,000 circular activities that were being carried out by of all kinds of societal stakeholders. The current count only considers circular businesses and includes a much higher figure from the web crawl. In addition, all business sectors have undergone another careful examination and an assessment for circularity, which has led to a number of changes. For example, the sector 'interior cleaning of buildings' was no longer included as a circular activity in the latest count.
The sectors 'public libraries' and 'retail in spare parts for electrical household appliances' were not included in previous counts, but now they are. The new classification of business sectors has been retroactively applied, insofar as possible, to the previous calculation.

No accelerated growth observed in the number of circular businesses

Directly comparing the figures mentioned above (Royal HaskoningDHV, 2020a) with the previous calculation over 2016 (PBL, 2019b) is complicated due to several substantial differences in the applied measuring methods (see Text box Counting circular businesses). However, it is possible to compare some of the data, because both calculations used existing statistics (see the LISA data in Text box 4.2) and the 2016 results have been retroactively corrected according to the new method. The comparison shows an 8.4% growth in the number of circular businesses between 2016 and

2018. The total number of companies in the Netherlands increased by 9.1% over the same period. Therefore, while the number of circular businesses did go up, the increase was proportionately smaller than that in the total number of businesses in the Netherlands. This is not an indication of an accelerating transition process.

Most circular businesses focus on repair

Almost 80% of the circular businesses focus on the R-strategy repair (Figure 4.5). These are mostly vehicle repair shops. Other relatively large business sectors that apply this strategy are those dedicated to repairing and maintaining machinery, electronic equipment (excluding consumer electronics), ships, furniture and other consumer goods. The R-strategies recycle and reuse rank second and third in terms of the number of businesses adopting them.

The repair category is also the one that grew most in absolute terms compared to 2016, mainly due to an increase in the number of businesses aimed at trade and repair of cars. The number of businesses adopting other R-strategies has remained practically the same, as has the distribution of businesses across the transition themes.

Innovative businesses and start-ups focus mainly on recycling

In 2018, there were about 1,900 innovative circular businesses[8], which is about 2% of the circular businesses in the Netherlands (Royal HaskoningDHV, 2020a). A circular business is considered innovative if, in addition to using an R-strategy, it introduces a business model, product design or technology that differs from the market standard. Most innovative businesses, such as various sharing platforms, fall under the theme of consumer goods.

What is striking is that the vast majority of innovative businesses (66%) focuses on recycling. Examples are StoneCycling, which makes building materials from construction and demolition waste; Rubber Upcycling, which makes new materials from old car tyres; RetourMatras, a company dedicated to recycling old mattresses; and Eastman Chemical, which focuses on chemical recycling of plastics without loss of quality. After recycling, the R-strategies that most innovative companies focus on are refuse and rethink (10%) and reduce (6%).

There are about 190 innovative start-ups (not older than three years old). Most innovative circular businesses are in the age group of 28 years or older. This means that it is mainly the established companies that are actively innovating within the circular economy. Amongst both young and established companies, the emphasis is on recycling.

Innovation projects supported by RVO also focus mainly on recycling.

Another indicator for innovative entrepreneurship comes from a study conducted by the Netherlands Enterprise Agency (RVO). The agency operates on behalf of the Dutch Government and facilitates entrepreneurship, for instance by implementing incentive programmes, such as subsidies, Green Deals and tax exemptions. It also takes on the role of partner in a wide range of supporting programmes, such as Nederland Circulair, the Green Deals and the Knowledge and Social Innovation Programme DuurzaamDoor.

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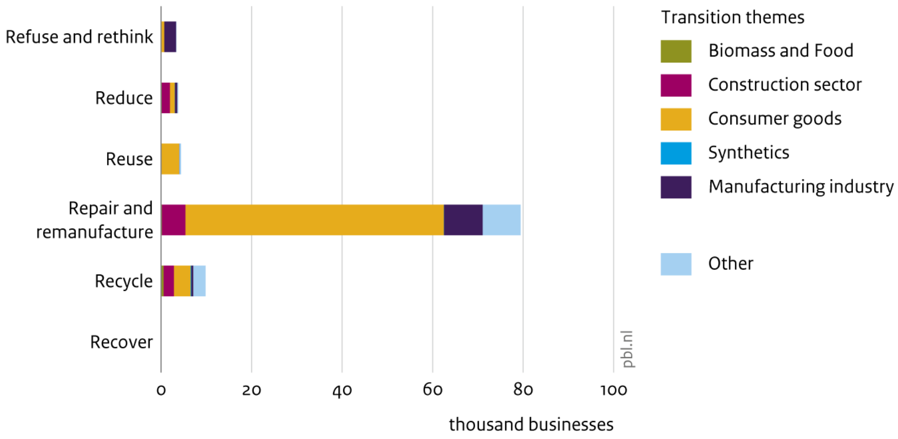
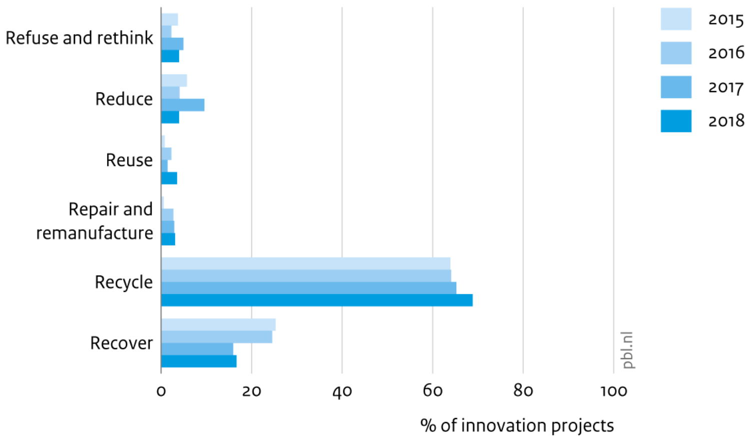
[8] This figure is not comparable with the previous calculation, because the method of identifying innovative businesses has been changed completely

Figure 4.5
Circular businesses, per R-strategy, 2020



Source: RHDHV 2020

Figure 4.6
Share of innovation projects per R-strategy



Source: RVO.nl

RVO has mapped out the circular innovation projects that are included in its schemes (RVO, 2020). In 2018, there were 237 circular innovation projects; this is, incidentally, a lower figure than for previous years (Table 4.2).

Table 4.2
Number of CE innovation projects in the RVO database

	2015	2016	2017	2018	Total
Number of circular projects	546	470	365	237	1518

In 2018, almost 70% of circular economy innovation projects directed efforts to recycling and 15% focused on recovering energy from waste (Figure 4.6). These projects are of a mostly technological nature. The R-strategies higher up on the ladder are adopted markedly less often in innovation projects that received support from RVO. Most projects are related to the transition theme Biomass and Food, followed by the themes Manufacturing Industry and Plastics. The recycling innovations being applied in Biomass and Food mainly have to do with the use of biobased resources to replace fossil resources or non-sustainably produced resources.

Reflections on entrepreneurship

Several entrepreneurs are engaged in activities related to circularity. They can make use of various programmes that are aimed at supporting and promoting entrepreneurship, such as Nederland Circulair, the business support organisation Versnellingshuis and the instruments implemented by the RVO on behalf of the government. At present, more than 100,000 businesses are putting one or several R-strategies into practice. It is not possible to determine whether the number of entrepreneurs is high enough to help the transition advance.

Besides the number of businesses, it is also relevant to acquire insight into their turnovers and market shares. For the identified businesses, these data are not yet available in a complete and structured form. Nevertheless, it is possible to get an idea of the direction and pace of the transition based on the number of businesses.

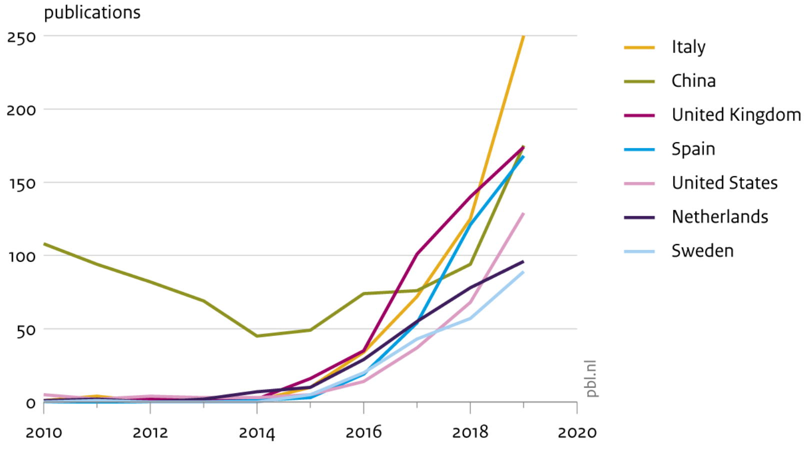
A notable fact is that, as mentioned above, the number of circular businesses has increased less than the total number of companies in the Netherlands. This is a sign that the circular economy has not yet entered a phase of acceleration. Also notable are the differences between the numbers of circular businesses across trade sectors. Most circular businesses focus on repair activities within a few specific sectors, such as car repair and bicycle repair. Repairing consumer electronics is apparently still not an interesting line of business, given that the number of companies there remains relatively low (around 600). Another striking observation is that the vast majority of innovative circular businesses is primarily aiming at recycling through technological innovations. This development path is proving to be attractive to entrepreneurs, given the number of innovation projects and start-ups with this central aim. The focus on recycling is also logical in view of past history. Thanks, in part, to earlier policy efforts, recycling has played a major role in the current production and consumption system for quite some time. The waste processing sector has been an important part of the economy for many years. The modest number of innovative businesses that focus on the higher R-strategies is an indication that for the business world it is still not interesting, or less interesting, to invest in them.

A challenge for entrepreneurs is to set up successful business cases for the higher R-strategies. Entrepreneurs themselves play a role in this, for example by enticing or convincing consumers through marketing and the products they offer. That does not alter the fact that the efforts of other parties are crucial to achieve a higher level of business activity aimed at the higher R-strategies. Entrepreneurs are part of the system, as are government authorities, consumers and investors. These other parties play a role in removing or maintaining the various obstacles there are to starting up and scaling up circular activities. This is illustrated in the other sections of this chapter.

4.3.2 Knowledge development

New knowledge, in all its forms, is necessary for innovation. Activities aimed at knowledge development are therefore of crucial importance in transitions. Knowledge development helps entrepreneurs, policymakers and others advance the circular economy. The following paragraphs first examine scientific publications to highlight a specific part of knowledge development, and then turn to research projects that receive support from instruments managed by the Netherlands Enterprise Agency RVO.

Figure 4.7
Number of scientific publications on circular economy, per country



Source: Türkeli 2020

The number of publications on the circular economy has increased greatly since 2014
Worldwide, the number of scientific publications that explicitly deal with the circular economy[9] increased markedly from over 70 in 2014 to more than 1,600 in 2019 (Türkeli et al., 2018; Türkeli, 2020). The rise from 2014 can be linked to the moment when the European Commission published its intention to work towards a circular economy. Besides scientists from institutions in China, scientists from EU Member States play a big role in these publications (Figure 4.7). Scientists from institutions in the Netherlands were involved in more than 6% of the works published between 2010 and 2019.

It is especially the technical disciplines that are involved
When surveying all publications, it is notable that it is the technical disciplines in particular that publish research on the circular economy (Kirchherr and Van Santen, 2019; Türkeli et al., 2018; Türkeli, 2020). These disciplines include the natural sciences, environmental sciences and environmental engineering. In the specific case of the Netherlands, it is evident that the disciplines that study water, soil and urbanisation are also active. Of the identified articles that were written by scientists in the Netherlands, more than half mention recycling or recover in the description of the subject matter, but not any of the other circularity strategies. The same picture arises when considering all articles published worldwide. Of this group, a small number (8%) discusses business models. The subjects policy and framework are covered more often (about 20% of articles for each). In articles by researchers from the Netherlands, the focus is more often on business models (20%) and the terms policy and framework appear, in comparison, more frequently (36% and 37%, respectively) in the subject description.

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[9] These are scientific publications that contain the search term "*circular* *econom*" in the title, abstract or running text. Therefore, papers that are related to the circular economy, but do not explicitly include the search term (e.g. publications on recycling technology or repair), are beyond the scope of the study.

For the transition to move forward, non-technical knowledge is also necessary

The technical disciplines are relevant to the transition towards a circular economy. But the transition has a strong socio-economic character and therefore, knowledge from non-technical disciplines is crucial to its progress. This has also been shown in previous studies. For instance, eleven researchers responsible for the leading publications on the circular economy have labelled the following topics as the most important for progress of the transition: new business models, extending product lifespans and political economy (Türkeli et al., 2018). Previous research has also shown that a large number of circular economy publications have a non-empirical nature, and that only 20% contains recommendations for the business world (Kirchherr and Van Santen, 2019).

Dutch research projects with government support focus mainly on recycling

The Netherlands Enterprise Agency has instruments that directly stimulate or support research projects (RVO, 2020). One of these is the SME Innovation Incentives Scheme for Regional and Top Sectors (MIT), which provides support for SMEs in technology development through feasibility studies and joint R&D projects (approximately 50–50). The 2018 budget for the MIT scheme totalled EUR 56 million, of which 10% was assigned to 112 circular research projects (Table 4.3).

Table 4.3
Number of circular economy projects under the MIT arrangement (NEA-database)

	2015	2016	2017	2018
Number of CE projects	162	93	106	112

What is notable is that, over the years, about 60% of the projects have been aimed at things such as recycling of waste, and also of residual streams from agriculture. About two thirds of those recycling projects have focused on biobased resources for use in, for example, the chemical industry. Those projects concern feasibility studies and product development. In 2018, attention for refuse and rethink intensified due to five projects that focused on the protein transition. They represented 13% of the total number of projects, whereas previously there had been none.

Another instrument is the bonus scheme for public-private partnerships. The government uses this to reward leading sectors, through the Top Consortium for Knowledge and Innovation Programme, for their use of industry resources in furtherance of innovation. In 2018, this programme invested over EUR 11 million, representing 8% of its total budget, in 24 circular projects. These are mainly research projects that are undertaken at universities, colleges of higher education and knowledge institutes, and that focus on recycling; of these, 90% are concerned with secondary material resources.

Reflections on knowledge development

In recent years, the number of publications on circular economy has increased, both internationally and in the Netherlands. These publications stem mainly from the technical disciplines. However, a great deal of the challenges and questions that arise in actual practice are more institutional in nature. How do you set up a successful circular business model? What policy mix is better at supporting the transition towards a circular economy? And how is the behaviour of companies and individuals to be brought more in line with circularity? All of this is not to say that technical knowledge does not contribute, or not sufficiently contribute, to the progress of the transition process. But there is a clear mismatch between the centre of attention of the knowledge base and the need for knowledge about business models in practice. The projects that come into view through the set of instruments employed by the Netherlands Enterprise Agency show a similar technical orientation, in which attention is directed particularly to recycling.

4.3.3 Knowledge diffusion

In addition to developing knowledge, having access to knowledge is important for innovation. The exchange of knowledge between entrepreneurs, government authorities, knowledge institutes and other organisations contributes to accelerating innovation and, through that, the transition itself. This ICER report presents an initial exploration from two perspectives. First, there is an overview of the number of circular conferences, events, seminars and symposia held in 2019. Secondly, there is an examination of a number of instruments managed by the Netherlands Enterprise Agency that focus strongly on knowledge exchange. The aim for the future is to have a more direct understanding of the degree of knowledge exchange between parties: is there sufficient exchange or do barriers exist here?

More than 100 conferences on circular economy in 2019

A total of 107 conferences, events, seminars and symposia focusing on the circular economy were held in the Netherlands in 2019 (Royal HaskoningDHV, 2020b). The National Conference on the Circular Economy was one of these. Almost half of these events were more general in nature and did not deal with any of the five transition themes as a specific topic. About one third of the events focused on the construction sector. The business world was the main target group in over 70% of the events. A far smaller number of events explicitly targeted government authorities and end users.

In Green Deals and DuurzaamDoor, knowledge exchange mainly concerns construction and biomass

The Netherlands Enterprise Agency runs two programmes that focus on the exchange of knowledge between different kinds of organisations. The Green Deals approach promotes cooperation between government authorities, entrepreneurs, civil society organisations, research, education and citizens (RVO, 2020). In a Green Deal, the participating parties work out agreements on circular initiatives and other matters. Since 2011, deals around the circular economy have also been reached. Examples include deals on circular procurement, circular festivals and circular buildings. Between 2016 and 2018, a total of 34 deals were reached, 18 of which focused partly or wholly on the circular economy. Most centred on the transition themes Construction Sector and Biomass and Food. Over the same period, one deal covered the theme Manufacturing Industry, and none addressed Plastics.

DuurzaamDoor is another instrument, which enables parties to cooperate and learn from each other (RVO, 2020). From 2016 to 2019, it managed 13 main projects of circularity. Most of these focused on Biomass and Food, followed by Circular Building.

Reflections on knowledge exchange

It is not yet possible to make a proper assessment of whether the current level of knowledge exchange is an obstacle to the transition or is high enough to move the transition forward. The current indicators (number of conferences and Netherlands Enterprise Agency programmes aimed at knowledge exchange) give only a partial impression of the role of knowledge exchange for the circular economy. For example, the indicators do not cover the government, even though some government initiatives have knowledge exchange as an objective. A case in point is the business support organisation Versnellingshuis, which gives entrepreneurs access to a network, knowledge and experts. This organisation allows entrepreneurs to share challenges and solutions, and offers matchmaking services. It also takes action with regard to other key functions, such as supporting entrepreneurs in attracting customers and obtaining financing. Another example of an initiative not covered by the indicators is CIRCO, an organisation that offers courses on circular business design. This ICER report does not study either of these crosscutting policy themes more widely.

A focus on knowledge exchange is of crucial importance and is appropriate for the initial phase of the transition. Municipalities and provinces regularly signal that there is a need for more knowledge sharing. This includes not just connecting front runners, but also informing third parties, and involving and inspiring them. Therefore, a subsequent ICER report will provide a closer examination of how knowledge exchange accelerates or hampers the transition.

4.3.4 Guidance of the search

At the beginning of an innovation project or a societal transition, there is often a great deal of uncertainty and disagreement. What exactly is the problem to be tackled and what is the best approach towards that? Giving direction to the search process, for example by spelling out expectations and visions, allows priorities to become clear and enables all kinds of parties to use their time, money and efforts in a more goal-oriented way. Chapter 6 discusses this more explicitly by looking at the targets set by the government. In a transition, it is important that societal stakeholders can eventually focus on a common goal or on broadly supported paths towards solutions.

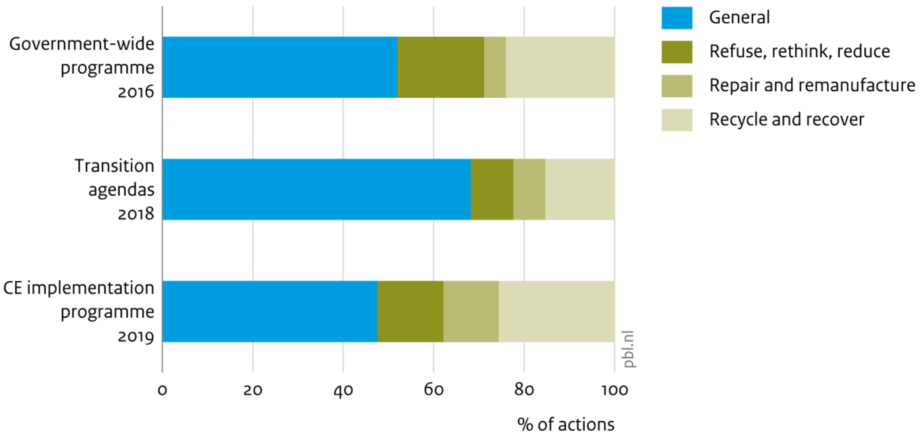
This section examines the actions taken by the government and the societal stakeholders involved in the transition themes. Although these actions may be related to all the key processes, they are discussed here because the analysis of actions is mainly intended to get a feel for the dominant direction within the transition towards a circular economy.

Many actions focus on exploring or describing plans and knowledge development

Since 2016, the government and the civil society parties involved in the transition themes have identified actions to accelerate the transition towards a circular economy (IenW, 2019; IenM and EZ, 2016; Transitieteam Biomassa en voedsel, 2018; Transitieteam Bouw, 2018; Transitieteam Consumptiegoederen, 2018; Transitieteam Kunststoffen, 2018; Transitieteam Maakindustrie 2018). It should be noted that the actions covered in the most recent implementation programme (IenW, 2020) have not been analysed yet, but will be examined in more detail, in 2021–2022. All the actions specified in the documents mentioned here have been analysed to ascertain what circularity strategy or what function of the transition process they focus on[10]. Many actions in the analysed documents (almost 50%) deal with the creation of an action plan, a roadmap or an exploration, such as the action plan for the production and use of biobased plastics (IenW, 2019). Even if only the actions in the implementation programme are considered, about half are found to be preparatory in nature. It is logical that such actions are taken at the beginning of a transition.

[10] RIVM (2020) started up the analysis; RWS (2021) applied several methodological changes, such as analysing all actions for both circularity strategies and innovation functions.

Figure 4.8
Share of actions per circularity strategy



Source: RWS 2021

If the actions are considered through the lens of innovation, and assigned to a key process, it becomes clear that many actions in the analysed documents are aimed at knowledge development. In the implementation programme this is the case for about half of the categorised actions. This concerns things such as drawing up action plans and exploratory studies, or pilot projects where circular business models are tried out. In addition, about one fifth of the actions in the implementation programme is related to knowledge exchange. The Government-wide programme for the Circular Economy and the transition agendas contain a considerable number of actions which, in addition to knowledge development, focus on the key process of giving direction to the search process. These are, for example, actions related to the development of a roadmap for a certain sector.

Actions are mostly general in nature or focus on recycling

Most actions in the analysed documents are not aimed at a specific circularity strategy (Figure 4.8). Many overarching actions have been formulated, particularly for the transition themes Manufacturing Industry and Construction Sector. In those cases where actions do focus on a specific circularity strategy, it is usually recycling. This applies to all the transition themes, except Construction Sector, for which the defined actions are almost exclusively general in nature. Under the themes Consumer Goods and Plastics, there are ten actions that focus on the highest circularity strategies. These include, for example, preventing waste, launching flagship projects that focus on sharing and product-as-a-service models, and actions aimed at avoiding the use of non-recyclable plastics or additives, such as microplastics in cosmetics.

4.3.5 Market formation

In general, at this moment, there is no large market demand for new circular materials, products or services. There are various reasons for this. It may be that new products or services have not yet been fully developed or that consumers are still very much used to traditional products or services. What is ultimately important for progress of the transition is that a market demand arises for circular material resources, products and services. This requires marketing, investments and other forms of support by the government and other parties. If a substantial and stable market demand arises, it will give entrepreneurs and investors the confidence to invest and scale up. This ICER report studies a number of instruments used by the government to enhance market demand.

Increase in investments in circular business assets through the MIA/Vamil regulations

The Netherlands Enterprise Agency is running two schemes to make it financially attractive for companies to invest in sustainable business assets. These are the Environmental Investment Deduction regulation (MIA) and the Arbitrary Depreciation of Environmental Investments regulation (Vamil). They contribute mainly to market creation in the business-to-business field. The Netherlands Enterprise Agency and the Ministry of Infrastructure and Water Management manage a register known as the Environmental List which details business assets that are eligible for tax deductions under the MIA/Vamil schemes. The Enterprise Agency has categorised 72 of the 182 business assets on the 2018 Environmental List as circular. Examples include installations for nappy recycling, carpet tiles containing at least 60% recycled material, and shower systems that use water recycling.

In 2018, of the overall government contribution through MIA/Vamil, about 16% (EUR 52 million) was assigned to circular economy projects (Prins and Rood, 2020). The share going to such projects is therefore still relatively small, but it has been increasing steadily in recent years. Investments in circular business assets grew more than four-fold between 2015 and 2018 (RVO, 2020). In terms of size of the government contribution, the MIA/Vamil schemes are amongst the most important instruments of the Netherlands Enterprise Agency for supporting the transition towards a circular economy (RVO, 2020). It should be noted that private money is also being invested in these business assets in addition to the public funding. Taken together, private-party and government investments oriented towards circular activities amounted to more than EUR 552 million in 2018. Section 4.3.6 provides a more detailed discussion of the deployed resources.

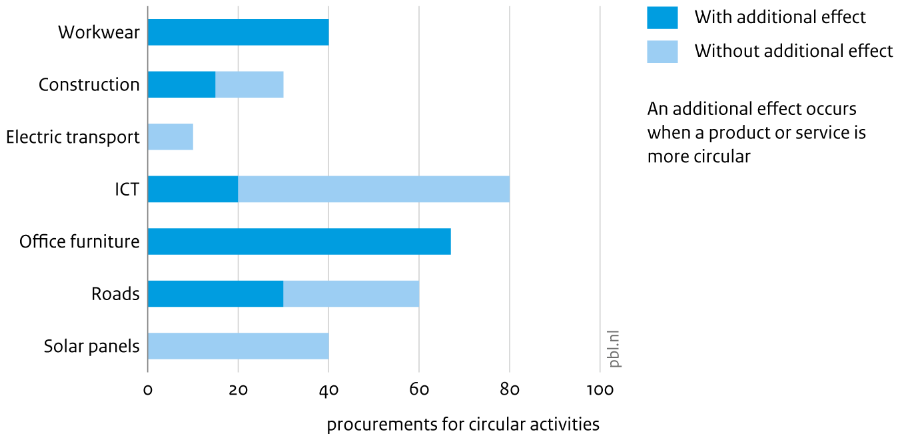
Volume of government procurement can influence market

The government can also directly create market demand by purchasing circular products or services. The government stimulates the supply of circular products and the uptake of circular production processes on the market through the volume of its procurement — EUR 73 billion per year by national and lower-tier authorities (EZ, 2016) — and by setting requirements for material resource use and environmental impacts when purchasing products and seeking tenders for works.

