And yet it circulates

Five outlooks on building a circular European economy

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edited by Samuel Tammekann and Antti Vesala

AND YET IT CIRCULATES:

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PROLOGUE

A change for cleaner and smarter is a change for better

Antti Vesala

M.A. / econ.hist, acting general manager of the Toivo Think Tank

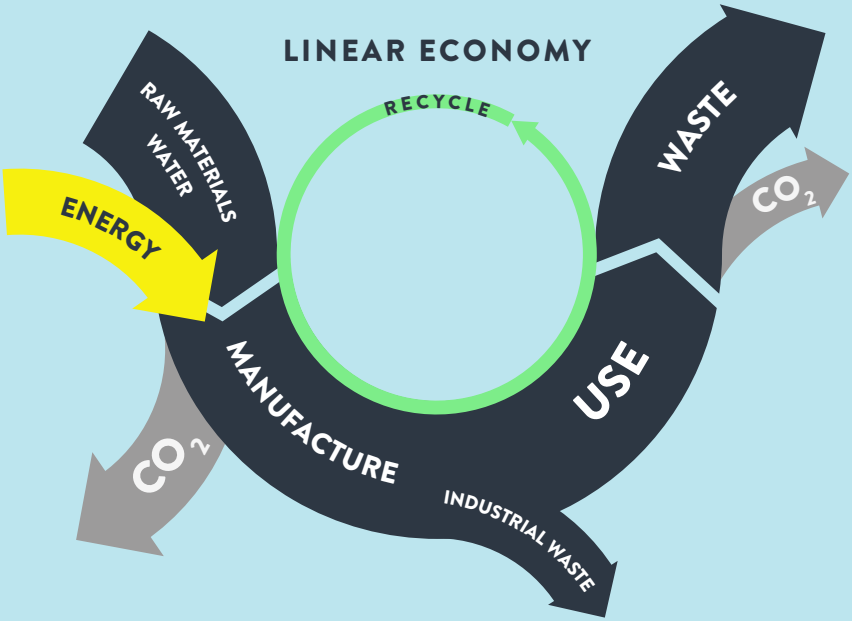
The humankind is in ongoing search for a better balance between improving standards of living and reducing environmental burden. Tackling today's massive challenges such as climate change, pollution or biodiversity loss can sometimes be seen as being on a collision course with other major attempts such as creating jobs for the unemployed and guaranteeing food security. This, at least partially, seems to be a question of perspective. But it still is a gap that needs to be closed.

Public and political awareness of these mega-issues has risen, and climate-action, for example, has become an important part of mainstream politics. This has caused some political counter-reactions, which appear particularly strongly in areas that are more dependent than others on for example the use of fossil fuels or other natural resources. There's a wide scientific consensus supporting actions and solutions that reduce carbon emissions, intensify efficiency in material and energy use and shifts the focus of economic growth to services and the production of immaterial goods.

The need of major pro-environment solutions is acute. But on the other hand, big changes can seem frightening. So, if we want to achieve sustainability, it should be done in a way that can be accepted as widely as possible. In a democratic society, people should be able to feel that changes are mostly for the better. One condition for public acceptance is that the decisions should treat different people as fairly as possible.

This is of course a matter of content but also of presentation. It's vital to make it possible for people to see that doing things in cleaner and more efficient way means change for better, not worse. A smarter life will be based on smarter ways, not wasting energy and valuable materials. A cleaner planet and a recovering environment are something that follows. And new ways also bring along new jobs.

This publication presents five different points of view to what a circular economy is about. It covers decision-making on many levels; the role of cities in promoting circularity is also viewed, along with examples about industry, raw materials and logistics. The writers represent many backgrounds. Mrs. Sirpa Pietikäinen is currently a member of the European Parliament. She was the minister of environment of Finland in 1991-1995. Mrs. Saara-Sofia Sirén is a member of Finnish Parliament and also a member of the city council of the city of Turku. Mr. Samuli Patala is an assistant professor in the Department of Management Studies of Aalto-University. Ms. Laura Eiro is a lawyer who currently works as a program director in a Finnish network of smart and clean mobility. Mr. Jonne Hirvonen is a research scientist in the VTT Technical Research Centre of Finland. The conclusion and the summary in Finnish were written by Mr. Samuel Tammekann, who also acted as the editor for this book.


LINEAR ECONOMY
RECYCLE
RAW MATERIALS
WATER
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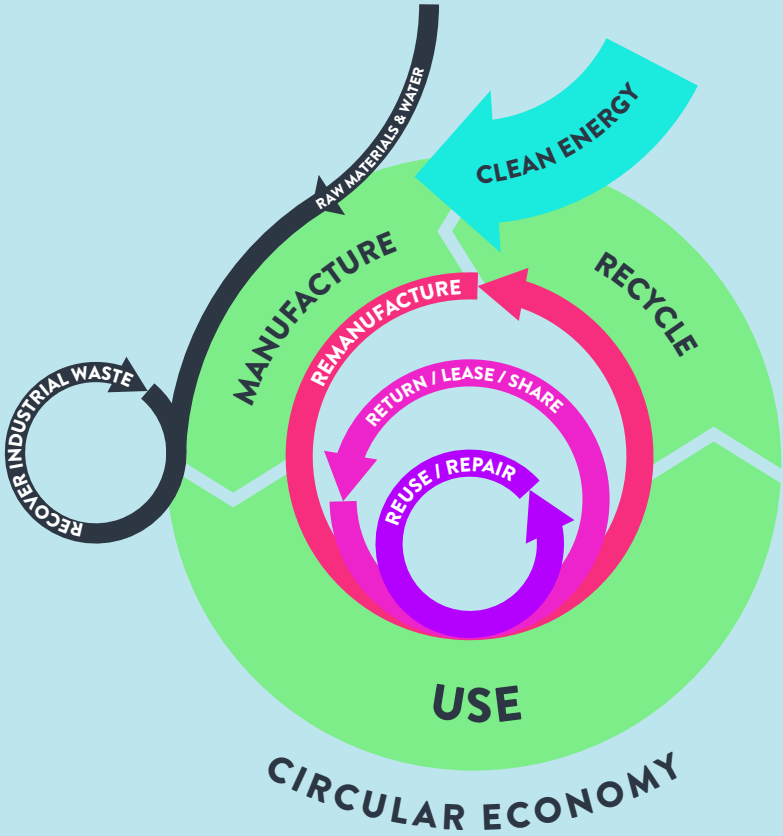
RAW MATERIALS & WATER
CLEAN ENERGY
MANUFACTURE
RECYCLE
REMANUFACTURE
RETURN / LEASE / SHARE
REUSE / REPAIR
RECOVER INDUSTRIAL WASTE
USE
CIRCULAR ECONOMY

INTRODUCTION

From linearity to circularity: European way and solutions

Sirpa Pietikäinen

MBA, Member of the European Parliament for Finland (epp.), Finnish Minister for the Environment (1991–1995)

Economic incentives and political decision-making are not created in a vacuum. They are affected by our perception of reality, which also has an impact on the political tools chosen. It is hard to innovate how to sail around the world if you believe Earth is flat.

The image of limitless Earth is false. In reality, Earth is very limited and small, with scarce resources. In our economy, all environmental impacts, adverse environmental effects, and resource scarcity are often externalized. Extracting natural resources do not cost their true scarcity or value. The extraction cost is formed only by the capital and labour costs related to it.

The same applies to emissions. Polluting environment does not create an economic cost, even though the natural capital costs and the costs to the society it causes can be greater than the benefit added to the economy. We do not give monetary value to the numerous services the nature provides us for free, like pollination and clean air or water. This structure, with environmental externalities, at the base of national and global economies, has created us a global problem.

Our current economic model and legislation are based on linear take-make-dispose culture. With exponential challenges like climate change, resource overconsumption and biodiversity loss underway, we need to achieve a paradigm change, as well as a change in our legislation. We need to bend our linear economy to a closed loop—a circular economy. Unlike a take-make-dispose economy, a circular economy is based on principles of designing out waste and pollution, keeping products and materials in use by reusing, repairing and recycling, not degrading the value and quality of the materials, and finally, regenerating deteriorating natural systems.

The challenges approaching us are immense, and we have yet to find the right track. Let us take an example, textiles. The consumption is growing and the number of times we use one piece of clothing is decreasing still. Between 2000 and 2015, sales have doubled. Ellen MacArthur foundation estimates that by 2050 the textile industry will need three times more oil than in 2015. In 2050, the textile industry will be responsible for over 25% of the carbon budget. Besides, the microfibers in our oceans will increase by 22 million tonnes.[1] In Finland only, we create 71 million kilos of textile waste every year.[2]

Over half of the world's tropical forests have been destroyed since the 1960s according to IUCN,[3] the International Union for Conservation of Nature. Already in 1992, when I was negotiating in Rio at the United Nations Conference on Environment and Development, the world's forests were in an alarming state, and since then deforestation has only increased.

