

Resource Effectiveness and the Circular Economy

Synthesis Report



THEME:
CLIMATE-
RESOURCES

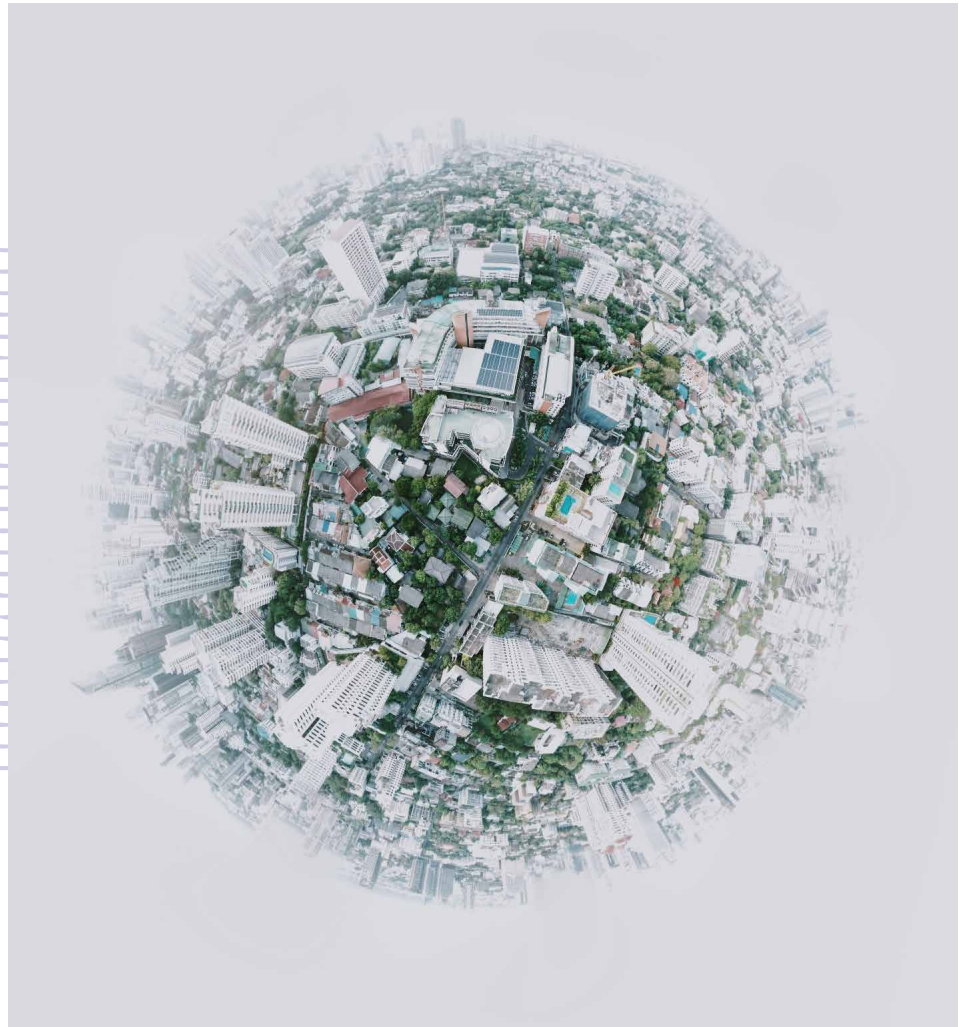
APRIL 2020



Royal Swedish Academy of
Engineering Sciences

Contents

| | |
|--|----|
| Foreword | 4 |
| Introduction | 6 |
| Summary | 10 |
| The subprojects' action plans | 16 |
| The Financial sector's role in the transition | 26 |
| Proposals from the subprojects: Mobility, Shared Space, Food, Textiles and Plastics | 34 |
| Outlook 2030 | 46 |
| Appendix | 54 |



Foreword

»Research & development is providing new ways to recycle and reuse materials and is reducing waste in value chains.«

The main focus of IVA's project *Resource Effectiveness and the Circular Economy* is how Sweden can economise with resources in five areas from a societal perspective and create circular business models that improve Sweden's competitiveness while also helping to reduce climate impact. New commercial opportunities are created when actors in politics, academia and industry work together. Research & development is providing new ways to recycle and reuse materials and is reducing waste in the value chains. Digital technology is providing whole new opportunities to, for example, improve efficiency in transport systems and increase the use of space in buildings.

Three material flows have been analysed: plastics, textiles and food. Measuring and understanding the waste in the material flows gives us a basis for placing a value on resources that would otherwise be defined as waste. This provides strong incentives for taking advantage of this and developing methods and processes to recover materials so they can become new resources. This reduces the need for virgin raw materials and allows us to take advantage of resources that are already available much more effectively.

Two key functions in society's infrastructure have been studied: mobility and facilities/space. Through new systems for sharing existing resources, they can be used more efficiently and we can reduce the need for new resources. Digital communication and artificial intelligence are pro-

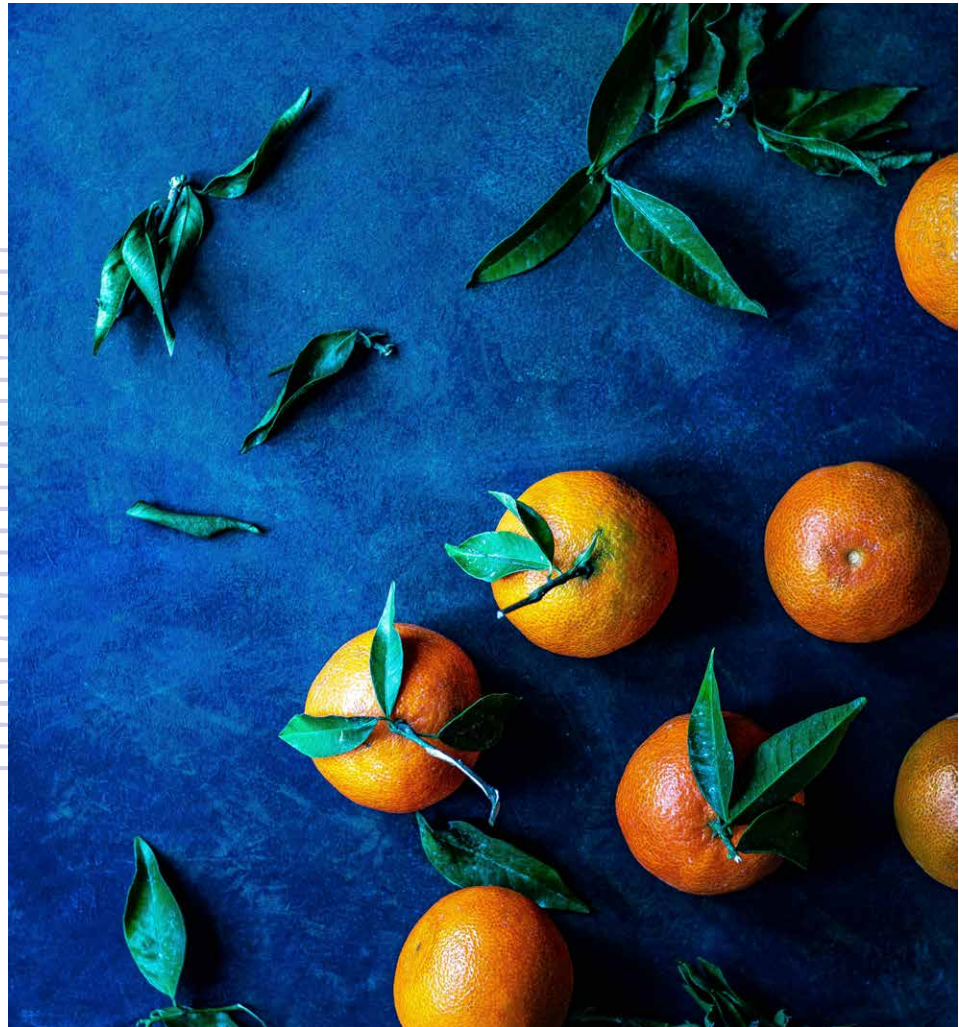
viding entirely new system optimisation possibilities. When new products are developed they can be designed right from the start for efficient and shared use.

The project shows how new opportunities can be created and how existing obstacles can be removed through political decisions to accelerate the transition over the next few years to resource-effective, circular ways of working in the Swedish market. This is in line with the sustainability work that is already being done. The five areas that have been analysed in this project can serve as examples of how similar analysis and changes can be implemented in almost all areas of society. The public and private sectors could together help to ensure that new solutions are financed and developed.

Through a successful export sector, Sweden, which is a small country in competition with an open global market, is making a very significant contribution to global climate efforts, at the same time as export income and investments are helping to continue to improve Sweden's prosperity.

All of the project managers have generously given their time and shared their knowledge to reach the project's goals – many thanks!

Åke Svensson, Steering Committee Chair



Introduction: Resource Effectiveness and the Circular Economy

»The purpose of the project is to strengthen Sweden's competitiveness in a future with finite resources in line with the UN's Sustainable Development Goals.«

The Royal Swedish Academy of Engineering Sciences' project *Resource Effectiveness and the Circular Economy* has assembled more than 50 companies, organisations and public authorities around the vision of Sweden being the leading nation as a resource-effective, circular society. The purpose is to strengthen Sweden's competitiveness in a future with finite resources in line with the UN's Sustainable Development Goals.

The project's goals are: to create a platform for resource effectiveness and circularity; to draw conclusions on Sweden's resource options in public policy, research and industry based on initiatives that are under way, and to create collaboration and forward motion.

Resource Effectiveness and the Circular Economy builds on the IVA project Resource Efficient Business Models – Greater Competitiveness from 2014–2016. That project presented significant opportunities that exist to make society considerably more resource efficient and to generate new business and business models. Five material flows were explored (biomass from wood, steel, concrete, food and textiles), in a number of stages from extraction or primary production to recycling. This was to show where flows are "leaking" and thus where commercial opportunities exist through more effective resource management.

Three parameters are used to assess the commercial opportunities:

- Potential for improved resource effectiveness
- Implementability
- Economic potential

The project continued the work of the previous one, using the same sector breakdown and exploring the commercial opportunities that were identified. This project is divided into five subprojects:

- Resource-effective mobility for goods and people
- Increased sharing of space
- Measuring and reducing lost food
- A resource-effective, circular textile flow
- The role of plastics in a resource-effective circular society

Reports have been produced to present analysis, observations and action plans from all of the subprojects. They

have different target groups, but all are focused on key actors within the respective subproject. The focus of the project has been to move from words to actions by creating action plans that address the following: What should be done? Who should have the authority and responsibility to act? When should it start/end? The most important conclusions from all of the subprojects will be compiled and presented as the project's recommendations for a broader societal transformation in this synthesis report.

The five subprojects have gathered representatives from their respective value chains to participate in their work groups. They come from the private and public sectors and from the research community. IVA's work is based on a scientific approach and draws from relevant research, but also involves critical analysis of other issues of significance. Source references are included where appropriate. The project results come out of an intense programme of workshops and work group meetings involving a large number of people.

The reason for this initiative from IVA is that resource effectiveness and circularity from a societal perspective are crucial for a sustainable future with greater global prosperity. One particularly important factor is ensuring that we successfully improve efficiency in material management and improve material development. We also need to design new business models and identify commercial opportunities that can remain relevant many years into the future, meet the UN's Sustainable Development Goals and allow us to remain within the planetary boundaries.

We need sustainable systems that can deliver resources to meet the real needs of society. To achieve this we need a long-term system perspective and an overall insight into society's resource flows. We need to take a holistic approach that includes all aspects of the production chain – from the material extraction and raw material stage, the design phase, production, business models and financing, through the user phase to the recycler and back to a new producer. This requires cooperation between all actors and clear, long-term rules to create the right incentives and market conditions. We also need to accelerate – and better understand the benefits of – digitisation, innovation and new business models that focus on resource effectiveness.

A lot is already happening – both internationally and around Sweden – with numerous initiatives and projects examining how resource effectiveness and circularity can be introduced in various sectors, but there is no unifying arena where different perspectives can come together to show the need for a systemic change. The project believes that a platform for cooperation between the private sector, the research community, the political sphere and the public sector is essential in order to achieve a resource-effective and circular society. Actors within this type of platform are also the project's overall target group.

The Resource Effectiveness and the Circular Economy project started at the beginning of 2018 and will end in mid-2020.

The synthesis report is based on the project reports, but also contains additional analysis, conclusions and recommendations. The project's Steering Committee is responsible for these. The Steering Committee stands behind the reports in their entirety, but not necessarily all of the recommendations or individuals statements.

The project's definition of resource effectiveness and the circular economy

Resource effectiveness¹ and circular economy² are two distinct concepts under the same umbrella. A measure that supports the circular economy often also supports resource effectiveness. In this project we regard resource use within the planetary boundaries as the overarching goal. In order to manage any conflicting objectives in future develop-

ment it is important for there to be clarity and an understanding of systems.

The primary focus of this report is more effective management of the value of society's and nature's resources beyond, for example, mere volumes or mass. Unless otherwise stated, this also includes the concept of a circular economy. Where conflicting objectives between the concepts are identified, they are described.

Geissdoerfer et al, for example, define circular economy below mainly in terms of the circulation of materials:

*A regenerative system where resource supply, waste, emissions and energy leakage are minimised by slowing down, closing and reducing the circulation of energy and materials. This can be achieved through careful design, maintenance, repair, reuse, remanufacturing, renovation and recycling.*³

The project's premise is that resource effectiveness takes priority over the circulation of materials, even if both are aiming to reach the same goals. We believe that it is important to include the user phase in the definition – not just the production phase; to include business models and services – not just physical products:

*A performance economy goes a step further by selling goods (or molecules) as services through rent, lease and share business models... In addition to design and reuse, the performance economy focuses on solutions instead of products, and makes its profits from sufficiency, such as waste prevention.*⁴

1 Europa 2020 – A strategy for smart, sustainable and inclusive growth COM(2010), and A resource-efficient Europe – Flagship initiative under the Europe 2020 Strategy COM (2011). There is unfortunately no actual definition of resource effectiveness.

2 Kirchherr, J., Reike, D., Hekkert, M., 2017, "Conceptualizing the circular economy: An analysis of 114 definitions", in Resources, Conservation and Recycling 127, pp. 221–232.

3 Geissdoerfer, M., P., Savaget, N., Bocken, N. and Hultink, E., 2017, "The circular economy – A new sustainability paradigm?" in Journal of Cleaner Production 143 (1), p. 759.

4 Stahel, W., "The circular economy", 23 March 2016, in Nature 531, pp. 435–438 (<https://www.nature.com/news/the-circular-economy-1.19594>; accessed 10 December 2019).

The project believes that this perspective is missing in some circular economy definitions, even if it is sometimes seen as an implicit aspect. One example is the average car which is parked 95 percent of the time. We do not improve the efficient use of resources by merely recirculating the materials the car is made from – no matter how good we get at it. The effective use of resources (“resource effectiveness” = using resources as efficiently as possible while also avoiding negative environmental impact) must be improved.

As Florian Lüdeke-Freund et al. wrote in their article entitled “A review and typology of circular economy business model patterns”:

The circular economy may not be a final goal, but rather part of an ongoing process to achieve greater resource efficiency and effectiveness.⁵

This is a theory our project is happy to endorse.