In government procurement, attention to circularity requirements varies by product group

In 2017 and 2018, the government gave thoughtful consideration to circularity in the procurement of various product groups. Figure 4.9 shows that the proportion of procurements with circularity requirements varied from 10% in the group of electric transport to 80% in the group of ICT (Zijp et al., 2020a). This includes procurement by the national government, other government authorities, schools, hospitals and the body for nature reserve management Staatsbosbeheer. Similar research covering the 2015 to 2016 period shows the same range of percentages (Van der Valk et al., 2019). The National Institute for Public Health and the Environment estimates that 53% of the examined tenders with circularity requirements resulted in a more circular product or service than would have been obtained through a tender without circularity requirements (Zijp et al., 2020a). This is illustrated in Figure 4.9. The achieved levels of circularity differ per product group.

Figure 4.9
Number of procurements, per product group, 2017 – 2018



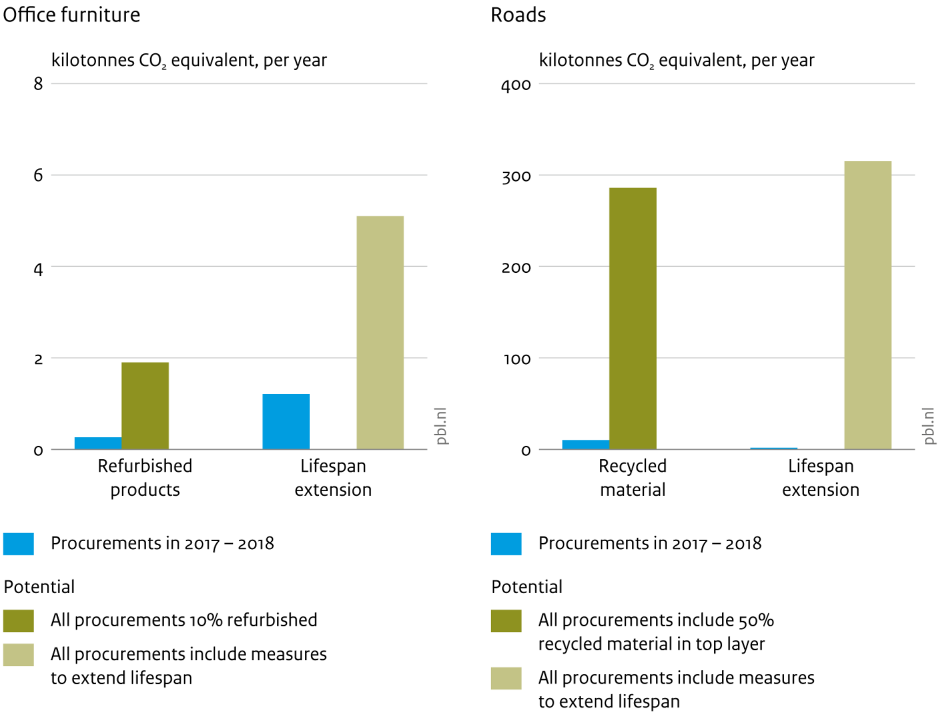
Source: RIVM 2020

Circular procurement has been promoted more intensively since 2018
As of mid-2018, the number of initiatives to promote and facilitate circular procurement has increased markedly. Initiatives include the Green Deal Circular Procurement 2.0, the Green Deal Biobased, the Green Deal Sustainable Care, the Circular Procurement Academy, the Circular Procurement Handbook, the Learning Networks Climate Neutral and Circular Procurement, and more than 200 pilot projects for climate neutral and circular procurement which count on expert support from the climate envelope budget (Zijp et al., 2020b).

More environmental gains possible through more innovative and more ambitious circular procurement
The circular strategies that received the most encouragement through circular procurement in 2017 and 2018 were reuse (18%), repair (32%) and recycling (22%). What is notable is that circular procurement is often applied in ways that are not very ambitious or innovative. A case in point is that the procurement schemes for several products are setting circular requirements that do not encourage producers to make their operations even more circular. In the recycling of solar panels, for example, requirements have been imposed to recycle the glass and aluminium. But this was quite often already being done. A more ambitious requirement states that the critical materials incorporated in the panels are also recycled (Koning et al., 2020). For certain product groups, circular requirements were already being imposed before the topic of circular procurement received explicit attention. In the procurement of ICT devices, for example, it has been standard procedure for quite some time to ask explicitly about the availability of components over a certain period of time, and, in the case of earth-moving projects, excavated soil is habitually used in locations that are as near as possible to the excavation site (Koning et al. 2020). But it is possible to distinguish a few innovative examples of circular procurement, such as the purchase of refurbished office furniture, or tenders for workwear and roads that are made with a certain percentage of recycled materials (Bijleveld and Uijttewaal, 2020; Zijp et al., 2020a).

Circular procurement has the potential to reduce material resource use and CO_2 emissions
The potential of circular measures has been explored for four product groups: What would happen if all government authorities imposed one or two circularity requirements for these groups? Analysis shows that this could bring about considerable savings in material resource use and considerable reductions in CO_2 eq emissions (as shown in Figure 4.10).

Figure 4.10
Avoided greenhouse gas emissions as a result of circular government procurements



Source: RIVM 2020

It is estimated that circular procurement of office furniture would have the effect of saving almost 600 tonnes of material resources and avoiding 2.9 kilotonnes of CO2 eq emissions. For circular contracting of road construction, the figures are 0.3 million tonnes of material resources and about 24 kilotonnes of CO2 eq (over a two-year period). The estimated effect of circular procurement of work clothing with a high percentage of recycled textiles is — based on data for 2017 and 2018 — at least 567 tonnes of saved material resources and 2.6 kilotonnes of avoided CO2 eq (Bijleveld et al., 2020). As for the product group of renovation and new construction of office buildings, the exploration found that half of the assumed measures would have no effect, while the effects of the other half could not be determined due to lack of data on realisation (Tokaya et al., 2020). For solar panels and electric transport, it is estimated that the assumed procurement criteria would not have any effects (Koning et al., 2020).

Realising environmental gains through circular procurement is not easy
The potential environmental gains are many times higher than the effect being realised at present. A certain level of effort is required for the actual realisation of the potential effects. For example, in strategies aimed at extending the lifespan of products, it is vital that the organisation using the products takes explicit action to ensure that they actually are used for a longer period. If furniture is purchased that can last for 20 years, but is replaced after only 5 years, a large part of the potential gains as to material resources and the environment are lost. It has been found that extending product lifespans is not always ensured in corporate culture and management (Zijp et al., 2020a).

Making tender projects more ambitious requires increased knowledge of and cooperation with the market. This is necessary to get to grips with, on the one hand, the possibilities the current technologies do and do not offer market parties (e.g. the highest possible percentage of recycled fibres in a material) and on the other hand, the possibilities for supplying products and services that are more circular if there is structural demand from an authority issuing tenders. For practical implementation too, coordination is required. A point to consider when refurbishing office furniture is the conditions under which components may be replaced. For example, whether or not it is acceptable to use fabrics with faded colours (Zijp et al., 2020b).

Usually, it is the smaller procurement departments in particular that do not have the time or capacity to do these things. In addition, purchasing officers may be deterred by the risk of facing a lawsuit, which may increase if they set requirements that many market parties cannot meet and that are more difficult to compare objectively from a legal standpoint than from a standpoint of price alone (Edwards, 2020).

It also regularly happens that sustainability criteria are ultimately not implemented in practice. This is the case when, for example, a call for tender includes a requirement for a sustainability plan, and during implementation the plans submitted by the supplier are abandoned for budget reasons.

Finally, for some product groups, the procurement volume of a single contracting authority is not large enough to influence the market. This applies to ICT, for example. For this reason, the Ministry of Infrastructure and Water Management is striving towards a European consortium for the sustainable procurement of ICT.

Reflection on market creation
The creation of markets for circular products and services is getting underway. The government is using various instruments to achieve this. Nevertheless, several major challenges remain. For example, substantial market demand only exists for relatively few circular products and services, whether innovative or not. A similar sign is also visible in the analysis of entrepreneurship. Through circular procurement, the government has the possibility to influence the market, foster circular entrepreneurship and reduce material resource use. The potential environmental gains are many times higher than the effect being realised at present. It is not easy to create actual markets and introduce changes into existing markets through circular procurement. There are, in addition, all kinds of other obstacles to market creation and entrepreneurship — and this is something which is not only a challenge for the government. Section 4.3.7 discusses several of those obstacles.

4.3.6 Resources mobilisation
Financial resources and well-trained employees are necessary for the transition to progress. A transition requires a sufficient number of competent employees, and also sufficient subsidies, investments and other forms of capital. If these resources are in place, ambitious entrepreneurs will be able to scale up. This ICER report describes what financial resources the government is making available for the circular economy in the programmes of the Netherlands Enterprise Agency, and what educational programmes are focussing on circularity.

Relatively small share of government budget for stimulating innovation and market introduction goes to circular economy projects
Companies can undertake research activities geared towards a circular economy or purchase innovative business assets with the financial support of the Netherlands Enterprise Agency. The MIA and Vamil tax deduction schemes have been discussed above; with 16% of the budget assigned to circular business assets, they are the largest government contribution to the circular economy within the set of instruments managed by the agency.

Another example is the promotion of the Research & Development Tax Credit Act (WBSO). It provides support for companies through a tax deduction on employer's costs linked to the tax on wages. Circular economy projects receive 3.2% of the WBSO budget. More than half of the tax exemptions granted through the WBSO goes to research companies and consultants and more than a quarter goes to the manufacturing industry (RVO, 2020). This distribution has remained stable for several years. The WBSO tax exemption only covers part of the overall project costs. The total research and development costs of the circular projects receiving this support amounted to EUR 216 million in 2018. Approximately 16.5% of this was covered by the WBSO, which means that the business world itself invested approximately EUR 180 million.

A study of the financial resources coming from other instruments of the Netherlands Enterprise Agency for uses toward the circular economy reveals varying but ongoing support for innovation (RVO, 2020). Due to the increasing focus on the circular economy, financial aid for innovation there is as large as the aid for innovation in the biobased economy, an area which had already been receiving attention for some time.

Financial resources are increasing slightly and becoming more structural

With regard to the financial resources the government deploys for the implementation of circular economy policies, two aspects are notable. Firstly, a shift is visible towards the provision of more structural resources. For instance, in both 2019 and 2020, incidental payments of EUR 8 million were made available for the Circular Economy Implementation Programme (IenW and MinFin, 2020). But now, in the budget of the Ministry of Infrastructure and Water Management, an amount of EUR 40 million has been assigned for the 2021–2024 period towards actual implementation of the Programme (IenW, 2020). The amount is broken down into EUR 15 million per year for 2021 and 2022 and EUR 5 million per year for 2023 and 2024. In addition, other ministries have drawn up budgets for the implementation of the transition agendas for which they are primarily responsible.

Secondly, financial resources destined for the circular economy predominantly come from climate budgets (also see Chapter 6). In the climate envelope an amount of EUR 10 million per year has been made available for 2021 and 2022 to bring about a reduction in CO2 through circular projects. On top of this, an amount of EUR 15 million per year is available for the 2023–2030 period. In all, EUR 25 million per year has been made available for 2021 and 2022. This is a comparatively limited amount, when considering the government contributions to the circular economy through some of the instruments managed by the Netherlands Enterprise Agency (i.e. EUR 53 million in the MIA/Vamil scheme and EUR 35 million in the WBSO scheme). The financial resources which the government dedicates exclusively to the circular economy are therefore relatively modest.

Number of study programmes focussing on the circular economy has increased

The courses available in the Netherlands that focus wholly or partially on the theme of circular economy have grown in number in recent years[11] (RVO, 2021). In the 2015–2016 academic year, circular economy was touched upon in 15 study programmes at 9 institutions for higher professional education. The offering ranged from an individual course to 7 study programmes. In

[11] At the level of intermediate vocational education, there are no courses that specifically address the circular economy. But all institutions at this level do give attention to sustainability in their study programmes

the academic year 2019–2020, the number increased markedly. The circular economy was covered in 46 study programmes at 17 institutions (in individual subjects, semester-long courses, minors subjects and masters programmes). This means that, at present, almost half of all 36 higher professional education institutions in the Netherlands focus attention on the circular economy.

At the level of higher education, a slight increase can be observed. In the year 2015–2016, the circular economy was included in 44 study programmes at 11 universities. In the year 2019–2020, this increased to 14 universities which focused attention on circularity in 58 study programmes (35 subjects, 6 minors, 2 bachelors courses and 15 masters courses). This means that 82% of the 17 Dutch universities in some way include the circular economy in their educational offerings.

In an international comparison (Ellen MacArthur Foundation, 2018) of the educational offerings related to circular economy at universities and schools of higher education in the period 2017 to 2019, the Netherlands and Finland occupied the top positions.

Reflections on mobilisation of resources

In recent years, increases have been observed in both financial resources and educational offerings. The attention given to the circular economy is modest, but clearly present. In this ICER report it is not possible to properly assess if the resources available are sufficient, or if they are inadequate and therefore form an obstacle to the progress of the transition towards a circular economy.

4.3.7 Counteract resistance to change and creating legitimacy

A transition often produces friction with the established system. It can generate resistance and needs legitimacy to develop into the new normal. A transition requires both the advancement of new systems, and the removal and conversion of existing systems. The current system of rules, standards, opinions and habitual practices is designed and based particularly on the linear take-use-waste economy. This means that circular products and services face various obstacles which affect all key processes. Below is a discussion of a number of obstacles that circular products and services are currently facing. This is followed by a closer look at the attitude and behaviour of consumers with regard to circular products and services.

Previous research (PBL, 2019b) has outlined several obstacles, the most important of which are listed here.

Insufficient pricing of environmental impacts

The fact that the environmental impacts of production and consumption are not fully factored into prices, if at all, forms a major obstacle to circular products and services. It means that there are not enough price incentives to use material resources more efficiently, and that investments in resource-saving products and services produce insufficient returns, or none at all (PBL, 2019b; Vollebergh et al., 2017). If environmental impacts are priced, for example in the form of a tax on fossil resources levied early in the production chain (Vollebergh et al., 2017), then it may become financially attractive to turn to alternative options, such using secondary materials (i.e. recyclate) instead of extracting new raw materials, or repairing defective products instead of throwing them away and replacing them. The next chapter discusses examples of instruments that respond to this issue, such as taxation of resources used to produce energy early in the production chain.

Markets for secondary resources are not operating properly yet

Markets for secondary resources are often not yet working at their potential. There is nothing that compels them to do so, because the prices of primary resources are low. But there are also other factors at play. For example, government policies are oriented primarily towards quantity of recycling (tonnes), which can obscure the focus on the quality of the recyclate. At present, volume-based policies concentrate on the amount of separated waste and not on as high-grade as possible applications of recycled material in products. This can be seen in the recycling of plastics and textiles, which is now often low-grade (Chapter 3), because the collected waste is of relatively poor quality. Due to these contaminated flows there is pressure on both yield and environmental gains, and markets for secondary resources are developing sub-optimally (Verrips et al., 2019).

Administrative burdens and concerns about image

Formal approval of circular products and materials often requires a long and costly procedure. For example, several residual flows fall under the legal definition of waste. As a result, businesses interested in processing these flows are required to apply for a waste processing permit. This creates additional administrative red tape and makes investing in this circular strategy less attractive. Businesses are also reluctant to apply for a waste processing permit, because in many markets the 'waste processor' label is detrimental to their image. For this reason, some businesses consider the use of recyclate 'undesirable'.

Lack of formal standards

Manufacturers prove the safety and quality of their products with standards such as the Dutch NEN for concrete structures or the ISO norms for bicycle tyres. For circular products, such standards are mostly inexistent. For example, the certification rules for ceramic tiles do not apply to tiles made of recycled plastic. In addition, it is often quite difficult to introduce such certifications for innovative techniques because existing parties are often closely involved in the defining of the standards, and they have an interest in maintaining the status quo. The lack of such standards for circular products is an obstacle to market acceptance.

Obstruction from legislation and regulations:

Existing regulations in various areas may form an obstacle to circular activities. A case in point is that it is often difficult to use recyclate because of the legal definitions and provisions on what things may or may not be considered waste, and on what may be done with waste, for example 'disposing' of it Taskforce herijking afvalstoffen, 2019). The implementation of regulations forms another obstacle. The rules around waste are often not interpreted consistently and experimenting with innovations is therefore difficult. The government is aware of the obstacles surrounding waste rules and their implementation, and has started up a range of programmes to address them (Taskforce herijking afvalstoffen, 2019). But regulations and laws in other areas can also hamper circular business models. This point can be illustrated with businesses applying the product-as-a-service model (e.g. those offering washing machines as a service). With the current calculation method, they score poorly on creditworthiness (solvency). These businesses need a relatively large number of products as working stock, and that requires a relatively large initial investment. The resulting longer payback period is typically qualified as risk-increasing by lenders. In addition, the residual value of product stocks is estimated to become considerably lower when initial users return products to the provider. As a result, lenders' screening processes see product-as-a-service businesses as relatively financially unhealthy. This puts off investors.

Impediments to licensing

Current regulations are not always properly attuned to circular production processes and products. Achieving this requires experiments, assessments and exemptions to give circular products and services a real opportunity and to learn what the corresponding regulations should look like. However, licensing officers and enforcement officers use standard procedures in risk assessments in order to process applications efficiently. These procedures are often risk-averse, even when laws and standards offer room for change or experimentation. Moreover, for fear of suffering legal consequences, licensing officers often do not dare to stray from a strict interpretation of laws and regulations. This may pose an obstacle for new circular production processes.

Consumers are sluggish in adapting their behaviour

Consumers generally buy the same 150 products which satisfy 85% of their needs (Schneider and Hall, 2011). This routine purchasing behaviour impedes the creation of markets for new, circular products. Consumer attitude and behaviour are discussed below in more detail.

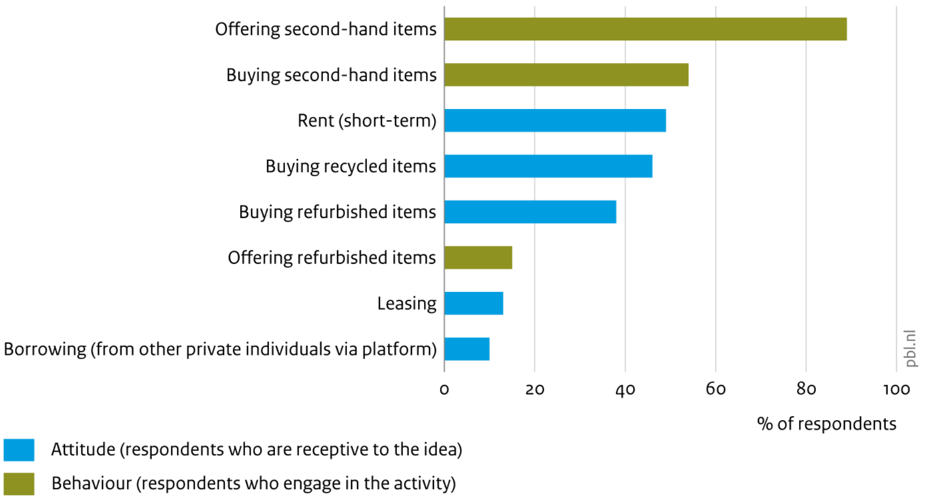
Half of consumers already buy second-hand products, but are less receptive to other circularity strategies

Nine out of ten Dutch consumers occasionally offer second-hand products for sale. This is most often done on online platforms, such as Marktplaats or eBay. The main reasons for people to offer their things for sale are that they think it is a shame to throw things away, to make some money from it, and to give others the chance to reuse things (Kantar, 2019). The number of people who actually buy second-hand items is smaller, about 55%. The things that consumers are most willing to buy second-hand are books and magazines, vehicles, and small pieces of furniture. The most frequently given reasons for buying second-hand items are: saving money, not having the need to possess the newest of the new, the fun of looking for special objects and products, and contributing to a better environment (ABN AMRO, 2018; Kantar, 2019). The reasons for not being open to second-hand products have to do with doubts about the quality, lifespan and hygienic condition of the products, and with the stigma surrounding second-hand (ABN AMRO, 2018; Kantar, 2019). Respondents indicate, for the greater part, that they are not open to buying second-hand sports items or bedroom articles. In addition, 12% of consumers would not like to run into acquaintances in a thrift shop (Kantar, 2019).

The acceptance of circularity strategies other than reuse is lower (Figure 4.11). Options shown to be unattractive in particular are borrowing products through a sharing platform and leasing products for a year or more. The longer the lease period, the less consumers are open to the idea of leasing. In product-as-a-service models, the alternative payment structure is also a serious obstacle; given the choice, consumers prefer take-back models which use a kind of deposit system (Elzinga et al., 2020b). Consumers are afraid that leasing or borrowing will lead to additional fuss and costs, and prefer to borrow things from people they know (ABN AMRO, 2018).

Less than 40% of consumers are receptive to the idea of buying refurbished products and only 15% has ever offered products for refurbishing (ABN AMRO, 2018). Consumers are often not open to the idea because they prefer new products, they have little confidence in the quality, and the price difference with a new product is too small (ABN AMRO, 2018). The low level of confidence in the quality of refurbished products has also been confirmed in other studies (e.g. Guide and Li, 2010; Hazen et al., 2012; Michaud and Llerena, 2011; Weelden et al., 2016). According to Weelden et al. (2016), this is mainly because of the lack of knowledge and understanding of what refurbished means. In the case of mobile phones, a share of the consumers equates refurbished with second-

Figure 4.11
Consumer attitude and behaviour with regard to circular products and services, 2018 – 2019



Source: ABN AMRO 2018, Kantar 2019

hand (Van Weelden et al., 2016). In the ABN AMRO survey, half of those who are open to buying refurbished products indicated that they have confidence in an item if it has been checked by an expert.

Reflections on counteracting resistance to change and creating legitimacy

Existing rules, norms and behaviours create obstacles to the transition towards a circular economy. Chapter 6 discusses the instruments the government is using to reduce or remove these obstacles. The current insights into consumer attitudes and consumer behaviour show that we still have a long way to go before circularity becomes the all-encompassing new normal. A level of acceptance of more than 50% can only be seen in the case of reuse of second-hand products. It is still too early to draw conclusions that are not marked by caution. This is because research in this field is still relatively young, and depending on the way questions are framed, widely varying results may be found. For example, a survey by the University of Groningen and the scientific support organisation Het Groene Brein (2019) shows that 78% of Dutch consumers are more or less willing to adopt a pay-for-use model instead of owning products. As indicated above, this readiness can also vary substantially across product groups. Consumers are more open to buying second-hand books than second-hand mattresses. It should be stressed that this section can only provide a partial picture. To better understand the progress of the transition, and to be able to make better assessments, it is highly relevant to study the resistance and behaviour of businesses. Follow-up research is needed to gain these insights.

4.4 The transition process in sub-domains

The transition towards a circular economy requires changes in all sectors and product groups. Due to the great differences between products and sectors, it is likely that the processes of change will also differ in terms of pace and direction. By taking a closer look at specific production chains or product groups, it is possible to obtain more detailed information on how to direct changes. To get a feel for the differences and similarities, four sub-domains have been studied in more detail.

These are plastic packaging, appliances produced by the manufacturing industry, clothing, and plant-based meat substitutes. For the first three product groups, the study involved conversations in workshops and personal interviews with an average of 15 people active in each group (Hekkert et al., 2020; Elzinga et al., 2020c). For plant-based meat substitutes, an ongoing in-depth study at Utrecht University was used (Tziva et al., 2020).

Progress of the transition varies per domain

Considerable differences can be distinguished between the various product groups. In the cases of plant-based proteins and plastic packaging, there is a long history of experimenting with circular solutions. For a long time, the government has been working on persuading the packaging industry to make a transition. This has resulted in a well organised innovation system in which the required financial resources are generated by the Waste Fund, knowledge is developed in the Sustainable Packaging Knowledge Centre and short lines of communication have developed between the sector and policymakers. Another feature of the product group of plant-based proteins is that a flourishing sector has emerged, in which the coordination of activities is becoming greater and greater. In the textile chain and the manufacturing industry, the circular economy has only recently appeared as a subject on the agenda, and progress is still limited.

For plant-based proteins and packaging, the transition started not because the theme of the circular economy was being addressed, but for other societal reasons. In the case of plastic packaging, changes were introduced by waste policies; as for plant-based proteins, a search for meat substitutes has been going on for decades, motivated by animal welfare, the impact of meat production on the climate, and the negative effects that meat consumption has on health. In recent years, the initiatives around plastic packaging and meat substitutes have been integrated into the transition towards a circular economy.