Similarly, worldwide species extinction is still accelerating. According to a recent report published by the Intergovernmental

1 Ellen MacArthur Foundation (2017). A new textiles economy: Redesigning fashion's future. http://www.ellenmacarthurfoundation.org/publications **2** Dahlbo et al. (2015). Tekstiilien uudelleenkäytön ja tekstiilijätteen kierrätyksen tehostaminen Suomessa. https://helda.helsinki.fi/handle/10138/155612 **3** IUCN (2017). Issues Brief: Deforestation and forest degradation. https://www.iucn.org/sites/dev/files/deforestation-forest_degradation_issues_brief_final.pdf

Science-Policy Platform on Biodiversity and Ecosystem Services, IPBES, up to a million species—there are an estimated 8 million species in the world—are threatened with extinction.[4] For example, Finland has not succeeded in achieving the international goal of stopping biodiversity loss. Of Finland's up to 48,000 species, as many as one in nine is endangered.[5]

And finally, according to the World Meteorological Organisations Statement on the State of the Global Climate, in 2019 the global temperature had already risen 1.1 °C above the pre-industrial levels.[6] The UN Environment Emissions Gap Report from 2019 showed that the cuts in global emissions required for the next 10 years should be more than 7% every year on average to keep the global warming below the line of 1.5 °C.[7]

We do not have time to waste. The later we act, the more radical and expensive the actions needed will be.

Game theories can provide useful insight into why seemingly rational people make seemingly irrational choices. The theories seek to explain how rules of action affect people's decisions. Sensible and well-meaning people make choices that affect them and their surroundings negatively if the incentives and the rules are set to support such behaviour. If greediness and short-sighted action are rewarded by the system, while simultaneously long-term stability and altruism are repelled, the results will not favour long-term solutions benefiting us all. This is exactly how our economies work globally at the moment. Therefore, we need a paradigm and regulatory change to disincentive short-termism and linearity and incentivise circular economy.

4 IPBES (2019). Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. E. S. Brondizio, J. Settele, S. Díaz, and H. T. Ngo (editors). IPBES secretariat, Bonn, Germany. **5** Suomen lajien uhanalaisuus – Punainen kirja 2019. https://punainenkirja.laji.fi/ **6** World Meteorological Organization (2020). WMO Statement on the State of the Global Climate in 2019. WMO-No. 1248. https://library.wmo.int/doc_num.php?explnum_id=10211. **7** United Nations Environment Programme (2019). Emissions Gap Report 2019. UNEP, Nairobi.

The global environmental and resource crisis highlights serious flaws in our current ways of thinking and acting. Lack of global rules and regulations means that the real costs of human action—the costs accrued as a result of the way we produce and consume, live, move, eat—are not included in the prices we pay. The profits are enjoyed by a few, while the costs and risks are borne collectively by all of us. As Nicholas Stern proved in his trail-blazing study,[8] the market has failed to incorporate the huge cost of climate change—and increasingly, resource overconsumption—created by our current way of life.

If the problem is the perversity of incentives created by current rules, then presumably the easiest and most obvious solution is to change the rules of the game.

8 N. Stern (2006). The Economics of Climate Change: The Stern Review.

The level of ambition must be right

We already consume some 1.6 planets' worth of resources every single year,[9] and following the available estimates, we would need more than two planets full of resources to satisfy our demand by 2050 if we continue with business as usual. There are, however, limits to growth as we only have access to this one planet. We are in 'overshoot mode' and must switch to a more sustainable way of living.

It is difficult to understand the exponential nature of the growth. The phenomenon is accelerating, and it is having a systems-level effect. These phenomena, like climate change and biodiversity loss, are not separate; they have an impact on each other creating a snowball effect. When setting the targets for the future, we need to anticipate this exponential and interdependent change and set our targets accordingly to halt and reverse it.

By 2050, we need to increase our resource efficiency by "factor-10": learn to create the same well-being with a tenth of the resources we use now. The cost of transition risks and sunk investments will only grow from today. [10]

The target needs to be a sustainable economy and society by 2050, which means fully implementing a cascading use of resources, sustainable sourcing, sustainable land use and compensating the land use, a waste hierarchy, creating a closed loop on non-renewable resources, using no emission renewables within the limits of their renewability, phasing out and preventing the accumulation of toxic and harmful substances and doing no harm on the biodiversity. If we do not manage to do this, and choose the wrong track, we will not be able to achieve the goal.

9 Global Footprint National Footprint and Biocapacity Accounts, 2021 Edition. (2020). **10** Directorate-General for Environment. (2011). Charting a path towards resource efficiency. European Union. https://ec.europa.eu/environment/efe/news/charting-path-towards-resource-efficiency-2011-05-01_fi

How do we get there?

The goals and actions need to be based on science. We need to apply backcasting, to pick the right actions and mid-targets. We need to start from the science-based goal and start thinking about what actions and what kind of a path is needed to get there. We cannot call it recycling or circular if glass jars end up as landfill base.

The biggest change that needs to happen is between our ears. The pattern of thinking needs to change first for us to be able to set the right goals and to focus on the right issues.

Recycling should not be the end in itself. Before that, we need to prioritize designing the product durable, repairable and upgradable, reducing material use, reusing the product, repairing and refurbishing it, and only after this recycling it in a way that the material does not lose its value.

As we have for climate change, we need binding targets also for resource efficiency. We need to know where we should be. If we do not have harmonized methodology on life cycle analysis, the results of what industries give us as the environmental footprint of a car, mobile phone or a t-shirt are not comparable. We can all understand that if a product's life span is 10 times or 20 times longer, its environmental footprint is relatively smaller. If we have life cycle accounting from a door to door of an industrial facility, it gives a completely different result. For example, for food products, including the sourcing of the food, and including the effects of GMOs or deforestation can change the results completely.

We need binding resource efficiency targets for the member states and industries, and harmonized indicators based on full life cycle analysis from cradle to grave. This means we need to transform the linear take-make-dispose economy to a truly circular economy.

Designing out waste, harmful substances and pollution

There is no circularity without good design. And by its definition, in the circular economy there is no waste, the materials circulate. They are designed to be reused instead of ending in the waste stream.

All products and packaging placed on the EU market should be upgradable, reusable, repairable, modular, and finally recyclable at the highest level, in a way that the value of the material does not degrade.

Extending the current Ecodesign directive[11] could be a good tool to make sustainable products a norm, to deliver on circularity and to make sure that the products and packaging placed on the EU market are fully circular. The current directive covers only a list of energy-related products, but it could be horizontally extended to cover all products and packaging placed on the EU market. In the Circular Economy Action Plan,[12] the Commission has mentioned the extension of the directive.

Circular economy should be based on the objective to achieve non-toxic and non-harmful material cycles that should fulfil the principles of phasing out and preventing the accumulation of toxic and harmful substances and doing no harm to the biodiversity. The Commission presented in October 2020 Chemical strategy for Sustainability.[13] The European Parliament has underlined in its position[14] that the strategy should be based on robust and up-to-date scientific evidence and take into account the risk posed by endocrine disruptors, hazardous chemicals in imported products, and combination effects of different and very persistent chemicals.

11 Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products **12** COM/2020/98 final **13** COM/2020/667 final **14** European Parliament resolution of 10 July 2020 on the Chemicals Strategy for Sustainability (2020/2531(RSP)

In addition, we need to make an end to the planned obsolescence of products and extend the consumer guarantees. The products need to be built to last, to be repaired and their parts to be reused. To support the longevity and circularity of products we need extended producer liability and a shift towards *a lease economy.*

Lease economy

Extended producer liability and rights should be applied so that the producer is the owner of the product and materials for their entire lifetime, which means they have the liability to organise closed-loop circulation and design based on ecodesign principles, but as well they have the right to collection and compensation in case of damaged goods.

As products become more durable, the whole logic of earnings based on the buy-use-throw away -model has to be reconsidered. We will be moving towards a “lease society” where products are no longer owned but rather leased. Whereby the value created no longer depends on the more and more products sold but rather on the durability of products, and the whole set of services that goes into creating the experience of using a given product. This creates co-benefits for the seller and buyer.

As an example, when buying a mobile phone, I do not yearn the plastic, copper, gold, platinum, silver, ceramics or other raw materials that go into that phone; I buy the service the phone can provide me.

The old and famous thought from business school teachings is that consumers in the last end do not buy the product, but they buy the real or experienced benefit of the service of the good. This old truth is not reflected in our goods markets, because if we would truly focus on this, we would be selling the benefits and experiences the consumer is buying when purchasing these goods. This thinking would reverse our systems of purchasing goods to purchasing services. One of the examples of businesses that have put this on practice is Interface carpet company and its famous CEO Ray Anderson.