Project Management

Steering committee

Åke Svensson, Association of Swedish Engineering Industries, Chair
Caroline af Ugglas, Confederation of Swedish Enterprise
Ola Alterå, Climate Policy Council
Tim Brooks, Swedish Agency for Economic and Regional Growth
Jonas Brännström, Vinnova
Uwe Fortkamp, Swedish Environmental Protection Agency
Thomas Nilsson, Mistra
Annica Sohlström, Swedish National Food Agency
Björn Stigson, Stigson & Partners
Henrik Sundström, Electrolux

Cecilia Tisell, Swedish Consumer Agency
Anders Wijkman, Climate-KIC

Adjunct members of the Steering Committee

Louise Staffas, Formas
Tuula Teeri, IVA
Jan-Eric Sundgren/Elinor Kruse, Association of Swedish Engineering Industries, Chair Mobility
Anna Denell, Vasakronan/Mattias Höjer, KTH – Chair Shared space
Ann-Karin Modin Edman, Arla – Chair Food
Cecilia Tall, TEKO – Chair Textiles
Magnus Huss, IKEM – Chair Plastics

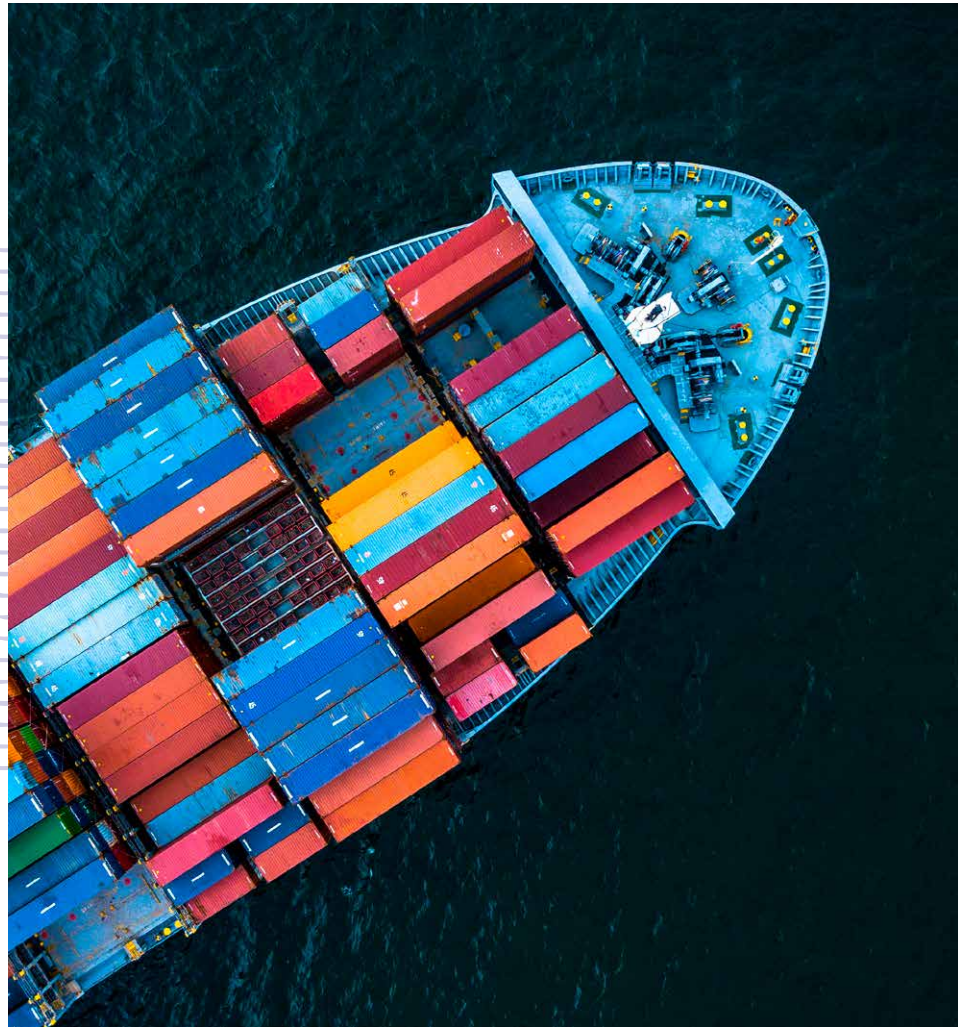
Project management

Caroline Ankarcrona, Project Manager
Jan Nordling, Project Manager
Joakim Rådström, Communications Manager
Gustaf Wahlström, Project Coordinator

Subproject Managers

Jacqueline Oker-Blom, AboutFuture – Mobility
Liv Fjellander, IVL – Shared space
Kristoffer Gunnartz, Addverbal – Food
Elin Larsson, Elco (**Caroline Hofvenstam**) – Textiles
Peter Stigson, PE Teknik & Arkitektur – Plastic

5 Lüdeke Freund, F., Gold, S. and Bocken, N., 2018, “A Review and Typology of Circular Economy Business Model Patterns”, in Journal of Industrial Ecology, Volume 23, Issue 1, February 2019, pp. 36–61.



Summary

»Swedish competitiveness can be strengthened by economising with resources and developing new technologies, new services and new business models.«

Although this synthesis report marks the end of the project Resource Effectiveness and the Circular Economy, the work must continue if Sweden is to have a real transition to greater resource effectiveness and circularity. The report presents the most important conclusions, recommendations and action plans from the five projects – mobility, shared space, food, textiles and plastics.

In addition to presenting the subprojects' conclusions and action plans, the project's Steering Committee also wants to describe general issues relating to the changes that still need to happen based on the proposals from the subprojects. The synthesis report places the subproject areas in a broader context to show the development that needs to happen in society. The Steering Committee has identified the following overall issues to take us from the subprojects' action plans to societal transformation:

- **See society from a system perspective** – it is not enough to examine and analyse one challenge at a time. Society is a system of systems that need to be interconnected.
- **Develop a circular strategy** – all parts of society need to produce a plan to act in a resource-effective and circular way. Policy-makers have a key role to play in creating a framework.
- **Expand the mission of the Ministry of Enterprise and Innovation** – one actor needs to take overall responsibility for society's collective resources with a mandate to promote a system perspective.
- **Use public procurement as a tool for circularity by**, for example, developing functions to drive resource-effective innovation..
- **Create common markets for resources** – there is significant potential for cooperation and synergies between sectors and industries to create effective resource flows. Brokers are also needed to match supply and demand.
- **Support small businesses in their transition** – driving change and quickly transitioning on their own is a major challenge, particularly for small enterprises.

The Steering Committee is convinced that Swedish competitiveness can be strengthened by economising with resources and developing new technologies, new services

and new business models. The project also shows how the public and private sectors can work together and accelerate the transition to a circular society.

The five subprojects' three most important proposed measures and recommendations are described on the following pages. A brief summary of the subprojects' work is provided in a section at the end of the synthesis report. For a more detailed description, please refer to the subprojects' separate reports. The reports from the subprojects contain well-researched analysis involving almost 400 individuals who participated at various times during the course of the project. Around 130 people from the private sector, organisations, the research community and public agencies have worked together on an ongoing basis in all of the groups and committees. A financial and a political reference group have also contributed to the project. Five in-depth workshops were carried out in the areas of design, business models, recycling and industrial symbiosis, innovative environments and the financial sector. A total of six reports – one from each subproject and a special report on food transportation – have been produced. All of them are available to read and download at IVA's website.

A separate section of the synthesis report describes the financial sector's part in promoting a transition to a resource-effective and circular society. The information is based on the work of the subprojects and from the financial reference group, although this was not a separate subproject. Challenges and potential obstacles to the ability of the sectors to finance the transition have been identified. The financial market has a key role to play in providing companies with venture capital for investments in new technology, new services and new business models. However, it is also important when credit is granted to include criteria for sustainability, resource effectiveness and circularity.

To bring about change we need visions to show us what future society might look like. As inspiration and to indicate a way forward, the subprojects have also produced future scenarios in Outlook 2030. It is written as if the subproject's proposals are implemented a decade from now. There are many potential synergies between the subproject areas that need to be explored further. The 2030 perspective is intended to encourage conversation, ideas and hope for the future.

The subprojects' top recommendations

Resource-effective mobility for goods and people

Produce a national strategy for digitisation and data sharing

Rapid development is taking place in mobility services and new actors are emerging, but business models, roles and regulations are not keeping up with the development of technology and innovative services. Digitalisation and data sharing are facilitators of resource-effective transportation, but three types of infrastructure – physical, energy and digital – need to work together to create transport systems that are efficient and safe in the long term and have the least possible impact on the environment. Neutral platforms for data sharing are needed in each application area, taking into consideration privacy, competition and security.

Invest in public transport combined with shared mobility services

Invest in public transport together with other forms of combined mobility based on sharing and pedestrian/bike traffic. This can be done by producing control mechanisms, pooling resources and building on combined mobility projects. Continued investment in research and evaluating the effects of existing projects and pilot projects in combined mobility.

Plan physical infrastructure and buildings for resource-effective transport solutions

The Government could regulate transport solutions, for example by coordinating common, supplier-neutral parcel lockers and collection points. Municipal authorities could plan

and change the design of cities to shorten transport distances and prioritise pedestrian/bike traffic and public transport. In connection with urban development, plan and create frameworks for how to use public transport, autonomous vehicles, ride-share vehicles and other vehicles more resource-effectively, both within and across municipal borders.

Increased space sharing

Create control mechanisms to reduce resource use and increase the sharing of space

The Government should create control mechanisms for reduced resource use and also ensure that the tax rules, e.g. VAT rules, promote sharing between enterprises/organisations. Rental laws should be overhauled to encourage solutions (such as tenancy protection, termination rules and definitions of residential and commercial properties). The Government should overhaul the Planning and Building Act so that zoning plan rules enable existing buildings to be used in more ways. Finally, data on the use of space and functions needs to be collected, shared and used.

Develop scalable services for space sharing and to promote sustainable behaviour

The private sector should develop scalable solutions that facilitate sharing and promote sustainable patterns of behaviour. Examples are match-making, contracts, insurance coverage, security, service and access designed based on the unique opportunities that sharing brings. Companies

will need to develop business models and contracts for the various incentives needed for commercial, public sector and non-profit actors and private individuals. The financial sector should invest in new business models for sharing, and require resource effectiveness (including sharing of space) in connection with so-called green financing of buildings.

Include sustainability gains and risks when evaluating and assessing sharing solutions

Performance measures and an understanding of these will be needed so that the financial sector can assess the risk and opportunities in sharing of space. This may be through key ratios for resource use, social gains in the surrounding community, economic gains and peripheral services, calculation of alternative costs, transformation potential or how space sharing contributes to the Global Goals. The financial sector should lead in the transition by investing in new business models for sharing, and require resource effectiveness (including sharing of space) in connection with so-called green financing of buildings.

Measuring and reducing the amount of lost food

Practical solutions for measuring and reporting lost food

To drive efforts to reach the global 12.3 target, to halve food waste per capita by 2030, the subproject has produced a proposal for a national framework to measure and report lost food and unavoidable food waste in the food supply chain. The framework includes measurement rules and definitions of key terms to ensure that all actors in the food chain measure in the same way – and can deliver data that can be compiled at the national level. These measurement rules must be designed so that they lead to increased resource effectiveness without preventing companies from being profitable and competitive. The proposed framework should be seen as a first version and one that will likely need

to be developed further and adapted to be applicable in all parts of the food supply chain.

Produce control mechanisms to incentivise companies to voluntarily reduce lost food

The Government should produce control mechanisms that incentivise companies in the food supply chain to voluntarily start measuring and setting goals for reducing the amount of lost food and unavoidable food waste they generate. Experiences from other countries show that establishing voluntary agreements can lead to a faster transition to increased resource effectiveness than legislation with rules that must be complied with. The subproject urges the Government, public authorities and the food industry to get involved in producing this type of agreement for the Swedish food supply chain.

Start measuring resource flows that are not covered by EU waste laws

In order for Sweden to be able to reach the goal of a resource-effective and long-term sustainable food loss supply chain, it will be necessary to also measure lost food and unavoidable food loss (according to the subproject's definitions) in the flows that are not currently covered by EU requirements. This applies, for example, to potentially edible food that leaves the food supply chain to go to the production of animal feed, biofuel or biochemical products. These flows are not counted as food waste today according to the EU.

A resource-effective, circular textile flow

Safeguard material flows in the textile cycle

A clear definition and an international standard will be needed for sustainable textiles and circularity to establish a common vision for the textile cycle. The industry needs to de-

velop a national framework for how to manage different materials and products in the final phase of their life cycle. European chemical legislation should be reviewed to guarantee reliable circular flows.

Optimise material recycling between different industries

A greater exchange of materials between different industries and sectors is needed – both for industrial flows and post-consumer flows. Potential industry partnerships could be formed between the forest industry, agriculture and the food, engineering, construction and automotive industries. In future there may be a need for material brokers who connect sellers with buyers. Support development of material refineries based on waste from various industries to optimise material recycling.

Reward resource effectiveness and circular business models

Reuse, renting and subscriptions for clothes and textiles need to be tax deductible to kick-start the transition. The public sector could take the lead to support change. One example is an updated procurement guide that includes circular criteria and buying functions tailored for different products based on resource consumption, quality and cost. New products manufactured using recycled materials, should be rewarded, for example through tax relief. Economic mechanisms should be used to increase supply and demand for materials that are based on residual flows.

The role of plastics in a resource-effective circular society

Create a marketplace for collected and recycled plastics

Resource-effective and circular plastics flows can only be achieved by developing a market that supports investment

in capacity for collection and recycling of plastics, as well as resource-effective design of products. To promote development, the following is needed:

- A digital marketplace for recycled raw materials.
- Market actors who promote trade in collected and recycled plastics.
- Test beds that boost confidence in the use of recycled plastics.
- Greater producer responsibility.
- Product declaration system.

Set an agenda for chemical recycling of plastics

Today a small portion of collected plastics and textiles become new raw materials and many therefore rely on chemical recycling. Technology is making it possible to handle many of the products that cannot currently be mechanically recycled. Investments in chemical recycling capacity are currently being made in other countries and this trend will affect Swedish actors. An agenda is therefore needed to guide Swedish businesses and policies to address the opportunities and obstacles relating to chemical recycling in Sweden.

Develop a political framework and strategy for the resource-effective use of plastics

At the end of 2019 the Ministry of the Environment tasked the Swedish Environmental Protection Agency with coordinating plastics flows, an area that needs to be developed and defined. There is currently no Swedish plastics strategy that sets goals and provides R&D proposals for resource effectiveness. The focus has often been on reducing plastics in the ocean and environment, but we need a system perspective that treats plastic as a resource and a material that has multiple functions in society. The extent to which the future strategy for a circular economy will meet such needs remains to be seen. There is no strategy to move the system towards higher efficiency and effectiveness. This is



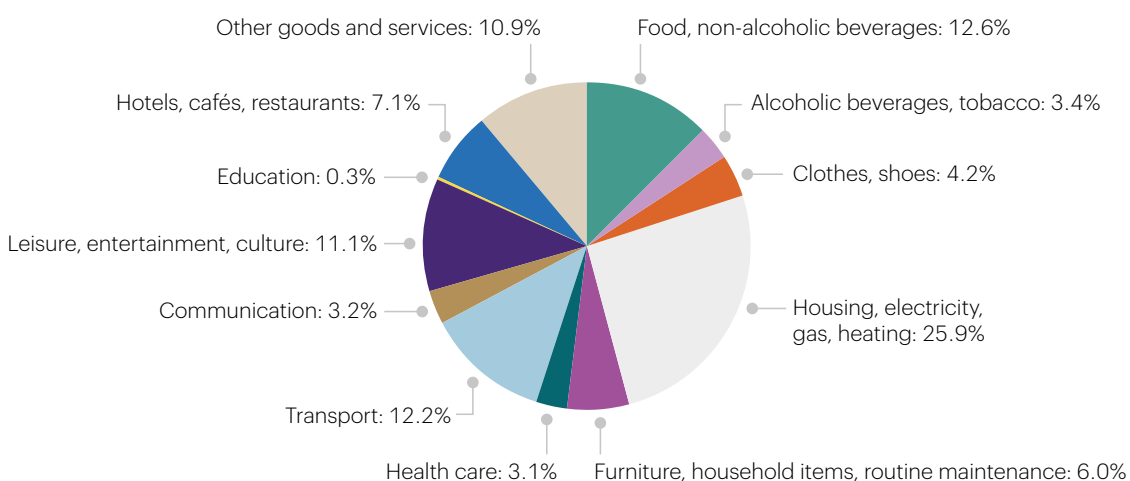
a problem because an assessment needs to be made of how plastics are helping to improve resource effectiveness in society. A political framework needs to be put in place quickly. The lack of one limits development because public and private sector actors have no long-term societal goals

as guidance for individual and joint strategies and investments. The system perspective should be made clear in the Swedish Environmental Protection Agency's plastics coordination assignment (today it is mainly focused on plastics as waste and pollution).



The subprojects' action plans

»Economising with resources is nothing new, but now technology offers entirely new possibilities to create a resource-effective future.«

Figure 1: Household consumption by purpose, 2018. Source SCB.

100 years ago a total of 50 kg of household waste was generated per person in Gothenburg in a year. In 2018 the amount of waste, based on the statistics available, has grown to 386 kg per person in the same city. Households that were once careful to make use of as much as possible are now wasting resources. If we go even further back in time to the old agrarian society, nothing that could be used went to waste. Resources were always used or reused in one way or another.

Economising with resources is nothing new, but now technology offers entirely new possibilities to create a resource-effective future.

The linear economy has up to now given us prosperity, but with today's insights on resources and the climate, we now know that we need to transition to a resource-effective,

circular model. In order to succeed in this, it is of fundamental importance for people to believe that society will continue to prosper, albeit in a different way. How can we now find ways to connect the respect for resources that existed just a few generations ago with today's and tomorrow's technology for traceability, realtime information, sharing opportunities and increased safety for collecting, sorting, reuse and recycling? To move forward we also need to look at the past and learn from past generations and other parts of the world.

Look at society from a system perspective

To achieve the change needed to reach the UN Sustainable Development Goals it is not enough to examine and

WASTE DEFINITION

From “waste” to “resource” – What does it mean?

Environmental Code (1998:808), Chapter 15 Waste, Definitions: Section 1 Waste in this chapter refers to a substance or object which the holder discards, or intends to or is required to discard.

The EU’s revised Waste Framework Director* states that waste is “a substance or object which the holder discards, or intends to or is required to discard”. These two starting points are problematic with respect to a resource-effective, circular society because the assumption in a circular society is that all materials are first and foremost resources.

How is a “resource” managed and how is “waste” managed? Waste involves getting rid of something; a resource is something of value. This is where we need to be!