Market demand is the driving force for plant-based proteins

The switch from animal to plant-based proteins is seen as a circular solution, because it can bring about a notable decrease in material resource use and its associated effects. As such, it occupies a prominent place on the Biomass and Food transition agenda. A fairly small but stable market for meat substitutes has existed for some time (PBL, 2020e). Vegetarians and vegans were the principal consumers of meat substitutes.

The whole playing field changed drastically following the development of a new protein extrusion technology that makes it possible to produce plant-based proteins with a similar ‘bite’ as meat. Thanks to the quality leap enabled by this technology, and also to ambitious entrepreneurship, the market demand for meat substitutes increased. A large group of flexitarians arose who considered the new product to be convincing enough to consume less meat. The growth of the market attracted larger food companies. At present, a mix of entrepreneurs is active on the Dutch market, including newcomers such as Beyond Meat, major food companies such as Unilever — which took over The Vegetarian Butcher — and even conventional meat companies that are transforming their production lines into plant-based operations. What is noteworthy is that government policies have played a limited role in this development, though in the early stages, the government did finance research into the new extrusion technology.

Circular concept has secured a place on the strategic agendas of the packaging, clothing and appliances industries

While the transition towards the increased use of plant-based proteins is not driven by circular arguments, the circular economy does act as an important theme in the other domains. In the case of the textile and manufacturing industries, the circular economy is starting to become a familiar idea and a sense of urgency is developing amongst industrial parties. As a result, circularity has secured a place on the strategic agenda. This is a crucial first step in the transition process. In the case of packaging, recycling and reuse have already been on the agenda for much longer and existing initiatives have their place within the circularity framework.

Lack of a market is obstacle for plastic packaging, clothing and appliances

In contrast to the developments in the domain of meat substitutes, in the domains of textiles and appliances, large players are reluctant to experiment with circular business models and scale them up. During the workshops, businesses mentioned the absence of market demand as an important reason for this. Parties in both sectors state that consumers are not very interested in circular products yet and are only minimally inclined to pay for them or to adjust their behaviour. In the case of textiles, this applies to end consumers, and for the manufacturing industry, it is about business-to-business interactions. The parties also point to the lack of policy measures that make circular products more attractive or mandatory. Due to the lack of market creation, businesses are very cautious about investments in circular products.

In the case of plastic packaging, a collection and recycling policy has been in place for a long time. An infrastructure has been built to this end and many parties are active in collection, sorting and processing. Nevertheless, during the workshop, parties indicated that the lack of a market currently poses a major obstacle to further development. There are sufficient initiatives to generate a substantial secondary material flow, but there are not enough options to sell the recyclate. Packaging companies still choose to work with primary resources, especially because of the low price of oil. In addition, there is little pressure (or other kinds of incentives) on packaging companies to opt for recyclate. Within the Plastic Pact, voluntary agreements have been reached on the application of minimum percentages of recyclate, but they have not yet led to a meaningful increase in demand for recyclate. The sector indicates that it is also necessary to educate consumers so that they accept products made of secondary materials, and that packaging companies should gain more knowledge about the possibilities of secondary materials.

Efforts by both government and businesses are required to create markets

Many of the businesses that took part in the workshops stated that the government is not taking enough action to force the creation of a market for circular solutions. At the same time, it can also be asserted that businesses are not enterprising enough to make circular products that are sufficiently interesting for consumers to buy on a large scale. For example, at many businesses, circularity does not yet feature prominently on the R&D agenda. Nor have marketers applied themselves to the subject yet. Until now, circularity has for the most part been the domain of sustainability officers. Consequently, there is a vicious circle in which the lack of market demand means that the circular economy barely features on the R&D and marketing agendas; this, in turn, means that no interesting proposals are put forward to ensure that customers make a choice for circular products and services. It is important to break this vicious circle to advance the transition towards a circular economy.

Newcomers are showing what the possibilities are
In the sub-domains of clothing, plant-based proteins and appliances, the most pioneering initiatives are being undertaken by either newcomers or smaller existing parties who surely have something to gain from circular innovations by being unlike conventional and larger companies. These smaller parties are important to show new and promising ways forward. Newcomers in the manufacturing industry are adopting completely new business models that are based on novel product-service combinations, and offer use of a product instead ownership of a product. These new parties still make use of the products that are supplied by existing major players. In the case of textiles, the new parties are textile shredders and yarn spinners who are experimenting with new materials based on recycled fibres, and new clothing brands who are developing fully circular business models. In the case of the protein transition too, the new companies were the first ones to recognise the potential of the new extrusion technology, develop attractive products and tap into a new market segment.

Path dependency makes prevention, reuse, and use of recyclate challenging
As mentioned above, the packaging sector has been governed by long-standing policies and is well-organised. This was originally motivated by the Dutch waste policy, which has been transformed into the circular economy policy. However, the fact that the policy initially aimed at reducing waste has major consequences for the way the circular economy policy is implemented today.

In the past, the policy was aimed at preventing as much waste as possible. As a result, the focus was on volume targets: separate as much plastic as possible from the rest of the waste in order to reduce the overall amount. The idea was therefore not so much to be able to achieve high-grade applications of recyclate in plastic products. To make successful applications of recyclate possible, minimum quality requirements are needed for it. The higher the quality of the recyclate, the easier it is to use.

In recent years, it has been recognised that there needs to be a shift from volume-based policy to enhancing the quality of recyclate and ensuring it is actually applied in products. This is visible in the Transition Agenda for Plastics and the Plastic Pact. However, it is likely that improving the quality of recyclate and expanding the scale of its application will still require some time. Another noticeable point is that strategies high on the R-ladder, such as reuse, refuse and rethink, are not receiving that much attention. It could therefore be argued that the long history of this transition, which started with a focus on waste, has brought about a certain path dependency (or even lock-in) that excludes the higher R-strategies. Those earlier developments mean that it is difficult to implement radical changes, such as those required for prevention, reuse, a mandatory percentage for use of recyclate, and the application of the best available technology. At present, the Plastic Pact is making efforts towards introducing such changes.

4.5 Summary and conclusions

4.5.1 The situation of the transition process

Interest for the circular economy is growing

The circular economy is on the agenda of many societal stakeholders. Monitoring has shown there is development and growth in several areas. For example, the number of circular businesses has increased by 8% over the past two years; the number of scientific publications has risen each year since 2014; supporting instruments are in place which, in the past few years, have been providing more and more financial resources; the number of circular study programmes has increased, and almost half of the institutions for higher professional education and 80% of the universities in the Netherlands devote attention to circularity. Although only a partial picture of the transition can be presented, it is possible to discern a certain move forward.

The transition is still in the initial phase

The transition is still in the initial phase. Experiments with circular innovations are being carried out, but significant growth of the market for circular business models has not been observed yet. The limited market has an effect on entrepreneurship. For example, the overall number of businesses in the Netherlands has grown more than the number of circular businesses over the same period. The vast majority of circular businesses focus on repair, recycling and reuse. Engaged mainly in traditional activities, they include vehicle repair shops, recycling centres and thrift shops. The truly innovative initiatives are mostly small-scale. Furthermore, almost half of the examined actions taken by the national government and almost half of the parties involved in the transition themes (Section 4.3.4) focus on making action plans, roadmaps and exploratory studies. These are efforts that are typical of the initial phase of a transition.

The larger part of today's economy is still operating according to linear principles (Bode et al., 2019). Thanks to the increasing attention for the circular economy in policy programmes (also see Chapter 6), changes are taking place in the institutional context — that is to say, in the rules of the game. However, up to now only few fundamental changes can be observed that will lead to an acceleration of the transition by creating markets or intensifying pressure on established parties. In addition, there are still many different visions of the future, which are related to a range of problem definitions and paths towards solutions.

Progress of transition varies across domains

Still, the fact remains that in some domains established systems are being phased out or converted, or the transition is accelerating. The transition towards a circular economy is actually a bundle of change processes that can vary widely across different domains. In the domain of plastics, for example, it is possible to see phasing-out efforts, such as the ban on free plastic bags and the goals to prevent waste incineration and landfill. In addition, a market demand is emerging for plant-based proteins, which is causing developments in that domain to accelerate.

Innovation focuses mainly on technology and recycling

Most innovations are of a technological nature and focus on recycling. The knowledge base, as can be seen in scientific publications and research projects, is also highly technological and aimed at secondary materials. Less attention is given to innovations of a more socio-economic kind, such as new business models, or R-strategies higher up the ladder, such as reuse, refuse and rethink.

If no complementary actions are taken, the recycling track will remain dominant
Recycling is an indispensable aspect of a circular economy. All the same, from a transition perspective, a strong or one-sided orientation towards recycling also results in limits to potential environmental gains. Recycling fits in neatly with the existing production and consumption system. Recycling is about closing the loop, and does not deal with reducing overall material resource use (narrowing the loop) or extending the lifespan of products and components (slowing the loop). Consequently, large or radical boosts to efficiency of material resource use are not realised, which means environmental pressure will only decrease to a limited degree.

Worse still, if the attention for recycling is too one-sided, it can even become more difficult for other R-strategies, such as product reuse, to gain themselves a place. A circular economy needs more radical structural changes in the form of, for example, sharing platforms, product-as-a-service models and modular products. At present, businesses are only applying these circularity strategies to a limited extent, mostly because of the lack of substantial market demand. The higher R-strategies, such as refuse and rethink, reuse and repair, can contribute greatly to reducing material resource use, the environmental pressures related to that use, and the dependence on suppliers. A circular economy requires the application of the full repertoire of R-strategies, including recycling.

4.5.2 Insights serving to accelerate the transition process

A transition cannot be managed by the government alone. A complex whole of societal stakeholders is part of the process. However, the government can use policies to influence the pace and direction of the transition.

It is not possible to give an unambiguous indication of the pace of the transition, but there are signs that it is too slow. Several trends in material resource use and its impacts are not developing towards a circular economy, even though government targets have been set with 10-year and 30-year time horizons. Since the transition process precedes measurable and unmeasurable changes in, for example, the pressure on the environment and nature, it is necessary to take the transition to the next phase.

To step up the transition, it is crucial to pay attention to the direction it is taking. The one-sided focus on technological innovation in recycling often leads to some form of incremental improvements to the current system and not to a disruptive transformation of the system. In Chapter 3 it became clear that concentrating on recycling alone is not enough to halve primary resource use over a 10-year period. In addition, excessive attention for recycling initiatives can thwart the deployment of high R strategies, such as sharing and reusing products. Changes must be made to ensure the development and widespread application of the full repertoire of R-strategies, from reducing overall material resource use (refuse, rethink and reduce), to extending the lifespan of products and components (reuse and repair) and closing loops (recycle). These changes are to take place in the market, in the knowledge base, in business practices and consumer behaviour, and in legislation and regulations. The government is one of the parties that plays an important role in creating the right preconditions to enable the upscaling of circular initiatives. In consequence, the following chapters will shift attention to efforts made by government authorities.

5 European Circular Economy policies

Main messages

- The European policies on circular economy have their origins in environmental and material resource policies. The European Union sees a circular economy not just as a means to reduce environmental impacts such as greenhouse gas emissions and stay within the ecological limits of the planet. For the European Union, the circular economy is also an opportunity to enhance the competitiveness of the European economy and reduce supply risks around the import of critical materials, which are essential for the European economy.
- The transition towards a circular economy is a shared responsibility of the European Union and its Member States. The European Union plays an important role in the consumption phase and in setting minimum requirements through its product policies. Examples include extending the minimum warranty period of products, legislation on hazardous substances, the requirement for products to contain a minimum share of secondary materials, and the requirement to make it possible to reuse or repair product components. These kinds of aspects need to be regulated at the EU level for the entire internal market (level playing field). EU policies that focus on these issues are therefore also important for the Dutch ambition to accomplish a circular economy.
- Until now, the European Union has mainly used supporting, or 'soft', policy instruments that are aimed at a circular economy, such as knowledge-sharing platforms or frameworks for voluntary monitoring and reporting. Legislation, regulations and stringent objectives are still largely missing in circular economy policies, particularly with regard to the design phase and the consumption phase of products. Exceptions to this are the policies on waste and on energy consumption, where regulations have been in place for some time. On the other hand, in its second Circular Economy Action Plan (2020), the European Union has specified ambitions to extend existing 'hard' instruments (legislation and regulations, such as the Ecodesign Directive) to the circular economy, while focusing more intensively on design and consumption.
- The European Union is the largest economic trading bloc world-wide. This means that European circular economy policies also exert influence outside Europe through import requirements — for example the adoption of rules applying to material resources, materials, semi-final products and products made for sale within the European Union. The European Union is the largest consumer market in the world and therefore it can influence the standard for many producers. In this manner, the European Union can take on an important role in promoting the transition towards a circular economy on a global scale.

5.1 The evolution of European circular economy policies

The internal market as an essential part of European cooperation

An important pillar of the European Union is its internal market, the area without internal borders in which free movement of goods, persons, services and capital is guaranteed. The rules of the internal market apply directly to businesses in the Netherlands. Therefore, EU policies are important for the transition towards a circular economy both in the Netherlands and in the other Member States. This chapter takes a closer look at EU circular economy policies, at how they originated, the motivations behind them and the instruments the European Union has put in place.

This is followed by a brief outline of the developments taking place in the context of the European Green Deal and the EU Recovery Fund.

European circular economy policies have multiple foundations

The current EU policy on the circular economy originated along two tracks: environmental policies and material resource policies (Figure 5.1).

European environmental policies are anchored in the 2012 Treaty on the Functioning of the European Union, and seek to preserve, protect and improve the quality of the environment, protect human health and use natural resources prudently and rationally (European Union, 2012; Treaty Article 191). From the early 1970s, environmental policies have been developed through successive Environment Action Programmes, the seventh of which covers the period from 2013 up to 2020. The point of departure of the seventh Programme (European Commission, 2013) is that Europeans will be living well in 2050, within the ecological limits of the planet. To achieve this, a circular economy is important (European Commission, 2020d). The eighth Action Programme was published on 14 October 2020 and will be confirmed in 2021 (European Commission, 2020a). The Council of the European Union (2019) expects the plan to respond to the urgency of building 'a climate-neutral, green, fair and social Europe'.

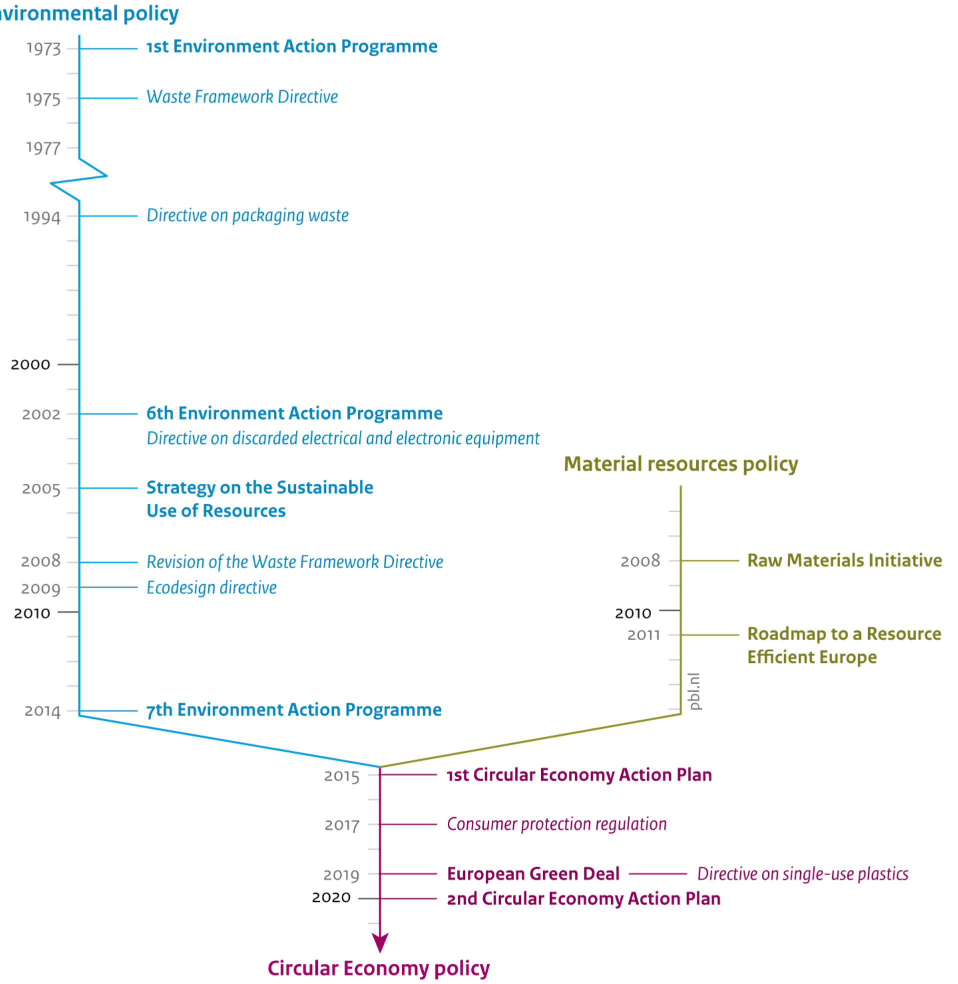
The basis for the EU material resource policy is the fact that European economies depend strongly on imports of material resources and that this may give rise to vulnerabilities (also see Chapter 2, Section 2.3.2). For example, security of supply may become compromised due to geopolitical tensions. The European Commission has launched a number of successive strategies to address such vulnerabilities. These policies are anchored particularly in the general economic policy and in efforts to protect a competitive European industry (European Union, 2012; Treaty Article 173). The role of the Commission here is primarily to coordinate and provide support.

With the 2008 Raw Materials Initiative, the European Commission initiated a strategy to secure access to material resources (European Commission, 2008). This was followed in 2011 by the Roadmap to a Resource Efficient Europe (European Commission, 2011) which made the move toward a coherent policy framework for material resource use. Analogous to the recent Environment Action Programmes, these initiatives on material resources aim, amongst other things, to increase material efficiency and to decouple economic growth from material resource use. The recent initiative in the field of critical resources (European Commission, 2020j) is another illustration that the European Commission considers the supply risks of critical materials for the European industry an urgent strategic issue.

Integral European circular economy policy is in the pipeline

The first circular economy action plan (European Commission, 2015) brings together, on the one hand, environmental policies and, on the other hand, material resource policies in an integrated policy framework (Figure 5.1). The action plan gives the initial impetus to the application of circular economy principles in areas such as plastics, water management and food systems. The initiatives include the promotion of circular product design, extended producer responsibility, product labelling, provision of services, and circular procurement by government authorities.

Figure 5.1
Developments that have lead to an integral circular economy policy in the European Union
Overview of main features



Source: PBL

In December 2019, shortly after taking office, the European Commission presented the European Green Deal (European Commission, 2019d). It is an ambitious roadmap that is meant to contribute to modernising the European economy with the goals of creating jobs, boosting competitiveness and achieving a climate-neutral Europe by 2050. The aim to support the transition towards a circular economy has been worked out in detail in the second circular economy action plan published under the Green Deal (European Commission, 2020i). This second action plan seeks to more firmly embed circular principles in existing EU instruments. With these steps, the European Commission wants to create adequate incentives and support harmonisation of policies between Member States. The European Commission has announced it will put forward legislative initiatives that are to ensure that products last longer, are easier to reuse and repair, and contain as many recycled materials as possible. Crucial aspects of the plan are the harmonisation of existing national approaches, and the improvement and broadening of extended producer responsibility to ensure more product groups are covered and eco-modulation of fees is applied. In this way, producers are, for example, discouraged from producing packaging that is difficult to recycle.

The first and second circular economy action plans are important steps in the development towards an integral European circular economy policy. The results include the 2018 plastics strategy (European Commission, 2018b) and the farm-to-fork strategy (European Commission, 2020g).

Environmental protection, economic growth and security of supply as the main motivations

The European Commission sees a circular economy as a means to reduce greenhouse gas emissions and pursue an economy that stays within the limits of the Earth's capacity regarding other environmental impacts too (European Commission, 2015). At the same time, the Commission sees the circular economy as an opportunity to boost the competitiveness of European economies. The Commission expects that new jobs will be created and economic growth will be supported through innovation, the creation of new revenue models (e.g. pay-per-use, rental, buy/sell-back, lease; see KPMG et al., 2019) and more efficient ways of producing and consuming, (European Commission, 2015, 2019b, 2020i). A strategically important additional motivation is the goal of ensuring the European Union becomes less dependent on imports of material resources, thereby limiting security of supply risks and the risk of rising and more volatile material resource prices. This applies particularly to critical materials, which are very important for the sectors that are deemed crucial for Europe's economic growth (also see Chapter 2.2).

5.2 Existing EU policy instruments for circular economy

Until now, regulation has been introduced mainly for waste

Current EU policies around the circular economy mainly address efficient use of material resources on the production side and management of waste streams (Table 5.1). Since the 1975 Waste Framework Directive, a complex body of legislation has developed with regard to waste reduction and treatment. The directive contains many instruments which focus on different types of waste. Sections of the directive include specific targets for waste streams such as municipal waste and construction and demolition waste, definitions of waste categories and residual products, and regulations concerning the efforts towards extended producer responsibility, product design, waste prevention, high-grade recycling and data collection by Member States. The European Union sets requirements for waste management, for example through binding targets for the shares of household waste or construction and demolition waste to be recycled (EEA, 2019a). An overview of the existing objectives for waste can be found in Appendix 4, Table B4.2. There are other directives which complement the Waste Framework Directive by specifically addressing packaging, vehicles, batteries and electronic equipment (Hughes, 2017).

The European Union has also deployed a number of legislative and regulatory instruments on the production side (Table 5.1). These focus mainly on certain product groups, such as electrical and electronic equipment, batteries, wrecked vehicles, packaging, manure, and agricultural products. They also include requirements for setting up extended producer responsibility schemes.

The European Union dedicates relatively little attention to issues concerning the use stage of products and services, such as lifespan extension, reuse, repair and product design that facilitates these things. With the exception of energy consumption, binding targets have not been set yet for the design and use phases. However, in its second circular economy action plan, the European Union has made a commitment to reach more imperative agreements for products too, including extending producer responsibility and making the minimum requirements for products more stringent. But such agreements have not been brought into effect yet.

Little legislation and regulation in place to change consumption patterns

The addressing of unsustainable consumption patterns falls primarily under the competence of the Member States. However, due to the internal market, the ability to influence what is sold in Europe is actually limited at the level of the Member State (Pantzar and Suljada, 2020). The European Union influences unsustainable consumption patterns through the imposition of quality requirements for products offered on the internal market. For instance, the European Union has developed Ecolabel, a quality mark for sustainable products and services, such as textiles, electrical appliances, cleaning products, furniture and hotels. In addition, steps have been taken to enhance the protection of consumer rights, such as the EU consumer protection directives and the New Deal for Consumers which strengthens consumer rights (European Parliament and European Council, 2017; European Commission, 2018c). Issues they deal with include combating unfair trade practices, such as misleading and unfounded environmental claims (greenwashing), and products that are designed to break or fail easily so that consumers have to replace them quickly (planned obsolescence). Such policy efforts are relevant to a circular economy because they provide consumers with support to make conscious choices, and they promote product lifespan extension.

Adopting a facilitating role, the European Union has taken several initiatives to promote and support the circular economy at various administrative levels (Pantzar and Suljada, 2020). Some of these initiatives are also related to consumption, for example the Circular Economy Stakeholder Platform (European Commission, 2019e) and the Ecolabel (European Commission, 2020k) which are both listed in the supporting policies section of Table 5.1.

Financial instruments for circular economy are the domain of Member States

The European Union has not deployed any financial policy instruments that directly address the promotion of a circular economy. However, the European Union does provide financial support for innovative businesses, and for research and cooperation through the framework of the programmes InvestEU, Horizon Europe, LIFE, COSME and ERDF/Interreg. Within these programmes attention is devoted to the circular economy. Through public procurement criteria (European Commission, 2016), the European Union intends to provide indirect market support for circular products and services (Table 5.1, Financial instruments).

The use of financial incentives to further the transition towards a circular economy is to a large extent left to the Member States. The European Union has used legislation and regulations to set up a framework for that purpose. For example, the Waste Framework Directive (European Parliament and European Council, 2008) determines that Member States are to take measures to apply the 'polluter-pays' principle and set up systems for extended producer responsibility. With regard to extended producer responsibility, the directive also sets out that Member States are to develop a modular pricing system that takes various circularity aspects into account, such as durability of products, and the possibility to repair, reuse and recycle them. How exactly they are to undertake this is left to the Member States.