Enabling factors

Digitalisation and lease or service economy can serve as important enabling factors for circularity. A good example is mobility. It should be designed to work based on demand. When we know there is a big crowd going to an ice hockey game, it is best to use buses to transport them. But if only one or two persons are going from Helsinki to Lahti, a taxi would be more efficient. Public transport is good, but driving empty buses is very inefficient. Digitalisation can help with this.

Cities and municipalities can play an important role in creating more sustainable and circular cities by for example supporting sustainable mobility and through spending public money. This would mean green public procurement and other public spending, as well as the current recovery fund, which should follow the *do no significant harm* principle.[15]

Public procurement has a big potential to boost the circular economy as it accounts for about 20% of the GDP, so compulsory green public procurement procedures could have a significant impact. Reused, repaired, remanufactured, refurbished and other resource-efficient products and solutions should be the default choice in all public procurement, and if they are not chosen, the 'comply or explain' principle should apply, which means that when the circular solution is not chosen, the purchaser would have to clarify why it chose something else.

You get what you measure, which means we need good-quality and comparable data on circular economy. We need harmonised indicators as the foundation for the information. This information should be based on existing good practices, natural capital accounting and reporting frameworks and take into account the full life cycle, from cradle to grave.

15 see e.g. EU Technical Expert Group on Sustainable Finance (2020). Taxonomy: Final report of the Technical Expert Group on Sustainable Finance.

Sustainable finance

All this transformation needs money, both private and public investments in R&D for innovation and emerging technologies, and new business models. The next Sustainable Finance Strategy could be the answer. 260 billion euros are needed annually in the EU by the end of this decade to reach climate and energy targets.[16] A common misconception is that this will require drastic additional investments. On the contrary: tools, resources and money already exist. Total assets under management in Europe in 2019 were estimated at 23 trillion euros.[17] The global assets under management are around 90 trillion dollars.[18]

We do have the money and, if we can by transparency reporting and harmonized indicators and lifecycle analysis incentivise the private assets, like our pensions and investments, from the unsustainable investments to sustainable ones, this could be the biggest game-changer in the whole sustainability sector. According to the estimates, one-third of our investments are in sunk investments, like fossil fuels.

Economic benefits

Between 2012 and 2018, the number of jobs linked to the circular economy in the EU grew by 5% to reach around 4 million.[19] Applying circular economy principles across the EU economy has the potential to increase EU GDP by an additional 0.5% a year by 2030[20]

16 Communication "United in delivering the Energy Union and Climate Action - Setting the foundations for a successful clean energy transition" COM(2019) 285 **17** EFAMA (2019). Asset Management in Europe. An overview of the asset management industry. **18** Boston Consulting Group (2020). Global Asset Management 2020 Protect, Adapt, and Innovate. **19** EUROSTAT. https://ec.europa.eu/eurostat/tgm/refreshTableAction.do?tab=table&plugin=1&pcode=cei_cie010&language=en **20** McKinsey & Company. (2015). Growth within: A circular economy vision for a competitive Europe. https://www.mckinsey.com/business-functions/sustainability/our-insights/europes-circular-economy-opportunity

creating around 700 000 new jobs.[21] And the jobs created are better than the previous ones.

EU is very dependent on imported resources, like minerals and some metals needed, for example, for electronics and batteries.[22] By creating closed-loop systems, we can keep the materials in the products in the EU.

Coronavirus recovery measures in the EU and the Member States reached 3 trillion euros within just a few months, even before the planned Recovery Package and Commission's proposal for the Recovery Instrument, Next Generation EU. In this perspective, the annual 260 billion seems rather achievable. Moreover, the sustainable transition makes financial and economic sense. Overall, the Global Commission on the Economy and Climate has estimated that climate action in broad stands a chance to deliver over 26 trillion dollars in economic benefits and to generate more than 65 million new jobs by 2030. The return on investment in carbon neutral and circular technologies and infrastructure is estimated to be manifold, over 7 trillion dollars by 2030. [23] The transition to a low-carbon and circular growth model is, therefore, an economic opportunity. Investments in sustainable projects and activities make economic sense.

21 Cambridge Econometrics, Trinomics, and ICF (2018), Impacts of circular economy policies on the labour market. **22** see e.g. European Commission (2018). EIP on Raw Materials, Raw Materials Scoreboard 2018 **23** The Global Commission on the Economy and Climate (2018). Unlocking the inclusive growth story of the 21st century: Accelerating climate action in urgent times. http://newclimateeconomy.report//2018

WHAT THE EU IS DOING

A European Green Deal[24]

- New Circular Economy Action Plan
  - » Legislative proposal for a Sustainable Product Policy Initiative, including potential product passports and the extension of the Ecodesign directive
  - » Legislative and non-legislative measures establishing a new “right to repair”
  - » Mandatory Green Public Procurement (GPP) criteria and targets in sectoral legislation and phasing-in mandatory reporting on GPP
  - » Review of the rules on end-of-life vehicles
  - » EU Strategy for Textiles 2021
  - » Strategy for a Sustainable Built Environment
  - » Waste reduction targets for specific streams and other measures on waste prevention
  - » Updating the Circular Economy Monitoring Framework to reflect new policy priorities and develop further indicators on resource use, including consumption and material footprints
- Renovation Wave, to refurbish and improve building stock in the EU to help to pave the way for a decarbonised and clean energy system
- Chemicals Strategy, to reduce the risks associated with producing and using chemicals
- Strategy for Sustainable and Smart Mobility, to ensure that we have a clean, digital and modern a transport sector

24 https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en

Lessons from leading developers

Finland has the potential to be the leading developer of the circular economy in the EU and globally. Sitra—the Finnish Innovation Fund—is doing tremendous work in this field. We have founded the World Circular Economy Forum. Finland's strengths lie in the textile industry, with its wood-based fibres, modular wood construction and perhaps food.

In all of EU member states, in the EU and globally we have tremendous possibilities to use our recovery funds after the pandemic to transform our economies to be climate neutral and from linear to a circular one. It can be done. The following articles will take a closer look on how different sectors are doing it in Finland.

RAW MATERIALS AND ENERGY

Closing the material loop: achieving resource efficiency with circular methods

Jonne Hirvonen

M.Sc. (Tech.), Research Scientist, Solutions for Natural Resources and Environment, VTT

The circular economy is an excellent and ambitious approach to reach sustainability with economics kept in mind. However, transition from a resource-wasting linear economy to the circular economy demands changes in all levels of society to gain true economic benefits—or to function at all. What should be done right now to boost up circularity economic-wisely?

Economic growth has leaned on intensive resource use throughout the human history. Needless to say, the use of natural resources has brought us prosperity and raised many nations out of poverty. However, societies throughout the world are facing now the consequences of this rapid development in a form of overloaded landfills, micro-plastic pollution and eutrophication, for instance. Restoring of such global problems is possible but cost intensive. In addition, multiple resources such as phosphorus and noble metals are getting even harder to mine although new technologies allow us to

utilize low contents ores. We are facing an emerging issue of supply and demand and the aftermath shows a high price tag. How do we detach our economy from this course of action?

As the amount of waste must be kept minimal, it must be recycled. Ideally, this would happen already in earlier stages of the value chain well before waste has even been generated. This brings us to the concept of circular economy where resources are kept in cycles: repair, reuse, remanufacture and recycle. The value and quality of the recycled material or product can be further increased by upcycling. A good example can be found from the brewing industry where spent grain can be refined into biogas, animal fodder or even food for humans instead of being disposed. Consequently, upcycling creates profits for the production unit instead of disposal cost.

Putting circular economy into practise may feel trivial and only a technically oriented challenge. However, for instance recycling of plastics packaging demands a lot of transportation and remanufacturing of housing with used construction materials faces the issues of regulation feasibility. Similarly, the repair of relatively cheap electronics is unprofitable with market-based approach and reuse of clothes have challenges due to our consumer habits. In addition to the four cycles mentioned above, we need to reduce consumption and replace old-fashioned methods with circular-compatible ones. Consequently, the circular economy is not only about technical solutions, as it demands efforts from all levels of the society. Starting from regulations, ending to you and me.

Circular economy calls for sustainable raw materials

Ideally our economy would run on a cycled system alone. There are however at least two reasons why we should pay attention to in getting raw materials into our loops. Firstly, cycles have losses and materials lose their chemical and physical characteristics as a result of use and time. This loss must be constantly replaced—preferably with resources from sustainable feedstocks. It is noteworthy that sustainable raw materials include also non-renewables such as metals and minerals. Yet, only the amount necessary to maintain quality in the cycles.

Secondly, in order to reach full-scale circularity, we must have enough high-quality materials to run our system. Unfortunately, current products might not have what it takes to circulate them. They might differ too much from each other or contain additives or mixtures that are challenging to be recycled with economically feasible manner. In other words, our current products have not been designed to circulate. This applies to many products from car batteries to multilayer plastics as well as to construction materials and electronics protected with old-fashioned fire retardants. Consequently, we need significant amounts of recycling-compatible resources to fuel our future economic model.