Nomenclature: Language affects how we think and act:

| Today: | Tomorrow: |
|-------------------|-------------------|
| Consumers | Users |
| Consume | Use |
| Waste | Resources |
| Used product | Product |
| Recycled material | Material |
| Reusing | Using |
| Energy recycling | Energy extraction |

Introducing a different nomenclature is necessary in order to further change attitudes to resource use.

* https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_sv EU (2018): DIRECTIVE (EU) 2018/851 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 30 May 2018 amending Directive 2008/98/EC on waste. (<https://eur-lex.europa.eu/legal-content/SV/TXT/?uri=CELEX:32018L0851>)

analyse one problem at a time. Society must be seen from a system perspective – a system of systems. It is, however, important not just to accept existing systems, but

to go a step further and ask if they are the right systems or if there are better ones, all the time aiming for better and more efficient systems. All too often systems are not questioned; instead attempts are immediately made to improve efficiency.

Among other things, resource flows need to be analysed further and made more transparent to give us an understanding of the volume of materials in the flows, where they come from and where they have gone. Otherwise it will be impossible to know how well or poorly we are utilising resources and where new commercial opportunities exist.

IWA identified and mapped the material flows of biomass from wood, food, textiles, steel and concrete in the project Resource-efficient business models – strong competitiveness. This showed us how difficult it is to get an overview of resource use, largely due to the fact that there are no reporting requirements along the value chains. In certain cases measurements are made in some parts of the value chains, but the units of measurement are different – weight, volume or value – which makes it harder to get a full overview.

In general there are gaps in the data for the resource flows – from extraction or primary production to recycling. The effect is that it is more difficult for policy-makers and businesses to develop resource-effective strategies. Without robust knowledge on the various flows there is a risk that decisions on technology development, investment and collaborative projects will be less effective, as will the political framework for the resources. Both the private and public sectors need detailed information on the quality of the resources in the flows, at the same time as all actors have a responsibility to contribute to the statistics. Statistics Sweden is responsible for collecting data and only through collaboration between the public and private sectors and academia can strategies and control mechanisms be designed effectively.

The transition to renewable energy sources and more effective energy use is key for a successful climate transition. At the same time the transition that is under way needs to focus on resource effectiveness, finding the right solutions and then on making them more efficient. If our sole focus is the climate, we will not achieve full resource efficiency and vice versa.

One example is that the average car is parked 95 percent of the time. Thus, switching to renewable fuels is not enough. We also need to use our car fleets more efficiently in new business models. Sharing services where we co-own, ride share or automate can make positive contributions to both the climate and resource efficiency goals. Similarly, we need to reduce the amount of food lost in all parts of the food supply chain and, in order to make a significant, positive impact on the climate globally, we also need to focus on the type of food we produce.⁶

Circularity and resource effectiveness are not only about circular materials or more efficient use of physical materials and products in society. One of the most important problems is over-production of materials and products due to the low cost of virgin materials and labour in the countries where materials and products are produced.

Today it sometimes pays to overproduce rather than to manufacture products of higher quality, produce on-demand or offer products through service agreements. Over-production pushes prices down and leads to inefficient resource use. It is therefore important for companies to develop and design products that have a long life and are easy to repair and maintain, and offer new business models.

Increased awareness among users (customers) is key and additional information and nudging aimed at the public is needed. The actions of both producers and users (customers) are crucial as we are to develop a resource-effective, circular economy.

Develop a circular strategy

In the future, circularity and resource effectiveness must be natural components in business models and in the behaviour of the general public. Individual positive initia-

tives will not be enough. This needs to be raised to a high level in all parts of society, and in particular in boards and executive management in the private sector. Policy-makers have a key role to play in creating a framework for the new game plan and in promoting the transition in business and industry.

Finland has succeeded in positioning itself among the world-leading countries in circularity and there are a number of explanations for this.⁷ Finland has identified clear commercial opportunities and development opportunities for industry. The term circular economy has also become firmly established at a higher political level, with ministers getting involved in developing national roadmaps. The Swedish circular strategy now being produced should be developed in cooperation with the Ministry of Enterprise and Innovation in consultation with the private sector and academia. It is of utmost importance to focus on the business climate, commercial opportunities and sustainable growth, because this is the basis for making the transition a reality.

All parts of society need to produce a plan to act in a resource-effective and circular way. This could include indicators for resource effectiveness and circularity.

The following actions could be included:

- Take stock of business operations on an ongoing basis.
- Produce action plans to increase resource effectiveness in the parts of an enterprise/organisation for maximum effect.
- Form partnerships and launch pilot projects to develop ways of sharing resources.
- Set concrete goals that can be followed up.

6 Sustainable consumption patterns – analysis of food, aviation and the total climate impact of consumption today and 2050, REPORT 6653 • FEBRUARY 2015, Swedish Environmental Protection Agency.

7 Johan Felix, Chalmers University of Technology and Innovation Manager at Re:Source.

- Show the effects:
 - a) Environment, social and financial gains and any losses or rebound effects and drawbacks of sharing.
 - b) Include goals and follow-up in sustainability reports.

Increase the role of the Ministry of Enterprise and Innovation

To avoid a silo mentality and to expose conflicting objectives, one actor needs to take overall responsibility for society's collective resources with a mandate to promote a system perspective. There are already examples of countries that have established a government entity for this. The Ministry of Enterprise and Innovation's mission could be expanded to include finding ways to more quickly create the best conditions for competitive, green and resource-effective solutions. One important issue to address when developing complex systems is who will be responsible for analysing the entire system and who will oversee its development.

Resource value chains are long – including from a time perspective – from raw material to processing to use, recycling and reuse. Many different political goals and policy areas – relating to nature, agriculture, basic industries, manufacturing industry, service sector, recycling importing and exporting, etc. This increases the risk that important considerations will fall between the cracks. Here, we need coordinated analysis of how decisions in various ministries and agencies affect both the system and the other ministries and agencies. Sweden needs to take an active role in the EU's efforts to promote a circular economy and resource efficiency, bringing Sweden's needs and opportunities to the table there as well, ensuring that the work being done at the EU level will support the transition in and competitiveness of our industries and businesses

as well, while also helping to meet the Global Goals. Methods/processes, indicators are needed and goals must be set that the ministries and public agencies can monitor, for example when developing political frameworks in various areas.

Public procurement tool for a circular economy

The public sector purchases goods and services for around SEK 700 billion annually. This is equivalent to 17 percent of Sweden's GDP. Municipalities are the actors most commonly engaged in procurement. Municipal and regional authorities' procurement contributes to emissions of around 18 million tonnes of carbon equivalents. This is more than all domestic transport for a year, and it accounts for a relatively large percentage of the 100 million tonnes of carbon equivalents that all Swedish consumption combined gives rise to. Procurement processes have a vital role to play in making Sweden climate neutral and entirely free from fossil emissions.⁸

Public procurement could function as a lever to promote development and upscaling of resource-effective and circular business models. This could lead to changed behaviour by purchasing functions instead of products and focusing on low life cycle cost as well as long life, instead of a low initial purchase price for a product. It could also improve recycling processes. It could also show the way towards new business models where, rather than traditional purchasing, the functions of e.g. clothes and textiles are purchased to promote resource effectiveness, benefit the environment and lower costs. Public agencies and municipalities should also require efficient time and space sharing. This could be done by, for example, requiring a purchased service to specify rental costs and then only be compensated for rent during business hours. This would significantly increase incentives to share and sublet space.

8 <https://skl.se/samhallspaneringinfrastruktur/miljohalsa/klimatsmartupphandling.25163.html>

The Government's procurement commission⁹ highlighted the need to raise the level of expertise through a Master's education for procurement officers. There is also a significant need for tools for procurement officers to use. The National Public Agency for Procurement has a "criteria library" containing sustainability criteria, but it needs to be further developed.

Aside from the fact that many municipal authorities have limited capacity to incorporate criteria and to follow up results, another problem is that purchasing and maintenance processes are often under different items in the municipalities' budgets. In other words, purchasers have incentives to purchase for a low price and there is therefore a risk of suboptimised purchasing affecting operating and maintenance costs. Clear instructions are needed here on how to take a comprehensive approach and focus on resource effectiveness and a circular economy.

To promote innovative, resource-effective procurement, the following is needed:

- Task the National Public Agency for Procurement with incorporating resource effectiveness and circularity criteria in procurement processes or in incentive agreements.
- Increased knowledge of resource effectiveness and circularity among public procurement actors at the municipal and national levels.
- Reliable and standardised indicators in order to scale up function and innovation procurement in resource effectiveness and circularity produced by. These could be produced by the Swedish Institute for Standards (SIS) and financed using public funds.
- Include the criteria in management of all municipal, regional and national activities,

such as state-owned companies and in appropriation directions for public agencies. The Government needs to be clear about the fact that environmental criteria and saving taxpayer money are to be prioritised parameters to be included procurement processes, and that conflicting objectives must be managed if they arise.

The circular economy commission report "Från värdekedja till värdecykel – så får Sverige en mer cirkulär ekonomi" (From value chain to value cycle – How Sweden will have a more circular economy) points to public procurement as an important tool in moving towards a circular economy by, among other things, extending product life and purchasing of functions instead of products.

There is good potential to meet the future challenges through public procurement and to leverage procurement to drive innovation. This could enable the public sector to share in the innovative power of enterprises and drive development and renewal. One option could be procurement of functions, where functional criteria combined with, for example, life cycle assessment describe what we want to achieve rather than how something is to be designed. These criteria are often linked to goals and indicators such as desired effects and results. Expressing an enterprise's needs in the form of desired functions, effects and results enables proposals to be developed for various solutions. The advantage of function procurement over traditional procurement is thus that there is no precise specification of what will be delivered. This creates more freedom in the innovation process.

Authorities should to a far greater extent be able to procure innovation, rather than purchase services that solve specific problems. One example is the Swedish Transport Administration's research and innovation initiative, Triple F – Fossil Free Freight, the purpose of which is to aid the Swedish freight transport system in its transformation. The idea is to provide authorities and the public sector in gen-

9 SOU 2013:12 Upphandlingsutredningen 2010 "Goda affärer – en strategi för hållbar offentlig upphandling".

eral with knowledge and pilot projects to help increase innovation in the area and thereby contribute to achieving the goal of a fossil-free transport sector.

Public authorities could also be proactive procurement actors by requiring new business models, for example the Swedish National Police Board could purchase mobility rather than police cars. Suppliers would then be responsible for delivering a system that is reliable. The public sector could also promote the growth of ride-sharing and set a good example by using vehicles at different times of the day or night.

KEY FACTORS FOR SUCCESSFUL SYMBIOSIS

- Focus on raising the value of underutilised resources such as materials, energy, water or knowledge.
- Connect actors from different industries who are in the same area.
- Present good examples of industrial symbiosis to start creative processes.
- Allow the actors involved to define the focus of their collaboration themselves.
- Ensure continuity in social processes that strengthen relationships and raise knowledge levels.
- Bring in external expertise, for example in legal matters or financing, as needed to make partnerships work.
- Communicate about partnerships and their benefits to attract more actors.

Source: Professor Mats Eklund, IEI, Linköping University.

Regions and municipalities are substantial purchasers of freight transport services. Public transport could serve as a role model in purchasing mainly fossil-free fuel. This works well in most places regardless of whether services are managed by the municipality itself or purchased from a private actor.

Create common markets

There is great potential for industry partnerships and synergies between sectors and industries to create effective and circular resource flows. As in other contexts where, for example, the forest industry is working with the chemical industry, new partnerships could be formed between the textile industry and the plastics industry, or between the forest industry and the food sector. Synthetic fibres account for more than 60 percent of fibres used globally in the textile industry. Recycled material from plastic products could be a source of raw material for the textile industry, and worn out fabric that is collected and recycled could be a resource in the plastics industry. There are also companies in the Swedish forest industry that now recycle textiles and mix them with pulp from the forest.

Resources are not just materials; they can also be in the form a space or a service – anything of which there is a surplus or deficit and that can be transferred between sellers and buyers. A marketplace is needed – locally, regionally, nationally and internationally. In their reports, all five subprojects for food, textiles, plastics, mobility and shared space propose creating some form of resource exchange.

In order for industrial symbiosis to be effective, we need standards, common systems that promote capacity development, efficient collection systems and marketplaces for raw materials where companies can purchase volumes of collected and recycled resources on an ongoing basis. We also need resource-effective development and design of products, market actors who promote commerce in collected and recycled resources, testbeds that help build confidence, advanced producer responsibility and product declaration systems.

The most important measure is the creation of digital marketplaces for resources. In the short term this should happen at the Swedish or Nordic level and in the longer-term at the EU level to create a larger market. A Nordic system to facilitate industrial and spatial symbiosis to use underutilised resources could be developed taking inspiration and lessons learnt from the UK's National Industrial Symbiosis Programme (NISP), and the Finnish Industrial Symbiosis System (FISS), where space and transport are included as resources to share in both urban and rural contexts. The main success factors are buying and selling resources locally because this is often based on a relationship between the buyer and seller. The system could be developed into a broader tool to coordinate resource-effective and circular resource systems by defining flows and opportunities to use resources more efficiently and effectively. The recycling industry should be an obvious partner, given the knowledge the companies have on the resource system. This responsibility should also include coordinating the delivery of statistics to SCB. In order for digital marketplaces for recycled plastics to function, standards are needed to enable buyers and sellers to establish specifications for a certain material and a certain application. Traceability and verification are also needed to avoid abuse of such markets.

Brokers could stimulate, improve and develop the market for collected resources. This could involve recycled raw materials being sold as an alternative to virgin materials, and familiarity with the market in the form of both buyers and sellers of recycled materials. These brokers could promote coordination among the various actors working with recycled raw materials based on their knowledge of resource flows and content.

It is time for Sweden and the Nordic region to create common marketplaces for resources. Cross-sectoral symbiosis is needed. This is a very important area and a topic for further research.

If we look at successful industrial symbiosis projects, we find that there is currently a significant need for hands-on work. The human factor plays a crucial role here, as do laws, regulations and technological development. Having a variety of incentive structures is also vital.

THE CONSTRUCTION INDUSTRY'S ENVIRONMENTAL CALCULATION TOOLS

One example is BM, a common environmental calculation tool for buildings used in the construction industry. The tool is based on a life cycle assessment method and enables non-experts to produce a climate declaration for a building. The tool can be used to calculate how large the climate impact of buildings will be and how emissions can be reduced by choosing different materials and production methods. BM is based on data produced in the planning stage for a building. The tool has a database already containing climate data for the building resources that are used in the Swedish market. It is thus possible to obtain an average result that describes a building's climate impact in Sweden. This can then be used to make improvements to the building in question.

Support small businesses in their transition

Much of the private sector consists of small businesses that, while agile, find it hard to allocate resources to drive and implement major changes on their own. This means that they are not always able to embrace alternative technologies. It is a major challenge for small businesses to implement, for example, the digital transformation that could lead to new business models. Insights, guidance and support are needed here – especially when the economy is strong. Government support, for example through Almi, or industry organisations with expert consultants, plays an important role in helping companies bring about the fast transition that is needed.

One possible way to attract businesses and create new solutions is through “challenge platforms” – open data platforms with challenges that need solutions, where business-

es can go in and present solutions, and spread information about successful projects that show good examples of the power of social networks.

Direct and indirect taxes on work accounted for 59 percent of the Government's total tax revenue in 2018. According to a 2018 report from the Swedish Trade Federation on circular economy obstacles, the regulations on renting, upgrading and reuse need to be simplified. Low profitability is still a critical obstacle preventing development of this type of business model. Meanwhile the cost of labour remains constant. The Government needs to create incentives for enterprises. The rules on VAT on used products could be changed for example. The Swedish Trade Federation and other industry representatives would also like to see the cost of employing people go down by lowering payroll taxes. One way to reduce labour costs could be to introduce a deduction for renting, selling used or repairing products. This was proposed in the report "Från värdekedja till värdecykel – så får Sverige en mer cirkulär ekonomi" (From value chain to value cycle – How Sweden will have a more circular economy).¹⁰

It is, for example, cheaper today to install a new door in a building than to repaint an old one. How can tax revenue from work be replaced by other revenue in order to lower business costs for labour?

EU Green Deal¹¹ and Circular Economy Action Plan

The European Green Deal is an important initiative, where the EU is taking an initial important step towards a holistic perspective for a more healthy, inclusive and resource-efficient Europe that makes use of its biological diversity and improves the well-being of its citizens. These ambitions, if implemented, will be in line with the project's action plans.

Life-cycle assessment (LCA)

In the future circular economy more products will consist of recycled or reused materials and the materials in more and more products will be recycled, but how do we put a value on recycled materials in a life cycle perspective?

The question is now a major focus within the EU due to its new Green Deal. Among other things, this is linked to how to inform consumers about products so that they can make active choices.

Researchers at Chalmers University of Technology, the Royal Institute of Technology and IVL are analysing and discussing how recycling can be modelled in life cycle assessments and similar environmental assessments. The project is testing a selection of methods in separate case studies in cooperation with the companies Essity, SSAB and Outokumpu, and is looking at whether it is possible for larger groups of companies, public agencies and LCA experts to reach a consensus. The results will contribute to international harmonisation of LCA in, for example, ISO standards and the EU Product Environment Footprint, PEF.¹²

¹⁰ SOU 2017:22.