Table 5.1
Overview of current EU policies on circular economy

Production	Use	Waste and recovery
Objectives and ambition		
Industry strategy		
Bioeconomy strategy		
Annual strategy for sustainable growth		
Plastics strategy		
Farm-to-fork strategy		
Legislation and regulations		
Regulations on chemical and toxic substances *		Regulations on chemical and toxic substances *
Directives on disclosure of non-financial information and on taxonomy		Framework directive on waste
Ecodesign Directive for electrical and electronic equipment	Regulation on consumer protection	Directive on landfill
Directive on on the restriction of the use of certain hazardous substances in electrical and electronic equipment	New Deal for consumers	Directive on waste transport
Regulations on the use of manure and on water reuse for irrigation in agriculture	Regulation on the trade in products for the construction industry	Directives on drinking water and wastewater treatment
Regulation on common organisation of markets for agricultural products		
Directives on discarded electrical and electronic equipment, batteries, scrapped vehicles, packaging waste and single-use plastics (extended producer responsibility (EPR))		
		* Unchanging policies
Financial instruments		
	Criteria for green commissions from government authorities	
Programmes under Horizon Europe, InvestEU, LIFE and EFRO/Interreg		
Supporting policies		
		Waste hierarchy
		Guidelines for waste auditing
Product Environmental Footprint Category Rules		EU Construction and Demolition waste management protocol
Organisation Environmental Footprint Sector Rules		Platform dealing with food loss and waste
CE design principles for buildings		Guidelines for biomass cascading
'Level(s)' framework for voluntary reporting on sustainability in the construction sector	Ecolabel for more than 20 groups of products and services	Guidelines for the use of foodstuffs as animal feed
CE stakeholder platform		
CE monitoring framework		

Source: PBL

Many current EU policy instruments for the circular economy still focus on waste and production.

Harmonisation at EU level is important for fiscal greening

Tax reductions and increases are instruments that can play an important role in the transition towards a circular economy. They can, for example, make repair and reuse more attractive for consumers, or give reused, refurbished or recycled products a price advantage over new products (Copper8 et al., 2019; Hartley et al., 2020; Stahel, 2013). But when it comes to primary resources or products with a high environmental impact, individual Member States are reluctant to introduce drastic tax increases. By unilaterally raising taxes, they fear that their international competitiveness will be affected. For this reason, harmonised changes in taxation are a measure that needs to be put into action at the EU level. In practice, however, this has often proved difficult, because some Member States regularly make use of their veto power on such proposals (Barker, 2019; Guarascio, 2019). In its VAT Directive (European Commission, 2006), the European Union describes the framework within which Member States may decide on adjustments to the VAT levied on products and services. The directive allows a reduction in VAT on second-hand goods and certain repair services (for bicycles, shoes, leather goods, clothing and household linen), and a number of EU

Member States, including the Netherlands, has indeed introduced such changes (Belastingsdienst, 2020; European Commission, 2006, 2020h; Dutch Government, n.d.-a). In contrast, the EU directive does not allow the application of a tax reduction for circular products, such as jeans made from recycled fibres.

5.3 Recent developments in circular economy policies in the European Union

More circular legislation and regulations are underway
As mentioned above, the second circular economy action plan also provides for legislative initiatives that address consumption. These initiatives have to do with issues such as the availability of reliable information on product life cycles, the availability of spare parts or access to repair and upgrade services, and the strengthening of consumer protection against planned obsolescence (European Parliament, 2020; European Commission, 2020i). The intention is also to convert these instruments — which until now have been supportive, or 'soft' — into 'hard' legislation and regulations. Examples are the criteria for Green Public Procurement, and measures concerning the reduction of plastic waste, the processing of microplastics and emissions of microplastics. With this move, the European Commission is taking a further step towards an integral circular economy policy, which encompasses additional legislation to the rules that only apply to the field of waste. As yet, these are still plans which need to be translated into specific legislative initiatives in the period ahead.

Important EU role in setting of requirements for products
With regard to the setting of requirements for production and design, Member States are somewhat limited in the influence they can exert and changes need to be introduced EU-wide. It is important to ensure that all Member States are on a level playing field. For example, the European Union plays an important role in drawing up product policies such as quality requirements for the use of secondary materials or labels for the energy consumption of household appliances. These steps can contribute greatly to furthering a circular economy in Europe and can only be organised at the EU level. Good examples are measures to extend the minimum warranty period of products and the requirement to enable reuse of product components.

The second circular economy action plan states that the Commission wishes to start imposing additional requirements on product design by expanding the Ecodesign Directive; the expansion concerns a shift from energy efficiency to material efficiency, and from a focus on electrical and electronic equipment (EEE) to a focus on a wide range of product groups. The first step, taken in 2019, involved broadening the directive with requirements for availability of product components and product information with a view to repair of refrigerators, washing machines, tumble dryers and dishwashers (European Commission, 2019c). The Commission has announced it will launch a legislative initiative on sustainable products in 2021, developed around the core proposal of expanding the Ecodesign Directive. In addition, the Commission wants to enhance transparency and traceability throughout the value chain, as has already been done reasonably adequately for waste (European Commission, 2020i).

Setting requirements for products for the European market has global significance. Examples include the extension of the minimum warranty period of products, legislation on hazardous substances, the requirement for products to contain a minimum share of secondary materials, or the requirement to enable reuse or repair of product components. The fact is that the European Union is the largest consumer market in the world. Due to its important position on the world stage as a major trading bloc, the European Union exerts influence on production outside its borders, for example, by imposing requirements on products sold within the European Union (Ecofys, 2014; European Commission, 2019a). This works because it is not efficient for producers to make different products for different markets. For this reason, the influence of the European Union on the transition towards a circular economy is, at the global level, relatively large.

Integral circular economy monitoring of Member States is under development

The European Union plays an important role not only in directing the transition towards a circular economy in Europe, but also in monitoring it. The second circular economy action plan includes a monitoring framework to measure progress in the transition at the levels of the European Union and its Member States. The framework has ten indicators for circular economy that have been brought into view by Eurostat. These already available indicators focus mainly on waste streams and recycling rates, on the share of sustainable procurement, the degree of self-sufficiency, the volume of investments and the number of patents. Under the second action plan, the 10 indicators are complemented by others for material resource use and consumption (European Parliament, 2020; European Commission, 2020i). Data harmonisation, which is important for measuring the indicators, is also still under development.

At present, EU Member States do not provide annual integral reporting on the circular economy. However, the European Commission has started up a debate with Member States and stakeholders under the slogan Greening the European Semester, to assess how environmental aspects and the circular economy can be given a place in future processes of the annual monitoring and coordination mechanism known as the European Semester (Behrens and Rizos, 2017; European Commission, 2020f). The European Semester is an annual cycle of actions toward coordinating the economic and fiscal policies of the European Union and its Member States.

European Green Deal starting point for European post-COVID-19 recovery

As a response to the corona crisis, the European Commission has revised the proposal for the common European budget (2021–2027) and presented a temporary European recovery fund (European Commission, 2020d, e). The fundamental idea of the Commission is to allow the use of these financial means to fit together with the sustainability tasks of the European Green Deal. With regard to the circular economy, the Commission points to the second action plan mentioned above. The European Council has given approval to a European budget of EUR 1,074 billion and the European Recovery Fund of EUR 750 billion. Negotiations are going on between the European Parliament and the European Council over an increase to the EU budget (European Council, 2020; Valero, 2020). Most of the spending from the Recovery Fund will be carried out on the basis of national recovery plans that will be assessed by the European Commission (also see Verwest et al., 2020).

With regard to the spending from the European budget and the recovery fund, it has been agreed to allocate 30% to climate-related measures and 37% to goals set in the Green Deal (Von der Leyen, 2020). The details still need to be worked out and the implementation still needs to be organised. The European Commission wants the spending effort to be in line with the definition of green investments laid out in the EU Taxonomy Regulation (European Parliament and European Council, 2020). Under the regulation, a broad categorisation system of sustainable financing has been developed; the specifications for climate mitigation and climate adaptation are ready, but those for circular economy still require further elaboration (Hirsch and Schempp, 2020).

The circular economy is referred to a few times in the European 2030 Climate Target Plan (European Commission, 2020b), along with references to the Green Deal and the second circular economy action plan. The Commission sees a circular economy as a means to modernise the European economy, to create new employment, including green jobs, and to reduce emissions throughout the industrial value chain.

It is not easy to assess the significance of the European funds that have been made available for the transition towards a circular economy. The emphasis is more on the climate than on the circular economy, although the two can go hand in hand perfectly well. Many details still need to be further developed, but until now it seems that funding for the circular economy is limited. A final consideration is that the use of financial resources through which the European Green Deal is taking shape is not the only important matter; certainly as important are the many legislative initiatives and policy strategies that are being developed under the umbrella of the Green Deal. Examples are product requirements that address the share of secondary materials, producer responsibility, and circular procurement and tendering. Such steps can enhance innovation and lead to the emergence of a larger market for circular products.

5.4 Summary and conclusions

European Union has a crucial role to play in facilitating the transition towards a circular economy

The transition towards a circular economy is a shared responsibility of the European Union and its Member States. But the European Union has an important role to play in improving and harmonising matters such as extended producer responsibility, product policies (e.g. legislation on hazardous substances or the requirement for a minimum share of secondary materials) and promoting circular economy policies in the Member States. Such aspects can only be dealt with at the EU level. It is important to ensure that there is a level playing field for all Member States. Because of the importance of the internal market for the export-oriented Dutch economy, European circular economy policies are also decisive for the Dutch ambition to realise a circular economy.

Due to its globally important position as the largest economic trading bloc, the European Union also exerts influence on production outside Europe by setting requirements for products sold on the European market. The European Union is, after all, the largest consumer market in the world and thereby sets the standard for many producers. This means the European Union can take on an important role in promoting the transition towards a circular economy on a global scale.

Until now, regulation has mainly been introduced for waste and for energy-efficient appliances

To limit supply risks and reduce environmental impacts, the European Union has in the last few years taken steps to promote the transition towards a circular economy. Policies on the environment and on material resources were brought together in an integral policy framework in the first circular economy action plan (European Commission, 2015). This framework comprises a large number of policy instruments that address the phases of production, use and waste of various groups of goods and services. To date, the European Union has mainly put into practice soft policy instruments aimed at realising a circular economy. Legislation, regulations and strict targets are lacking in circular economy policies. Exceptions to this are waste policies and policies for the production phase of goods and services, such as requirements to limit the use of hazardous substances and the use of manure and water in agriculture. Legislation, regulations and strict targets are mostly missing with regard to the design, supply and use phases of products and services.

The announced expansion of the existing set of tools for a circular economy is crucial

With its second circular economy action plan, the European Union has made a further step towards an integral circular economy policy: the development of legislation and regulations covering more than just the field of waste. The European Union has announced a further expansion of existing and new instruments in the coming years (European Commission, 2020i). Particularly with regard to product design and the consumption phase, an expansion of existing instruments at the EU level is feasible and relevant. This can involve extended producer responsibility, the Ecodesign Directive, and the setting of product requirements, such as extension of the minimum warranty period of products or enabling reuse and repair of product components.

6 Circular economy policies in the Netherlands

Main messages

- To achieve a circular economy in the Netherlands, the government has opted for a public-private approach: government authorities, market parties and other social organisations together form transition teams that focus on five domains, or transition themes. In pursuance of the transition, the government is concentrating on ten clusters of policy instruments. To date, national circular economy policies have mainly focused on bringing parties together and launching and supporting circular activities. These include knowledge development, the establishment of Versnellingshuis Nederland Circulair! (organisation to accelerate the Dutch circular economy) and voluntary arrangements such as the Concrete Agreement and the Plastic Pact. Putting the circular economy on the agenda, mobilising parties and facilitating knowledge are all activities that are typical of the initial phase of policy. With these efforts, the government has created a foundation and set up a structure to take further steps together with the societal stakeholders and regional authorities involved.
- A more detailed and widely supported vision is needed to give businesses and social partners a clear idea of what a fully circular economy exactly is and what specific goals and intermediate objectives are being pursued. These goals should focus on the use of material resource flows, the use of material resources in products, and the disposal of products in the form of waste. Additional goals are needed for the impacts, such as greenhouse gas emissions, biodiversity loss and supply risks. It makes sense to follow an approach that is differentiated according to domains or product groups because impacts can differ greatly across transition themes, product groups and regions. A matter that also forms part of concrete goals is a clear division of responsibilities between the various parties involved. For example, what are the responsibilities and competences of the transition teams and what role does the government play in these teams?
- Besides a vision of the aimed-for direction that is widely supported and has set of concrete goals, the speeding up of the transition towards a circular economy also requires an intensification of policies. That acceleration can be seen as the next phase of the transition. The realisation of a fully circular economy requires not only setting agendas, promoting, structuring and creating support, but also, in the short term, a more frequent use of more stringent instruments, such as levies and regulations, including the setting of standards. These instruments may include establishing a compulsory share of recycled materials in products, introducing environmental taxes on the use of fossil fuels as feedstock, and making it compulsory to provide product information — about assembly, for example — in order to have more opportunities to repair products and extend their lifespan. It often takes a long time to adopt such measures, as generally, societal support is first sought for them and there is insufficient political consensus about the exact approach. An example that illustrates this point is the long history of the introduction of a deposit scheme for small bottles. It is therefore imperative to step up existing processes and promptly launch new instruments.
- Two instruments that can promote innovation and circular production methods, and lead to less environmental pressure, are circular procurement by government authorities and measures around producer responsibility. These two instruments have the potential to make a greater contribution to a circular economy than they currently do. Steps may include, in the case of producer responsibility, setting requirements that are dynamic rather than static and that become stricter over time, and in the case of circular

procurement, setting requirements that go beyond the market standard or that only focus on recycling.

6.1 Introduction

This chapter describes the circular economy policies that have been developed in the Netherlands in the last few years and outlines the possibilities for the next step.

Reading guide

Section 6.2 starts with a brief overview of the circular economy policies adopted in the Netherlands. The transition agendas for the various themes play an important role in these policies, and therefore Section 6.3 takes a closer look at the five themes —Biomass and Food, Plastics, the Manufacturing Industry, Construction and Consumer Goods — and at their shares in material resource use and contributions to environmental pressure. Section 6.4 then dedicates attention specifically to the long-term goals that the government has formulated in the framework of the circular economy. What do they entail and how can they be made measurable? And what scope and function do these goals have? This is followed by a discussion in Section 6.5 of the instruments the government is currently using to switch to a circular economy. The status of the policies is also examined: what established policies are already in place, what matters still need to be worked out in more detail, and what policy intentions are there? This section also zooms in on two instruments that are high priority for policies: producer responsibility and circular procurement. Policies to accelerate the transition towards a circular economy are also being deployed at the regional level, in addition to those at the national and EU level (Chapter 5). Section 6.6 provides an outline of the issues regional governments are focusing on and the type of instruments they are generally using for those purposes. After that, Section 6.7 takes a brief look at the importance of the European Union and neighbouring countries for Dutch circular economy policies. The relationship between the transition towards a circular economy and the energy transition is discussed in Section 6.8. This chapter closes with a series of conclusions: what insights are offered with regard to the realisation of a circular economy and what role is the government playing in spurring the effort?

6.2 Dutch circular economy policy in brief

Material resource policy is not new

The ambition to be sparing in the use of material resources and to close loops is not new. It was already formulated as an important starting point for Dutch environmental policy in the first National Environmental Policy Programme (VROM, 1989). In recent decades, further elaboration of the programme concentrated mainly on waste policies with the goal of preventing negative environmental impacts. As a result, in the Netherlands today hardly any waste goes to landfill and 80% of waste is recycled (Chapter 3). With these rates, the Netherlands is an international front runner. But that does not mean that the Netherlands is already circular. A circular economy involves much more than just managing waste streams and recycling a lot.

Table 6.1
Government-wide CE programme: 5 transition themes and 5 interventions

Transition themes	Interventions
• Biomass and food	• Stimulating legislation and regulations
• Synthetic materials	• Smart market stimulation
• Manufacturing industry	• Financing
• Construction sector	• Knowledge and innovation
• Consumer goods	• International cooperation

Policymakers started to focus on a circular economy for the first time in the programme From Waste to Resources (IenM, 2014). The programme still strongly emphasises waste stream management, with measures such as promoting recycling and halving the amount of incinerated or landfilled Dutch waste by 2023. But it is also possible to find several initial steps in the programme that seek to advance circular production. One of these is the inclusion of the plan Towards a Biobased Economy, which at the time meant the Ministry of Economic Affairs and Climate became co-responsible for the From Waste to Resources programme.

Nederland Circulair 2050 is the first government-wide programme for the circular economy. It formulates the ambition to achieve a fully circular economy in the Netherlands by 2050 (IenM and EZ, 2016). The programme covers all the material resources in the Netherlands, but has a specific target for abiotic resources (minerals, metals and fossil fuels): to halve the use of primary abiotic resources by 2030. This comes on top of existing targets for waste, such as the cap on the volume of waste and the target for separation of household waste (Section 3.3.6 for further details on these targets).

Government-wide programme for the circular economy forms the basis for policies in the Netherlands

The government-wide programme describes five priority transition themes and five interventions (Table 6.1). They form the core of the circular economy policy in the Netherlands. Given the differences between societal domains and between product chains — such as those between construction and food — the programme focuses on five transition themes that 'are important to the Dutch economy, exert high environmental pressure, already count on a great deal of social energy for the transition towards a circular economy, and are in line with the priorities of the European Commission.' (IenM and EZ, 2016). These themes are: Biomass and Food, Plastics, the Manufacturing Industry, Construction, and Consumer Goods. The five interventions are coherent bundles of policy instruments labelled as: smart market incentives, stimulating legislation and regulation, financing, knowledge and innovation, and international cooperation.

The Raw Materials Agreement and the transition agendas are a joint ambition

The government wants to take up the challenge to realise a circular economy explicitly with other parties from society. There is broad support in society for the approach and ambition to achieve a circular economy. For example, the 2017 Raw Materials Agreement has been signed by more than 400 societal stakeholders, including the employers' organisation VNO-NCW, the SME organisation MKB, the FNV trade union, provincial authorities, municipalities and water boards, NGOs, and several large enterprises (Dutch Government, 2017). Grouped into five transition teams, representatives of these parties further worked up the ambitions for the individual transition themes into five transition agendas, which were presented in early 2018 (Transitieteam Biomassa en voedsel, 2018; Transitieteam Bouw, 2018; Transitieteam Consumptiegoederen, 2018; Transitieteam Kunststoffen, 2018; Transitieteam Maakindustrie, 2018). They are briefly outlined in the Text box on the five transition agendas.

The government sets priorities and moves towards implementation

The transition teams have identified a number of shared topics that are relevant to the implementation of their plans, such as product design, circular procurement, circular tendering, and producer responsibility. In its response to the transition agendas, the government has labelled ten of these overarching topics as priorities and indicated what its plans and highest concerns are for accelerating the transition towards a circular economy together with the societal stakeholders involved (IenW, 2018). This involves both targeted government actions for the transition agendas and the formulation of ten crosscutting themes — that is to say, clusters of policy instruments which are assigned priority in promoting the circular economy, and which are a more detailed elaboration of the five previously mentioned interventions contained in the government-wide Circular Economy programme (Table 5.1). The ten clusters of policy instruments are: (1) producer responsibility, (2) legislation and regulation, (3) circular design, (4) circular procurement, (5) market incentives, (6) financing instruments, (7) monitoring, knowledge and innovation, (8) behaviour and communication, education and labour market, (9) international commitment and (10) the business support organisation Versnellingshuis.

Together, these clusters of policy instruments comprise a broad palette of possibilities for the government to direct the transition. These crosscutting themes have been worked out in greater detail in the 2019–2023 implementation programme (IenW, 2019, 2020), which also contains actions and projects of the transition teams. The programme aims to make the step from planning to actual implementation. The transition agendas and their elaboration into an implementation programme that is updated every year, play an important role in the approach of Dutch circular economy policy.

Four ministries directly involved in circular economy policies

Government policy is made up of the government-wide circular economy programme, the government response to the transition agendas and the implementation programmes for the circular economy. In the government-wide circular economy programme, a structure has been put in order in which the Ministry of Infrastructure and Water Management has a coordinating role with regard to circular economy policies in the Netherlands. In addition, each of the following ministries is responsible for one or several transition themes (also see the Text box The five transition agendas in brief).

- Ministry of the Interior and Kingdom Relations: Construction (housing and non-residential)
- Ministry of Infrastructure and Water Management: Construction (civil engineering)
- Ministry of Economic Affairs and Climate Policy: Manufacturing Industry
- Ministry of Infrastructure and Water Management: Plastics and Consumer Goods
- Ministry of Agriculture, Nature and Food Quality: Biomass and Food

A recent analysis shows that the participating ministries are especially involved in the transition agendas they themselves are in charge of, and feel less responsible for circular economy policy as a whole (IenW and MinFin, 2020). These ministries also draw up specific and operational policies to stimulate the transition within the transition themes they oversee. Examples include the toughening of the environmental performance requirement for buildings, introduced by the Ministry of the Interior, and the promotion of circular agriculture by the Ministry of Agriculture.

Implementation of transition agendas is a joint responsibility of public authorities and societal stakeholders

The government-wide circular economy programme is still decidedly a document in which the government expresses its own ambition and presents plans for the transition towards a circular economy, but, in contrast, the Raw Materials Agreement, the transition agendas and the implementation programme prominently present a joint ambition of the parties involved (Figure 6.1). The realisation of the transition theme actions and projects in the implementation programme is therefore a joint responsibility. For the crosscutting themes in the implementation programme, the responsibility lies with the government.

The responsible ministries have set up a structure to enable the discussion with the parties involved on the ambitions and plans for achieving a circular economy. The discussion includes administrative consultations between the primary signatories of the Raw Materials Agreement, an annual national conference on the circular economy, and an annual update to the implementation programme. In addition, knowledge development has been structured thanks to a stable provision of financial resources, with the aims of improving insights into monitoring and directing the transition towards a circular economy. PBL Netherlands Environmental Assessment Agency is responsible for coordinating the knowledge development (PBL, 2019a; 2020a). The available knowledge on the progress of the circular economy is published every two years in an Integral Circular Economy Report (ICER), to make it possible to make adjustments to the policy on the basis of up-to-date information.

Text box 6.1: The five transition agendas in brief

Biomass and Food

The transition agenda Biomass and Food deals with the renewable biotic resources (biobased resources) that the Netherlands uses in the economy. This concerns biomass for food and animal feed, biomass as a material resource in production processes and products (e.g. wood or paper), biomass for medicines and other fine chemical products, and for use as compost, fertiliser and fuel. This transition agenda stresses the importance of the protein transition, and aims to achieve a shift in consumption from the 60% animal and 40% plant proteins in today’s diet to a 40:60 ratio in the future. The various lines of action of the transition agenda include increasing the supply of sustainably produced biomass, ensuring circular and regenerative use of soil and nutrients, achieving optimal valorisation of biomass and residual flows into circular and biobased products, and reducing food waste (Transitieteam Biomassa en voedsel, 2018).

Plastics

The transition agenda on Plastics focuses on various types of plastics (e.g. PET, PVC and PUR) and rubber. These materials have all kinds of applications, for example in building materials, cars and electronics. This transition agenda concentrates on four paths of development: 1) prevention, producing more with less material resources, and preventing spills into the environment; 2) more demand and supply of renewable plastics; 3) better quality along with improved environmental efficiency; 4) strategic cooperation in the product chain. This transition agenda takes strong action in the field of chemical recycling and improving the collection and sorting system of plastics. The aims of the transition agenda are to produce plastics without oil by 2050, and to reduce the volume of incinerated plastics by 44% by 2030 compared to 2016 (Transitieteam Kunststoffen, 2018).

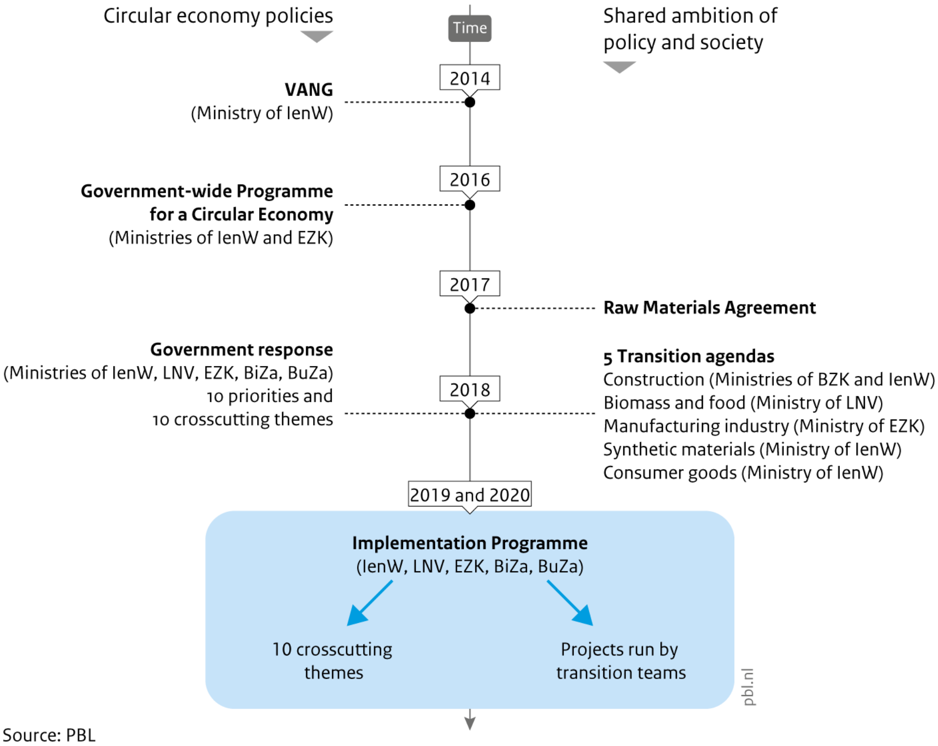
The Manufacturing Industry
The transition agenda Manufacturing Industry relates to all sorts of businesses that process material resources and materials into products. Examples of this are the production of base metals and plastics, tools and packaging, vehicles and electronics, means of transport, medical equipment, furniture and products for the construction sector. The transition team focuses on seven lines of action, including circular design, security of supply of critical material resources, recycling technology and facilitating circular business models. This transition agenda aims to improve the security of supply of critical materials, close the cycles of products and material resources in the manufacturing industry, and reduce the environmental pressure stemming from products through circular design, reuse, repair, and refurbishing (Transitieteam Maakindustrie, 2018).