For instance, the recent governmental target of increasing the number of electric cars and e-hybrid cars from 40.000 to 700.000[1] during the following ten years takes a lot of effort in terms of the circular economy. Eventually there might be thousands of tons

1 Finland needs 700,000 electric cars, higher prices on car emissions, says task force. (28.10.2020). https://www.helsinkitimes.fi/finland/finland-news/domestic/18238-finland-needs-700-000-electric-cars-higher-prices-on-car-emissions-says-task-force.html

of used batteries, which might have been produced without too much thought on recyclability although they can be reused as energy storages.[2] Currently, process for recovering of cobalt, lithium, nickel and manganese used in batteries is under development yet still techno-economically unfeasible for large-scale use.[3] Our focus should now be in developing battery and recycling technologies hand-in-hand with this aspect in mind. With the battery production and recycling in our hands, we have a possibility to both maintain resource sustainability and recycling feasibility by developing co-creative Finnish battery cluster. However, maximum self-sufficiency cannot be the only indicator in setting targets—economic performance and environmental impacts are mandatory for long-term success.

Functionality of circularity is defined at the design desk

As mentioned above, the design and source of the products are both highlighted when putting circular economy into practise. In terms of batteries, this could mean developing battery technologies that would allow small amounts of metal impurities compared to metal minerals from mining.[4] From another point of view, batteries could be designed to be more easily and safely discharged and disassembled. The same applies to several products including the ones stated earlier. With good design, plastic packaging could be more easily stacked, or construction sector could benefit from using non-hazardous and coated fire retardants. Blended fabrics could be avoided

2 Sähköauton akkua havittelee moni. [An electric car battery is coveted by many]. (11.3.2019). https://www.uusiouutiset.fi/sahkoauton-akkua-havittelee-moni/
3 Karvonen, K. (2019). Saadaanko tulevaisuuden akkumetallit käytetyistä akuista vai kaivoksista? [Will the battery metals of the future be obtained from used batteries or mines?]. https://tulanet.fi/2019/03/28/tulevaisuuden-akkumetallit/
4 Karvonen, K. (2019).

in textiles to enable remanufacturing and electronics could be built on extendable and non-brominated circuit boards. Moving upper in value chain, second-hand service models could be updated to more digitalized forms in cooperation with manufacturers—covering new fields of industry instead of consumers only. The boundaries of the business models expand in circular economy due to increased responsibility on the product's lifecycle.

Many of the fore-mentioned examples are not easy to apply as the volume of cheap imported products not suitable for recycling is high and they cross our borders unlimitedly. This fact illustrates the need for wide perspective in sustainable transition—we cannot design circularity without taking the outside world into account. This may be approached by legislation or preferably by adaptability. By designing adaptable technologies and business models we have an opportunity to solve global and domestic challenges despite the uncertainties of foreign markets and politics.

Energy and data enable the change

Keeping resources in cycle demands energy generated in a sustainable manner. Whether it is about recycling plastics and metals or recovering nutrients and removing antibiotics from municipal sewage, energy is present in a way or another. Generally, products made from recycled materials demand more energy than the ones made from raw materials.[5] In addition to processing, this is mostly due to collecting and sorting of materials from numerous sources. This requires a lot of transport and after all, transport is all about energy.

How should we minimize the transport and energy use? First thing to do is to eliminate unnecessary transport. A good example can be found from agriculture which is generating a lot of nutritious waste and simultaneously using a lot of nutrients. This brings us to the very heart of circular economy, generating local closed loop systems. Currently, a huge amount of the EU budget is allocated into agriculture as it is indeed necessary for national security of supply. A big part of the budget is spent continuously into basic payments which have been divided in multiple funding instruments.[6] As a consequence, way too small an amount of the budget is used in developing more self-sufficient and profitable agriculture.

For instance, generation of biogas could improve farming economy with outsellable biomethane and nutrient recovery for self-use. This however requires modernization and upscaling of many farms in order to be economically feasible. On the other hand, market-based investments towards larger units might occur if the

5 VTT. (26.8.2019). Circular economy of the future requires a lot of clean energy. https://www.vttresearch.com/en/news-and-ideas/circular-economy-future-requires-lot-clean-energy **6** Ministry of Agriculture and Forestry of Finland. (2020). EU direct payments. https://mmm.fi/eu-n-suorat-tuet

transport sector has the urge to use biomethane or bio-LNG instead of current fuel alternatives. The change towards closed-loop agriculture might be initiated by transport—or by some other sector. Simultaneously, sustainable energy sources for transport can be generated due to biogas generation. However, investments in agricultural circularity and farming derived biomethane require forceful public funding.[7]

Another method in decreasing transport is the pre-treatment of materials before carriage. In many cases this means making them denser and less moist. In biogas production, this would mean dewatering nutritious digestates as if they are not needed on the spot. Consequently, value of the rejected material increases as a result of higher nutrient content. Once again, affordable energy is needed to enable the simplest sounding process in the world—removing water. In many cases it is not that simple when you take all costs into account. New technologies are needed urgently, and they need a good push to be initiated.

As energy is known to be the key enabler in moving to an elevated stage of recycling it is important to understand its complex nature. Currently we are shutting down fossil-based energy production, which is the primary method to lower our CO2 emission levels. At the same time, more weather-dependent solar and wind energy is set up. It is necessary to talk about megawatt-hours instead of megawatts at this point. Although originating from same sources, energy does not equal power. Replacing the current fossil-based load from our energy infrastructure demands a lot more of wind and solar load as we talk about power in megawatts. This is due to alteration of renewable energy production. Higher peak load

7 Ministry of Economic Affairs and Employment of Finland. (28.1.2020). Työryhmältä ehdotukset biokaasun kannattavuuden kohentamiseksi. [Proposals from the working group to improve the profitability of biogas]. https://tem.fi/-/tyoryhmalta-ehdotukset-biokaasun-kannattavuuden-kohentamiseksi

means excessive energy production in times of wind and sun. In the current electricity market balance this can be seen in occasional negative electricity market prices.[8]

Consequently, our energy use must adapt itself to variating availability of energy. This applies consumers and industry—the era of static power use is about to reach its end. Fossil-based energy production is being currently replaced partly with biomass use and the electricity grid balance can be eased out up to a certain point by energy storing. Nevertheless, we are moving into a whole different society in terms of energy generation and use. How to balance the mixture of complex energy sources with weather-dependent production? By connecting the actors of the puzzle with more than cables and pipes. This requires incentives, especially for industry to tune their processes. We have been connecting people for ages, but now it's time to connect everyone. New kind of actors are entering our energy infrastructure as producers, users and storagers, simultaneously. How ready are we for this change and most importantly, how do we enable it to happen?

Global sustainable transition calls for European excellence

Needless to say, it is necessary to act quick in order to reach our governmental sustainability targets. This requires bold actions in multiple sectors. If just minimising CO2 emissions defines our strategic moves, we might do short-sighted decisions harmful to reaching comprehensive sustainability with best possible economic impacts. So, let's take a step backwards and go back to the design desk together. Building foundations of circular economy is some-

8 Fingrid. (2020). Is a negative price the new normal? https://www.fingridlehti.fi/en/is-a-negative-price-the-new-normal/

thing worth taking a closer look when we are allocating our finite public resources.

Systemic changes are always the most difficult ones. We need to think our society's global placement in a whole different way to initiate a functional and truly relevant circular economy into our society. The grand challenge is in thinking in decades instead of few years and simultaneously making required decisions concerning the present day. Cycles of industrial and research investments require us to look beyond the obvious. Policymakers must have the courage to allocate funding according to the long-term plan. This would demand consensus from all parties to eliminate alteration in political guidance between periods of rule. Maybe reaching better self-sufficiency with investments in technological know-how could be the foundation in which to build this long-term plan?

Could Finland be the leading country in manufacturing sustainable batteries and offer recycling solutions beyond comparison? Could we transform our agriculture into maximal nutrient self-sufficiency by refining the needed additional nutrients out of Baltic Sea and industrial side-streams? The actions are always interconnected—the math shows a whole different outcome if we multiply benefits instead of counting them together.

It is also important to realize the global scale—91 % of materials are disposed either with official or un-official methods.[9] This is a major challenge to solve and our current choices define whether it is also an opportunity for Europe. There is of course the chance to reduce our carbon footprint but with right moves, we also have an opportunity to increase our self-sufficiency, clean tech exports and eventually our carbon handprint. Instead of just individual investments, however, this requires bold strategic moves.