¹¹ https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_sv

¹² <https://www.lifecyclecenter.se/projects/modeling-of-recycling/>





The Financial sector's role in the transition

»It will be important to identify potential obstacles and challenges that may hinder the financial markets' ability to finance the transition.«

One of the Paris Agreement's three overall measures emphasises the important role of the financial markets in the transition to a low-fossil society to address climate change (Article 2C). The same applies to reaching the Sustainable Development Goals (Agenda 2030) and building a resource-smarter society. The role of the financial markets is to provide venture capital for investment in new technology, new services and new business models, and to include criteria when providing credit to businesses. If the transition to a resource-effective society is to succeed, it will be important to identify potential obstacles and challenges that may hinder the financial markets' ability to finance the transition.

General challenges for the financial sector in integrating sustainability

There are several fundamental challenges that the financial sector is struggling with when it comes to integrating various sustainability aspects into its decision-making.

One initial challenge is how to handle externalities (see fact box). As long as the external effects are not correctly priced

and integrated into the financial sector's assessments, there is a risk of decisions being made that are suboptimal for society. A clear example is that no price has been established of the cost of carbon emissions for society and there is a false impression that this has been a "free-of-charge" resource, which has led to overuse. A global market for emission allowances is therefore needed to solve this type of market failure.

The concept of market failure illustrates a situation where the market does not lead to optimal use of society's resources. In the event of external effects, the real social cost is greater than the price tends to indicate, because not all factors are taken into account when the value of a product or service is calculated. The market price only reflects the private costs that are born by companies and other actors.

Social cost = private (direct) costs + external (indirect) costs.

There are different types of control mechanisms that could be used to correct market failures such as taxes, fees, regulation and subsidies. Control mechanisms facilitate internalising, i.e. market actors taking into account and including external environmental impacts.¹³

13 <https://www.upphandlingsmyndigheten.se/omraden/lcc/lcc-och-externa-miljoeffekter/vad-ar-externa-effekter/>

Another challenge for the financial sector when it comes to integrating sustainability aspects is that the financial market in some cases has a short horizon. A study from the Stockholm Sustainable Finance Center (SSFC) and Sweden Sustainable Investment Forum (Swesif) shows that stock market actors indeed have a short-term perspective. A large portion of a company's value creation is associated with short-term financial consequences. According to the experts, there is a risk that the market will not be able to handle long-term risks such as climate change. Another aspect identified in the study is that information collected in investment analysis needs to be expanded and include sources outside of conventional channels and relationships.

Sustainability aspects raised in the financial sector are often ESG factors (environmental, social, governance). In order to integrate these factors in financial analysis and decision-making, they need to be quantified and sometimes monetised (given a monetary value). This is an additional challenge for the financial sector. It is experienced as difficult and different and few actors are educated in how to address it.

A further challenge for the financial sector is the lack of information on which to base decisions, where the sustainability performance of companies is difficult to evaluate. Sustainability reporting by companies has traditionally been retrospective and has focused on the company's impact on its surroundings and providing multiple indicators with varying degrees of relevance. The challenge for the financial sector is to determine which ESG factors are the most important and which financial consequences these will have in the short and long term.

It is also difficult for an external assessor to differentiate between the company's reporting and the sustainability work that is actually being done. In a recurring study called Walking the Talk from MISUM at Stockholm School of Economics, the researchers show that more listed companies can be characterised as "talking low performers" than as "silent walkers." This means that the sustainability information that companies disclose does not necessarily represent the work that is actually being done.

The financial sector often uses the so-called ESG ratings for companies. These ratings are produced by independ-

ent analysis firms that base their ratings on the companies' sustainability reporting, surveys completed by the companies and other information. One challenge is that concordance between the ESG ratings of different analysis firms for the same company is sometimes low and it is often unclear how they arrived at their ratings. The potentially low data quality affects the ability of actors in the financial market to take the information into account when making their financial decisions.

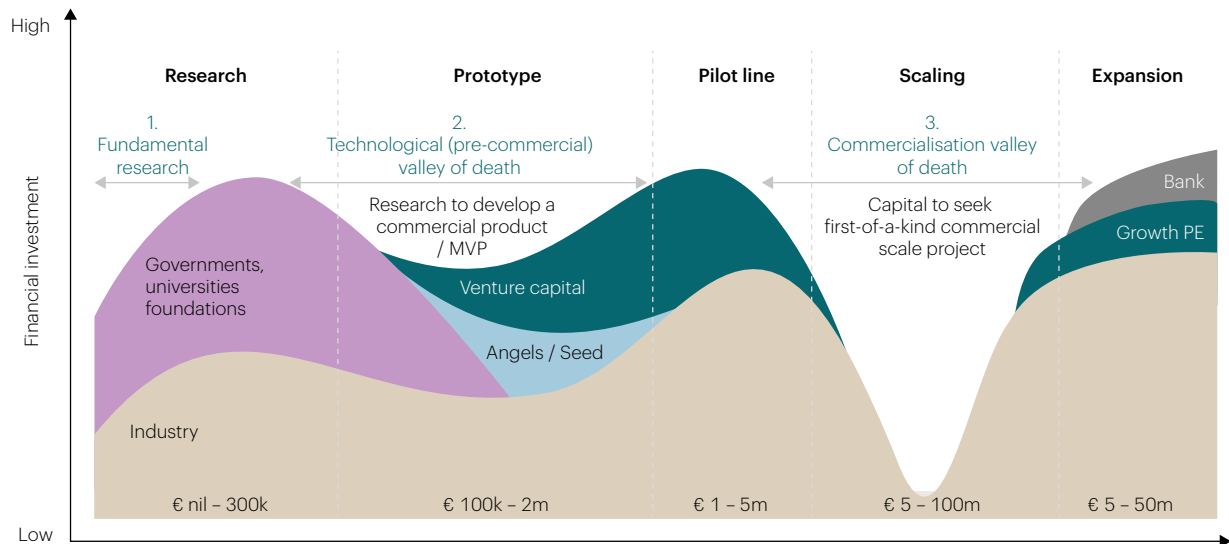
The financial sector and resource-effective, circular business models

The challenges described above of the financial sector integrating sustainability aspects also impacts the sector's ability to provide financing for a transition to circular business models. The transition to circularity adds another layer of complexity in that the emphasis is on new, innovative business models. The financial sector looks for investment opportunities, but favours long-term, tried and tested, profitable projects in various industries and technology areas. Circular business models can rarely demonstrate the same documented history and success.

It is difficult today to secure financing for new business models and solutions that are based on sustainability and circularity. Representatives from the investor side themselves say that there is not enough capital at the early stages for new companies or innovations. We hear the term "death valley" when actors want to scale up and commercialise new solutions and innovations to the commercial level, (see Figure 2). Public funding is available for the research and pilot phases, but when actors want to take the next step and need more financing, they encounter a gap in the capital market. The capital requirements are often too large for government grants, too small for investment banks and institutional investors, and too new and unknown for commercial banks. Private venture capital is not reaching these actors either.

When it comes to providing credit for resource-effective and circular business models, the challenge is that the traditional indicators for risk and risk targets are not directly

Figure 2: “The valley of death” in financing of innovation in the upscaling phase.
 Source: SOU 2015:64 – En fondstruktur för innovation och tillväxt.



applicable to the new business models. There is, for example, no established standard for indicators and targets, or for benchmarking of resource effectiveness initiatives.

In autumn 2019 the Minister for Business, Industry and Innovation announced that the Swedish Export Credit Corporation (SEK) is starting to finance climate transition projects, including in Sweden. SEK is a state-owned export bank that every year issues credit in the amount of SEK 60–80 billion. The idea is for Swedish industry to be developed at home and then branch out into the world and help with the global transition.

Positive sustainability and investment trends

Despite the challenges described above there is positive development in the financial markets in terms of taking sustainability aspects into account in investments and lending

decisions. In recent years, both demand and supply of green investment objects have grown rapidly in areas such as energy, infrastructure, water and sanitation.

More and more institutions are signing up to the Principles of Responsible Investment (PRI) which was started in 2006 and is based on six UN-supported principles for responsible investment. When investors become signatories they undertake to, for example, integrate ESG into their investment decisions and to participate in spreading PRI principles within the financial sector.

We will see more and more tools to drive sustainable development on the investor side. The UN, for example, has an online course in sustainable investment, and several Swedish banks have started offering services to support small businesses aiming to make a positive impact. The SPP pension insurance company, for example, chooses to invest in companies that adhere to the UN Sustainable Development Goals. The company also has an 80-year perspective when it evaluates investment opportu-

nities and measures and monitors its investments based on sustainability KPIs.

The trend towards sustainable investments is accelerating globally as well. The United Nations Development Programme (UNDP) is now developing a tool called SDG Impact to make it easier for investors. The tool is being tested in Brazil among other places. The aim is for it to lead to certifiable investments. There is also interest in testing the tool in the Swedish market. In Denmark the UNDP is testing a programme to support to SMEs in finding ways to contribute to Agenda 2030 and use the Global Goals in their business plans.

Another initiative, one that addresses the challenge of company sustainability reporting is the Task Force for Climate-related Financial Disclosure (TCFD). This framework for reporting on climate risk is voluntary, but more and more companies are joining it. The basic idea is for a company to report which financial consequences climate change will have on its operations in the future. These consequences are then modelled in a future scenario analysis. The TCFD is expected to be able to have a big impact on how the financial sector will integrate the climate issue into its financial analysis because the financial consequences will be expressed explicitly, and the framework is also forward-looking.

Positive trends in sustainability and lending

Although we are beginning to see the financial sector integrating ESG factors in lending decisions, great success is being achieved here too. Perhaps the best-known product that links sustainability performance to financing is the so-called green bond, where the bond issuer promises to use the funds for specific projects that improve the environment. The most common categories for these projects

are buildings and renewable energy, but we are also seeing water and sewage projects, as well as transport projects. It is, however, crucial for the right sustainability criteria to be required for the projects. The green bond market is constantly advancing, emissions are increasing significantly year after year and the percentage of green bonds is steadily growing. Sweden is the country with the highest concentration of green bonds and while the market was previously dominated by the municipal sector, we are now seeing more and more private companies as issuers. Green bonds have over time been joined by other types of “labelled” bonds, such as sustainability bonds, social bonds and blue bonds. Blue bonds come under the definition of green and have emerged as a subgroup with a niche focus on water-related commitments. The global market for labelled bonds set a record in 2019 and according to predictions from SEB bank, the cumulative number of labelled bonds issued in 2020 will reach USD 1,000 billion. This is, however, only 1 percent of the total global bond market.

So far the green bond market has been following the Green Bond Principles, a voluntary framework produced by the financial industry and administered by the ICMA (International Capital Market Association). Within the EU efforts have been intensified to develop a standard for green bonds, aimed at further scaling up this type of financing in the transition to a more sustainable society. The standard is expected to initially be voluntary and in line with the Green Bond Principles, but the addition of external verification will become mandatory and the reporting requirements will be stricter.

The new Green Bond Standard is strongly linked to the European Commission's efforts to produce a taxonomy within the EU to define which financial activities can be classified as green. The purpose is to make it easier for investors and lenders to channel capital to projects that are facilitating the transition to greater sustainability in society. In order to be classified as green, a project needs to make a positive contribution to one of the six established objectives¹⁴ and

14 The six objectives are climate change mitigation, climate change adaptation, sustainable use and protection of water and marine resources, transition to a circular economy, pollution prevention and control, and protection and restoration of biodiversity and ecosystems.

to do no significant harm to any of the other environmental objectives. The project also needs to be in compliance with minimum safeguards with respect to social sustainability. A Technical Expert Group is also developing specific benchmarks and criteria for projects to live up to.

In addition to the identified objectives, which clearly link the borrowed capital to sustainability, more initiatives will come from banks linking interest on business loans to a company's sustainability performance. Provided that the company reaches certain sustainability targets the bank will provide an interest discount. Examples of banks that are applying this system include ING, BNP Paribas, Bank of America, ICB and SEB.

Proposals for solutions to address the challenges

The more general trends in sustainability and the financial sector will also affect access to financing for circular business models. In particular, the fact the circular economy is a prioritised objective in the EU's taxonomy is promising. It is, however, important to invest in various ways in projects aimed at making operations more resource-effective, and not only in those that are already "green".

There are also more specific initiatives and proposals for solutions to facilitate financing of circular business models. In a document with the heading "Accelerating the transition to the circular economy – Improving access to finance for circular economy projects", the European Commission points to seven categories of incentives¹⁵ and their consequences for financing that it believes should lead to a successful transition to a resource-effective circular economy. Coordination is needed here, as well as a logical order in the transition process.

Seven categories of incentives

1. The need for a level playing field, for example in the laws and the tax system.
2. Cooperation within, and between, value chains to optimise resource-effective solutions.
3. Long-term value-creation. The current linear economic models are transaction-based and a product's life or utilisation rate is not taken into account.
4. End user market participation. People and companies are used to disposing of things that are considered to be waste. That needs to change. Materials need to return to an upstream part of the value chain.
5. Charge for externalities. This would create a fairer competition climate, help to achieve public objectives and reduce society's costs.
6. Increase knowledge about the economics of circular models. If circular operations differ significantly from past models – such as renting instead of selling – it is important for investors to understand these differences in order to make an accurate evaluation of a business model. For example, if cash flows are changed significantly and assets remain on the balance sheet, this results in:
 - a. lower solvency;
 - b. credit risk increased by the time shift;
 - c. different customer loyalty compared to in a linear transaction;
 - d. different break-even point;
 - e. higher initial capital investment and financing needs, etc.

¹⁵ The term "incentives" does not mean subsidies for circular economy activities. The idea is instead to have incentive structures: a set of rules that determine how actors in a relevant system make decisions. This is described in, for example, Fehrenbacher, D.D., Design of Incentive Systems. Experimental Approach to Incentive and Sorting Effects (Contributions to Management Science), Physica-Verlag, 2013.

Here, it is crucial for financing actors to understand the differences between linear and resource-effective, circular business models.

7. Show the benefits of being first and creating role models. If demand can be demonstrated, it will work as a magnet for new customers and businesses to change their business models. Regardless of how perfectly the value chain is organised, it will not be possible to build a robust business without people/organisations that are willing to pay.

To address the problem of the difficulty of obtaining financing for innovative circular business models, it may be of interest to explore what a credit council for resource effectiveness and circular economy would look like. A credit council could be tasked with providing guarantees or beneficial loans as a form Government supported risk relief. Another option is for multiple companies to join forces and build a consortium and together search for financing for circularity, thereby enabling them to, for example, reach the investment limit of the European Investment Bank (EIB). It is also important for large projects aimed at making an enterprise/organisation more resource-effective to be able to access various types of financing. A Government guarantee is needed here, similar to those issued in export credit.

The Government should actively invest in enterprises and projects aimed at increasing resource effectiveness and circularity. A discussion about loan-to-value ratio would be very useful in this context. Examples of where significant investment is needed:

- Refinery for recycled plastics and other carbon-based substances.
- Refinery for recycled cellulose-based substances.
- Sorting plant for textiles.
- Spinning of textile fibres.
- Resource exchange for materials, services, space etc.