Consumer Goods
The transition agenda for Consumer Goods studies products with a short lifecycle, such as disposable products and packaging, and products with medium and long lifecycles, such as electronics and clothing. The focus is on consumer goods which people use at home, but others are also taken into account. They include items used by businesses and goods used out of the home, for example, at work, at school or during journeys. This transition agenda aims to reduce the volume of residual household waste and comparable forms of residual waste from offices, shops and the services sector, and to ensure that by 2025 consumer goods are kept in the cycle for as long as possible and the presence of litter is prevented. The transition team concentrates on four sub-goals: 1) value creation; 2) use of less material resources — 'rethink, refuse and reduce'; 3) optimal lifespan; 4) optimal use of functionality (Transitieteam Consumptiegoederen, 2018).

Construction
The transition agenda for construction deals with housing, non-residential construction and civil engineering. This means it focuses on buildings, roads, bridges, dykes, railway tracks, sewer systems and more. The transition agenda has four spearheads: 1) market development; 2) measuring; 3) policies, legislation and regulation; 4) knowledge and awareness. These spearheads are to lead to, amongst other things, a higher level of circular tendering by government authorities, a reduction in CO_2 emissions and the realisation of uniform measuring methods. The first step is to set up a 'base camp' in 2021, on the way to a circular economy in 2050. An important recommendation in this transition agenda is 'that from 2023, the government puts all contracts out to tender in a 100% circular fashion' (Transitieteam Bouw, 2018).

The five transition themes overlap to a certain extent. For example, biomass can be used to replace abiotic resources — as a building material or to produce a synthetic material. This creates an overlap between the three themes Biomass and Food, Construction and Plastics. And there are even more ways in which the themes overlap. Food products for consumers that are sold in biobased plastic packaging are an example of the confluence of Biomass and Food, Plastics and Consumer Goods. Other examples are plastic window frames (Plastics and Construction) and enclosures for electronic devices (Plastics and the Manufacturing Industry). In addition, the manufacturing industry can make use of biomass, and it produces consumer goods, building materials and plastics.

Figure 6.1
Circular economy policies in the Netherlands and the common ambition of policy and society



Source: PBL

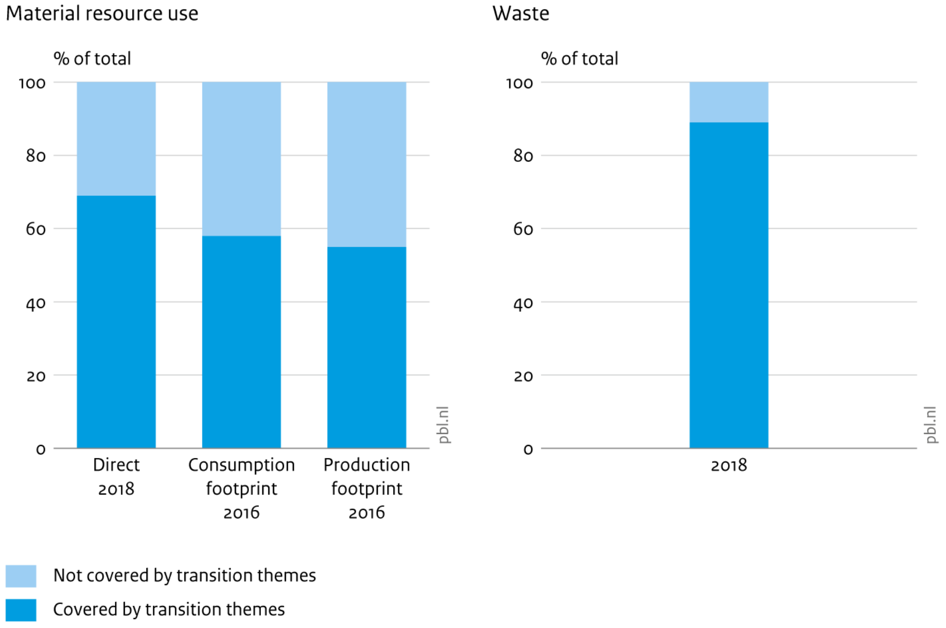
The approach chosen is a basis for starting up the transition towards a circular economy

The government has explicitly opted for a public-private approach. It has brought together a broad coalition of parties who wish to contribute to the transition towards a circular economy. The government works side by side with these parties in transition teams that direct their attention to five priority transition themes. In addition, the government has given its policies focus by clustering its policy instruments into ten crosscutting themes. With this approach, the government has laid a solid foundation for starting up the transition towards a circular economy in cooperation with the societal stakeholders involved.

6.3 Share of transition themes in material resource use and environmental pressure

The five transition themes were chosen especially because of their interest to the Dutch economy and their share in environmental pressure in terms of material resource use, waste and environmental impacts. This section examines how fully the five transition themes cover Dutch material resource use and environmental impacts. With regard to direct resource use and its impacts, this inquiry considers the business sectors that fall directly under the transition themes (see Text box Assigning business sectors to transition themes). As for the footprints, the use of material resources and its impacts earlier in the chain are also taken into account.

Figure 6.2
Share of material resources covered by the transition themes



Source: CBS 2021, CBS 2020

Text box 6.2: Assigning business sectors to transition themes

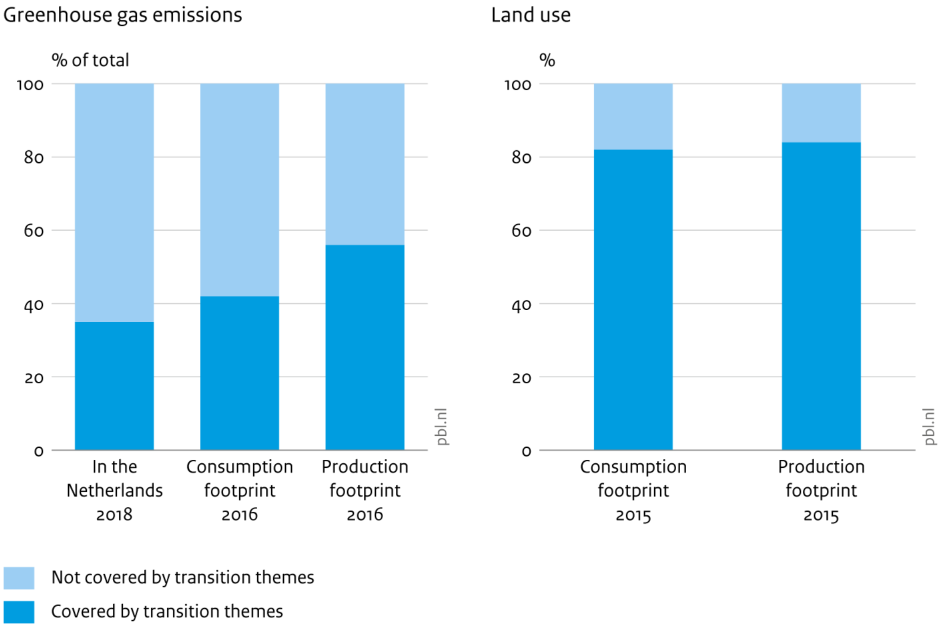
All business sectors were studied to determine whether they fit in with any of the five transition themes. As a result, a number of sectors are now included, even though they are not subject to any actions based on a transition agenda. For example, the sectors furniture manufacturing, car trade and car repair fall under the transition themes, even though at present no specific actions are targeting them. Therefore, the analysis in this section does not show the actual impact of all the actions of the transition themes, but it gives a broad indication of material resource use and the associated effects of business sectors that have a relationship with the transition themes. Further research is required to be able to answer the relevant question of the extent to which the current actions of the transition agendas actually influence material resource use and its impacts in the chain.

The following paragraphs first look at the shares of material resource use and waste supply that fall under the transition themes. Then greenhouse gas emissions are considered, and finally land use and biodiversity loss.

The largest share of material resource use and waste is covered by transition themes

The direct use of material resources in the Dutch economy — direct material input — falls largely (69%) under the transition themes (Figure 6.2). This is due in particular to the manufacturing industry and construction. Of the part that is not covered by the transition themes, most corresponds to material resources used by petroleum refineries and energy companies. With regard to the footprints of both production and consumption, about 60% of the material resource use in the chain falls under the transition themes.

Figure 6.3
Share of impacts covered by the transition themes



Source: CBS 2020, PBL 2019, PBL 2021

Almost all the waste in the Netherlands (89%) is released by the full set of business sectors falling under the five transition themes (Figure 6.2). Most of the waste comes from the construction sector and the manufacturing industry. Some waste streams are not covered by the transition themes, such as waste streams from the energy supply industry, the petroleum industry and drinking water companies.

Large proportion of greenhouse gas emissions not covered by transition themes

Most greenhouse gas emissions in the Netherlands (greenhouse gases emitted within the country by businesses and consumers) are not produced by the business sectors covered by the transition themes (Figure 6.3). In total, about 65% of greenhouse gas emissions in the Netherlands does not fall under the transition themes. This is because the sectors that are responsible for a large proportion of emissions, such as energy supply, refineries and transport, are not part of the transition themes. However, these issues do receive considerable attention in the energy transition and in mobility and transport policies. Since a circular economy applies to all material resources, proper cooperation is required between the transition towards a circular economy and the mobility and energy transitions (Section 6.8).

In the case of footprints too, a large share of greenhouse gas emissions is produced by business sectors that are not covered by the transition themes. The share is slightly larger for direct greenhouse gas emissions. As for the consumption footprint, the share is 42%, which is lower than the 56% share corresponding to the production footprint. This is mainly because the consumption footprint includes household energy consumption for heating and private vehicles, while the transition themes do not.

Land use is for the greater part covered by the transition themes

Most of the land use corresponds to the production of food and wood. Wood is used, for example, in construction or for the production of consumer goods, such as furniture and paper (Chapter 3, Section 3.5.1). These product groups are part of the three transition themes Biomass and Food, Construction and Consumer Goods. Since these land-intensive product groups fall under the transition themes, the largest shares of the land-use footprints are covered: approximately 82% for Dutch consumption and 84% for Dutch production (Figure 6.3).

Land use is also the most decisive factor in biodiversity loss (Wilting et al., 2017). But greenhouse gas emissions also have a marked influence on global biodiversity. These emissions stem mainly from agriculture, transport and the energy supply. As mentioned above, the last two sectors are not part of the five transition themes and therefore, the share of the biodiversity footprint that falls under the transition themes is smaller for greenhouse gas emissions than for land use (Wilting, 2021).

By focusing on the entire chain, more environmental impacts can be tackled

As explained in Chapter 3 (Sections 3.2.1 and 3.4), businesses and government authorities can exert influence on material resource use and its impacts. This requires not only focusing on material resource use in the Netherlands, but specifically also considering the entire production chain, which for a large part takes place abroad. To reduce the use of material resources and its impacts, government authorities and businesses need to take explicit actions along the entire chain. This approach makes it possible to achieve greater environmental gains.

A more precise definition of transition themes is needed to obtain information for steering

It is not really possible to indicate the volume of material resource use and its effects for each transition theme individually without double counting. This is because several business sectors are linked to more than one transition theme. For example, the use of metals in the base metal industry is covered by both the Manufacturing Industry and the Construction themes. To derive useful information for the purpose of steering individual transition themes, it is necessary to more precisely classify and further define the business sectors.

6.4 Long-term objectives

The government's objective is to achieve a fully circular economy by 2050. The government has formulated the interim target for 2030 to halve the use of primary abiotic resources (IenM and EZ, 2016).

It is still unclear what a fully circular economy is

At the moment, it is not yet clear what it means to have a fully circular economy by 2050. There does seem to be some agreement that in a circular economy the capacity of the world’s nature (the planetary boundaries) is not exceeded, but in society there are still differing opinions on what is required to achieve this. Is it mainly about making production more resource-efficient, recycling material resources, and limiting environmental pressure in global production chains? Or does it have more to do with new relationships between production and consumption which emphasise the local economy, product sharing — with an important role for alternative designs to make products more durable and easier to repair — and the corresponding new revenue models (Bode et al., 2019)?

In addition, it is not yet clear what a fully circular economy entails. Having no input of material resources at all and no output in the form of waste seems unrealistic. The use of resources always comes with some loss and often with a decline in quality. Recycling and other R-strategies require a certain amount of energy. And to avoid the use of abiotic resources, a shift can be made to biotic resources, but these are also needed for food and other applications. And food, once consumed, cannot be used again for the same purpose. The question is whether and how the current demand for material resources fits in with the carrying capacity of nature and the environment. And what, then, is the definite picture of a fully circular economy?

Since it is still insufficiently clear what a fully circular economy means, it is complicated to translate a generic final picture into a quantitative target for 2050. As a result, it is also difficult to determine operational objectives and draw up roadmaps for 2030 or the present, as has been done for the energy transition. In more general terms, the fact is, that in order to translate global ambitions for the environment — such as those articulated in the Sustainable Development Goals — into national goals, various choices need to be made with regard to risks, solidarity and precautions (Lucas and Wilting, 2018a): how great is our willingness to leave room for consumption by the peoples in other parts of the world?; and what level of precaution is the Netherlands prepared to take to limit risks to nature and the environment?

Put briefly, the guiding principles and permanent preconditions of the final picture are not clear yet. However, a clear picture that counts on broad support is really necessary to ensure parties start taking action. A panoramic view of what a fully circular economy represents may be of help as an enticing perspective and can probably provide additional support to parties so that they can invest in more circular production processes and products. A definite picture of that kind also makes it possible to get a clearer sense of which innovations are appropriate for the transition towards a circular economy, and which do not contribute to the transition or even slow it down. It is not necessary for such a view to be complete or 'finished', but it has to contain several elements of the final picture that spark the imagination, and it has to provide clarity on the guiding principles and the preconditions. These things provide direction for circular initiatives. An example of an inspiring element is the ambition expressed by the transition team for Plastics to no longer use fossil resources as input for the production of plastics by 2050. In contrast to the energy transition, however, there is still no clear final picture for the circular economy.

Target to halve use of material resources

The interim target for 2030 is more specific than the final target for 2050, namely halving the use of primary abiotic resources. With this target, the government is aiming to limit the input of material resources into the economy (Figure 6.4). Primary abiotic resources comprise minerals (e.g. gravel, salt and phosphate), metals (e.g. iron ore and bauxite) and fossil resources (e.g. natural gas and oil). Biobased resources, therefore, do not fall under this target.

Choices need to be made to ensure the 2030 halving target is measurable

For the halving target to be measurable, choices need to be made. The following recommendations were offered some time ago by PBL Netherlands Environmental Assessment Agency, Statistics Netherlands, and the Netherlands Organisation for Applied Scientific Research: (1) measure material use in tonnes; (2) establish the base year in policy; (3) decide whether fossil fuels are to be subject to the halving target; (4) adopt a chain approach that includes direct and indirect use of materials; (5) use both the production perspective and the consumption perspective to assess use of materials, as they both offer relevant leverage points for policy (Kishna et al., 2019).

Directing the circular economy requires more than just one figure

As observed in Chapter 1, a circular economy is not an end in itself, but rather a means to attain underlying objectives, such as reducing environmental pressure and enhancing security of supply (Figure 6.4). Directing the process on the basis of material resource input only does not guarantee the taking into account of the specific material resources and uses that strongly determine environmental pressure and security of supply. This is because in a halving target that focuses on input, all material resources count evenly, while there is a big difference between a tonne of gold and a tonne of sand in terms of both economic value and impacts on nature and the environment. For example, the extraction and processing of gold has much greater local impacts on the landscape and emissions to water, soil and air than the extraction and processing of sand. While a focus on reducing material resource input is beneficial, it is inadequate as an overarching and general goal. The fact is that the progress of the transition towards a circular economy cannot be captured in a single figure (Kishna et al., 2019).

Circular economy requires a set of goals for material resources and impacts

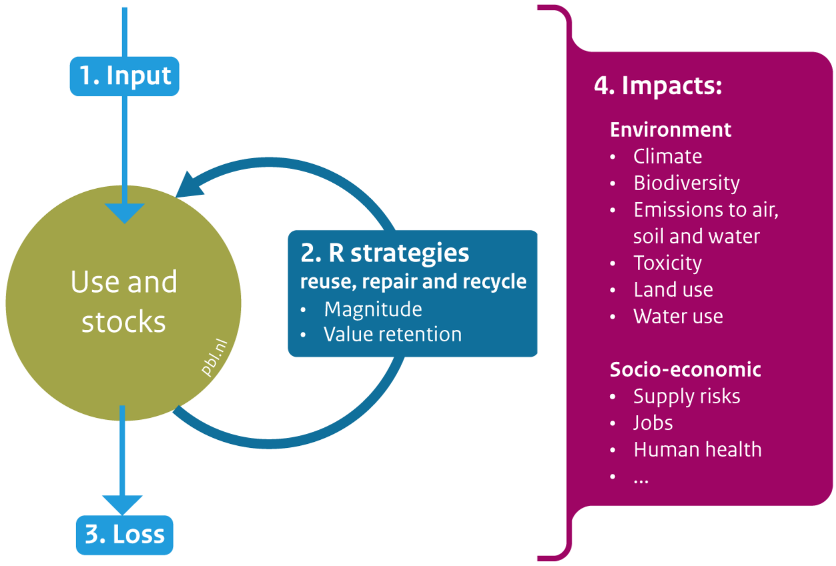
A readily communicable set of goals and key indicators is needed for material input, use and output, measured in both tonnes and euros (Kishna et al., 2019). Ideally, the set should also focus on the sought-after effects: less environmental pressure in the chain (e.g. greenhouse gases, land use and toxic substances) and improvements to socio-economic effects, such as security of supply of critical materials, including lithium and neodymium.

Part of these goals already exist. In waste policies, for example, targets have been in place for some time to halve the volume of materials that leave the chain after incineration and landfill (output target) and to increase the share of recycling (target for one of the R-strategies). For the other R-strategies, however, no targets have been set yet, even though they are particularly important in ensuring material use is as high-grade as possible, so that materials remain in use in the economy longer than they do at present, and contribute to better environmental and socio-economic effects (Chapter 3). In addition, the circular economy policy does not include targets for the desired environmental and socio-economic effects.

Objectives tree with strategic and operational goals makes directing easier

The government has adopted the above-mentioned recommendations (offered by Kishna et al., 2019) on the interim target and in 2020 it started to work with other parties on further specifying and interpreting the halving target and other complementary targets (Van Veldhoven, 2020a). In this process, the government distinguishes between strategic goals and operational goals (Van Veldhoven, 2020a). This makes it possible to also direct the transition on the basis of operational targets, in addition to the targets for the impacts of material resource use (environmental pressure, security of supply). An example is the operational target to save 1 megatonne of CO_2 emissions through circular procurement by the government. In this way, such operational targets are given a logical place in the policy to promote a circular economy.

Figure 6.4
Framework for targets and indicators of circular economy monitoring



Source: PBL

Growth model is needed for target development

The current halving target can have a mobilising function: it can encourage parties in society to use less primary resources. It gives a broad indication of the direction of the transition towards the circular economy. However, this halving target is not suitable for directing the transition in an accountable fashion. A better way to achieve this would be by establishing, in consultation with societal stakeholders, sets of targets for each transition theme and product group. Moreover, within themes, it is possible to work on further development of the targets that takes other social issues into account. For example, halving the amount of material resources is at odds with the tasks around housing for the next few years because demolition and dismantling do not generate sufficient building materials to meet demand for the construction of new homes (Prins and Rood, 2020). Given that not all the necessary data are available yet, it is sensible to start with targets and indicators for which the data are already at hand, and then to expand to others over the coming years (see Chapter 3 for data that are already available).

6.5 National policy instruments

Chapter 4 identified several obstacles that the market for circular products and services is facing today. It is necessary to gain insight into these obstacles, so that policies can deploy instruments to remove or reduce them. To speed up the transition towards a circular economy, the government has a wide range of instruments at its disposal. This section takes stock of how things currently stand as to the instruments applied in circular economy policies. Which instruments are part of established policy to promote a circular economy? And which are only policy intentions that still need to be developed in more detail? This section also contains starting points for policy to take the transition towards a circular economy to the next phase. Efforts are being made on all ten policy instruments earmarked as priorities by the government, but this report singles out two which are arousing high expectations for the transition towards a circular economy: extended producer responsibility and circular procurement.

6.5.1 Proposed and established circular economy policies

The scientific support organisation Het Groene Brein has made an inventory of instruments that have been proposed and deployed in the period between the launch of the government-wide Circular Economy programme in 2016 and the summer of 2020 (Het Groene Brein, 2021). This encompasses all those activities in which the government plays a distinct role and will be involved in for a long time. The inventory therefore covers actions such as initiating cooperation between parties and creating laws and regulations. It also includes an examination of the status of policies and the types of instruments used.

To describe the degree to which a policy is approved, the inventory distinguishes between three categories: policy intent, proposed policy and established policy:

1. A policy intent is still in the idea phase. No choice has been made yet for a specific instrument, let alone for its design and the required budget. A policy intent may, for that matter, already have been approved by the Dutch House of Representatives.
2. In the case of proposed policy, an instrument, or a bundle of instruments, has been specified with the purpose of realising the policy intent, but a concrete policy plan with the necessary financial resources is not in place yet, and the exact design of the policy intervention has not been determined yet.
3. The category established policy applies when the intent, the instrument and the required resources have been worked out in detail and have been established directly or indirectly by the Dutch House of Representatives.

A large part of the circular economy policy is still in the making

The field of policy creation aimed at stimulating a circular economy is, in many regards, still young and dynamic. This is illustrated by the fact that a large share (over 40%) of the approximately 500 policy elaborations can be categorised as policy intent and are as such still in the idea phase (Het Groene Brein, 2021). An example is the exploration of a Public Private Partnership for chemical recycling under the Plastics transition agenda.

Almost 30% of policy actions can be categorised as proposed policy. An example of a measure in this category is the decision to devise a system of extended producer responsibility for mattresses (Section 6.5.3). The choice for this instrument was described in a letter to Parliament (Van Veldhoven, 2020b). Since then, an agreement has been reached with mattress manufacturers on a voluntary system of producer responsibility. To make it apply to all manufacturers who offer mattresses on the Dutch market, the Ministry of Infrastructure and Water Management is planning to declare the system devised by the manufacturers as generally binding (Van Veldhoven, 2020b).

Approximately 30% of the policy elaborations is established policy. An example of this category is Versnellingshuis Nederland Circulair! (organisation to accelerate the Dutch circular economy). It was set up together with various public and private partners, the financing has been arranged, the Dutch House of Representatives has given its approval, and the organisation is now operational (Het Groene Brein, 2021).

Until now, the focus has mainly been on facilitating instruments and on communication

Most of the implemented circular economy policies are aimed at communication and at supporting and facilitating initiatives of other parties. Policies include knowledge development, the establishment of Versnellingshuis Nederland Circulair! to provide support to businesses, and voluntary arrangements such as the Concrete Agreement, the Plastic Pact and 'United against food waste'. In the interpretation of this classification, the fact to keep in mind is that not only the number or the percentage of actions is relevant, but also the 'weight' of each action. After all, no two policy actions are the same. However, the present study has not dealt with this aspect. Instruments aimed at supporting other parties have passed into established policy more often than instruments with a more steering and regulatory nature, such as standards and levies.

Instruments aimed at communication and facilitating have more often passed into established policy and have on average undergone more development into proposed policy than instruments that are more steering and regulatory in nature (Het Groene Brein, 2021). Of the communicative and facilitating instruments, 46% have come to be established policy. This is markedly higher than the average of 30%. Of the others — that is, legal, financing, regulatory and market creation instruments — 14% now form part of established policy.

Waste policies have, on average, become established policies more often than other circular economy policies

A large share of the measures aimed at recycling and reducing waste have arisen from waste policies that have already existed for some time. In contrast, other instances of circular economy policies are relatively new, such as instruments that promote resource-saving design, or circular business models that enhance resource efficiency. Measures which have traditionally been grouped under waste policy have more often gained the status of established policy; this also applies to instruments of a more regulatory and juridical nature. For example, the levy on incineration and landfill of waste is already established and in force. But differentiation that is based on the design of products, and that can be captured in producer responsibility systems is still policy intent. Policies aimed at recycling and waste are therefore more fully developed than policies aimed at higher R-strategies, such as redesign, refurbish and repair.

6.5.2 Points of interest for next phase of circular economy policy

Policies need to be intensified to ensure circular economy objectives are met

Although the objectives for a circular economy still need to be worked out in more detail, the ambition is huge: to have a fully circular economy by 2050 and to halve the use of primary abiotic resources by 2030. There are domains where significant reductions in environmental pressure have been realised or are being considered, such as reductions in CO_2 emissions and air pollution. In addition to covenants and voluntary agreements, these domains also use more stringent instruments to bring about drastic emission reductions. These almost always involve a combination of regulation and promotion.