9 World's consumption of materials hits record 100bn tonnes a year. (22.1.2020). https://www.theguardian.com/environment/2020/jan/22/worlds-consumption-of-materials-hits-record-100bn-tonnes-a-year

INDUSTRY AND BUSINESS

Circular business models in textile industry: facilitating the shift

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The circular economy aims for an economic system where resources are used in a less wasteful and more sustainable manner. The prevailing linear economic systems is characterized by many inefficiencies regarding resource use, leading to considerable environmental and social harm, as well as economic losses. The circular economy has gained increased attention in the past decade, boosted partly by considerable public-sector support in the EU and China. In tandem, the private sector has become increasingly interested in the business opportunities created by the transition to circular economy, which as a concept holds the promise of a win-win solution in terms of the environment and the economy.

The shift to a circular economy requires changes in business models. There are multiple strategies available for businesses to accomplish this. For example, businesses can source recycled material as one of the inputs to their processes or may sell residual

material from their own processes to customers looking for recycled materials. Alternatively, businesses can form reverse supply chains in order to collect used products from their customers, and either reuse or remanufacture these products. Another model of circular business focuses on various types of sharing platforms. For instance, car sharing platforms, second-hand shops and firms that buy and upcycle used products are examples of this business model. Models focused on creating longer-lasting products compared to industry standards can also contribute to the circular economy.

The shift to circular business models is seldom easy for businesses. Several barriers are typical for preventing the shift to a circular economy. Firstly, a circular economy often requires new types of data information sharing among businesses and customers. For instance, material databases can facilitate cross-industrial information exchange on residual materials—businesses may find new information on the quality and quantity of recycled material that they could source. Customers may need to share data on product quality and use patterns for businesses to determine the life-cycle stage of a product. This requires increased openness from parties that not everyone may be ready for, as well as increased trust in new systems where the data is stored. Secondly, lack of technology might be a hindrance to circularity. For instance, new digital technologies may be needed to trace a product's material footprint or new types of process technologies may be needed for more effective recycling of materials. Thirdly, a circular model can be hindered by a lack of scale, as the scale of residual material generated by one firm may not be enough for profitable business.

Textile industry and sustainability challenges

The textile industry today is characterized by complex global supply chains. For instance, the supply chain for a cotton product of European fashion label could involve for instance raw cotton production and spinning the cotton into yarn in India, producing fabrics from the cotton yarn in Turkey, cutting and sewing the fabrics into clothing in Estonia, and finally selling the clothing product to a consumer in Finland. The largest producers of cotton are India and China with 25% and 20% of the global share, respectively. The largest exporter of clothing products by far is China, with 36% of the global exports, but in the recent years, countries such as India, Cambodia and Vietnam have been rapidly increasing their share of exports. These figures tell a story of manufacturing constantly moving to lower cost countries.[1]

The textile industry faces various systemic challenges regarding sustainable development. Firstly, the production of textiles is highly resource intensive. Producing cotton, the most widely used natural fibre, requires high amounts of land and water, which could be used for food production instead. This industry is also polluting, being responsible for 10% of industrial CO2 emissions and 35% of microplastics entering the oceans. In addition to the environmental challenges, the social impacts across the supply chain are vast. Much of the industry relies on production in low-cost countries, and human rights violations, irresponsible wage practices and inhumane working conditions have been common problems in the industry.[2]

1 Mikkonen, H. (toim.). (2018). Kohti kestävää kasvua. [Towards sustainable growth]. Suomen Tekstiili & Muoti ry. https://s3-eu-west-1.amazonaws.com/stjm/uploads/20181018125258/Tilastojulkaisu-Kohti-kestavaa-kasvua-verkko.pdf

2 Ellen MacArthur Foundation. (2017). A New Textiles Economy: Redesigning fashion's future.

While many of these problems originate in the producing side of the industry, the problems are compounded by unsustainable consumption practices. The predominant business model in the fashion industry is based on 'fast fashion' —a practice that emphasizes high turnover rate for clothing collections, ultra-low-cost production and clothing products with short lifespans. The biggest players in the fashion industry have built their businesses around this business model, with vast global supply chains. Customers have benefited from these practices by having access to affordable clothing for low prices, which has led to increased consumption and increasing amounts of textile waste. A report by the Ellen MacArthur Foundation found that clothing utilization rate has decreased 36% between 2000 and 2015.[3]

Unlike many other high-volume material streams, such as paper or various valuable metals, the recycling rate of textiles is notably low. Of the textile materials flowing through the supply chains globally, 73% percent is either landfilled or incinerated after end-use, and another 14% is lost as waste along the supply chain. Much of the material which is being recycled currently (12%) is cascaded recycling, leading to use in lower-value applications such as insulation materials or mattress stuffing. The material from these products is difficult to reuse and these uses thus likely present the endpoint for the materials. Consequently, only 1% of textile material is reused in a true closed-loop manner.[4]

The textile and fashion sectors in Finland have undergone considerable structural change over the last few decades. While the sector enjoyed rapid growth during the first decades in post-war Finland and most of the clothing that was used was domestically produced, since the 1980s, rapid globalization has shifted production to low-cost countries. While the industry has seen sustained

3 Ellen MacArthur Foundation. (2017). **4** Ellen MacArthur Foundation. (2017).

periods of growth during the 2000s, the structural change in the industry has been somewhat slower than in some comparable countries. Compared to Denmark and Sweden, for instance, the value of exports in the fashion industry is notably lower. The industry has considerable growth potential by utilizing new innovations related to digitalization, materials or new business models. One particular area where the sector has had displayed innovative potential in the recent years is the shift to a circular economy model.[5]

Circular developments in the Finnish textile sector

During the 2010s, there have been many instances of development towards circular textiles in the Finnish textile sector, including new business models, technological innovations and public sector initiatives. This has also created new links between the textile sector and other industries, which is typical for circular economy transitions. For instance, the forest industry, which has historically been one of the largest sectors in Finland, has had to find new innovations with the decline of the paper industry. Novel technological innovations in the interface between textile and forest industries have emerged partly as a result of this.

There are several examples of new innovations and business models utilising textile recycling as a core component. For instance, Pure Waste Textiles uses leftover cotton material from textile manufacturing processes, which is mechanically recycled to produce garments such as jeans and shirts. There are also new innovations for the chemical recycling of textiles. For instance, Infinited Fiber and Ioncell are both solutions to produce new textile material from a variety of cellulose-based feedstocks, including clothing waste, card-

5 Tekstiiliteollisuusmuseo. (2006). Suomen tekstiiliteollisuuden tarina. [Story of the Finnish textile industry]. http://www.tkm.fi/lehdistokuvat/tekstiiliteollisuusmuseo/Lue_historia.pdf

board or agriwaste. Their production processes are considerably more environmentally friendly than conventional semi-synthethic fibers such as viscose. Finlayson is a large Finnish textile manufacturer which uses recycled materials in a range of products, e.g. towels and sheets.

New initiatives have also emerged to develop recycling infrastructure in Finland. Alongside the new EU directives, which mandate textile waste collection from consumers by 2025; there are initiatives for industrial waste collection. For example, Rester is building a new textile recycling plant in Southwestern Finland, scheduled to start in 2021. It will process textile waste to be reused by various industrial customers e.g. furniture manufacturers. Rester is owned by several businesses from the textile and fashion industries, and the new plant is intended to form an anchor point for a new ecosystem in textile recycling, involving various producers and (re)users of textile waste material.

In addition, there are many developments for new business models that are changing the way customers utilize clothes and giving new life cycles to clothes. For instance, Vaatepuu operates a clothing rental shop, where customers can rent clothes either as one-time rentals or with a longer membership. There are also many second-hand businesses for clothing and textile products, which prolongs the lifespans of said products.

Several industrial workwear businesses also utilize circular economy strategies. For instance, Lindström provides workwear as a service, where they lease the workwear to their customers, prolonging the product lifespans e.g. with repair services. Touchpoint, another workwear manufacturer, collects their used products from customers in order to recycle the materials for further use, e.g. in furniture manufacturing.

These developments in aggregate show that circular business models are emerging in the textile sector, and they can revitalize the industry in the EU, but considerable development is needed before they can be considered mainstream, considering that less than

1% of material used to produce clothing is currently recycled into new clothing, and the utilization rate of clothing is in decline. The wasted material represents a loss of USD 100 billion worth of materials each year, which also affects the profitability of businesses in the sector. It is estimated that the current business-as-usual trajectory will lead to a decline in fashion brands' profitability of more than three percentage points by 2030.

Towards circularity-based textiles and fashion

What can be done in the EU to facilitate the development towards circular economy in the textile and fashion industries? EU policies require member states to organize separate collection for consumer waste textiles by 2025. Some member countries are also advancing faster, e.g. Finland is proposing mandated collection of textile waste by 2023. While this is an important enabler of new recycling practices for textiles, a broader mix of policy instruments needs to be used to fully enable circular business models in the sector. Certain challenges remain even if textile waste is broadly collected. Firstly, the product lifespans of textile products remain unaffected. Secondly, while people's prospects for recycling their worn clothes are improved, customer decision-making while purchasing new clothing can also be improved to promote circular products. Thirdly, following the textile collection, new business networks are needed to utilize the recovered material. We will next examine each of these in turn and give three recommendations for policies that can enable this.