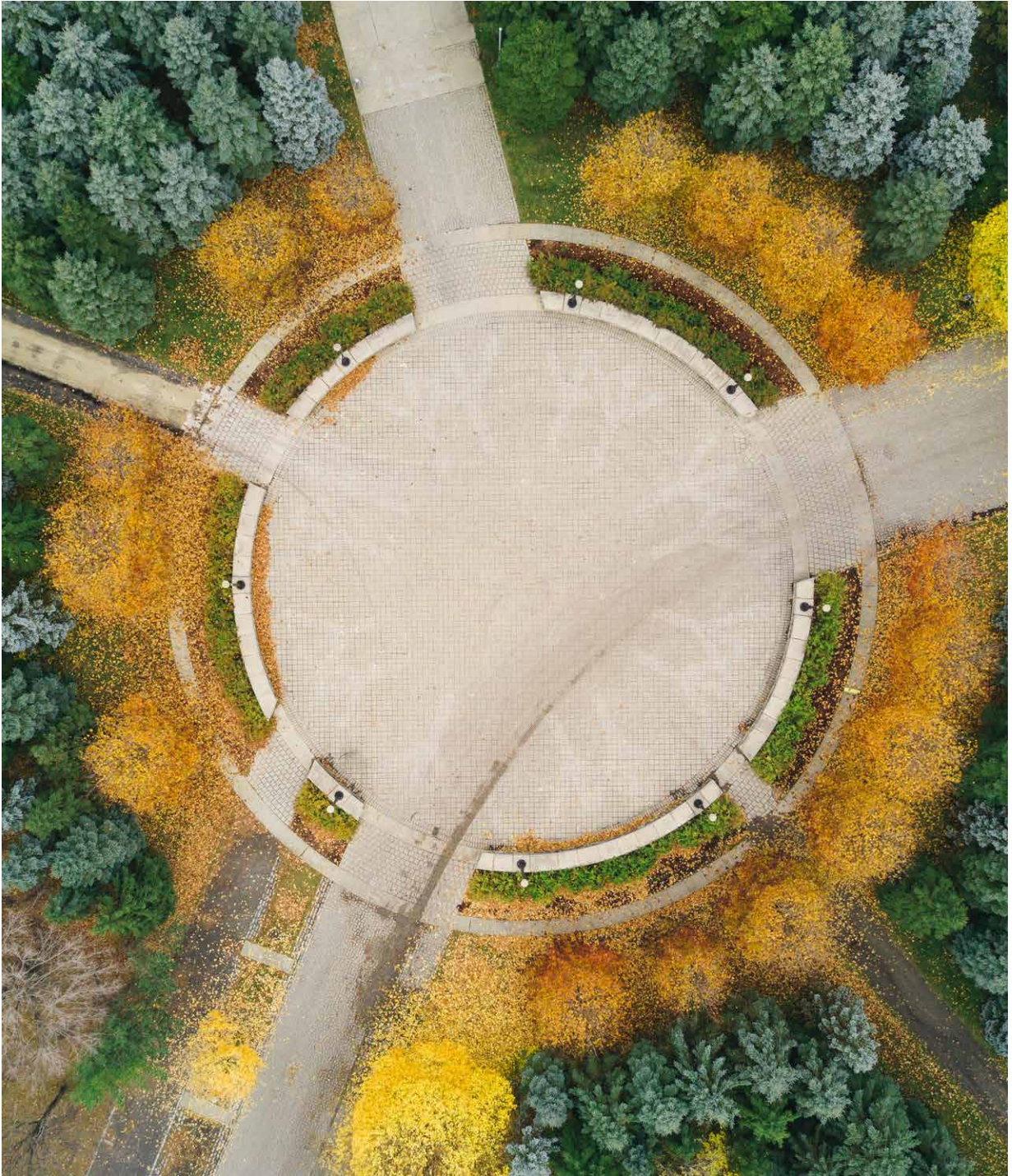
We also need a hub for innovative financing models that gathers representatives from the various parts of the fi-

ancial sector. Through cooperation and innovation, new standards and indicators could be produced to facilitate the financial sector's assessment of the potential of projects focused on circularity and resource effectiveness. As previously mentioned, the fact that targets and levels in traditional financial indicators are not directly applicable to circular business models is a challenge because cash flow patterns can be very different. One such innovative approach could, for example, be to use the framework for each industry as a starting point to produce relevant indicators for that industry, such as:

- For the bond market: Green Bond Framework, Climate Bonds Initiative
- Manufacturing companies: Percentage of waste in relation to produced volume/value, energy efficiency at plants/factories (such as the Nordic Swan Ecolabel), actual emissions in the logistics chain etc.
- For individuals: Reward resource effectiveness through better terms for mortgages, ride share membership etc.

Society needs to internalise more of the externalities (such as climate footprint) with the help of various control mechanisms so that market mechanisms lead to more desirable results. The financial sector could have shadow costs for externalities, similar to those of certain corporations, to more easily see how to create value without incurring large external costs. This would allow them to incorporate the real cost of natural resources and ecosystem services in their calculations. This is an important component in future effective resource use because it reveals the cost of conventional methods and the value of green solutions.

Co-authors: Hanna Setterberg, PhD, researcher at Stockholm School of Economics Institute for Research (SIR).





Proposals from
the subprojects:
Mobility, Shared
Space, Food, Textiles
and Plastics



Resource-effective mobility for goods and people

Mobility is highly significant and has a considerable impact on all sectors because products and people need to be moved around in a globalised world. Historically, transport volume has increased in line with economic and population growth. We will continue to see a similar trend in the future, i.e. an increase in demand for freight and passenger transport.

Emissions are the most significant challenge for the transport sector (accounting for 43 percent of Sweden's carbon emissions if we include domestic and international transport and bunkering in Sweden). However, if we are to reach the UN Sustainable Development Goals, transitioning to sustainable fuels and electricity is not enough. We also need to increase resource efficiency in transport systems. The main question is therefore: How can we meet increased transport needs in the future without using more resources than necessary? By making essential transportation as efficient as possible, we reduce total energy consumption in the transport sector and thereby also carbon emissions in relation to transport volumes. When transport is optimised in terms of resource use it also has a positive effect on other drawbacks of transportation, such as reducing particle emissions, accidents and congestion.

Resource effectiveness is extremely important for society and the economy – from both an environmental and cost perspective. If Sweden can contribute to mobility solutions for the future being designed that maximise resource effectiveness, transport costs will go down, there will be a positive impact on the environment and Swedish businesses will be more competitive. Mobility is very important in and impacts all sectors because goods and people need to be moved around in a global world.

SUBPROJECT



**Resource Effectiveness
– Circular Economy
Subproject: Mobility**

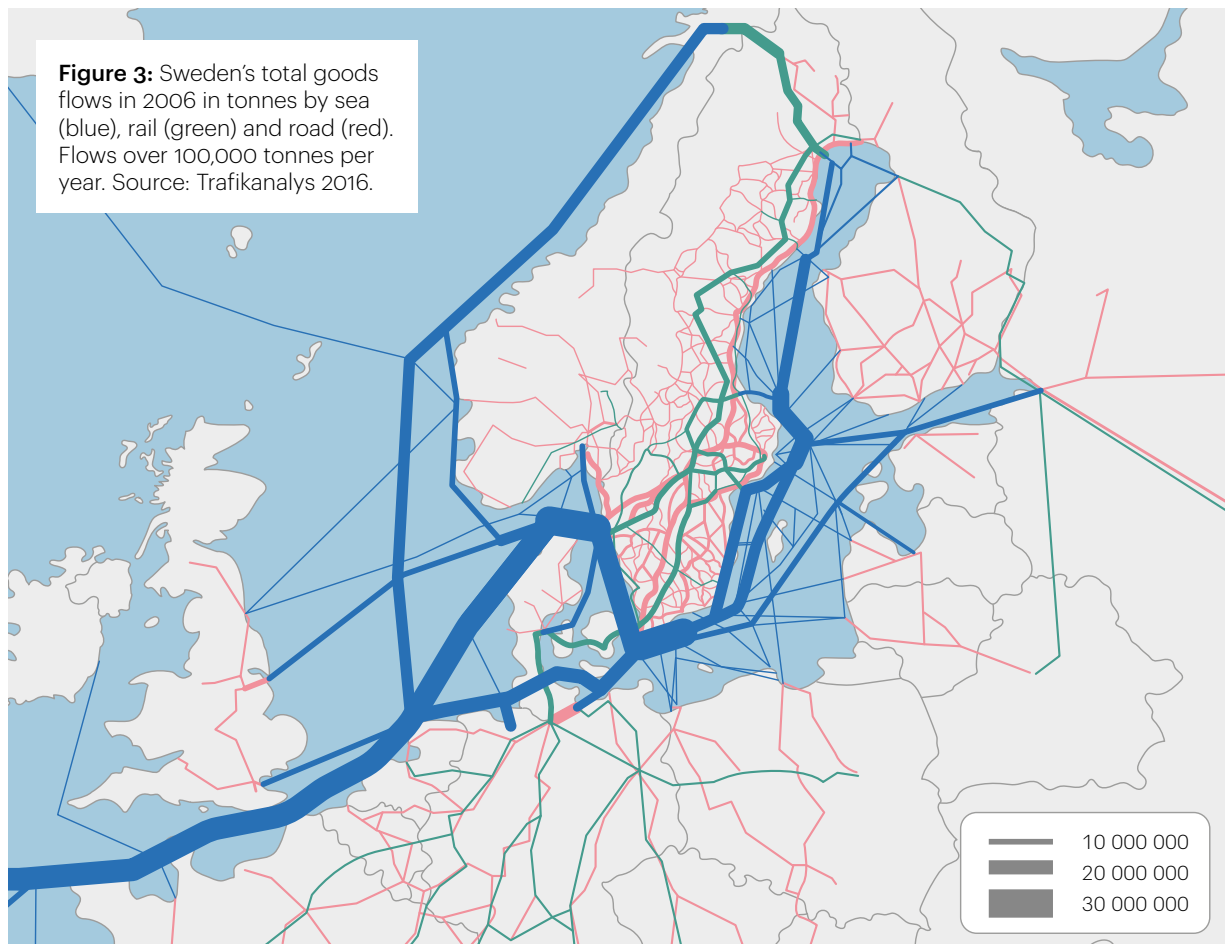
A sector report from the IVA project
Resource Effectiveness and the
Circular Economy (ReCE)

Read more in the sector report for the **Subproject Mobility** (IVA-M 515).



Measures proposed by the project

1. Sweden needs to develop a national strategy for digitisation and data sharing to promote the development of resource-effective transport solutions. Three types of infrastructure – physical transport, energy and digital – need to work together for a transport system that is efficient and safe in the long term and has the least possible impact on the environment. We also need to establish data sharing platforms for neutral and reliable data sharing in each application area.
2. Continued investment to improve public transport together with other forms of combined mobility based on sharing and pedestrian/bike traffic. This could be done using control mechanisms, working together and building on combined mobility projects, continuing to invest in research and evaluating the effects of implementation and pilot projects in combined mobility.
3. Plan physical infrastructure and structures for resource-effective transport solutions. This could be done by regulating transport solutions, for example by coordinating common (not supplier-



specific) parcel lockers and collection points. Plan and change the design of cities for short transport distances and prioritise pedestrians, cyclists and public transport. In connection with urban development, plan for how ride share cars, autonomous vehicles, public transport etc. can be used more resource-effectively – both within and across municipal boundaries.

4. To increase transport capacity utilisation, independent, digital marketplaces should be introduced for all four modes: road, rail, air and

waterborne. Capacity utilisation of pallets, rolling cages etc. should be transparent and freight exchanges, shipping agents and fourth-party logistics should include a resource efficiency parameter to encourage customers to differentiate their demand, instead of routinely choosing expedited shipping.

5. Cooperation between transport buyers and sellers could lead to more flexible delivery terms and increased utilisation rates, for example through night-time deliveries (using the potential of electrification and autonomous vehicles).

Increased space sharing

Buildings have a long life and sometimes stand for several centuries. The construction sector accounts for 40 percent of the annual resource use in the world. A large percentage of the resources used and the environmental impact of buildings is during new construction. The greatest resource efficiency gains within the industry can therefore be made by using existing buildings and their surrounding areas more efficiently to reduce the need for new construction. The subproject has therefore focused on how existing space can be shared.

Many actors are focusing on social drivers. Sharing space may require new work processes, networks, inspiration and knowledge. Sustainable sharing of space and functions should improve people's wellbeing and promote efficient meeting, education and work spaces, and not take place at the expense of these. There are large economic drivers for space sharing, in terms of both potential savings and new commercial opportunities. A lot of innovation is taking place around various sharing formats. There is significant interest in sharing space and functions, and in the business models it open doors to, but there are obstacles relating to acceptance within enterprises/organisations and the way in which contracts, insurance policies and laws are designed today.

Seven steps to increase space sharing:

1. Identify on an ongoing basis how much existing space is being used.
2. Study space and function needs on an ongoing basis. Could space be used differently? Could organisations be organised differently?
3. Is it possible to share space within the framework of an organisation's existing work processes?

SUBPROJECT



Read more in the sector report for the **Subproject Shared space** (IVA-M 518).



4. Identify and communicate which spaces are empty and at which times, and how to share them with particular organisations at the same time or at different times of the day.
5. Explore how systems for sharing space and functions with other enterprises/organisations can be developed if the conditions are changed through, for example, remodelling, new work processes or different rules.
6. Build for multifunctionality and flexibility in connection with reconstruction or new construction so that spaces can be used for more types of activities now and in the future.
7. Show the effects of sharing space: Communicate the environmental, social and financial gains and any losses or rebound effects and drawbacks of sharing. It is important to include goals and follow-up processes for space utilisation in sustainability reports.

All actors need to produce their own action plans for how to increase sharing of their facilities. Cooperation on a larger scale between multiple actors is necessary in order to establish a market for shared space. Partnerships and more pilot projects will be needed to develop ways to share resources.

Dimensions of sharing

| | |
|---------------|--|
| WHEN? | <ul style="list-style-type: none"> • Simultaneously/At different times • All the time/Repeatedly/On one occasion |
| WHAT? | <ul style="list-style-type: none"> • Space/Function • Access to everything/Access to several parts/Access to a specific part |
| WHERE? | <ul style="list-style-type: none"> • Within the same space/In the same building/ In the same area/In the same network |
| HOW? | <ul style="list-style-type: none"> • Owners invites other actors to share with them/Different owners agree to share with each other/An actor manages the sharing solution for participating actors/ Actors rent or own together • Free of charge/Pay as you go; subscription; participant fee/Sharing of costs and investments |
| WHO? | <ul style="list-style-type: none"> • Open to all/Open for those within the organisations that are sharing/ Open for certain individuals or groups that have been approved by owners |

Measures proposed by the project

The Government should create control mechanisms that reduce general resource use. Tax rules should be overhauled – for example VAT rules – to promote sharing between enterprises/organisations. Chapter 12 of the Code of Land Laws addressing renting should be reviewed to encourage sharing solutions (tenancy protection, termination rules and definitions of residential and commercial properties). The Planning and Building Act should be overhauled so that zoning plan rules encourage flexibility to enable existing buildings to be used in more ways. Finally, data should be collected on the use of space and functions.

Municipal authorities should offer open digital infrastructure with municipal platforms to show where underutilised space and functions are and to facilitate matching of supply with demand. A sharing component should be required in procurement and land allocation processes. Develop zoning plans that encourage using buildings in multiple ways, preparatory land use plans that explain the benefits

of sharing, and development contracts that guide actors towards circularity.

The private sector should develop scalable services that can facilitate sharing and support behavioural patterns around matchmaking, contracts, insurance, safety, service and access. Business models and contracts could be developed based on different types of incentives for commercial, public-sector and non-profit organisations. The financial sector should invest in new business models for sharing and require resource effectiveness (including space sharing) when providing green mortgages. Civil society actors who need or are offering space should spread information about the opportunities for sharing and present the positive effects.

Academia should develop utilisation indicators as well as supplementary indicators. Researchers could study utilisation rates and define what a reasonable utilisation rate is in different sectors. Quality guidelines could be produced for existing buildings to facilitate long-term sharing and to present models for a gradual shift from owned to shared space.

Measuring and reducing the amount of lost food

Global production of food today accounts for a significant percentage of human impact on the environment, the climate and the planet's natural resources. An important piece in the puzzle is therefore creating a resource-effective food supply chain as we work towards achieving the 17 Sustainable Development Goals established by the UN in Agenda 2030.

One of the fastest ways to increase resource effectiveness in the food supply chain is to reduce the amount of lost food. According to the UN 12.3 target, the world must halve its food loss (Agenda 2030 definition) per person in the retail and consumer part of the food supply chain by 2030, and also reduce it throughout the chain, including post-harvest losses. The UN member states are expected to establish their own political goals based on the Global Goals. As of 2020 the EU is also requiring member states to measure and report their total food waste at the national level annually. Living up to these requirements will require robust action. One critical step is, of course, getting all of the actors in the chain to measure and report – based on a common standard – accurately on the volume of their lost food and unavoidable food waste. To help with this the project has:

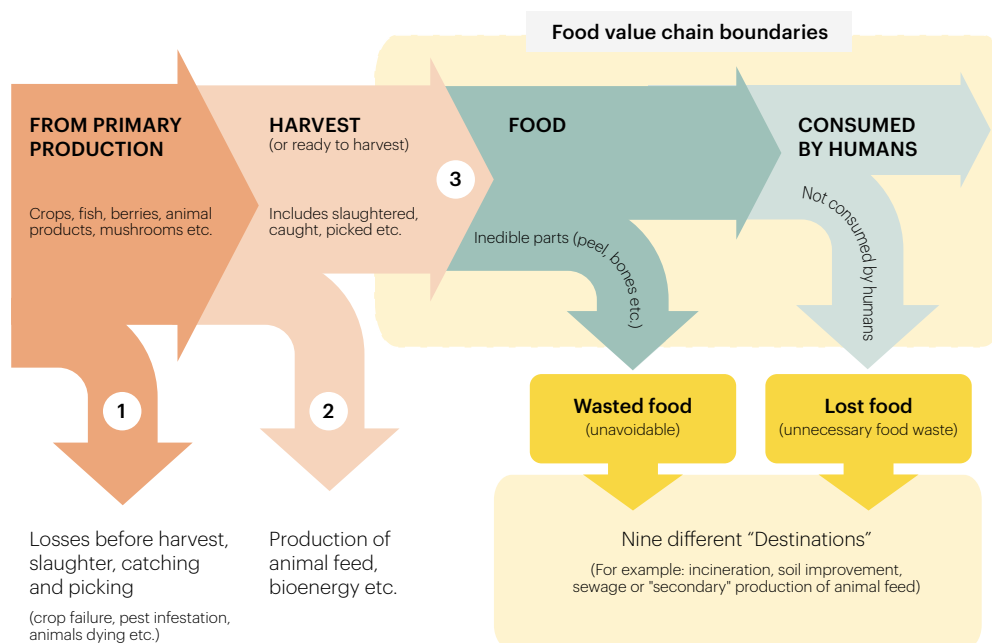
- produced an initial proposal for a national framework for how to define lost food and unavoidable food waste, how companies in different parts of the food supply chain should measure and report this and how to do it in a way that enables all of the data to be compiled at the national level;
- participated in the development of a national platform so that companies in the food supply chain will be part of a voluntary agreement on adopting common goals to measure, report and reduce their lost food;

- identified solutions that make it possible for companies throughout the food supply chain – financially and in practice – to measure and report their lost food and unavoidable food waste.