For these reasons, an intensification of current circular economy policies is necessary to realise the ambitions and meet targets which are yet to be specified. Ideally, this intensification would consist of a combination of promoting and regulating instruments, because this kind of policy mix is expected to produce the greatest effect, according to an official report on the circular economy drawn up in the context of a broad social revaluation (Ministry of IenW and Ministry of Finance, 2020). This report states that promoting would mean that policies need to focus on supporting circular initiatives and business activities through innovation and knowledge development. What is also needed is more regulatory instruments — such as standards, rules and pricing systems — to give shape to the efforts to phase out and convert the linear economy, and to build a circular economy. These instruments might include setting a compulsory share of recycled materials in products (PBL, 2018), introducing environmental taxes on the use of energy carriers as material resources (Vollebergh et al., 2017) and making it compulsory to provide product information in order to have more opportunities to repair products and extend their lifespan.

More regulatory and standard-setting instruments needed

A timely and more frequent use of regulatory and standard-setting instruments to realise the transition is also in line with advice recently provided by the Council for the Environment and Infrastructure on a sustainable economy — of which the circular economy is an important part. In its advice, the Council also points out the benefits of regulation for the business world. Regulation provides transparency on the preconditions companies will need to operate under in the near or more distant future. This defines the playing field on which businesses are active and heightens security with regard to their investments. By deploying such instruments, the government stimulates innovation and supports the emergence of markets for more circular and sustainable products and processes (Rli, 2019).

The move to the next phase requires a greater sense of urgency and a clear direction. That will open the possibility for considerable market demand to arise in the future, for new rules of the game to be laid down, and for contradictions and resistance in the established system to surface (Section 4.2). It has been observed that only a limited part of the available set of policy instruments has been deployed to date, and that the next phase will require more promoting and regulatory instruments to stimulate the transition towards a circular economy.

More financial resources needed to achieve ambitions

Until recently, no structural resources had been made available for the great ambitions of the 2030 halving target and the realisation of a fully circular economy by 2050. In both 2019 and 2020, EUR 8 million were released for the implementation of circular economy policy in the Netherlands. For the period 2021 to 2024, the Circular Economy Implementation Programme now counts on an amount of EUR 40 million on the budget of the Ministry of Infrastructure and Water Management for the actual implementation of the programme (IenW, 2020). On top of that, the climate envelope has made an annual amount of EUR 10 million available for 2021 and 2022 to reduce CO_2 emissions through circular projects. For the 2023–2030 period, the amount will be raised to EUR 15 million, annually (Chapter 4). Other ministries have also included expense items in their budgets for the execution of the transition agendas for which they have primary responsibility. Therefore, a shift is taking place from occasional funding to more structural financial resources for the circular economy, a shift that is appropriate to the long-term nature of the tasks at hand. However, according to experts from society who are involved in the process, substantial changes — such as the transition towards a circular economy and attaining the policy targets for 2030 and 2050 — require more money. But with the currently available knowledge, it is not possible to indicate how much more.

Elaborating the division of roles in further detail is a step towards the next phase of the transition

In order to reach agreements in the next phase of the transition about goals to be achieved and actions to be taken, it is important to have an unambiguous division of roles between the various parties involved. Creating more clarity as to the responsibilities of the various stakeholders, and the debate around those responsibilities are therefore important factors in strengthening the governance of the transition towards a circular economy (IenW and MinFin, 2020). For instance, what competences and what mandate have been given to the various transition teams working on the realisation of the transition agendas? And what role does the government play in those teams?

How is the relationship between the five transition themes and the ten crosscutting themes being safeguarded? And what is expected of the various ministries that are involved in the transition towards a circular economy? Is that mainly a matter of, for example, the Ministry of the Interior and Kingdom Relations being responsible for circular construction, or the Ministry of Agriculture, Nature and Food Quality being responsible for circular agriculture? Or is it already seen as a matter of joint responsibility for the transition towards a circular economy as a whole? Transparency is needed on these issues in order to arrive at a tightly managed, government-wide policy process, as is already more so the case in climate policy.

6.5.3 Producer responsibility

Extended producer responsibility (EPR) is one of the ten priority interventions that policymakers want to use to further the transition towards a circular economy. In an EPR system, producers are also responsible for their products in the phase after disposal by the consumer. EPR usually comes with a quantitative and legally set target for collection or recycling, which requires producers to operate an efficient waste management system. Producers pay a waste management fee on their products to cover the costs of collection and end-of-life processing in that system. In the European Union, EPR is applied to scrapped vehicles (passenger vehicles and delivery vans), batteries, electrical and electronic equipment and packaging. In the Netherlands, EPR also applies to paper and cardboard, sheet glass and tyres. Textiles and mattresses are product groups for which the introduction of EPR is currently being considered in the Netherlands and the European Union. In addition, the possibility of applying EPR is being explored for façade construction, wind turbines, floor coverings and various building materials. In some EU Member States, EPR also applies to medicines and used oil.

Extended Producer Responsibility leads to more recycling and more stable input into secondary resource markets

EPR increases the share of discarded products that is collected and recycled in the particular product group it applies to (CPB and PBL, 2021). This creates a decrease in the environmental damage that occurs in the phase of processing waste, particularly unsorted, non-recyclable waste. It also leads to a more abundant and more stable supply of materials to recycling markets. This then results in a lower per-kilogram cost of produced secondary material and, by extension, in the emergence of economies of scale on the markets for secondary resources. There is little evidence that the current EPR schemes have also contributed to more environmentally friendly product design (CPB and PBL, 2021). In the Netherlands attempts are currently being made to stimulate the production of packaging that is more readily recyclable through price differentiation in the EPR scheme for packaging. As for other product groups, the European Commission is working on a directive on the possibilities of applying price differentiation in order to influence product design.

More environmental gains can be made by shaping the Extended Producer Responsibility system

To improve the environmental effects of EPR systems, CPB Netherlands Bureau for Economic Policy Analysis and PBL Netherlands Environmental Assessment Agency have put forward the following recommendations (CPB and PBL, 2021):

- Increase the use of flexible economic instruments in the design of the EPR schemes, such as disposal fees whose rates are based on the cost of waste processing, and requirements for collection and processing that become more stringent over time. This creates a lasting incentive and is also more likely to encourage producers to adopt circular design. Such effects do not occur with static regulatory instruments, such as fixed goals for collection and recycling, which, once attained, do not act as incentives for further efforts by producers.

- EPR systems that differentiate financial contributions at take-back according to relevant environmental characteristics offer stronger incentives for circular product design than schemes based on fixed contributions. Government policies can set relevant criteria for the differentiation of contributions, such as the level of recyclability and the share of recycled material in a product. The higher the share, the higher the per-product reimbursement for the producer.
- Policies can make a useful step towards preventing low-grade recycling by setting requirements not only for the share of products that are taken back or recycled, but also for the quality of the collected and recycled material. In addition, policies can be developed to stimulate the demand for secondary materials. Appropriate instruments are the differentiation of contributions mentioned above, the financing of innovations in the recycling sector, and taxes on the use of virgin material.
- It is advisable to expand EPR to other product groups which include goods that can easily be separated at the end-of-life phase, but at present bring with them high collection costs or serious environmental risks. Apart from furniture, textiles and mattresses, expired medicines would be a prominent candidate for a future EPR scheme.
- In the design of an EPR scheme, it is important to take into account other (municipal, national and European) waste policies and their effects on producer and consumer behaviour.
- There are at present insufficient data on EPR systems to properly understand the effects they have on prosperity. To rectify this, a higher level of transparency is needed on issues such as the cost of these systems.

6.5.4 Circular procurement

The second priority policy theme of the government to be highlighted here is circular procurement. Chapter 4 already noted that the number of initiatives designed to stimulate and facilitate circular procurement has increased substantially. Below is a discussion of several possibilities to ensure this instrument makes more environmental gains than it currently does.

Circular procurement has potential to achieve more environmental gains

The government can directly create market demand by purchasing circular products or services. Office furniture and road construction are examples of product groups which still can realise significant environmental effects, such as a reduction in greenhouse gas emissions. Actually achieving this poses a challenge, because it involves combined actions by different parties and divisions of organisations. Three examples from actual practice are described here to illustrate this.

Firstly, with regard to strategies focused on lifespan extension, it is important that the organisation using the products takes explicit action to ensure that those products are actually used for a longer period. For example, if furniture is purchased that can last for 20 years, but is replaced after only 5 years, a large part of the potential material and environmental gains are lost. It is found that extending product lifespan is not always ensured in corporate culture or in administrative processes and practice.

The second point that attracts attention is that circular procurement is often applied in ways that are not particularly ambitious or innovative. An example is the requirement to recycle solar panels in which the actual recycling obligation is limited to the glass and the aluminium — something that is already standard practice (Koning et al., 2020). Requirements such as these do not stimulate the market to move beyond what is already possible. More ambitious tendering processes require the contracting authority to have more market knowledge and to cooperate with the market in order to not only work out a tender that encourages suppliers to deliver higher performance and innovation, but also stay informed of what happens to the components and secondary resources after the contract has been awarded (Zijp et al., 2020). Smaller procurement departments in particular usually do not have the time or capacity to undertake all of this.

Thirdly, in the case of some product groups, the procurement volume of a single contracting authority is not large enough to influence the market. This applies to ICT, for example. For this reason, the Ministry of Infrastructure and Water Management is striving towards a European consortium for the sustainable procurement of ICT. More frequent joint tendering can help to influence the market.

These three examples show that it is possible to use circular procurement and tendering to achieve more environmental gains than is usually done at present.

6.6 Regional policies

6.6.1 Regional stakeholders

Many policies touch down at the regional level, for instance through the promotion of training centres for trades or through the Versnellingshuis organisation, which supports businesses in regions. The national government and regional authorities have also launched an initiative known as 'buyer groups' with the aim of bundling purchasing power in regard to various product groups. These groups can act as 'launching customers' to jointly promote the creation of a market for circular products and services. In addition, the government is actively promoting the circular economy at the regional level. Initiatives include knowledge exchange during the 2019 Circular Economy Region Days event, support for regional circular economy strategies and promotion of the manufacturing industry in regions.

Many parties at regional level focus on circular activities

A wide range of parties dedicate efforts to the circular economy at the regional level. These include businesses, regional authorities, development companies, enforcement bodies, educational institutions and regional 'accelerators' such as employers' organisation VNO-NCW, economic boards and partnerships for nature and the environment. At the regional level, it is usually easier to exchange materials and products than at the national level. Parties are often in close contact with each other and easily make new contacts. There are now several regional networks around circular initiatives. To name a few examples: parties in the north of the Netherlands have joined forces in the Circular Friesland coalition; in Metropolitan Region Amsterdam, 32 municipalities from 2 provinces are working together on circular procurement and on overturning legislation and regulations that are impeding progress; they are also jointly developing plans for the processing of a number of materials, namely plastics that are difficult to recycle, textiles, nappies, biomass, materials from construction and demolition work, and electronic waste; in the 'Food Valley' in the province of Gelderland, circular projects are being set up and regional municipalities are working together with entrepreneurs and educational institutions on knowledge exchange and drawing inspiration for the circular economy; the Flevoland province aspires to become a front runner at the intersection of circular economy and biomass. These are just a handful of the countless examples of regional initiatives. Presented below is an overview of current circular economy policies of regional authorities. This is followed by study of starting points for policies in the next phase of the transition.

6.6.2 Policies of regional authorities

Municipalities, provinces, water boards and the regional services associated with them, such as development agencies and environmental services, all stimulate the circular economy in a region in all sorts of ways. But what kind of activities are they actually engaging in? What options do they have are their disposal to promote initiatives? And how are they going about it?

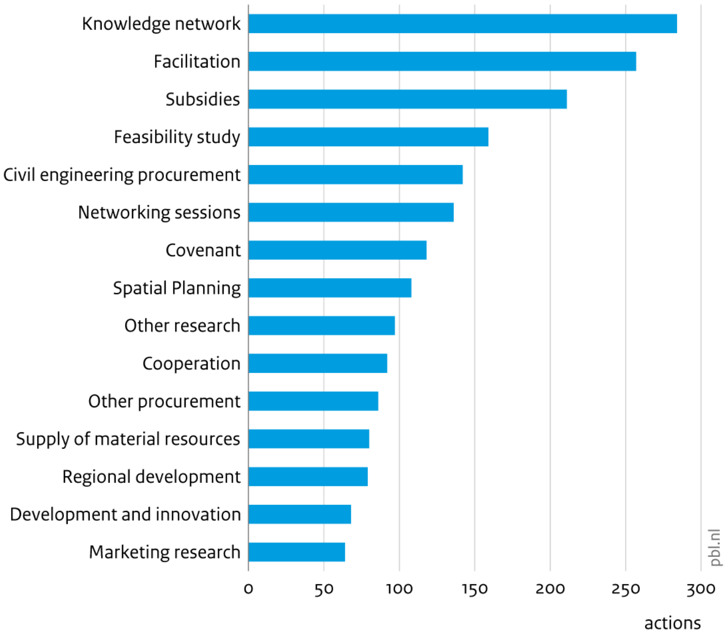
Almost 2,000 circular policy actions by leading group of regional authorities

PBL Netherlands Environmental Assessment Agency and engineering consultancy firm Royal HaskoningDHV are aware of the efforts of a leading group of 75 provinces, municipalities, water boards, regional bodies and environmental services to actively promote the circular economy, and an examination has been carried out to verify what policy instruments this group uses. The effort concerns these front runners and is therefore not a representative picture of all regional authorities. A total of almost 2,000 policy actions have been identified, which involve the deployment of approximately 60 different policy instruments (Figure 6.5).

Regional authorities facilitate and stimulate businesses to operate along circular principles

Regional authorities facilitate and stimulate businesses in their regions. Businesses are involved in 70% of the actions carried out by regional authorities. Regional authorities mainly offer these companies business support, with subsidies (around 220 actions) and wide-ranging facilitation efforts (around 270) as the most notable measures (Royal HaskoningDHV, 2020c). For example, the Vallei en Veluwe Water Board has made a test site at its water treatment plant available for SMEs to hold trials on innovations in water treatment technologies and to create higher-quality residual flows. The municipality of Almere is providing support for a plastic factory for regional processing and selling of the low-grade mix of packaging plastics. The city’s efforts include performing a market survey and feasibility studies, and providing assistance in the subsidy application and the search for a location. Examples of subsidies are those offered by the municipality of Tilburg to advance circular initiatives, and those offered by the province of South Holland for the waste processing plant Waste to Chemistry.

Figure 6.5
Actions for the circular economy carried out by regional governments, by policy instrument, 2019



Source: RHDHV 2020

Regional authorities dedicate financial resources to circular economy

Most of the provincial subsidies that can be used for circular projects undertaken by businesses are broadly centred on innovation. The most important source of capital is the European Regional Development Fund which all provinces draw on as co-financing to set up regional programmes, such as OP Zuid, OP Noord, OP Oost, and Kansen voor West. Between 2014 and 2020, the provinces jointly put up EUR 229 million per year for those programmes, but it is not known how much of that was allocated to circular economy projects. In addition, all provinces pay half of the regional shares of the Innovation Incentives Scheme for Regional and Top Sectors (the MIT scheme). Over the period 2015 to 2020, this amounted to a total of EUR 118 million, or EUR 20 million per year for all provinces taken together. In 2018, approximately 10% of the MIT scheme funding was allocated to circular projects. The provinces, together, spend EUR 107 million per year on loans granted through their broad investment funds. It is difficult to indicate exactly what proportion is dedicated to circular projects, but in some cases the figure is known. For example, 13% of the amount lent by the Innovation and Energy Fund Gelderland goes to circular businesses. Most provinces also have specific circular economy-related subsidies and are spending a collective annual total of EUR 11.1 million on them (RVO, 2021).

Many policies are aimed at studies and explorations

A large number of policy activities focus on the preparatory phase, pilot projects or trials (approximately 450 actions). In addition, regional authorities are encouraging the creation of networks (approximately 400 actions) and have carried out studies or explorations on around 350 occasions (Royal HaskoningDHV, 2020c). For example, several provinces have commissioned analyses on material resources to gain insight into the materials and the possibilities to promote circular production and consumption at the regional level. These are all interventions that correspond to the initial phase of the transition towards a circular economy. Setting up research, sharing knowledge and developing expertise are important in this phase (Chapter 4.2).

Circular procurement is a frequently used instrument
Regional authorities often use their purchasing power to promote a circular economy (approximately 400 actions). The purchasing categories that are by far the most popular are civil engineering (about 150 actions) and, to a lesser extent, housing and non-residential buildings (about 30 actions). The Civil Engineering Green Deal has perhaps played a stimulating role here. An example of this kind of circular procurement processes in the field of civil engineering is the tender by the province of Flevoland for the construction of bridges according to circular criteria.

Local and regional authorities can also contribute to a circular economy by fitting out and managing their own property in a circular fashion. This is done regularly in the municipalities and provinces studied here (about 40 actions and 10 actions, respectively). In addition, the municipalities in the survey are often working on circular urban area development (about 60 actions), for example, in order to make it easier for companies to use each other's residual flows. Then there are the actions by water boards, who regularly extract resources from waste water (about 60 actions), such as struvite — a biobased substance — and cellulose, which can be used in the production of bioplastics.

Different regional authorities play specific roles in the transition
The policy focus varies according to the type of regional authority. Provinces, for example, concentrate mainly on support and financing for businesses. So do municipalities, but they also often stimulate knowledge networks. Water boards, on the other hand, predominantly conduct research (such as feasibility studies) and often function as suppliers of material resources. Regional bodies are, much the same as municipalities, more active in the creation of networks and the provision of information. Finally, Environmental Services are bodies that mainly deal with issuing licences and act as knowledge partners.

6.6.3 Starting point for next phase

Learning together is crucial
The paragraphs above describe how various parties are taking the lead in making production and consumption processes in their region more circular. To take the transition to the next stage, these front runners need to exchange knowledge and experiences in order to learn together, learn from each other, and be able to connect more quickly to circular initiatives and projects that are relevant to them. It is not necessary for everyone to invent the wheel over and over again. By building on previous experiences, circular activities may be able to start faster and scale up sooner.

At present, surely not all regional authorities and institutions have a clear view of the possibilities of a circular economy in their region. It is important that amongst regional authorities the in-between groups and those lagging behind have the possibility to build on the experience of the front runners. What is relevant in this regard is that regional parties are given access to knowledge that has been built up nationally. A regional knowledge infrastructure would be able to facilitate all these exchanges of knowledge and experience, for example, a system that has suitable links to the knowledge base that is being developed for national circular economy policy (PBL, 2020a). The national government can also benefit from the experiences which businesses, local authorities and other societal stakeholders acquire in their regions. For example, regional experiences may provide insight into obstacles to the circular economy that require policy adjustments at the national level, and regional activities provide leads that can help national policies to step up the transition.

The national government is already working actively towards the exchange of knowledge within and between regions. In addition, a higher level of concordance should be created between regional policies, the transition themes and the crosscutting themes.

6.7 Circular economy policies in Europe and surrounding countries

The Netherlands needs Europe for a circular economy

The previous chapter elaborated on the development and design of European circular economy policies. European and national policies cannot be seen in isolation from each other. For the greater part, they have been developed simultaneously and have also influenced each other. For example, the Netherlands had been implementing ambitious waste policies for years and was one of the first countries to adopt a national policy plan for the circular economy. This Dutch knowledge and experience has been introduced into the European policy track. Circular procurement and producer responsibility, for instance, appear as key items on both the European and the national agenda. Several spearheads of EU policy — such as Plastics and buildings — are also priorities in national policy. EU policies are of major importance to the circular economy in the Member States: trade policy, product policy and waste policy are good examples. Setting requirements for the use of material resources in product design, or prohibiting the use of harmful substances in products are efforts which expressly call for an EU approach.

In the coming years, developments in European policies will be crucial to circular economy policies in the Netherlands, especially those governing trade and product standards (Chapter 5). This involves matters such as extending the minimum warranty period of products, requiring a minimum share of secondary materials in products, and ensuring that it is possible to reuse or repair product components.

Strategies in neighbouring countries offer starting points

The following paragraphs provide a closer look at the strategies and instruments that surrounding countries have applied to stimulate a circular economy. Developments in neighbouring European countries cannot be viewed in isolation from policy opportunities to accelerate the transition towards a circular economy in the Netherlands. After all, the Netherlands is a trading country with a high level of imports from and exports to European countries (Chapter 3). The circular economy policies in those countries are a factor in determining the opportunities for speeding up the transition towards a circular economy in the Netherlands. In addition, those national strategies offer starting points for further shaping EU policies.

Various Member States have national circular economy strategies. Outlined below is a number of key points of the circular economy policies of other European Member States. For both the European Union and individual EU Member States, important motivations for a national transition towards a circular economy are economic aspects (e.g. increased productivity and competitiveness), security of supply and growing independence from other countries, and the fight against climate change. In addition, in some countries the ambition to stimulate innovation (e.g. Flanders, Germany, Finland) and create new jobs (e.g. France) also plays a role (Ashraf et al., 2020; Chavannes et al., 2020). In the implementation, however, countries partly differ with regard to the issues they emphasise (Chavannes et al., 2020; Salvatori et al., 2019). This is why some countries have made more progress than others in some areas. The following observations show that this provides various sources of inspiration for policies in the Netherlands.

Finland was the first country to develop a national circular economy strategy. It is mainly aimed at the business world and focuses on research and innovation. The country has the ambition to be a global leader of circular economy by 2025, seeing it as an opportunity to export Finnish expertise and innovations. One example of an initiative conforming to this ambition is the organisation of the World Circular Economy Forum (WCEF). Businesses, policymakers and experts participate in this event, which is held in Finland every two years and at another place in the world in the in-between years. The next WCEF+ on Climate was held in the Netherlands in April of 2021.

Germany has broadened its circular economy policies in the last few years from resource efficiency and waste management to include, for example, the design phase of products (Chavannes et al., 2020; Wilts, 2017). In Germany, more efficient material resource use is explicitly linked to the ambition to be a leader in strengthening and greening industry. German circular economy policies are strongly influenced by their dependence on imports of material resources. Because of this, Germany also feels responsible for environmental impacts occurring elsewhere in the chain (Ashraf et al., 2020).

France pays a great deal of attention to mobilising consumers. The strategy goes beyond waste management as it also explicitly addresses product lifespan extension, product reuse and producer responsibility (Chavannes et al., 2020). Further to that, in January 2020 France adopted legislation that prohibits businesses (including online retailers, such as Amazon) from destroying unsold items. Food waste is also prohibited.

The *United Kingdom* has launched a sustainable clothing action plan to reduce the environmental impact of clothing through voluntary collective action by businesses. The United Kingdom offers VAT exemption on second-hand clothing if it is sold by an organisation that designates the profits for charitable causes (Ecopreneur.eu, 2019; WRAP, 2020).

The *Flemish* strategy aims to limit potential supply problems of material resource imports (European Economic and Social Committee, 2019). In addition, it is expected that a circular economy with higher levels of circular production and consumption will create economic opportunities and prompt innovation for the manufacturing industry, the services sector and the agro-industry. Flanders aims to achieve this by focusing particularly on the design of products and processes, and on the development and application of new business models (Chavannes et al., 2020). Involving different societal stakeholders and focusing on knowledge development are seen as important components of a successful circular economy strategy (Winans et al., 2017).

Sweden has applied a VAT reduction from 25% to 12% on the repair of bicycles and clothes since 2017, and also enabled consumers to reclaim tax on the cost of repair of white goods (Rreuse, 2017; Starritt, 2016).

This examination of the strategies of several countries in north-west Europe shows that the focus is mainly on waste management, the construction sector, food production and the manufacturing industry, while less attention is given to mining activity, electronics and the clothing industry. Public procurement and product design are subjects that frequently appear in the strategies (EEA, 2016).

6.8 The relationship between the circular economy and the energy transition

The transition towards a circular economy is, in a number of ways, closely linked to the energy transition. This creates opportunities for both tracks of development to reinforce each other, but may also involve risks. This section deals with various aspects of the relationship between the two transitions.

Circular economy can contribute to reduction of greenhouse gas emissions and vice versa

The relationship between the transition towards a circular economy and the energy transition aimed at combating climate change is evident from the fact that a considerable proportion of greenhouse gas emissions is linked to the extraction and processing of material resources, the use of products and the waste phase. For the Netherlands, the share of greenhouse gas emissions from sectors that are relevant to the circular economy amounts to 28%. If emissions that occur earlier or later in the production chain are also included, the share rises to between 55% and 77% of Dutch greenhouse gas emissions (Drissen and Vollebergh, 2018). Policies focusing on a circular economy can therefore make a significant contribution to realising the ambitions related to energy and climate. And inversely, the supply of renewable energy contributes to a drastic reduction in the use of primary fossil resources.

There are risks attached to the material resources needed for renewable energy supply

A circular economy requires a supply of renewable energy, and to achieve the energy transition, material resources are needed, such as biomass and the critical rare earth metals for power plants that generate wind and solar energy. This is not without risk. After all, the supply of sustainable biomass is not unlimited and, from the perspective of a circular economy, biomass has other applications, such as food, building materials and medicines, which are more high grade than energy production. The large-scale use of critical rare earth metals in applications such as energy production entails risks as to security of supply. Timely availability of these materials is crucial for the energy transition, but they are mainly extracted and refined in China, which implies a relationship of dependency.