As mentioned previously, the current fast fashion business model promotes short lifespans for clothing. Even if textile material is collected at the end of these lifespans, considerable amounts of resources and energy is needed to create new clothing out of recycled material. Other business models, such as repair of clothing can lengthen product lifespans and require fewer resources compared

to recycling (EMF). However, repair services may in many cases be costlier compared to buying a new piece of clothing, incentivizing the customer to buy new rather than repair. **A lower value-added tax on repair services compared to new products can improve the competitiveness of repairing.** This can enable customers to improve the usage rate of their clothing, increase the market for repair services, and also promote local employment.

Secondly, there has to be higher demand for new clothing products made of recycled materials, in order to better utilize the textile material which is collected. Research has shown that consumer decision-making regarding sustainable products is complex, and even well-intentioned customers don't always buy the sustainable choice. This issue can be alleviated by policy tools which help customers choose more circular textile products. **Governance instruments such as standards and ecolabels for recycled materials in clothing can be developed and promoted by the public sector to provide clarity to recycling practices and facilitate customer decision-making.** Collaboration within the EU can enable the harmonization of standards and labels, in order to prevent confusion in customer decision-making. **Developing circularity criteria for public procurement is another important mechanism that can facilitate the development of markets for recycled textile products.** Textile products make up a large part of public procurement, as it's estimated that up to a quarter of public sector workers in the EU have employer-mandated workwear[6]. Procurement professionals can also work to establish dialogue and collaboration with industry players in order to promote circularity developments[7].

6 Dodd, N. & Gama Caldas, M. (2017). Revision of the EU Green Public Procurement (GPP) Criteria for Textile Products and Services. European Commission. https://ec.europa.eu/environment/gpp/pdf/criteria/textiles_gpp_technical_report.pdf
7 Alhola, K., Ryding, S.-O., Salmenperä, H., Busch, N. J. (2018). Exploiting the Potential of Public Procurement: Opportunities for Circular Economy. Journal of Industrial Ecology, 23(1). https://doi.org/10.1111/jiec.12770

Lastly, ensuring the reprocessing of textile waste following its collection is a vital link of the circular value chain. For this, businesses need to form novel business ecosystems beyond their typical supply chain. These ecosystems might even require cross-industrial collaboration if textile materials are reutilized in another context, such as in furniture manufacturing. The Rester case described previously is an emergent example of this type of an ecosystem. The development of these new business ecosystems can be facilitated by public sector intermediaries[8], as well as new types of data platforms and information sharing systems that make it easier for potential collaborators to connect to each other. For instance, material databases, traceability technologies and supply chain information systems are tools to facilitate this. Furthermore, businesses from various parts of the textile value chain as well as technology suppliers, new industrial customers and the public sector and NGOs need increased coordination for effective management of such ecosystems. **Governments in the EU can support the formation of new ecosystems by facilitating information sharing between the involved organizations as well as investing in infrastructure which supports such ecosystems.** For instance, the European Textile and Apparel and Textile Confederation (Euratex) has proposed the development of five textile recycling hubs withing the EU, in Belgium, Finland, Germany, Italy and Spain[9].

The textile and fashion industries have considerable potential for a transition towards sustainability by shifting towards business models based on circular economy. While progress towards these business models is at a relatively early stage, there are many promising developments. The EU stands to benefit considerably by supporting these actions, which can promote a cleaner environment, more socially responsible work practices and a revitalization of the textile and fashion industries in the region.

8 Patala, S., Salmi, A., Bocken, N. (2020). Intermediation dilemmas in facilitated industrial symbiosis. Journal of Cleaner Production, 261. https://doi.org/10.1016/j.jclepro.2020.121093 **9** EURATEX. (2019). Circular Economy. https://euratex.eu/sustainable-businesses/circular-economy/

TRANSPORT AND LOGISTICS

Politics can help untap the potential of circularity in transport and logistics

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The transport sector is often seen as a source of negative externalities and as an expenditure in the national and households' budgets. What if we could turn the European transport and mobility sector into a sustainable engine for circular economy and at the same time could provide people and companies with better mobility and logistics services? It is more and more evident that our competitiveness and well-being can no longer be based on the wasteful use of natural resources. Rather than offering products, the foundation for earnings will be services, recycling of products and intelligence-based digital solutions. This all is true for the transport sector as well and it has its own part to play.

Transport is a field where the pressure for change is unusually strong. Currently passenger cars provide over 80% of travel and transport occupies some 40% to 50% of urban space. Transport is typically the second largest expense for a household only exceeded by housing. It is a major feature of everyday life and shapes the cities and communities we live in. Nevertheless, the average car is parked 95 percent of the time and in logistics, the full capacity of ve-

hicles is nowadays not used, creating significant unnecessary costs and increasing emissions.[1]

Transport represents almost a quarter of Europe's greenhouse gas emissions and is the main cause of air pollution in cities. The transport sector has not so far seen the same gradual decline in emissions as the other sectors. In 2017, 27% of total EU-28 greenhouse gas emissions came from the transport sector, road transport being the biggest emitter accounting for more than 70% of all greenhouse gas emissions from transport.[2] To reach the ambitious emission reduction targets set by the EU and the national governments, a systemic change in the sector is a necessity and needs to be adopted without delay.

At the same time, the opportunities are huge. The pursuit of a carbon-neutral circular economy has created the world's fastest-growing market: circular economy is estimated to have the potential to yield €1.8 trillion worth of annual benefits to the European economy by 2030.[3] When combined with the other rapidly growing market, mobility, the business opportunities are massive. Already the global *Mobility as a Service* market is estimated to reach 1.75 trillion US dollars by 2028,[4] not to speak about the growth forecasts of the rest of the mobility sector. By creating forerunner solutions in the EU, we can both increase the European carbon handprint—our positive climate impact—and foster economic activity.

1 Material Economics. (2018). The Circular Economy a Powerful Force for Climate Mitigation - Transformative innovation for prosperous and low-carbon industry. https://media.sitra.fi/2018/05/04145239/material-economics-circular-economy.pdf **2** European Environment Agency, https://www.eea.europa.eu/data-and-maps/indicators/transport-emissions-of-greenhouse-gases/transport-emissions-of-greenhouse-gases-12, The European strategy for low-emission mobility. (2016). European Commission. https://ec.europa.eu/transport/themes/strategies/news/2016-07-20-decarbonisation_en **3** McKinsey & Company. (2015). Growth within: A circular economy vision for a competitive Europe. https://www.mckinsey.com/business-functions/sustainability/our-insights/europes-circular-economy-opportunity **4** BIS. (2018). Global Mobility as a Service Market. https://bisresearch.com/industry-report/mobility-service-market.html

Circular economy in the mobility sector —from recyclable materials to MaaS

The vision for the future should be a fair transition to a low-emission, safe, highly automatized transport system which enables seamless, connected and multimodal customer-oriented service. The concept of circular economy in the mobility sector can be seen to cover a broad variety of solutions and many viewpoints. Different solutions can be divided e.g. in the following categories:

- **Transfer from ownership to usership** with the help of digital technologies that enable sharing and servitisation of mobility and logistics solutions. Alternative forms of transport could replace private cars, such as compatible door-to-door mobility services, Mobility as a Service (MaaS), smart and easy-to-use public transport, and the development and spread of new services, walking, cycling, ridesharing and car sharing. Combining passenger and freight transport services leads to less vehicles needed. In addition to urban areas, MaaS and demand-responsive transport offer new possibilities for better and more efficient mobility services in rural areas likewise.
- **More efficient use of the infrastructure** with a digital system-level integration of all transport modes and assets. Smart traffic management systems and smart pricing increase the optimization and efficiency and further encourage the shift to lower emission transport modes.
- **The deployment of low-emission alternative energy for transport,** such as electricity, advanced biofuels, hydrogen and renewable synthetic fuels

and removing obstacles to the electrification of transport and low- and zero-emission vehicles.

- **Automation** of all the transport modes and systems will improve the mobility system's efficiency in many ways. Solutions range from optimization of speed, drones, autonomous pods to automated ports and logistics centres.
- **Sustainable, long-lasting materials** in infrastructure and vehicles. Renewable, recycled and/or fixable materials and products can lead e.g. to better aerodynamics and longer life for vehicles and infrastructure.