Measures proposed by the project

- The Government and Riksdag should produce control mechanisms with the aim of getting companies throughout the food supply chain to measure and report their lost food and unavoidable food waste. This type of control mechanism should first incentivise and reward and only be obligatory as a last resort.
- The Government should intensify its efforts to encourage food supply chain actors to also start to measure the flows of lost food and unavoidable food waste (according to the subproject's definitions) which are not addressed today by the EU. This means, for example, edible food that leaves the food supply chain to go to the production of animal feed, biofuel and biochemical products. These flows should not be considered to be contributing to the UN 12.3 target of food loss by 2030.
- The Ministry of Enterprise and Innovation should appoint an actor to be responsible at the national level for compiling all of the data on lost food and unavoidable food waste reported from the various parts of the food supply chain. The Swedish Environmental Protection Agency, which is already collecting food waste data on a smaller scale, should be given an expanded mandate.

Figure 4: Three flows from primary production. The material that leaves primary production can be divided up into three flows. Arrow 1: Losses before harvest, slaughter, catch etc. Arrow 2: Material that goes to production of animal feed, bioenergy etc. (i.e. products that are never intended to become food for humans). Arrow 3: Material that goes into the “food supply chain” to become food for humans.



- The Ministry of Enterprise and Innovation, which is responsible for the national food supply strategy and action plan to reduce food loss, should get involved and produce solutions that make it possible in practice for more actors in the food supply chain to measure and report their lost food and unavoidable food waste. This could, for example, involve producing financial control mechanisms to get more waste management companies to invest in technology that can measure waste at the individual business or household level.
- The Government and Riksdag should continue, and preferably intensify their commitment to building

a national platform so that companies in the food supply chain will be part of a voluntary agreement on common goals to measure, report and reduce their lost food. It is important for the Government to continue to provide the funding that will be required to put an actor in charge of organising, managing and following up efforts to implement the Swedish agreement. The subproject proposes that IVL Swedish Environmental Research Institute, which is already heading this effort, be given a mandate to move forward in cooperation with other qualified actors.

A resource-effective, circular textile flow

Most of our textiles are produced today at low cost in countries outside the EU and are transported by sea or in some cases by air to Sweden. An extremely small amount of the garment production capacity is in Sweden. There are few solutions for on-demand production and few brands own their own factories. 80 percent of a garment's climate impact is in the production phase¹⁶ – the phase that companies today have little or no control over. Most of the countries where production takes place use energy from fossil sources, usually coal. There is waste in every part of the value chain and it is rarely used efficiently. In order for companies to set concrete goals and start to take action they need to educate themselves and get a comprehensive overview of their operations and of the products they design and sell.

New business models are needed that support increased use, resource effectiveness and circularity. We will need a new palette of the fibres because the demand for fibres is expected to increase by around 50 percent by 2050, from 100 to 240 million tons. Advances are needed in the recycling of both synthetic and natural fabrics and alternative raw materials need to be identified e.g. from waste generated in other industries. Cotton cultivation also needs to be sustainable. New business models and new fibres need to be developed based on a life cycle perspective and life cycle assessment to ensure that they really are better for the environment and climate, and are profitable. One of the most important parameters to reduce water and climate impact, as well as toxicity from consumption, is re-

SUBPROJECT



Textiles – from waste to resource by 2030
A sector report from the IVA project Resource Effectiveness and the Circular Economy (ReCE)

Read more in the sector report for the **Subproject Textiles** (IVA-M 517).

ducing the volumes of textiles produced. Increasing the life of garments – using the garments and textile products for longer instead of buying new ones – is probably the most effective way to reduce climate impact. As 93 percent of all climate impact is associated with purchasing new products, doubling the life of all textile products would reduce climate impact by 47 percent.¹⁷ Promoting a transition to renewable electricity production would have the second biggest effect (43 percent). In addition to the reduction in climate impact that could be achieved by doubling the life of products, water consumption could be reduced by 48 percent as well.

The Government must do its part to help make Sweden the leading nation for a value-creating textile industry that is sustainable, resource-effective, circular and profitable. It is vital for the Government, as well as the financial sector, to find financing solutions for businesses that support

16 Mistra Future Fashion Environmental assessment of Swedish clothing consumption: Six garments – sustainable futures, Sandin et al. 2019.

17 Mistra Future Fashion Environmental assessment of Swedish clothing consumption: Six garments – sustainable futures, Sandin et al. 2019.

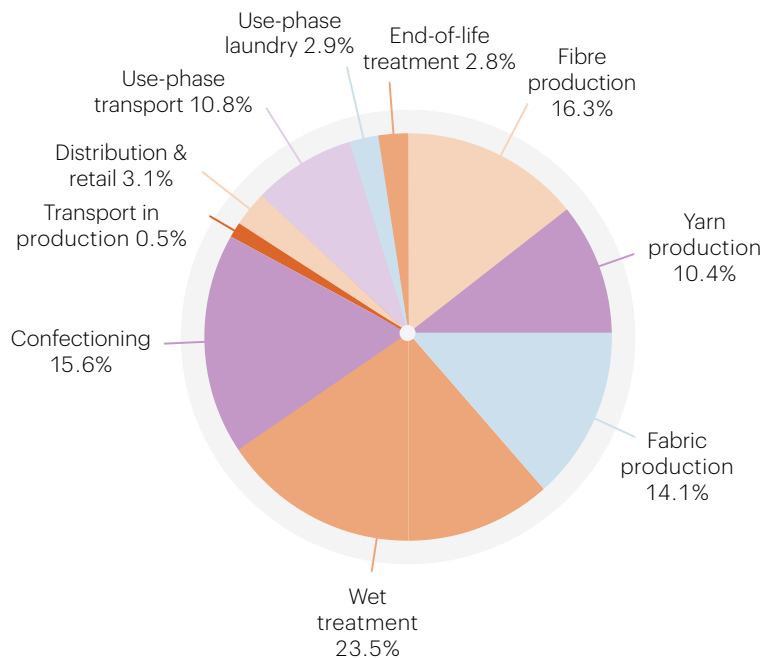


Figure 5: Climate impact from Swedish clothing consumption. Source: Sandin et al., 2019.

development, investment and upscaling. They need to go beyond individual initiatives and ensure that sustainability, circularity and resource effectiveness are a natural aspect of business and behaviour. Policy-makers have a role to play in establishing the rules for the new game plan, which companies must abide by. A Swedish circular strategy that also addresses commercial opportunities and sustainable growth is therefore a top priority in order to encourage all actors to join in the transition.

Measures proposed by the project

1. **Safeguard the flows:**
 - a) A clear definition and an international circular standard will be needed for sustainable textiles and circularity to establish a common vision.
 - b) The industry needs to develop a national framework for how to manage different materials and products in the final phase of their life cycle, such as collection, sorting, preparation for reuse, recycling, composting etc.
2. **Material brokers:** A greater exchange of materials between different industries and sectors is needed. Analysis is needed to identify important and relevant flows and new streams. Potential industry partnerships could be formed between agriculture and the forest, food, engineering, construction and automotive industries.
3. **Reward more sustainable and circular business models based on life cycle assessment:** Reuse, renting and subscriptions for clothes and textiles could be tax deductible to accelerate the transition. The public sector should take the lead to support change. Manufacturing new products with recycled materials should be rewarded, for example through tax relief. Economic mechanisms could also be used to increase supply and demand for materials that come from residual flows.
4. **Financial support for circular development:** Establish a credit council for resource effectiveness and circularity that provides guarantees or beneficial loans. Another way is for the Government or the regions to support the building of industrial parks, including comprehensive solutions for infrastructure.

The role of plastics in a resource-effective circular society

Plastics play an important role in today's society: they are mouldable, lightweight and can be adapted for different purposes. Recently the material has been criticised for causing pollution and for its fossil origins. The project has studied how production, use and recycling of plastics can improve the role of the material in a resource-effective society. Using plastic to protect food is a classic example. Without plastic the amount of waste in the food chain would increase significantly, and the environmental impact of efficiently produced plastic film is often far lower than the environmental impact of some types of food.

To achieve resource-effective manufacturing and use of plastics, multiple sectors need to work together and take action. The subproject's report describes how this can be done by applying action plans that focus on how to:

- Develop the market and business models for recycling plastics
- Increase the capacity of the recycling system
- Develop new recycling technologies

Measures proposed by the project

- Help develop the market for recycled plastics to build capacity development and efficiency in collection and recycling of plastics, as well as the resource-effective development and design of products. There is a need here for a digital marketplace for recycled raw materials, market actors that promote commerce in collected and recycled plastics, testbeds that help build confidence in the use of recycled plastics, advanced producer responsibility and product declarations.

SUBPROJECT



Read more in the sector report for the **Subproject Plastics** (IVA-M 516).



- Promote supply and demand for recycled plastics. The commitments made so far that are linked to the EU strategy for plastics in a circular economy indicate a clear market failure. Actors in plastics recycling (supply side) have demonstrated a higher level of ambition than users (demand side). Thus we need to focus on the demand side by, among other things, building confidence in the use of recycled plastics.
- Better statistics are needed as there is currently a lack of robust knowledge about the various flows. This makes it difficult to take the right decisions on technology development, investment and collaborative projects. Industry actors also have a responsibility to produce data and Statistics Sweden (SCB) needs to collect it.
- In addition to knowledge on flows and their volumes, information is also needed on the content of the plastics and products. Traceability needs to be expanded with respect to content and previous use. Without this information, resource efficiency is limited by plastics flows going to energy recovery unnecessarily or losing value at the recycling stage. The same applies to plastics reuse – also an area where more information is required. Traceability is needed at a more general level as well in order to measure

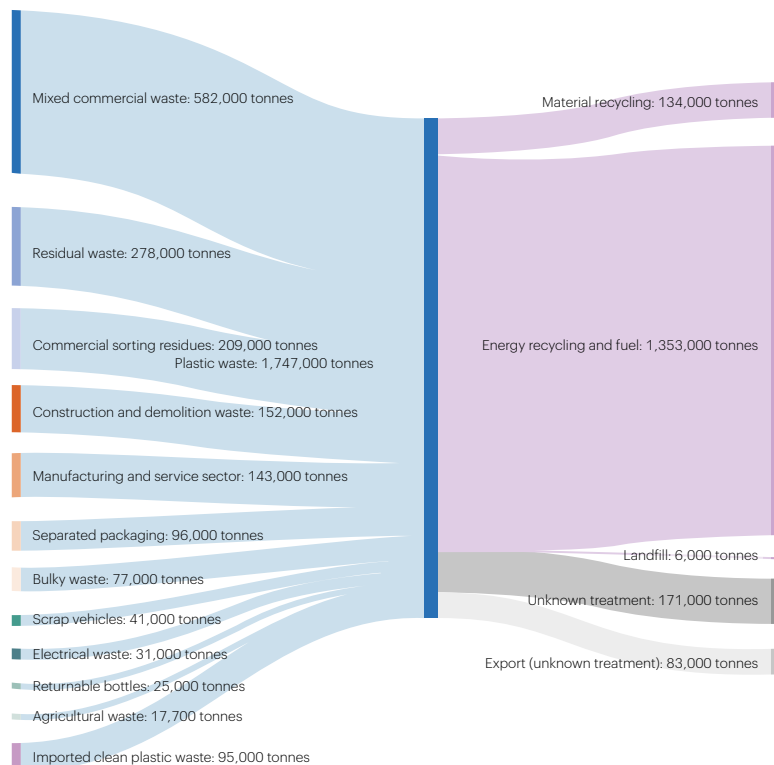


Figure 6: Overview of the Swedish plastic flow. Source: Ljungkvist Nordin, H., Westöö, A-K., Boberg, N., Fråne, A., Guban, P., Sörme, L. & Ahlm, M., 2019.

and verify how recycled plastic raw materials are incorporated into new products. A lack of traceability can negatively affect confidence in labelling of recycled raw materials. A digital system is needed to be able to handle the large volumes and variations in the plastics flows, and this should as far as possible be an international system.

- Life cycle assessment (LCA) is also needed to guide actors towards and promote resource effectiveness, and to reduce environmental impact. LCA methods may also need to be developed so that simpler comparisons can be made by both public and private sector actors more quickly and at a lower cost.
- Chemical recycling, i.e. where plastic materials with different properties are broken down at the molecular level, makes more plastics recyclable and can provide the market with high-quality recycled material. This is, however, an energy-intensive method. A study is needed of the opportunities and obstacles relating to chemical recycling in Sweden. It should look at how chemical recycling can contribute to resource effectiveness and circularity, and include aspects such

as cost and financing options, technology choices, environmental relevance through LCA, and the need for cooperation among actors.

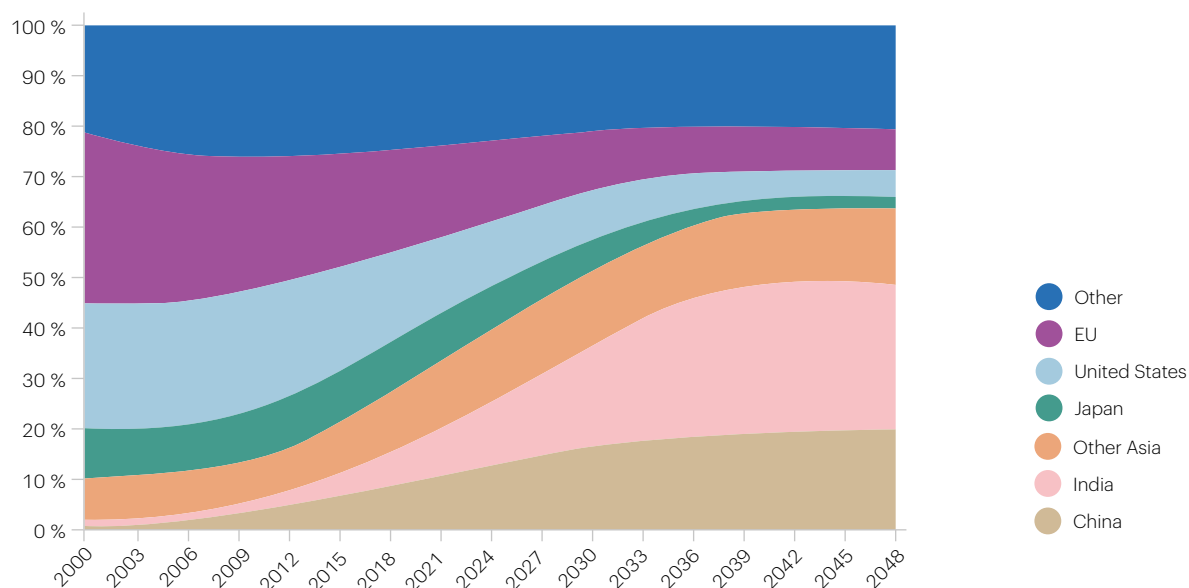
- At the end of 2019 the Ministry of the Environment asked the Swedish Environmental Protection Agency to coordinate the plastics flow – a process that needs to be developed and concretised. There is currently no Swedish plastics strategy with goals, strategies and R&D proposals for resource effectiveness. The focus has often been on reducing plastics in the ocean and environment, but we need a system perspective that treats plastic as a resource and a material with multiple functions in society. The extent to which the future circular economy strategy will meet such needs remains to be seen. There is currently no strategy that could move the system towards higher efficiency. This is a problem because we need to understand how plastics are helping to improve resource effectiveness in society. The project urges the Government to define the role of the Environmental Protection Agency in coordinating the plastics flow, form a commission to develop a clear Swedish plastic strategy and link it to resource effectiveness and circularity goals.



Outlook 2030

»To achieve lasting change
we need attractive visions,
examples and concrete action.«

Figur 7: Growth of the middle class globally. Source, OECD.



In ten years' time the global population will have increased. The OECD predicts strong growth in the middle classes in various parts of the world with people aspiring to the have same comforts as we have here in the Nordic region. The WWF's Living Planet Report says that we would need four Earths if everyone lived like we live in Sweden.

In order to manage this and address climate change, the extinction of species and pressure on national resources, we need a radical transformation of society. Resource effectiveness and circularity are critical factors for that transition.

We need insights and an understanding of how to solve the global climate and resource challenges. An increased focus on these aspects to create awareness in society is a positive thing, but to achieve real and lasting change we need attractive visions, examples and concrete action. Here, leadership in politics, business and industry, research and society is key. Research, new technology and innovations are not sufficient on their own – a social and cultural shift in perspective throughout society is required.