Climate policies focus on stack emissions, the circular economy focuses on chain emissions

An important difference between the two policy areas lies in their focus. Climate and energy policies concentrate mainly on stack emissions, whereas the circular economy centres attention on emissions throughout the production chain, which therefore includes greenhouse gas emissions occurring abroad. This can create tensions between the two policy areas. Investments in a circular economy can lead to a reduction in greenhouse gas emissions in other countries, but the current energy and climate policies do not reward companies that invest in reducing greenhouse gas emissions outside the Netherlands (Von der Wijst and Van der Vooren, 2020). This is all the more troublesome because the resources available for circular economy policy have until now been to a great extent dependent on climate policy. It is therefore important to look for opportunities for future rewards for efforts to reduce greenhouse gases in order to exploit the synergy between the two domains.

Gains from more energy-efficient appliances are not determined by the use phase alone

Another field of tension between the energy transition and the circular economy is the lifespan of appliances. In a circular economy, extending the lifespan of products is a way of using material resources more efficiently. This may be at odds with energy savings made possible through the development and production of increasingly energy-efficient products and appliances (Von der Wijst and Van der Vooren, 2020). In the 1990s and 2000s, considerable improvements in energy efficiency were already achieved for many household appliances. This means that today's additional environmental gains in the use phase from even more energy-efficient appliances will be limited. Therefore, a broader assessment must be made, in which the gains from a more energy-efficient appliance can be weighed against the energy required for the extraction of material resources and the environmental impacts that occur during production and in the waste phase.

Product design plays an important role in ensuring the possibility to use products longer and to recycle materials. The question is to what extent circular design is already being used as a criterion for renewable energy technologies. This determines whether components, critical materials and other material resources can be reused in high-grade applications in the longer term.

Linking waste incineration with heat networks entails a risk of lock-in

Linking waste incineration to energy supply systems such as heat networks poses a risk to the transition towards a circular economy. At present, sizeable investments are being considered or actually made to connect incineration plants or other incineration or fermentation facilities to heat networks, as has been done in Amsterdam. This connection entails a risk of lock-in. That is to say, the Dutch energy supply would become dependent on the incineration of a sufficiently large volume of waste, thereby creating an incentive to enable the practice instead of limiting the generation of waste and giving useful materials contained in the waste a new life through recycling.

More attention is needed for synergies and trade-offs between climate and circular economy

The aspects outlined above show that the energy transition and the transition towards a circular economy are strongly intertwined. Up to now, attention has been focussed mainly on the potential of the circular economy to accelerate the energy transition; the resources which national policies have made available for the circular economy are largely dedicated to this goal. In contrast, climate policy has until now given limited attention to the circular economy. It is advisable to devote more attention to the relationship between both tracks of development, and to the opportunities they have and the risks they are facing, in order to prevent situations where aimed-for effects in one track produce undesired effects in the other.

6.9 Summary and conclusions

This chapter has examined circular economy policies in the Netherlands and the way they relate to the government's ambition to achieve a fully circular economy by 2050. We conclude that attention for the circular economy has increased and that government policies have led to the mobilisation of societal stakeholders. At the same time, these paragraphs have provided an outline of the great challenge that exists after the initial phase: achieving the scaling up of circular initiatives and ensuring that the transition towards a circular economy indeed takes place in the coming decades. Rounding off this chapter is a brief summary of the challenges and the possible responses to them that have been discussed in the previous sections.

Policies have mobilised a broad group of parties for the circular economy

In recent years, the transition towards a circular economy has become more prominent on the agendas of policymakers, businesses and other organisations in the Netherlands. In policies for the promotion of a circular economy, a public-private approach has been chosen. This has led to broad social support for the Raw Materials Agreement and cooperation with stakeholders in various domains. It has also prompted the development of the five strategic transition agendas for Biomass and Food, Construction, Consumer Goods, Plastics Materials and the Manufacturing Industry. These agendas have been worked out in further detail into the concrete plans and actions included in the implementation programme.

By selecting five transition themes and ten clusters of policy instruments, the government has created the necessary focus for the transition towards a circular economy. Differentiating between transition themes is necessary, because there can be substantial differences between the themes with regard to the scale of the problem, the stage it has reached and possible solutions. The ten clusters of policy instruments comprise a broad palette of relevant tools that policies can use to stimulate the transition. In addition, the government is explicitly involving parties from regions in national policy. With these steps, policy has laid a foundation and created a structure in order to start up the transition towards a circular economy together with the societal stakeholders involved.

Up to now, national policy has mainly used facilitating instruments

National policy has, until now, mainly focused on forging a broad social coalition and on using communication and facilitation to support initiatives by businesses, NGOs and consumers. Efforts include knowledge development, the establishment of Versnellingshuis Nederland Circulair! to provide support to businesses, and offering guidance on the formulation of voluntary agreements, such as the Concrete Agreement, the Plastic Pact and 'United against food waste'. In addition, existing financial instruments, such as the MIA/Vamil tax deduction schemes, have been broadened to encompass investments in a circular economy. These kinds of supporting actions are appropriate for the start-up phase of circular economy policy.

Policies need to be intensified to realise the circular goals

To step up the transition towards a circular economy and to realise the firm ambition to become fully circular by 2050, policy measures need to be more intensive. There is also a need for more financial resources, although it is not yet possible to indicate the exact volume. These matters can be looked upon as the next phase of the transition. The voluntary and noncommittal nature of the current approach do not square with the government's firm ambitions. The environmental policies of the past decades have shown that covenants and voluntary agreements are not enough to achieve the ambitious targets and emissions reductions of 70% to 90%. In addition to putting the circular economy on the agenda and creating support, there is also a need for instruments of a more stimulating and regulatory nature, along with a broadly supported vision of the aimed-for direction that is worked out into specific targets. The government can also promote innovations geared towards circularity, for example, by engaging extensively in circular procurement and by extending producer responsibility.

The need to reach a widely supported vision and set measurable targets

To determine the desired direction and pace of the transition towards a circular economy, there needs to be a widely supported vision amongst the various parties in Dutch society that are working on the circular economy, such as the ministries involved, businesses, local, regional and provincial authorities, and other societal stakeholders. This entails a joint effort to investigate and define what it means for the Netherlands to be fully circular by 2050. What images correspond to this? Are the guiding principles and sustainable preconditions of the final picture clear and do all parties share them? What things do the parties agree on, and on what points do differences in opinion still exist? The clearer these things become, the better it can be assessed whether the actions and projects being undertaken today are headed in the right direction and are progressing at the right pace.

The interim target for 2030 to halve the use of primary abiotic resources is already more concrete, but it still needs to be made measurable, and it does not count on wide support in its current form. Therefore, the steps that the Ministry of Infrastructure and Water Management is currently taking to further specify the target are vital. In this kind of approach to influencing the transition towards a circular economy, an important aspect is the need for a set of targets and indicators, rather than a single target. Ideally, this set should cover the input of material resources and materials, their use in products, and the output of material resources in the form of waste, and also the impacts of material use that occur during production and consumption processes. These impacts include both environmental effects — such as greenhouse gas emissions, nitrogen emissions and biodiversity loss — and socio-economic effects, such as risks to security of supply. Across the various transition themes and product groups, there can be great differences in the scale of the problems experienced, the nature of material resource use and the impacts related to that use, and for this reason it is necessary to ensure the targets are differentiated accordingly.

Along with concrete targets there also has to be a clear division of responsibilities between the various parties involved. For example, what are the responsibilities and competences of the various transition teams and what role does the government play in those teams?

Policies should use persuasion and coercion, such as levies and regulation, more often and at an earlier stage

To make the next step in the transition towards a circular economy, policymakers need to add, in the short term, more 'persuasion and coercion' to the set of instruments they are using. Examples include regulatory levies, standards, and attaching conditions to licences. The justifications for such measures are that, until now, environmental damage has not been sufficiently factored into prices, and that the current rules give undue preference to linear practices over circular initiatives. At present, products are often offered for sale at prices that are too low because the costs of damage to nature and the environment are not sufficiently taken into account. This makes it difficult for consumers to consider the pros and cons when purchasing products.

Until now, circular economy policies have used few legal and economic instruments. And those that have been deployed are often still in development, and need to be worked out in further detail and be passed by the Dutch House of Representatives. However, interventions such as adapting legislation and regulations and introducing price incentives, usually require a long time (to gain social and political support, and to go through the legislative process), as is illustrated by the long history of the introduction of a deposit refund scheme for small bottles. It is therefore important to speed up existing processes and start new instruments in due time.

Waste policies, which have existed for a longer time, have already seen the use of legal and economic instruments, such as the tax on incinerating recyclable waste. In that regard, policies focusing on recycling and waste are in a more advanced stage than policies aimed at starting up new chains, creating markets, circular business models and circular design.

More environmental gains possible through circular procurement and producer responsibility

The government can promote innovation by engaging in procurement of circular products or services to create market demand. Many government authorities already do this, but greater environmental gains can be achieved by paying more attention to innovation aspects in tendering processes and by guaranteeing the results within their organisation. This may be done by seeing to it that circular procurement goes beyond merely setting requirements for recycling, and, in the case of efforts to extend product lifespans, by ensuring that corporate culture and the administration guarantee they accept the idea, so that the products are indeed given a longer lifespan. Finally, it is advisable for contracting authorities to make joint purchases more frequently in order to influence the market. Joint circular procurement and tendering lead to more environmental gains than the practice of operating independently.

In Extended Producer Responsibility systems, the producer is responsible for a product in the phase after the consumer has discarded it. As a result, larger amounts of discarded products are collected and recycled, generating a more abundant and more stable supply to recycling markets. An effective way to increase the positive environmental effects of these systems is the use of flexible economic instruments in order to offer producers a lasting incentive to design their products in a circular fashion. It is also sensible to differentiate the height of return premiums according to aspects such as recyclability and the share of recycled material in a product. After all, what really matters, in addition to the proportion of products that are taken back or recycled, is the quality of the collected and recycled material.

Regional policies are crucial for bringing parties together and exchanging knowledge
In various regions, there is a great deal of activity in the field of circular economy. Parties based in regions are near the material flows and in close contact with each other, which makes it relatively easy to set up networks or chains. For instance, in various locations in the Netherlands, regional authorities, businesses and other regional accelerators — such as economic boards and partnerships for the environment — are actively developing circular initiatives. By focusing on increasing the degree of joint learning, regional parties and the national government can accelerate the transition. An analysis has shown that frontrunning regional authorities do this chiefly by facilitating businesses with efforts such as promoting networking and placing an expert at their disposal in order to further a circular initiative. A large number of activities focus on the preparatory phase, pilot projects or trials. Regional policies are important for bringing parties together and exchanging knowledge. Finally, regional authorities often use their purchasing power to promote a circular economy (Royal HaskoningDHV, 2020c).

Synergy and tension between circular economy and energy transition
Policies aimed at a circular economy can make a substantial contribution to realising ambitions regarding energy and climate. And conversely, increased use of renewable energy sources means that the need for primary fossil energy sources will, in principle, decline. An important difference between the two policy areas is the policy focus. Policies that promote the energy transition focus their attention primarily on stack emissions of greenhouse gases, whereas circular economy policies focus on, amongst other things, greenhouse gas emissions in the chain — and therefore also on emission reductions achieved in other countries. This can lead to tensions between the two policy areas. Under the current energy and climate policies, companies that invest in reducing greenhouse gas emissions outside the Netherlands are not compensated for their efforts. To make better use of the synergy between the two transitions, it is therefore important to look for opportunities for future compensation for achieving reductions in greenhouse gas emissions abroad.
Two other issues which cause tension between the energy transition and the circular economy concern the lifespan of products and the coupling of waste incineration to heat networks. For example, the direct link between waste incineration plants and heat networks acts as an incentive

for waste incineration rather than waste recycling. In addition, the ambition to replace the stock of electrical appliances with items that are becoming more and more energy efficient in use might be at odds with the environmental impacts associated with that replacement. Therefore, a broader appraisal needs to be made in which the gains reaped from a more energy-efficient appliance can be weighed against the energy required for the extraction of material resources and the environmental impacts that occur during production and in the waste phase.

These points show that the energy transition and the transition towards a circular economy are strongly intertwined. Until now, policies have dedicated attention mainly to the contribution a circular economy can make to the energy transition, and the resources which the government has made available for a circular economy are mostly directed towards this aim. Conversely, climate policies have, up to now, given limited consideration to the opportunities that the circular economy may offer them. It is advisable to devote more attention to the relationship between both tracks of development, and to the opportunities they provide and the risks they are facing, in order to prevent situations where the aimed-for effects in one track produce undesired effects in the other.

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Appendix 1: Glossary

Abiotic resources | Raw materials extracted from non-living sources (minerals, including metals and fossil raw materials).

Biobased resources | All types of biotic substances of plant or animal (including microbial) origin, such as material resources, materials, products and waste products from agriculture, forestry, fishery, aquaculture, industry and households (e.g. organic household waste). (also see: Biomass)

Biomass | All types of biotic substances of plant or animal (including microbial) origin, such as material resources, materials, products and waste products from agriculture, forestry, fishery, aquaculture, industry and households (e.g. organic household waste). (also see: Biobased resources)

Chain | The complete process of extraction of natural resources, their processing into materials, manufacturing of components and final products, distribution of products to consumers, and finally, waste collection and treatment.

Circular Economy Implementation Programme | Implementation programmes contain concrete actions and projects for the transition themes and transversal themes (clusters of policy instruments), and the parties involved in the transition agendas participate in their selection and development. The programme is updated every year and new initiatives can be added to it. To date, there are implementation programmes for 2019–2023 and 2020–2023.

Circularity strategies | Also known as R-strategies. Strategies aimed at significantly reducing the use of material resources and the related environmental pressure. There is a hierarchy of R-strategies (the R-ladder), and those higher up the ladder generally come with less use of materials and less environmental pressure. In its most extensive form, the hierarchy, from top to bottom, is: refuse, rethink, reduce, reuse, repair, refurbish, remanufacture, repurpose, recycle and recover.

Consumption footprint | The consumption footprint visualises the environmental impacts that arise during the manufacturing of all products consumed in the Netherlands. This concerns household consumption, corporate investments in production goods, and public administration consumption and investments.

Critical materials | Materials that are deemed critical due to the combination of supply risks and their economic significance.

Direct resource use | This refers to the material resources (see corresponding entry) used in the Dutch economy or for domestic consumption.

DMC | Domestic Material Consumption measures the direct use of material resources for consumption. It is defined as DMI minus the weight of primary resources, materials, components and export products.

DMI | Direct Material Input measures the direct use of material resources in the economy. The DMI includes all domestically extracted raw materials (abiotic raw materials and harvested crops) plus imported primary resources, materials, components and products. DMI does not include any resources used abroad to produce the imported materials, components and products (e.g. fuel to power machines).

Effects | The impact of natural resource use on nature and the environment and the subsequent impact on security of supply and socio-economic developments, such as job numbers and working conditions in the production chains (also see: National effects).

Environmental footprint | This footprint reflects the environmental pressure of entire production chains, both nationally and abroad (also see the Material footprint). Two variants can be distinguished: the consumption footprint and the production footprint. The two overlap in the case of materials that are both processed into final products and consumed in the Netherlands.

Established policy | A policy is considered established when the intention, the instrument and the required resources have been detailed in concrete terms and have been determined, directly or indirectly, by the Dutch House of Representatives.

Fossil resources | Coal, petroleum and natural gas. Substances formed from the remains of plant and animal organisms that died millions of years ago. Fossil resources are used to produce energy as well as products such as plastics or fertiliser. Fossil fuel combustion leads to CO_2 emissions.

Government-wide Programme for a Circular Economy | A Circular Economy in the Netherlands by 2050 is the name of the government-wide programme, set up in 2016, for a circular economy in the Netherlands. Within the plan, a vision was developed and ambitions and goals for a circular economy were formulated. This prompted five transition agendas, a government response to the proposals, an annually updated implementation programme, and the Raw Materials Agreement, which has already been signed by more than 400 parties.

Indirect use of material resources | Part of the Dutch use of material resources is indirect because several segments of the production chains are located in other countries and because production processes involve the use of materials that are not present in the final product. An example is the fuel used to power machines that make products for the Netherlands. The whole of direct and indirect use is also called the material resource footprint.

Key processes | Key processes can be considered as preconditions for accomplishing a societal mission. If certain key processes are working only partially, or not at all, the transition process will slow down. Key processes are crucial for the transition and include entrepreneurship, developing and exchanging knowledge, moving the search process in the right direction, creating markets, mobilising resources, breaking down resistance, and coordinating the various change processes.

Material resources | We use the term material resources to refer to the entirety of all primary resources (see corresponding entry), materials, components and products.

Material | Natural or manufactured substance destined to be processed into usable products (also see: Secondary material).

Material resource footprint | The material resource footprint comprises all the direct and indirect use of material resources. It can be quantified in regard to both the economy and domestic use.

Material resources for domestic use | These are the resources used by consumers, companies and government authorities in the Netherlands. A share of the resulting products originate from Dutch companies (e.g. pork from Dutch livestock farmers), the other share is imported and supplied to Dutch consumers (e.g. the bananas sold in Dutch supermarkets). This category does not include exports.

Material resources for the economy | These are the resources that companies use during production, and materials contained in imported products used in the Netherlands (consumers, companies and the public administration). It is the aggregate of primary resources extracted in the Netherlands (minerals, harvested crops), imported primary resources (e.g. crude oil), materials (e.g. steel or animal feed), components (e.g. microchips) and products (e.g. cars).

Metals | Examples of metals are iron ore, aluminium, copper, neodymium and rare earth elements.

Minerals | All metals and other minerals. This report uses the term mainly to refer to non-metallic minerals, such as stone, sand and salt.

Mission-oriented Innovation System (MIS) | An MIS consists of the actors and rules that, together, contribute to carrying out a societal mission (e.g. the transition towards a circular economy). This is done by developing all manner of innovations (technological innovations, new business models, social innovations), and also by phasing out existing practices that impede accomplishing the mission. The quality or performance of an MIS (and therefore the likelihood of completing the mission) can be evaluated on the basis of a number of key processes (see corresponding entry).

National effects | National effects are the environmental effects that occur on Dutch territory, such as. land use, and greenhouse gases emitted by businesses, organisations and households in the Netherlands (national greenhouse gases).

Policy intent | Policy intent concerns measures that are still in the idea stage, without choices having been made yet for a specific instrument, design and budget. However, policy intent may nevertheless already have been approved by the Dutch Parliament.

Primary resources | Primary resources are resources that are extracted from nature, such as iron ore. They are generally processed into materials and components, such as iron and steel plates, and, once contained in those, they end up in final products, such as cars.

Production footprint | The production footprint comprises the environmental impacts that are created in the production chains of all material resources, materials, product components and final products used in the Dutch economy, such as soya from Brazil that is added to cow feed in the Netherlands. It does not matter if the milk from those cows is consumed in the Netherlands or exported. The effects of imported final products that are consumed directly (e.g. bananas from Costa Rica) are not factored into the production footprint.

Proposed policy | Proposed policy refers to the existence of an instrument or set of instruments that has been determined to achieve the policy, although there is no concrete policy plan yet with the necessary financial resources, and the exact design of the policy intervention has not been established yet.

R-strategies | Also known as Circularity strategies. Strategies aimed at significantly reducing the use of material resources and the related environmental pressure. There is a hierarchy of R-strategies (the R-ladder), and those higher up the ladder generally come with less use of materials and less environmental pressure. In its most extensive form, the hierarchy, from top to bottom, is: refuse, rethink, reduce, reuse, repair, refurbish, remanufacture, repurpose, recycle and recover.

Recover | Combustion or fermentation of a product with energy recovery. Winning back nutrients through composting is, in fact, also a form of energy recovery. In all these variants, the processing of a discarded product or material does give rise to something useful, but the product or material itself is completely lost.

Recycling | Recovering materials from end-of-use products (secondary materials), and reusing them to make products. If the secondary material is of the same quality as the original (new or primary) material and is employed as such, this is referred to as high-grade recycling. If the secondary material is of a lower quality and financial value than the primary material, this concerns low-grade recycling.

Reduce | A product for which use becomes more efficient (e.g. a washing machine that uses less energy, water or detergent), or for which production becomes more efficient (e.g. a car built with less sheet material thanks to smart design), without affecting its functionality.

Refurbishing | The process of renewing products that are still functioning properly by remodelling them (e.g. buildings) or modernising them (e.g. the Fairphone), thereby often enhancing their basic function.

Refuse | The process of making products superfluous by discontinuing their use (e.g. alcoholic drinks or recreational drugs), or by ensuring their functions are performed by a radically different service or product (e.g. Spotify instead of CDs, or blankets instead of patio heaters).

Renewable natural resources | Renewable natural resources are primary resources from a source that can be renewed on an ongoing basis. Biobased resources are renewable.

Repair | Mending and maintaining a defective product to ensure continued use in its original function (as in cars and clothing).

Repurpose | The reuse of components of an end-of-use product to create a 'new' product with a different function.

Rethink | Intensify the use of products through, for example, sharing schemes (e.g. car sharing, or apartments with shared facilities), or by making them multifunctional (e.g. smartphones and all-in-one printers). In this way, a single product can offer a higher level of functionality.

Reuse | This refers to products and their components being given a new use without drastically changing their shape or composition (see: Reuse and Repurpose). Materials cannot be reused, but they can be recycled (see: Recycle). Reuse is about taking a discarded, but still properly functioning product and putting it to use again in its original function (e.g. vintage clothing, second-hand vehicles, tableware and all kinds of other products sold online (e.g. on Ebay), or in second-hand and antique shops). Sometimes, second-hand products are renewed before they go on sale, making the reuse strategy overlap with repair and refurbish.

RMC | Raw Material Consumption is the sum of Domestic Material Consumption (DMC) and material resources used in the chain. The RMC calculation also factors in all material resources that are needed in other countries to create the imported materials, components and products (e.g. fuel used to keep production machinery running).

RMI | Raw Material Input is the sum of Direct Material Input in the economy (DMI) and material resources used in the production chain for the economy. The RMI calculation also factors in all material resources that are needed in other countries to create the imported materials, components and products (e.g. fuel used to keep production machinery running).

Secondary Materials | Secondary materials consist of waste and by-products which, after being released, collected or prepared (e.g. by the Preparation-to-Recycle industry), are used once more as materials in the production process.

Socio-economic impacts | These are both the social and economic impacts of resource use. Examples include job numbers, health, security of supply, and the conditions under which people are working in production chains.

Substances of very high concern (SVHC) | SVHCs are substances with one or more of the following properties: carcinogenic, mutagenic, toxic to reproduction, persistent or very persistent, bioaccumulative and toxic, and substances that arouse similar concern about human health or the environment. These substances are listed in a register, which is updated twice a year.

Supply risk | This refers to the risk of unavailability of a material resource for either the economy or businesses.

Transition | Structural change in society as a result of large-scale, interacting and mutually reinforcing developments in the technological, economic, ecological, socio-cultural and institutional arenas. It necessarily involves the end of an existing situation (i.e. change) and the creation of a new one. The process is often long and arduous and will see losers and winners. A well-known example is the transition from coal to natural gas and all that it entailed. The ‘digital revolution’ is another example.

Transition Agendas | In 2018, the Raw Materials Agreement was worked out by its endorsers into five transition agendas: Biomass and Food, Plastics, the Manufacturing Industry, the Construction Sector, and Consumer Goods. Each agenda contains its own specific objectives and designs a strategy to achieve them.

Transition teams | Each transition agenda is drawn up by a transition team, consisting of a group of experts from science, government, and market parties.

Transition themes | Five priority transition themes have been established in the Government-wide programme for a Circular Economy. They were chosen specifically because of their importance to the Dutch economy, they exert high environmental pressure, already count on a great deal of social energy for the transition towards a circular economy, and are in line with the priorities of the

European Commission. The five transition themes are: Biomass and Food, Plastics, the Manufacturing Industry, the Construction Sector, and Consumer Goods.

Transversal themes | These are themes from the Circular Economy Implementation Programme that the government has considered as priorities and are relevant to all five transition agendas. They concern fields such as innovation, circular procurement, producer responsibility, financing and Versnellingshuis (the organisation to accelerate the Dutch circular economy). To avoid confusion with transition themes, this report speaks of clusters of policy instruments.

Appendix 2: Reporting process and quality assurance

This Integral Circular Economy Report for the Netherlands was completed thanks to the intensive cooperation with and monitoring by colleagues at PBL Netherlands Environmental Assessment Agency and independent external institutions. This appendix first describes the steps that were taken together with external parties to design the report's structure and contents. This is followed by an explanation of how quality control of the reporting was carried out.

At various stages in the process, internal and external parties were consulted and asked to provide input on the structure and contents of the ICER report. Internal consultations took place with the steering group and through seminars. External parties were also involved from the initial stages. The key issues were: what questions should the report aim to answer, and how can it arrive at these answers? And what is a logical structure for the report? These discussions were first held internally at PBL Netherlands Environmental Assessment Agency and thereupon with the knowledge institutes involved in the Work Programme on Monitoring and Directing the Circular Economy and with the Ministry of Infrastructure and Water Management.