All these actions are needed simultaneously and in an integrated manner. Clean or automated vehicles alone are not enough to make the change if they are used as they currently are. Five vehicles are still five vehicles occupying roads and public space. To put it simply: the change happens when we replace five combustion-engine vehicles with two electric ones. We need shared transport and services to complement public transit to make it as an attractive option for a private car. We need digitalization in all phases of the supply chain as well as efficient control of material streams. MaaS, sharing and lease economy solutions, on-demand shuttles, novel logistics solutions and optimized and clean transport will take the energy and resource efficiency of transport and logistics to a new level.[5]

The potential of an integrated systemic change has been estimated to be huge in terms of CO2 and material savings: e.g. in a sce-

5 See e.g. ICoMaaS 2017 Proceedings, 381 Circular Economy in Mobility: Sharing and Rural Areas, Juho Kostiainen, Aki Aapaoja ja Tuomo K. Kinnunen, VTT Technical Research Centre of Finland, 2017 https://cris.vtt.fi/en/publications/circular-economy-in-mobility-sharing-and-rural-areas, Finnish Roadmap to a Circular Economy 2016 - 2025, The Finnish Innovation Fund Sitra, 2016 https://www.sitra.fi/en/publications/leading-cycle/, The Future of the Last-Mile Ecosystem, World Economic Forum, 2020 http://www3.weforum.org/docs/WEF_Future_of_the_last_mile_ecosystem.pdf

nario where professionally managed, shared vehicle fleets account for two-thirds of travel, materials requirements for passenger cars could fall by as much as 75% by 2050.[6] In another scenario, with the ecosystem-wide change, combined interventions could reduce emissions and traffic congestion by 30%, and delivery cost by 25%, compared to the "do-nothing" scenario.[7] Basically, the circular economy enables the same distance and convenience of transport but requires much less input of materials.

In addition, transport and mobility compose a part of the life cycle in many other sectors of the economy. Particularly logistics plays a significant part in creating the environmental footprint of several fields of industry. Therefore, solutions in transport can have widespread positive effects.

Policy recommendations to accelerate a systemic change

Many actions are already underway on the European path towards an integrated and digitalized mobility system embracing the idea of circularity. Yet, much is still needed to scale up action and secure the competitive advantage circular economy brings to European businesses.[8]

6 Material Economics. (2018). **7** ITF Transport Outlook 2019, OECD, International Transport Forum. (2019). https://www.oecd-ilibrary.org/transport/itf-transport-outlook-2019_transp_outlook-en-2019-en **8** Recommendations are based on various sources and the author's experience in the field, see in particular
The Commission's Communications on "Closing the loop - An EU action plan for the Circular Economy". (2015). https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52015DC0614
More circularity - Transition to a sustainable society - Council conclusions. (2019). https://www.consilium.europa.eu/media/40928/st12791-en19.pdf
Finnish Roadmap to a Circular Economy 2016 - 2025, The Finnish Innovation Fund Sitra. (2016). https://www.sitra.fi/en/publications/leading-cycle/,
National Growth Programme for the Transport Sector, The Finnish Ministry of the Employment and the Economy. (2017). https://julkaisut.valtioneuvosto.fi/handle/10024/160721

A joint vision and ambitious policy measures

At all levels, forming a joint vision is a prerequisite for coordinated action. We need to play the ball to a common goal.

Policy instruments should set the ambition level for emission reductions and circular economy targets and ensure a predictable operational environment for the companies. Promoting the single market in mobility sector as well the digital single market and advanced data policy create opportunities for European businesses to develop scalable circular economy services for global markets. Enabling and fostering a competitive environment leads to more innovation.

Financial steering to favour circularity

To speed up the circular transformation it is necessary to adopt a framework of incentives and taxation that steers all the entities and individuals to sustainable actions. This includes e.g. enhanced build-up of charging infrastructure, incentives for electric vehicles, personal incentives to enhance the choice of alternative transport methods and reducing subsidies that favour private cars. Transport pricing should also incentivize efficiency in logistics.

In this context a just transfer is a necessity to acquire public acceptance. Typically, environmentally friendly vehicles require larger initial capital investments than regular vehicles and are beyond the reach of many consumers and companies struggling with the COVID-19 crisis. However, the total costs of ownership of for example electric buses or cars are much lower than those of internal combustion engine vehicles. This means that consumers save money and environment if they only can afford the initial purchase of the environmentally friendly vehicle. Besides, steering the user behaviour towards more sustainable modes requires the actual availability of those modes.

The exploitation of digital data

Interoperability and integration of everything through data is a must in developing smooth multimodal travel and logistics chains. Data enables real-time monitoring of the system as well as information on life cycle emissions from well-to-wheel both to private people and businesses.

With data, it is possible to make the carbon footprint visible. MyData solutions can be used to incentivize consumers to contribute more to the circular economy in their everyday mobility decisions. Accurate monitoring and traceability help to meet the circular economy goals and create a basis for auditing the whole logistics chain.

Data also enables the transfer to real-time economy, the e-receipt e.g. could enable different taxation levels for vehicles based on what type of usage they are in. This could allow shared or private rides to enjoy different tax levels guiding consumers to look for services instead of ownership.

Diverse forms of funding

A coherent policy for circular economy investments, in particular in digital infrastructure and RDI, is needed to incentivize innovation and markets for high-quality secondary raw materials and service-based circular business models. Ecosystem funding encourages the development of large-scale solutions that have advantage in global competition.

Public sector funding both at national and at the EU level should always be linked to the promotion of a circular and green economy. A joint framework needs to be developed to measure and evaluate the selection and outcome of the projects as well as the overall progress in the EU.

Cities as platforms for circular change

Cities and local authorities will play a crucial role in delivering the circular economy approach. Multimodal travel chains, integrated ticketing and payments systems as well as car-sharing/pooling schemes make the sustainable modes attractive and competitive compared to private cars.

Integrated approach in land use, transportation and housing promotes the sustainability of the system both vis-à-vis personal transport and city logistics. Planning and development of infrastructure to prioritize walking, cycling and public transport as well as shared services is one of the key areas in cities.

The concrete measures should follow the circular economy strategies, and this needs to be ensured by active steering measures, right leadership models, dedicated ownership and KPI's in various city functions.

Scalable solutions through experiment and public procurement

Trials, experimentation and testing platforms should focus on the potential for synergy and scalability, with successful experiments generating new circular services. Cities should act as platforms for innovation in circular economy and encourage experimentation.

Public procurement will play a key role in renewing the transport sector and boosting circular economy business model development. Public authorities need to develop procurement competence, including various incentive models that support the transfer to circular economy. In procurement within the context of urban projects in particular, attention should be paid to mechanisms for scaling up successful solutions.

Promoting standardization work in various fields also enables the development of interoperable services and scalability.

Stronger PPPP collaboration and an ecosystemic approach

Last but not least, new value is created together and in continuous interaction with customers. To achieve breakthroughs in circular economy, both cross-sectoral and cross-national cooperation is needed. There is also demand for open-minded cooperation across administrative branches. Sharing the best practices across the EU and in the city level networks speeds up the progress. Joint efforts and cooperation support the function of growth ecosystems and help identify new user needs, weak signals, business opportunities and applications.

Promoting the circular economy transfer in the transport sector requires a new mindset, new capabilities and new kinds of partnerships. Everybody needs to play their role: the state administration, towns and cities, business life and people. Everyday choices have to be made by all of us.

CITIES AND LOCAL POLICY

Are cities the main hubs of the European economy—in a circular one as well?

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The circular economy is so much more than just recycling. Circulation of materials and business models with extended lifecycles create value across value chains. The idea of circular economy is simple—everything we do, should be done in a more intelligent way, with less resources and with as little waste as possible.

Concrete examples show how cities in Europe can be main hubs of circular economy. We have already seen how cities have placed ambitious goals to encourage climate neutral and resource smart ways of life. These goals can be promoted in many effective ways in agriculture and transportation, for example. An important factor is to succeed in including and committing all parties, such as decision makers, residents and stakeholders, into the necessary changes. In a world were countries often struggle in decision-making, cities can be the changemakers of sustainability.[1]

1 OECD. (2020). The Circular Economy in Cities and Regions. https://www.oecd.org/regional/cities/circular-economy-cities.htm

Numbers show the potential of cities in solving the sustainability gap and leading the change towards a circular economy. The potential is only growing as cities are getting bigger. Urbanization is still a global megatrend and in fact, one of the most significant megatrends of our time. According to the World Bank more than half of the world's population live in urban areas and it has been predicted that by 2050 two out of three people will live in cities.[2]

This of course creates both possibilities and challenges. Emissions and waste are already causing problems in many cities and as the number of people grows, these problems grow too. Cities are aggregators of materials and nutrients. Cities consume over 75% of natural resources, produce over 50% of global waste, and emit between 60-80% of greenhouse gases.[3]

At the same time cities obviously play a central role as engines of the global economy. Cities already account for 85% of global GDP generation.[4] For economic growth to be sustainable, it needs to follow the limits of our planet's capacity. Circular economy provides an opportunity to rethink how we produce and use the things we need. This allows us to explore new ways of ensuring long-term prosperity.