Education and dialogue play a crucial role as drivers of transformation. It is not only technical and social innovations, new

institutional conditions and economic rules that make transformation possible, but also a change in perspective. To create legitimacy and demand for services and solutions, a shift in perspective in society is needed on what to prioritise, what is important and what defines a good life. Interactive dialogue is needed on what sort of society is possible and desirable.

What would Swedish society look like if we really succeeded in making a shift towards greater resource effectiveness and circularity by 2030?

To inspire, highlight and propose areas in which we can establish requirements and sectors in which development can be accelerated, the five subprojects have created future scenarios, expressed in Outlook 2030. They are written as if the subprojects' proposals have been implemented and we have already reached the goal of a resource-effective and circular society with reduced greenhouse gas emissions. There is great potential for multiple synergies between the subprojects' areas. This is a key factor in a societal perspective and needs to be studied. The future scenarios are intended to inspire conversation and reflection.

Welcome to the future – Outlook 2030

Integrated infrastructure – a road to resource-effective transport

Carbon emissions in the transport sector were reduced by almost 70 percent by 2030 – first through the use of biofuels and later electric engines. An accelerated expansion of electrified roads has freed up biofuels for waterborne and air traffic, but the seismic shift came when the three infrastructure areas – transport, energy and digital – were integrated. This allowed data from the different areas to be compiled in a secure way and all parts of the transport system to be optimised based on both space and capacity utilisation, and how and when we use energy in a 24-hour period through an electrified vehicle fleet that functions as energy storage when not in use. Thanks to autonomous vehicles, a smaller number of vehicles on the road around the clock can provide more services to more people. Due to the fact that products are anonymously traceable, and that demand for passenger transport and traffic flows are monitored in realtime, transportation through the various modes is increasingly efficient. It is also coordinated well in advance of departure and up to arrival.

With fewer and more resource-efficient packaging, carriers (pallets, rolling cages) are only dispatched once they are full, and with heavy goods vehicles packed with stackable pallet systems, space utilisation throughout the transport chain has been significantly improved. The three-step principle: avoid–shift–improve, is used by the public sector, industry and private individuals. Asking ourselves how to make transport as efficient and effective as possible is second nature. Containers that are to be transported long distances between rail, ship or lorry are moved easily and economically in automated combi terminals.

A lot of goods are transported during low traffic times in electrified and quiet autonomous vehicles. Loading and unloading is automated. Deliveries go to local loading hubs for transportation to end recipients. Food can be placed directly in refrigerators with the help of digital one-time codes.

Public transport is the obvious choice for mobility in metropolitan areas. Public transport is on time, climate-smart and safe, and has significant and flexible capacity. Before

a trip begins passengers enter the end destination on their phones, transport data is shared in a secure way and the whole trip is planned from door to door. Trips by train, bus and tram are adapted to the traffic flow. At the end station passengers can switch to a bike, electric scooter, other form of micromobility or a self-driving car. Transport to and from a person's door can also be in a ride share solution with neighbours. More people share self-driving cars and the conversion of car parks, including multi-story ones, into space for buildings for other purposes or green spaces has started.

In rural areas there is co-transporting of goods and people in self-driving and electrified vehicles. Convenient transport solutions and improved internet infrastructure (digitalisation) means it is not always necessary to travel to work at a physical location. This has made it possible for more people to remain living in the countryside instead of moving to growing cities.

The public transport authorities were among the first in the public sector to implement function procurement for mobility, instead of purchasing physical vehicles. Many companies have replaced company cars with mobility as a benefit. Other companies are offering their employees the option to work from home or at work hubs close to their homes on certain days, instead of travelling to a central office. The “mobility” function is purchased as needed. There is also the possibility of paying for an individual vehicle which is at a person's disposal if they live in a more secluded area. It can be rented out through sharing services to people living nearby when not in use. They prefer to have control over their own vehicle because the vehicle is also an important part of the power grid and stores energy, which is part of the business model and also a revenue stream.

Shared space frees up resources in the real estate sector

An important area of focus in the construction and real estate sector at the beginning of the 2020s was reducing climate impact and resource usage in combination with a significant demand for sharing functions. This contribut-

ed to a fast transition of space utilisation in the real estate sector (homes are not included in this analysis). Ten years later fewer facilities are being built. The industry assumes that space and functions will be shared by multiple tenants and used more efficiently 24 hours a day. This transition is identified as one of the factors that resulted in the resource effectiveness goals for sustainability development in the built environment being reached by 2030.

More people ventured into sharing solutions when the rules relating to legal matters and taxes (e.g. VAT), leases and insurance policies became clearer. More flexible zoning plans facilitated sharing between enterprises/organisations and industries, and increased the mix of functions in buildings, neighbourhoods and districts. One positive consequence is more vibrant urban environments. Adjusted VAT rules and incentives have simplified sharing between different types of operations/organisations such as non-profits, public sector actors and businesses. Credit institutions that improve risk management in large projects have enabled large enterprises/organisations to make the transition more quickly. Fifteen or so large municipalities, as well as a few medium and small ones, offered open digital infrastructure early on. This promoted scalability and replicability, which made it easier for sharing services to grow.

The fact that the cost of premises in relation to their capacity utilisation increased due to things like flexible work and fewer physical shops also accelerated the transition. More and more voices are saying the same thing: "We already have all the space we need; it just needs to be shared more efficiently". Essentially all enterprises/organisations have now taken stock of their space needs and existing space. This has had an impact on multiple actors. Businesses in numerous industries have reduced the amount of space they use and the market for shared space is flourishing.

In connection with the growth of the shared space market, more indicators were changed and new ones applied. Energy use is linked to, for example, the number of users during the day and night and not just the space. Values such as health, wellbeing, participation, creativity and innovative capacity, security, culture and vibrant environments are now incorporated into sustainability assessments and other calculations.

Control mechanisms have been overhauled in the construction and real estate industries. The need for adapted and flexible facilities is greater than the need to build new ones. This in turn has resulted in a significant reduction in resource use and an overall reduction in environmental impact. Reuse of construction materials and interiors has accelerated and now constitutes more than 50 percent of the materials used in remodelling. More efficient use of space at different times of the day, week and year has also resulted in a levelling out of peaks and valleys in flows of energy, water, waste and traffic.

Criteria included in mobility plans have further contributed to the development of sharing to reduce transportation. Coordinated plans for facilities and mobility have improved the quality of sustainability programmes.

The significant transitions that accelerated in 2025 created multiple new services and business models and drove urban development. Societal gains were much greater than estimates in 2020. Well-composed cooperation hubs are in high demand. They help to significantly increase security, activity, participation and inspiration. Looking back, factors relating to health and wellbeing appear to have been of significance for the transition to a more resource-effective society.

Platforms have reduced the volume of lost food dramatically

For more than a decade Sweden has gone through changes that have made us leaders in building a resource-effective, profitable and more sustainable food supply chain. One crucial step was taken through the creation of entirely new information and cooperation structures. At the beginning of the 2020s a large number of food companies and authorities and a team of academics decided to create a platform to measure and reduce the amount of food lost and wasted based on voluntary agreements. Within a few years this initiative had a number of positive outcomes. More and more companies started to measure total lost food and waste in the food supply chain, which resulted in a focus on reducing and avoiding loss of food. A combina-

tion of existing technology and new partnerships also made it possible for companies to identify in which processes lost food and waste was occurring. And to which application areas or waste management methods, so called “destinations”, the lost and wasted food was being sent.

Increasingly detailed information on the material flows quickly led to new types of partnerships, technology development and innovation. This in turn created opportunities to optimise the use of resources moving throughout the value chain. New partnerships emerged between different parts of the food supply chain and the volume of food that left the chain to be used for other things was dramatically reduced. There were, however, also new partnerships between companies in entirely different industries, such as the agricultural sector and the textile industry, and the slaughtering industry and biorefineries.

Growing knowledge about where in the value chain unutilised resources could be commercialised sparked interest in the financial sector in investing in new technology and innovation. Within the space of a few years, several hundred start-ups saw the light of day and started to grow. A few years later, large co-financing initiatives in innovation and technology development led to new industrial collaboration and manufacturing processes. Several revolutionary ideas were turned into practical applications. Residual products from the food supply chain are an important part of the circular bioeconomy – and on a large scale.

The thorough mapping of material flows in the food supply system had another positive effect. Increased access to statistics that show lost and wasted food flows make it possible to define and take action to reduce or avoid it. This is helping to further increase resource effectiveness in the food supply chain and the rest of society.

After just over a decade of targeted initiatives, Sweden is established as one of the countries in the world that is leading the way to reach the 12.3 target in Agenda 2030 on halving food loss and food waste, as well as several other SDGs. Effects from the resource-effective food supply chain are benefiting the country in increased productivity and resilience, a stronger Sweden brand and increased opportunities for business exports.

Subscription and second hand – profitable clothing business

In 2030 all fabrics in clothes are significantly more sustainable from an environmental and climate perspective, and adapted to their use. A whole palette of fibre solutions that are easy to recycle and environmentally sound have replaced conventional cotton and virgin polyester. The industry is mainly using recycled materials for both synthetic and natural fibres, as well as regenerated fibres derived from waste from other industries. There are garments manufactured from polymer fibres produced from monomers formed from bacteria from a carbon conversion process. Production, which in 2020 was in general the largest environmental villain in the life cycle of clothes, is today more resource-effective and green, and therefore also more profitable. Modern dyeing technology and digital printing have reduced water consumption. All energy comes from renewable energy sources.

An important contributing factor to the improvement is changed business models: today clothes are offered as a function instead of being sold. The focus is no longer on manufacturing and selling, but on offering a function that provides significant customer satisfaction over time. Clothes are also easy to mend and improve, and easy to recycle in the end.

Clothes are displayed and tried on in digital environments supplemented by retail networks that add value for the customers. There are plenty of business models, solutions and offerings. Companies that manufacture new garments offer both fast and slow solutions. There are brands that sell patterns so that customers can produce their own garments at the brand’s various centres (formerly shops), via local collective hubs, or themselves if they have a 3D printer at home. Other companies offer their customers the option to design their own garments by choosing fabrics, colours and measurements. Garments are only produced on demand. These solutions have enabled the industry to move away from over-production, over-stocked warehouses, campaigns and discount-driven sales.

In the 2020s large quantities of clothes were “stored” in our homes without being used. They became unfashionable,

the fibres deteriorated and they were easily torn. This was also true for shoes, where the plastic and leather became dry and cracked. This insight resulted in clothes being used more efficiently and having a longer active life through new business models and solutions that provide a better customer experience.

Second hand, pre-owned or vintage is a very profitable business model and accounts for one third of all sales. Clothing rental and subscription services have grown significantly and are now a natural way for people to access fashion.¹⁸ These services account for at least one third of all off-the-peg sales. The industry has understood that this is the future and the Government has reduced VAT on both services and function sales. There is an advanced ecosystem of business models and companies around second hand and subscriptions – everything from laundering and mending centres to local remake hubs where garments are mended, altered and even redesigned. These services already existed well before the 2020s, for example for work clothes, but have now been adapted for broad groups of users.

When customers purchase clothes they make conscious choices. All garments have information on how they were produced and which substances were used in the process, where and by whom they were produced and their environmental and climate footprint. Thanks to platforms for traceability and efficient tagging solutions, information on the garment is stored, for example on a chip, which can be read by other customers, employees and recyclers etc. Consumers wash their clothes less frequently. Instead they air them out with new water- and detergent-free cycles in washing machines. They also use environmentally sound detergents to remove stains or odours. Water is no longer always used in laundering clothes; carbon dioxide is often used instead. Problems relating to laundering using water have largely dis-

appeared. Companies have service offerings for everything from buying back clothes and reselling them to subscription services and renting. They increase their sales without producing more, and have broken traditional norms where sales and production volumes go hand in hand.

Essentially all garments enter a return flow once they are worn out, going either to recycling or composting. Sorting is efficient since all garments are traceable and contain relevant information. Recycled materials are in demand and the market price has gone up. It is possible to make a business out of collecting, sorting and recycling. Virgin fibres are more expensive so the demand for recycled fibres is high. Since clothes are designed for recycling, essentially all textiles are made into new materials again. All recycling of mixed materials is done through chemical separation processes. Much of the sorting and recycling takes place in Sweden, but a portion is sent to other parts of the world.

Fluctuating prices and a plastics strategy gave birth to a recycling market

With increased knowledge on how plastics reduce climate impact and save resources, policy-makers shifted their focus. They produced a national plastics strategy for how Sweden could lead the transition to a circular and resource-effective plastics economy. One of the most important political decisions was to stop extracting energy from recyclable materials and instead invest to advance industrial processes for chemical recycling of plastics. As a result, the materials in plastics can now be recycled, including the plastics in complex products or that are broken down.

18 The active life of garments is extended through intensified use – if each garment is used twice as much, its footprint is almost halved. The reduction is mainly due to the fact that fewer new garments need to be produced. Extending the active life of a garment through changed user behaviour has therefore been an important step towards more sustainable clothing consumption. Mistra Future Fashion Environmental assessment of Swedish clothing consumption: Six garments – sustainable futures, Sandin et al. 2019.

Meanwhile the private sector has invested substantially in packaging collection and a plastics programme (Plastklivet) has led to a dramatic increase in mechanical recycling of plastic packaging. Sweden has become a forerunner – both in terms of designing for recycling and using recycled plastics. A contributing driver was differentiation of packaging fees to promote recyclable plastic packaging and increase the amount of recycled plastic content.

Back in 2010 the resource markets started to experience higher and more fluctuating prices. This created incentives to reduce exposure to this type of market risk. Access to resources – both virgin and recycled – is largely a geopolitical power factor. Altogether this gradually resulted in the need for commercial, political and social action.

A Swedish plastics strategy developed based on the EU's plastics agenda is in place and has been used for a number of years. The Swedish strategy that defines targets and control mechanisms for reuse and recycling is promoting resource-effective and circular business models. One of the most important measures was that the political framework was changed and clearly promoted recycled raw materials over virgin ones. Chemical recycling in the EU has become an important complement to mechanical recycling for plastic products that are more difficult to recycle. The amount of plastics going to landfill is minimal. The continuing burden on and degrading of the global ecosystem has resulted in a price being assigned to ecosystem resources and ecosystem services. One overall effect is that advanced recycled plastics markets exist and there is a dramatic increase in collection and recycling capacity. Sweden has done its part towards reaching the target in the EU's plastics strategy of increasing the Union's recycling capacity fourfold. The result is that recycled plastics have an obvious and growing role in the market.

Standards for recycled plastics were developed and made it easier for actors to choose recycled plastics when developing and designing products. These standards also promote confidence among suppliers and customers – they can now make choices that appeal to their environmental ambitions. The ability to make more resource-effective choices is also based on a system of certification for recycled plastics in products. This was important from both a political perspective and for credibility in the private sector.