From the 70% version of the report onwards, there were several occasions on which a wider group of people from the scientific community, knowledge institutes, government authorities, businesses, NGOs and other societal stakeholders conducted a specific substantive review of the report. The 70% and the 90% versions of the report were distributed widely to seek comments, and they were discussed both internally, through seminars, and externally, during Experts' day events with parties involved from the areas of science and policy and from society (see Table B2.1 for a complete overview). The definite main messages and the findings were submitted for a final review to the knowledge institutes involved in the Work Programme on Monitoring and Directing the Circular Economy. Finally, the ICER report was approved internally by management and sector heads at PBL Netherlands Environmental Assessment Agency. Thanks to the oral and written responses received during the drafting of the report, its quality has improved considerably and can be vouched for.

Table B2.1
Internal and external consultations for the production of the ICER report

Date	Subject / report phase	Group	Institutions involved
2019-10-03	ICER design and structure	Start-up seminar	PBL
2020-02-23	ICER design and structure	Working group CE Monitoring and Directing	PBL, CBS, CML, CPB, IenW, RIVM, RVO, RWS, TNO and UU
2020-01-30	ICER design and structure	Managers' Consultation on CE Monitoring and Directing	PBL, CBS, CML, CPB, IenW, RIVM, RVO, RWS, TNO and UU
2020-02-04	Annotated list of contents	PBL Steering group	PBL
2020-04-16	Transition agendas and policies	Transition team secretaries	CE Transition teams
2020-03-30	Situation report	Working group CE Monitoring and Directing (in writing)	PBL, CBS, CML, CPB, IenW, RIVM, RVO, RWS, TNO and UU
2020-04-02	Situation report	Managers' Consultation on CE Monitoring and Directing (in writing)	PBL, CBS, CML, CPB, IenW, RIVM, RVO, RWS, TNO and UU
2020-04-20	Situation report	Working group CE Monitoring and Directing	PBL, CBS, CML, CPB, IenW, RIVM, RVO, RWS, TNO and UU
2020-04-23	50%-version	PBL Steering group	PBL
2020-06-23	70%-version	Working group CE Monitoring and Directing	PBL, CBS, CML, CPB, IenW, RIVM, RVO, RWS, TNO and UU
2020-06-25	70%-version	Midway seminar	PBL
2020-06-26	70%-version	Experts' day	Knowledge institutions and academia
2020-06-26	70%-version	Experts' day	Policies and social organisations
2020-06-29 to 2020-07-03	Written review 70%-version	–	Knowledge institutions, academia, policies and social organisations
2020-06-30	70%-version	SER CE Reflection group	SER, TU Delft, VU, UU, WUR and Triodos
2020-07-02	70%-version	Managers' consultation on CE Monitoring and Directing	PBL, CBS, CML, CPB, IenW, RIVM, RVO, RWS, TNO and UU
2020-07-03	70%-version	Periodic consultation IenW	IenW
2020-08-13	Progress ICER	PBL Steering group	PBL
2020-09-01	Chapter on CE policies	Periodic consultation IenW	IenW
2020-09-08	Findings and transition process	PBL Steering group	PBL
2020-09-23 to 2020-10-02	Written review 90%-version	–	Knowledge institutions, academia, policies and social organisations
2020-10-01	90%-version	Working group CE Monitoring and Directing	PBL, CBS, CML, CPB, IenW, RIVM, RVO, RWS, TNO and UU
2020-10-01	90%-version	Periodic consultation IenW	IenW
2020-10-08	90%-version	Managers' consultation on CE Monitoring and Directing	PBL, CBS, CML, CPB, IenW, RIVM, RVO, RWS, TNO and UU
2020-10-09	90%-version	Experts' day	Knowledge institutions and academia
2020-10-09	90%-version	Experts' day	Policies and social organisations
2020-10-12 2020-10-16	90%-version	Part of SER CE Reflection group	UU, VU
2020-10-29	95%-version	Final seminar	PBL
2020-11-13	Final draft of main messages and findings	Working group CE Monitoring and Directing	PBL, CBS, CML, CPB, IenW, RIVM, RVO, RWS, TNO and UU

In addition to the activities listed in the table above, periodic consultations were held with the Ministry of Infrastructure and Water Management to make adjustments to the reporting process and the report contents.

Below is a list of the persons involved by organisation:

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Attendees of the Experts' Day events
Ronald van den Heerik and Leonie Reinders (BKN), Esther 't Hoen (BZK), Roel Delahaye and Vivian Tunn (CBS), Geert Warringa (CE Delft), Michelle Steenmeijer (Circle Economy), Arthur ten Wolde (Circular Future), Klaske Kruk (Circularities), Anne-Marie Rakhorst and Carolina Santamaria (duurzaamheid.nl), Matthéus van de Pol and Peter de Waal (EZK), Jan Paul van Soest (Gemeynt), Laura Birkman (HCSS), Antoine Heideveld (Het Groene Brein), Mari van Dreumel, Reinier Guijt, Lani Kok, Linda Korpershoek, Imke Haenen Ralph Peters, Saskia Ras, André van Rodenburg, Sanne Westra and Dorine Wytema (IenW), Jeannette Levels (LBP Sight), Jessica Thio (LNV), Gerard Roemers (Metabolic), Aniek Ivens (Milieu Centraal), Marc Pruijn (MVO), Jelmer Vierstra (Natuur en Milieu), Tim Bulters (NMU), Niels Ruijter (NTVB), Harald Tepper (Philips), Suzanne Buter and Pieter Jan Bouwmeister (Prov. Groningen), Franck Kuiper (Prov. NH), Kim Simons (Prov. Utrecht), Hans Koot (Prov. ZH) Paul Mul (RHDHV), Johannes Lijzen and Michiel Zijp (RIVM), Astrid Hamer and Kees Kwant (RVO), Guus van den Berghe, Henk Hortensius, Marjon Jansen, Juliane Kupfernagel, Jacqueline Rohde, Claartje Vorstman and Mandy Willems (RWS), Ton Bastein (TNO), Meinke Schouten and Ruud van Esch (UVW), Christian Lorist (VNO NCW).

Appendix 3: Frameworks for monitoring and directing

In the report What we want to know and can measure an initial outline is provided of the framework for monitoring the circular economy (PBL, CBS and RIVM 2018). The framework encompasses, firstly, the visualisation of material resource use and the effects of that use on the environment and the economy under the transition towards a circular economy, and secondly, the transition process itself as it prepares for the ultimate realisation of those effects. The 2018 report describes three components of monitoring: (1) monitoring of material resource use and the effects of that use, (2) monitoring of actions, and (3) monitoring of transition dynamics. This approach is in line with the policy assessment framework in Figure B3.1, which gives an indication of how the various components are related. The monitoring of actions and the monitoring of transition dynamics together form the monitoring of the transition process. Both actions and transition dynamics contribute to the transition process which is then to lead to the aimed-for decrease in material resource use, the reduction of environmental pressure and the creation of opportunities for the economy. The 2018 report also puts forward an initial set of indicators for the monitoring components.

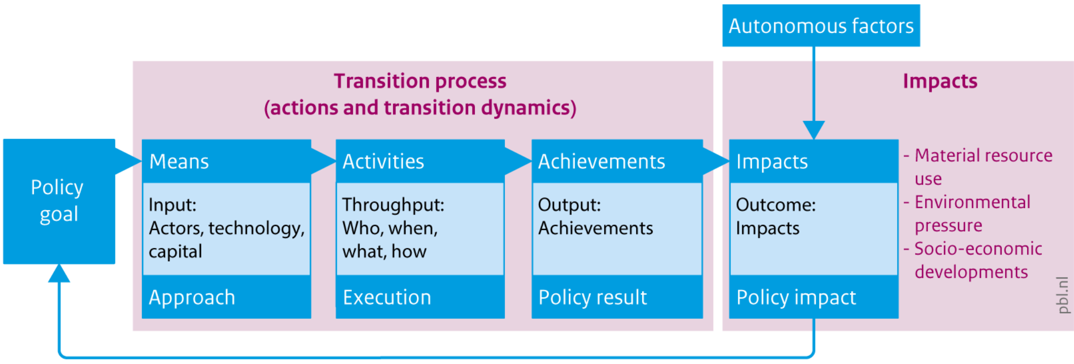
The ICER monitoring framework focuses on (1) material resource use and its impacts; and (2) the transition process and the deployed actions and resources

In the ICER report 2021, two major components subject to monitoring are further developed and elaborated in greater detail: (1) material resource use and the impacts resulting from it — such as environmental pressure and risks regarding the security of supply of material resources — and (2) the transition process towards a more circular economy. As explained below, the monitoring of actions is part of the monitoring of the transition process. Below, a general outline is provided of the elaboration of the two components.

Monitoring material resource use and its impacts

The approach to monitoring material resource use and its impacts is based on the report Towards robust monitoring of the circular economy (Prins and Rood 2020) and the policy letter Targets Circular Economy 2030 (Kishna et al. 2019). The main idea of the two studies is that a circular economy can be seen as the whole of (1) input — material resources entering the economy, (2) use — material resources converted into semi-final and final products, and (3) output — the stream of material resources leaving the economy as waste (also see European Commissionl 2018d; Mayer et al. 2019). This is schematically represented on the left side of Figure B3.2.

Figure B3.1
Framework for measuring progress of the transition towards a circular economy



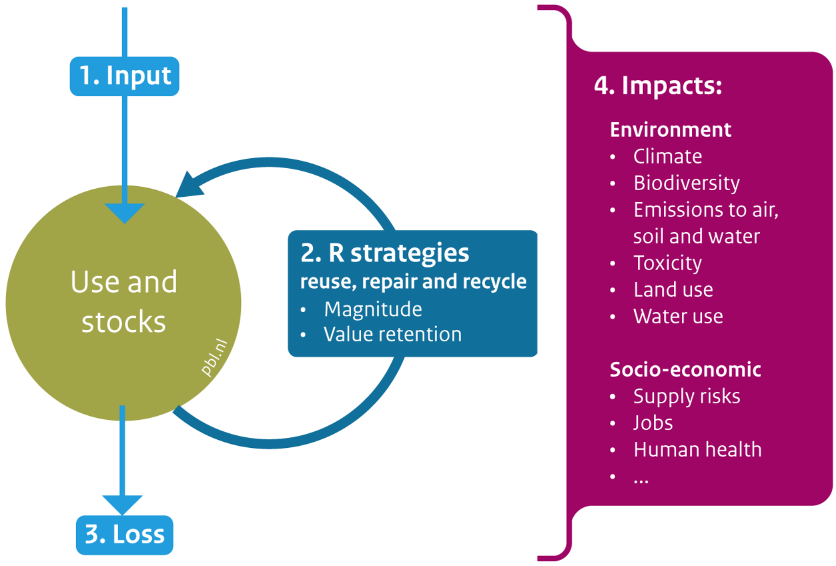
Source: Netherlands Court of Audit, 2005; adaptation by PBL

This approach carries the implication that the degree of circularity can only be determined if the set of indicators visualises all three aspects of material resource use mentioned above. Firstly, indicators are needed that show the amount of material resources required as input for the Dutch economy and consumption. This includes both direct use and use throughout the entire production chain. Input can be lowered by extracting smaller amounts of material resources and by employing them in considerably more efficient ways in production and consumption processes. Secondly, indicators are needed for the use phase of products. These give an idea of matters such as recycling and the lifespan of products and their components. Through second-hand use or repair, the lifespan of products can be extended. Because products last longer, new material resources to make replacement products are needed in smaller amounts, or less frequently. The need for primary resources is reduced through high-grade recycling, which ensures that the quality of secondary materials equals that of primary resources. In the third place, indicators are needed that describe the outflow of material resources from the system. This concerns landfilling and incinerating waste.

Besides the volume of material resource use, attention must also be given to the quality and economic value of material resources. Up to this time, there is only a limited amount of data and few indicators available on these issues, and for this reason, the ICER report discusses them only briefly.

Material resource use goes hand in hand with all manner of environmental and socio-economic impacts. Decreasing material resource use, or making use more circular, is not the ultimate goal, but a way of reducing impacts such as the associated environmental pressure. This means that indicators are needed that give insight into the effects that a circular economy is pursuing, namely the reduction of various forms of environmental pressure, and the contributions to improving the security of supply of crucial material resources and final and semi-final products (illustrated on the right side of Figure B3.2). The impacts on the environment and nature include climate change, biodiversity loss and the presence of toxic substances (also see Table 1 in Findings). The socio-economic impacts of more circular production and consumption have to do with matters such as security of supply and employment, and changes therein.

Figure B3.2
Framework for targets and indicators of circular economy monitoring



Source: PBL

Monitoring the transition process

The transition towards a circular economy is a lengthy process; it evokes resistance and is stymied by entrenched habits, rules and interests, which means the effects of more circular production and consumption only become visible in the long term. Nevertheless, many types of societal stakeholders are already endeavouring to make their production and consumption processes more circular. Since the transition process goes largely ahead of transition results, knowledge about the process is essential to make it possible to assess, at an early stage, whether the aimed-for effects of more circular production and consumption can be expected to eventually arise, and, if effects occur too slowly or not at all, what the causes of the setback are. Changes that take place in, for example, business practices, consumer behaviour or in government regulations (European Union, national government and regional authorities) provide information about the circular economy's current development direction and speed. Figure B3.1 brings this together, in the pink rectangle on the left, in the categories of means, activities and achievements. Indicators that provide insight into these points are used to monitor the transition process.

However, monitoring the transition process is a complex task. Businesses, government authorities, citizens, knowledge institutes, networks and NGOs all play a role in the transition towards a circular economy, without any of these parties dominating the process. In addition, the transition towards a circular economy is not only about new technology, but also about different rules (institutions), new knowledge, and new products and services, such as sharing platforms and product-as-a-service schemes. To monitor this complex whole, the ICER report builds on two perspectives or conceptual frameworks which have already existed for some time: the innovation system model (Hekkert et al. 2007; 2020) and transition management (Loorbach 2007). The first framework assigns a central place to several key functions that are crucial to the success of innovations. These key functions are linked to actions that parties can take to step up the change process and they offer direct starting points for monitoring. In the perspective of transition management, the transition towards a circular economy is a bundle of mechanisms of construction of circular production and consumption processes, and of conversion and phasing out of linear production and consumption processes. This report combines and operationalises the two frameworks. The resulting framework, depicted in Figure B3.3, gives a central role to eight key processes that are crucial to the success of the transition.

This is an elaboration of the schematic representation of the transition process in Figure B3.1. The key processes cover various types of means, activities and achievements, and can be translated into concrete indicators such as the volume of investments in the circular economy, the number of businesses offering circular products, adjustments to legislation and regulations to remove obstacles to more circular production and consumption, and the coordinating role of the government. In this report, the monitoring of actions is therefore not an independent element, but it forms part of the description of the transition process.

Structured and validated data for these key processes are still only available to a limited extent. Therefore, this first ICER report uses a combination of the best available knowledge and newly developed knowledge on the processes. For example, to monitor the process exchanging knowledge, use was made of newly developed insights: a first measurement of the number of conferences on the circular economy held in the Netherlands in 2019, and an analysis of the themes on which cooperation is taking place between Green Deals and DuurzaamDoor — two instruments managed by the Netherlands Enterprise Agency RVO that focus strongly on knowledge exchange. While this picture provides an overview of exchanging knowledge, it does not yet fully cover the process. Nor is it possible to draw conclusions about the most problematic bottlenecks in all key processes. Chapter 4 gives a more detailed description of the used indicators and also points out where insights are still limited. The specific role of the government in the transition towards a circular economy is dealt with in Chapter 6. In spite of the limitations, the transition indicators provide an image of the extent to which businesses, consumers and other parties are preparing for a circular economy and are concentrating on more efficient use of materials, with the aim of reducing environmental pressure and supply risks. It is precisely by using the various key processes for the inspection of the transition process that its central themes can be identified. One prominent theme, for instance, is recycling being a dominant solution direction. This is noticeable in the number of innovative businesses (entrepreneurship), in scientific articles (developing knowledge), actions by the parties involved (guiding the search process) and the financing of innovation projects (mobilising resources). The transition process also encompasses changes in consumption processes that aim for more repair, a shift from ownership to use, and more frequent sharing of products. Monitoring based on these indicators offers the opportunity to make adjustments even before the effects of the transition towards a circular economy can be registered.

Figure B3.2
Elements of a successful transition to a circular economy

Source: PBL 2013; based on Hekkert et al. 2021

Conclusion

Using a broad set of indicators for both effects and the transition, it is possible to visualise the progress of the transition towards a circular economy. The set can also be used to assess whether the various actors are 'doing the right thing' to bring a circular economy closer, and whether 'those things are done properly'. Although the scientific knowledge needed for these tasks is still being developed, this first Integral Circular Economy Report offers an overview of insights that are already available. This knowledge provides actors in society and the realm of politics and policy with the necessary information to steer the process.

Appendix 4: Dutch and EU targets for specific waste streams

I Dutch targets for specific waste streams

Table B4.1
Objectives for specific waste flows

Themes	Sub-themes	Measuring method	Objectives	Attainment
Food waste	Waste supply	-	Halve the per-capita volume, by2030, compared to 2015 (1)	Stable up to 2018 (4)
Waste from construction and demolition	Preparation for reuse and recycling	-	At least 95% by 2023 (2)	98% in 2016 (5)
Industrial waste	Preparation for reuse and recycling	-	At least 85% by 2023 (2)	78% in 2016 (5)
Packaging brought into the market	Recycling	Existing measuring method	At least 70% (6)	78% in 2017 (3)
		New measuring method	At least 70% by 2021 (2,3)	74%–75% in 2017 (3)
	Reuse and recycling		At least 71% by 2021, At least 74% by 2025 (3)	71% in 2017 (3)
Synthetic packaging	Recycling	Existing measuring method	At least 47% by 2017 (6)	50% in 2017
		New measuring method	At least 40% by 2021, At least 50% by 2025, At least 55% by 2030 (3)	35%–39% in 2017 (3)
	Reuse and recycling		At least 40% by 2021, At least 50% by 2025, At least 55% by 2030 (3)	35%–39% in 2017 (3)
Wooden packaging	Recycling	Existing measuring method	At least 35% by 2017 (6)	73% in 2017 (3)
		New measuring method	At least 55% by 2021 (3)	73% in 2017 (3)
	Reuse and recycling		At least 55% by 2021 (3)	73% in 2017 (3)
Themes	**Sub-themes**	**Measuring method**	**Objectives**	**Attainment**
Glass packaging	Recycling	Existing measuring method	At least 90% (6)	85% in 2017 (3)
		New measuring method	At least 70% by 2021, At least 75% by 2030 (3)	71% in 2017 (3)
	Reuse and recycling		At least 86% by 2021 (3)	86% in 2017 (3)
Paper and cardboard packaging	Recycling	Existing measuring method	At least 75% (6)	87% in 2017 (3)
		New measuring method	At least 85% by 2021 (3)	85% in 2017 (3)
	Reuse and recycling		At least 85% by 2021 (3)	85% in 2017 (3)

Metal packaging	Recycling	Existing measuring method	At least 85% (6)	96% in 2017 (3)
		New measuring method	At least 85% by 2025 (2, 3)	Not known (3)
	Reuse and recycling		At least 85% by 2025 (3)	Not known (3)

Legend
- Objective achieved
- Objective not yet achieved

Sources: (1) Schouten 2018; (2) Ministerie van IenW 2019; (3) Van Veldhoven 2020c; (4) Soethoudt & Vollebregt 2020; (5) Rijkswaterstaat 2020c; (6) Rijksoverheid 2014.

II Waste targets set by the European Union

The European Union uses, to a certain degree, other definitions and measurement methods than the Netherlands. As a result, for some themes, the figures differ from those presented for the Dutch targets.

Table B4.2
European objectives for waste

Themes	Sub-themes	Objectives	Attainment in the Netherlands
Household waste and similar waste streams	Preparation for reuse and recycling	At least 50% by 2020 (1)	53% in 2018 (13)
Urban waste	Preparation for reuse and recycling	At least 55% by 2025, At least 60% by 2030, At least 65% by 2035 (4)	56% in 2018 (8)
	Landfill	At most 10% by 2035 (5)	Not known (9)
Waste from construction and demolition (only non-hazardous)	Preparation for reuse, recycling and other useful applications	At least 70% by 2020 (1)	99% in 2018 (9, 10)
Electrical and electronic equipment	Separate collection	65% of all devices sold or 85% of total waste supply from electrical and electronic devices by 2019 (6)	in 2019, 48% of all devices sold, including solar panels (11)
Food waste	waste supply	Halve by 2030, compared to 2015 (12)	Not known; measuring method still needs to be developed (12)
Packaging waste total	Recycling	At least 65% by 2025, At least 70% by 2030 (2)	74%–75% in 2017 (7)
Synthetic packaging	Recycling	At least 50% by 2025, At least 55% by 2030 (2)	35%–39% in 2017 (7)
Wooden packaging	Recycling	At least 25% by 2025, At least 30% by 2030 (2)	73% in 2017 (7)
Ferrous metal packaging	Recycling	At least 70% by 2025, At least 80% by 2030 (2)	Not known (7)
Aluminium packaging	Recycling	At least 50% by 2025, At least 60% by 2030 (2)	Not known (7)
Glass packaging	Recycling	At least 70% by 2025, At least 75% by 2030 (2)	71% in 2017 (7)
Paper and cardboard packaging	Recycling	At least 75% by 2025, At least 85% by 2030 (2)	85% in 2017 (7)

Synthetic bottles for beverages	Separate collection for recycling	By 2025, at least 77% of the amount traded; by 2029, at least 90% of the amount traded (3)	Not known (9)

Legend

Objective achieved
Objective not yet chieved

Sources: (1) European Parliament and European Council, 2008; (2) European Parliament and European Council, 2018a; (3) European Parliament and European Council, 2019; (4) European Parliament and European Council, 2018b; (5) European Parliament and European Council, 2018c; (6) European Parliament and European Council, 2012; (7) Van Veldhoven, 2020c; (8) Eurostat, 2020k; (9) Rijkswaterstaat, 2020d; (10) Eurostat, 2020l; (11) Nationaal (W)EEE Register, 2020; (12) Council of the European Union, 2016; (13) Rijkswaterstaat, 2020d.

Appendix 5: Data sources for indicators on material resource use and the related impacts

Table B5.1
Data sources for indicators on material resource use and the related impacts

Indicator	Sources of national figures	Sources of comparison with EU figures
Material resources required		
Material resources for domestic use, DMC (Mt)	CBS, 2021	Eurostat, see CBS, 2021
Material resource footprint from domestic use, RMC (Mt)**	-	-
Material resource efficiency (GDP in euro/kilo DMC)	CBS, 2021	Eurostat, see CBS, 2021
Material resources for the economy, DMI (Mt)	CBS, 2021	Eurostat, see CBS, 2021
Material resource footprint from use in the economy, RMI (Mt)	CBS, 2021	Eurostat, see CBS 2021
Share biobased resources (kilo biobased resources/DMI, in %)	CBS, 2021	Eurostat, see CBS, 2021
Total sustainable renewable material resources (kilo/DMI)	CBS, 2021	Eurostat, see CBS, 2021
Share of secondary materials, CMUR (kilo secondary/DMI, in %)	CBS, 2021	Eurostat, see CBS, 2021
Use		
Lifespan	-	-
Value retention	-	-
Waste processing and recovery		
Share recycled waste in processed waste (recycled waste/waste, in %)	CBS, 2021	Eurostat, see CBS, 2021
Waste recycled in the Netherlands (Mt)	CBS, 2021	Eurostat, see CBS, 2021
Incinerated waste in the Netherlands (Mt)	CBS, 2021, Rijkswaterstaat, 2020a	Eurostat, see CBS, 2021
Landfilled waste in the Netherlands (Mt)	Rijkswaterstaat, 2020a	Eurostat, see CBS, 2021
Impacts		
Environmental impact		
National greenhouse gas emissions ($MtCO_2eq$)	RIVM et al., 2020	Eurostat, 2020k
Greenhouse gas emission footprint of consumption ($MtCO_2eq$)	CBS, 2021	Wilting, 2021
Greenhouse gas emission footprint of production ($MtCO_2eq$)	CBS, 2020g	Wilting, 2021
Emissions to air, water and soil, such as nitrogen and particulate matter	-	-
Indicator	**Sources of national figures**	**Sources of comparison with EU figures**
Land-use footprint of consumption (million ha)	PBL, 2020d	Wilting, 2021
Land-use footprint of production (million ha)	Wilting, 2021	Wilting, 2021
Water extraction	-	-
Water footprint of consumption (km^3)	Arto et al., 2012	Arto et al., 2012
Biodiversity footprint of consumption (million MSA loss ha/yr)	Wilting, 2021	Wilting, 2021
Biodiversity footprint of production (million MSA loss ha/yr)	Wilting, 2021	Wilting, 2021
Toxicity	-	-

Socio-economic impact		
Supply risks (indicator still in development)	–	–
Added value of circular activities (billion euros)	CBS, 2020c	–
Share of circular activities (added value circular / GDP in %)	CBS, 2020c	–
Circular employment (number of circular jobs in full-time equivalents) (*1,000)	CBS, 2020c	–
Share of circular employment (number of jobs / total jobs in %)	CBS, 2020c	–