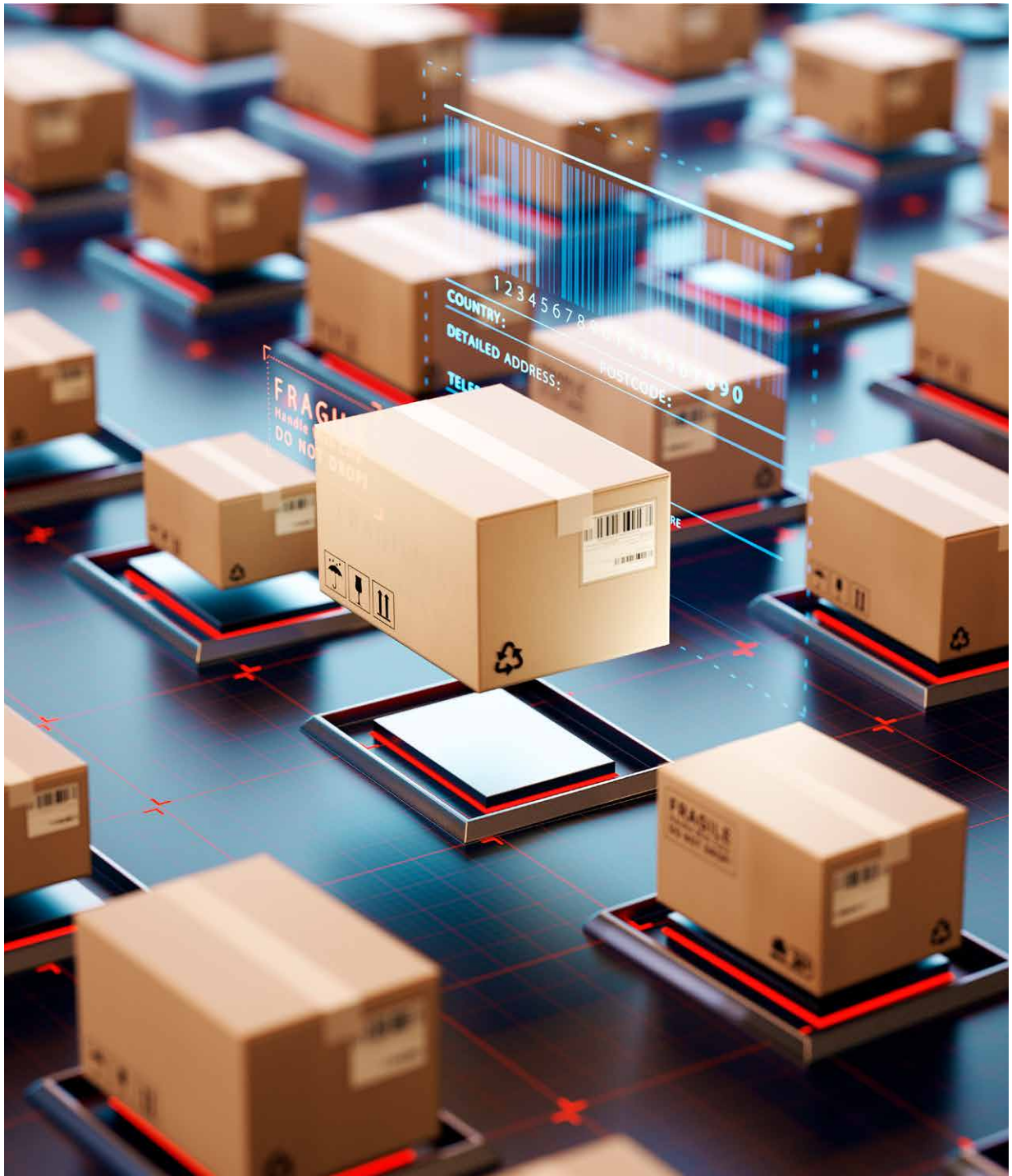
Cooperation for developing and designing for resource effectiveness over the past 10 years has been a high priority. When producing strategies to address policy and market development, the private sector agreed that no individual party could solve it alone, but that cooperation is necessary. Different platforms were gradually created and there is now a Nordic plastics centre that coordinates private sector considerations in the Swedish and European plastics strategy. The term “value chains” is no longer used but has been replaced by “value networks”, where resources and materials jump between value chains and are used where they can be used most effectively. This is taking place both bilaterally and within the Nordic system for resource effectiveness, developed from the Finnish initiative Finnish Industrial Symbiosis System, where actors in the plastics value network can find each other.

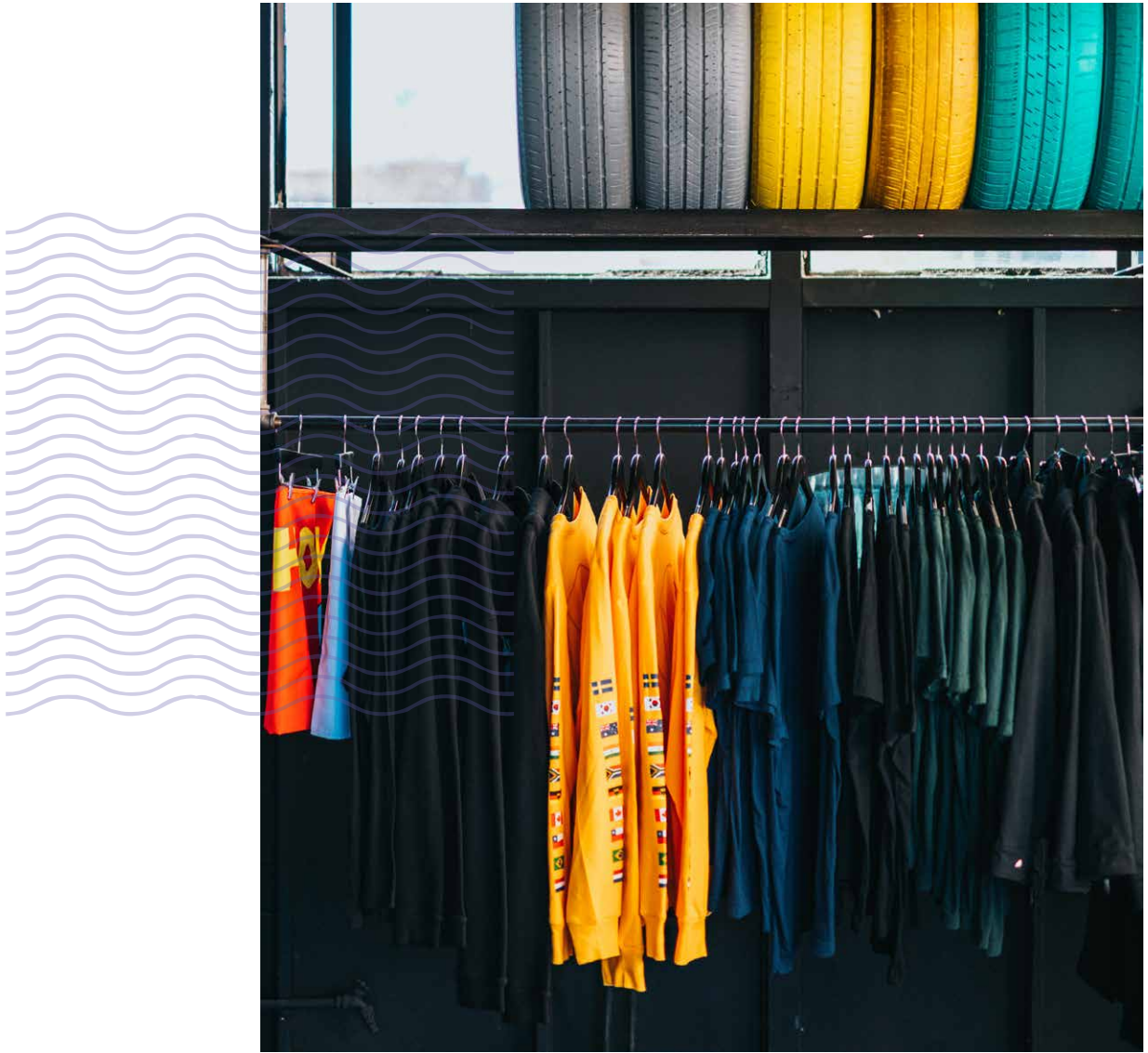
General requirements

In order for these scenarios to become reality, a long list of measures need to be implemented, such as:

- Creation of profitable business models.
- Regulatory changes at both the national and EU level.
- Ensure that customers are on board with acting and purchasing in a circular way.
- Essential international cooperation is in place, etc.

The financial sector and customers have an increasingly important and influential role to play – not least since resource-smart and sustainable solutions have been proven to be more profitable, especially over time. Brands are being judged to a greater extent on their resource effectiveness. Access to green capital has increased and is enabling large-scale investments to be made in increased resource effectiveness. Sweden and Swedish industries that took part – and in some areas were drivers – in the global development are now benefitting from this situation. Sweden attracts students, researchers, innovators and investors in resource effectiveness and circularity, and as a result it looks like we will retain our leading position.





Appendix

Project participants
Bibliography

Project participants

Mobility subproject

Chair: **Jan-Eric Sundgren**, Association of Swedish Engineering Industries

Vice Chair: **Elinor Kruse**, Association of Swedish Engineering Industries, Head of Environment

Project Manager: **Jacqueline Oker-Blom**, AboutFuture

Kristian Bjursell, Handelsbanken

Ulrika Bokeberg, Västra Götalandsregionen

Henrik Gustafsson, Scania

Tord Hermansson, Lindholmen Science Park

Pär Hermerén, Association of Swedish Engineering Industries

Olle Isaksson, Ericsson

Anna Kramers, KTH, MISTRA SAMS (Sustainable Accessibility and Mobility Services)

Helena Leufstadius, Swedish Public Transport Association

Lina Moritz, CLOSER

Annelie Nylander, Swedish Transport Administration

Harry Robertsson, Stena Line

Helena Wiberg, Landvetter Airport

Lars Zetterberg, IVL Swedish Environmental Research Institute

Shared space subproject

Chair: **Anna Denell**, Vasakronan

Vice Chair: **Mattias Höjer**, KTH, Centre for the Future of Places

Project Manager: **Liv Fjellander**, IVL Swedish Environmental Research Institute

Ylva Frithiofson, Ramboll

Charlie Gullström, RISE/Viable cities

Ivana Kildsgaard, Tengbom

Mats Olausson, SEB

Ulf Ranhagen, Sweco/Chalmers University of Technology/Dalarna University/Smart Cities

Robin Al-Salehi, IHUS

Monica von Schmalensee, White and National Council for Sustainable Cities

Björn Sigurdson, Uppsala Municipality

Camilla Wieslander, Skanska Öresund

Food subproject

Chair: **Anna-Karin Modin Edman**, Arla Foods

Project Manager: **Kristoffer Gunnartz**, Addverbal

Katarina Rosenqvist, Swedish Food Retailers Federation

Per Liljedahl/Anna Burholm, Sodexo

Sara Sundquist, Swedish Food Federation

Karin Bildsten, Axfood

Carolina Sachs

Louise Ungerth

Åsa Stenmarck, IVL Swedish

Environmental Research Institute

Karin Östergren, RISE

Textiles subproject

Chair: **Cecilia Tall**, TEKO

Project Manager: **Elin Larsson**, Elco (Caroline Hofvenstam, About Future)

Maria Sandow, Swedish Trade Federation

Yvonne Augustsson, Swedish Environmental Protection Agency

Gunnela Hahn, Church of Sweden

Maria Ström, Wargön Innovation

Åsa Östlund, RISE
Jonas Aspling, RISE
Lisa Schwartz Bour, RISE
Susanne Nejderås, Smart Textiles,
Swedish School of Textiles
Lena-Marie Jensen, Smart Textiles,
Swedish School of Textiles
Anett Aldman, Smart Textiles, Swedish School of Textiles
Adrian Zethraeus, Smart Textiles,
Swedish School of Textiles
Jonas Larsson, Swedish School of Textiles,
University of Borås
Felicia Reuterswaerd, H&M
Harald Cavalli-Björkman, Re:Newcell
Gustav Hedström, Houdini
Rickard Lindqvist, Atacac
Eva Karlsson, Houdini
Eliina Brinkberg, Nudie Jeans
Sigrid Barnekow, TreeToTextile
(formerly at Mistra Future Fashion)
Annica Karlsson, IKEA

Plastics subproject

Chair: **Magnus Huss**, Innovation
and Chemical Industries in Sweden (IKEM)
Project Manager: **Peter Stigson**, PE Teknik & Arkitektur
Anette Löhn, Förpacknings- och
tidningsinsamlingen (FTI)
Birgitta Resvik, Fortum
Christer Forsgren, Stena Metall
Dag Duberg, Tarkett
Emma Strömberg, KTH
Hanna Skoog, Axfoundation
Henrik Sundström, Electrolux
Jenny Svärd, Confederation of Swedish Enterprise
Johan Dahlgren, Swedish Standards Institute (SIS)
Johan Henningsson, Svensk Exportkredit (SEK)
Kristin Geidenmark Olofsson, Trioplast
Lena Lundberg, Innovation and
Chemical Industries in Sweden (IKEM)
Lina Bergström, Swedish Recycling
Industries' Association
Linda Zellner, Perstorp

Marie-Louise Johansson, Borealis
Nils Hannerz, Innovation and
Chemical Industries in Sweden (IKEM)
Pernilla Löfås, NCC
Rajni Hatti-Kaul, Lund University and Mistra STEPS
Åsa Stenmarck, IVL Swedish
Environmental Research Institute

Political reference group

Magnus Ek (C)
Janine Alm Ericson (MP)
Joar Forssell (L)
Hampus Hagman (KD)
Martin Kinnunen (SD)
Birger Lahti (V)
Ingemar Nilsson (S)
Cecilie Tenfjord-Toftby (M)

Financial reference group

Kristian Bjursell, Handelsbanken
Emir Borovac, Cliens Kapitalförvaltning
Magnus Emfel, WWF International
Gunnela Hahn, Svenska kyrkans kapitalförvaltning
Johan Henningsson, Svensk Exportkredit (SEK)
Åsa Knudsen Sterte, Ministry of Finance
Bo Källstrand, IVA's Division II Electrical Engineering
Therése Lennehag, EQT AB
Christer Olander, SEB Large Corp
& Financial Institutions
Mats Olausson, SEB
Michael Schragger, The Sustainable
Fashion Academy
Hanna Setterberg, Misum, Stockholm
School of Economics

Bibliography

A resource-efficient Europe – Flagship initiative under the Europe 2020 Strategy COM(2011).

Europa 2020 – A strategy for smart, sustainable and inclusive growth COM(2010).

Fehrenbacher, D.D., Design of Incentive Systems. Experimental Approach to Incentive and Sorting Effects (Contributions to Management Science), Physica-Verlag, 2013.

Geissdoerfer, M., P., Savaget, N., Bocken, N. och Hultink, E., 2017, "The circular economy – A new sustainability paradigm?" i Journal of Cleaner Production 143 (1), s. 759.

Europeiska kommissionen. "En europeisk grön giv – Sträva efter att bli världens första klimatneutrala kontinent" (https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_sv; hämtad 2020-03-02)

Kirchherr, J., Reike, D., Hekkert, M., 2017, "Conceptualizing the circular economy: An analysis of 114 definitions", i Resources, Conservation and Recycling 127, ss. 221–232.

Kungl. Ingenjörsvetenskapsakademien. 2020. Resurs-effektiv transport och mobilitet i Sverige – Vad behövs? (IVA-M 509).

Kungl. Ingenjörsvetenskapsakademien. 2020. Resurseffektiva lokaler i Sverige – Lokaldelning som norm (IVA-M 512).

Kungl. Ingenjörsvetenskapsakademien. 2020. Resurs-effektiv livsmedelssektor i Sverige – Mätning av matsvinn och övrigt matavfall (IVA-M 513).

Kungl. Ingenjörsvetenskapsakademien. 2020. Resurseffektiv textil i Sverige – Textil från avfall till resurs (IVA-M 511).

Kungl. Ingenjörsvetenskapsakademien. 2020. Resurseffektiva plastflöden i Sverige – Plastens roll i ett cirkulärt samhälle (IVA-M 510).

Lüdeke Freund, F., Gold, S. och Bocken, N., 2018, "A Review and Typology of Circular Economy Business Model Patterns", i Journal of Industrial Ecology, Volume 23, Issue 1, februari 2019, ss. 36–61.

Naturvårdsverket. 2015. Hållbara konsumtionsmönster – analyser av maten, flyget och den totala konsumtionens klimatpåverkan idag och 2050, Rapport 6653.

Sandin et al. 2019. Mistra Future Fashion Environmental assessment of Swedish clothing consumption: Six garments – sustainable futures.

Sveriges Kommuner och Regioner. "Klimatsmart upphandling", 28 februari 2020 (<https://skl.se/samhallsplaneringinfrastruktur/miljohalsa/klimatsmartupphandling.25163.html>; hämtad 2020-03-02).

Stahel, W., "The circular economy", 23 mars 2016, i Nature 531, ss. 435–438 (<https://www.nature.com/news/the-circular-economy-1.19594>; hämtad 2019-12-10).

Swedish Life Cycle Center. "Modeling of Recycling" (<https://www.lifecyclecenter.se/projects/modeling-of-recycling/>; hämtad 2020-03-02)

Upphandlingsutredningen. 2010. "Goda affärer – en strategi för hållbar offentlig upphandling". SOU 2013:12.

Utredningen cirkulär ekonomi. 2017. "Från värdekedja till värdecykel - så får Sverige en mer cirkulär ekonomi". SOU 2017:22.

Upphandlingsmyndigheten. "Vad är externa effekter?", 12 januari 2017 (<https://www.upphandlingsmyndigheten.se/omraden/lcc/lcc-och-externa-miljoeffekter/vad-ar-externa-effekter/>; hämtad 2020-03-02)

The Royal Swedish Academy of Engineering Sciences (IVA) is an independent academy whose mission is to promote the engineering and economic sciences and the advancement of business and industry. In cooperation with the business community and academia, IVA initiates and proposes measures to improve Sweden's industrial expertise and competitiveness. For more information about IVA and the Academy's projects, see the website www.iva.se.

Published by: The Royal Swedish Academy
of Engineering Sciences (IVA), 2020
Box 5073, SE-102 42 Stockholm, Sweden
Tel. +46 (0)8 791 29 00

IVA publishes various types of reports within the framework of its activities. All reports are fact-checked by experts and then approved for publication by IVA's President.

IVA-M 521
ISSN: 1100-5645
ISBN: 978-91-89181-05-2

Project Managers: Caroline Ankarcrona & Jan Nordling, IVA
Editor: Lars Nilsson, IVA
Communications Manager: Joakim Rådström
Co-ordinator: Gustaf Wahlström, IVA
Illustrations: Moa Sundkvist & Jennifer Bergkvist
Photos: Shutterstock.com & Unsplash.com
Layout: Pelle Isaksson, IVA

This report is available to download as a pdf file at www.iva.se



Royal Swedish Academy of
Engineering Sciences

in cooperation with



VASAKRONAN