When more people live in cities, the importance of development in urban areas grows. Solutions considering topics such as zoning, infrastructure and usage of technology will largely define the direction of development in the future. Transition to circular economy will support development in many priorities: carbon neutrality, biodiversity and sustainability in e.g. agriculture, mobility and the overall economy.[5]

2 The World Bank. (2020). World Development Indicators. https://datacatalog.worldbank.org/dataset/world-development-indicators **3** Ellen MacArthur Foundation. (2017). Cities in the Circular Economy: An Initial Exploration. https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Cities-in-the-CE_An-Initial-Exploration.pdf **4** Ellen MacArthur Foundation. (2017). **5** Williams, J. (2019). Circular cities. Urban studies, 56(13), page(s): 2746-2762.

Regional decisions can battle global challenges

When President Trump decided to deny global warming and withdraw from the Paris Climate Agreement, it was the cities of the United States of America that decided to, nevertheless, do their part for a sustainable future. No less than 461 mayors committed to adopt and uphold the Paris Agreement despite of the president's opinion. "We will intensify efforts to meet each of our cities' current climate goals, push for new action to meet the 1.5 degrees Celsius target, and work together to create a 21st century clean energy economy. We will continue to lead", stated the U.S. Climate Mayors representing over 72 million Americans.[6]

Many of these mayors were from the State of California, which has become a symbol for the power of regional decision-making in battling global challenges. Already in 2008 there were 12,253 green establishments in the State of California. Collectively these establishments employed 163,616 workers across six distinct green economic sectors. Just within a decade, green solutions have taken over a massive part of the economy.[7]

The State of California has been successful in decreasing emissions and along the way its targets regarding reducing greenhouse gas emissions have been further raised. California as a state is now achieving impressive outcomes from the implementation of its climate policies. Economically California is growing while emissions are decreasing. With innovative advancements in clean energy and energy efficiency, the state is well on the way to meeting its renewable energy target.[8]

6 Reuters. (2017). #WeAreStillIn: 'America will meet the Paris Agreement despite Trump'. https://www.reutersevents.com/sustainability/wearestillin-america-will-meet-paris-agreement-despite-trump **7** Chapple, K. & Hutson, M. (2009). Innovating the Green Economy in California Regions. University of California, Berkeley. **8** Environmental Defense Fund. (2020). California leads fight to curb climate change. https://www.edf.org/climate/california-leads-fight-curb-climate-change

On the other hand, the city of San Francisco adopted a zero-waste goal already in 2002 and since then the city has been leading the green transition in North America.[9] A few years later global megacities, such as San Francisco in California, joined forces and created a "C40" network which now consists of almost 100 cities representing over 700 million citizens and 25% of the global economy.[10] The C40 cities around the world have committed to addressing climate change and promoting sustainable solutions.[11] As an example, in 2018 Mayor London Breed committed San Francisco to a circular waste pledge and challenged other mayors to join as sustainable communities. Tens of mayors around the world joined in this commitment – one of many that has been introduced by a single city. In San Francisco material efficiency, reuse, recycling and composting have created thousands of jobs and reduced disposal by half between 2000 and 2015.[12] The city's goal is to achieve zero waste by the current year of 2020.[13]

According to a survey of C40 results, the network has been successful in spreading and accelerating best practices. For example, one of the member cities, Amsterdam, set a target to be a global leader in transition to circular economy and started by putting into effort a thorough mapping of the whole material flow of the city.[14] Furthermore, the economic benefits of circular economy were scanned, as the city aimed to prove that circular economy is a realistic and profitable concept. With a focus on construction, Amsterdam's roadmap included initiatives such as criteria for circular buildings, development of partnerships and training for more effi-

9 San Francisco Department of Environment. (2020). Zero waste FAQs. https://sfenvironment.org/zero-waste-faqs#practices **10** C40. (2018). Municipality-led circular economy case studies. https://www.c40.org/researches/municipality-led-circular-economy **11** C40. (2018). **12** United States Environmental Protection Agency. (2019). Zero Waste Case Study: San Francisco. https://www.epa.gov/transforming-waste-tool/zero-waste-case-study-san-francisco **13** United States Environmental Protection Agency. (2019). **14** C40. (2018).

cient supply chains. Implementing these circular strategies in Amsterdam was estimated to create 700 additional jobs and a yearly value of 85 million euros within the construction sector only. At the same time the annual material savings within the sector would be 500 000 tons, which adds up to half a million tons less CO2 emissions every year.

Examples from near

The cities of Finland are not members of C40 network of global megacities, but we have some good examples here too. For example, the City of Turku has set a goal to achieve carbon neutrality by the year 2029 – on the year when the city turns 800 years old. This goal is one of the most ambitious in the world and serves as an example of how sometimes cities can set more ambitious targets than even the most ambitious governments.[15]

The climate plan and carbon neutrality target were unanimously approved by the city council of the City of Turku in 2018. The climate plan of Turku was prepared based on the EU's Sustainable Energy and Climate Action Plan. The plan includes both actions and milestones for years 2021, 2025 and 2029. Next year, in 2021, the milestone target is to have reduced emissions by 50% compared to emissions in 1990.[16]

Besides carbon neutrality, the city wants to be an international forerunner when it comes to circular solutions. Circular economy is seen in the core of the city's ambitious climate policy. In February

15 City of Turku. (2019). Turku vastaa vahvasti ilmastonmuutokseen. [Turku answers climate change strongly]. https://www.turku.fi/blogit/kohti-vuotta-2029/turku-vastaa-vahvasti-ilmastonmuutokseen **16** City of Turku. (2018). Ilmastosuunnitelma 2029. [Climate action plan 2029]. https://www.turku.fi/sites/default/files/atoms/files/ilmastosuunnitelma_2029.pdf

2020 Turku published its first "Circular Turku" -report.[17] According to the report “The City of Turku is committed to a resource wise future with zero emissions, zero waste and low ecological footprint with the sustainable use of natural resources by the year 2040”. The report introduces Turku’s learnings and best practices from the city’s road towards operationalizing circular economy.[18]

The actions in Turku have a special focus on promoting participation. The city believes that the key to success in implementing circular economy is to get people involved: citizens, communities, companies. Through shared targets different stakeholders have noticed that a smarter way of doing things does not only provide a more secure and sustainable future for all, but also creates possibilities to businesses and economic growth. Sustainable inventions are needed all over the world. Circular solutions provide easier transportation, healthy living environments, high quality drinking water and enjoyable nature.[19]

Most effective impacts Turku has achieved through cross-sectoral and multi-level collaboration. The idea of circular economy has turned into actual solutions through different activities of the city: for example, in food value chains and nutrient cycling, energy systems, buildings and construction, transport, logistics and water cycles.[20]

Decisions made at local level can have a huge impact in the sustainability of our world. Cities around the world have shown that concrete actions are not only possible but also profitable. However, circular economy cannot be left for the implementation of scattered cities only. A sustainable future requires systematic planning, strategic cooperation and decision-making capacity on all levels of decision-making. Targets set on EU-level are needed to direct national legislation binding local policies.

17 Circular Turku. (2020). A blueprint for local governments to kick start the circular economy transition. https://e-lib.iclei.org/publications/Turku-report-web.pdf
18 City of Turku. (2020). Circular Turku. https://www.turku.fi/en/carbon-neutral-turku/circular-turku **19** City of Turku. (2018). **20** City of Turku. (2018).

When the future of our children is at stake, free riders cannot be accepted. Everyone needs to do their share and participate in the rebuilding of our structures to a more sustainable form. Transition to circular economy requires new ways of thinking and a lot of practical work, but the outcomes are well worth the effort.

SUMMARY AND CONCLUSIONS

And yet it circulates

Samuel Tammekann

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Paradigms do not change easily. The prevailing truths are often deeply rooted in people's minds, although the facts might show otherwise. A change requires a transformation in the whole fundamental way of thought. We long believed that Earth is the centre of everything: like the Moon, so do the planets, the Sun, and ultimately the entire universe orbit this world, endowed by our Creator for us, the humankind, to control. This worldview worked for a long time and made sense, but as the knowledge increased, its basis became more and more fragile and unstable. Based on the models of pioneers like Nicholas Copernicus, and his own empirical observations, Galileo Galilei argued that the reality is twofold moving: the earth revolves around itself, but with the other planets, also orbits the Sun. The truth did not immediately become accepted, but it had nonetheless been found. *E pur si muove*. And yet it moves.

The impact on the geo- and anthropocentric cosmology was revolutionary, and today hardly any of us believe in the old Ptolemaic star models. But still we haven't fully surpassed our increasingly fragile, one-dimensional and people-centred worldview. One such paradigm coming to its endpoint is related to extractive consumption and material-centric economic growth.

For a long time, the most significant part of economic growth has been based on finding, exploiting and consuming new natural resources in ways that increase our material standard of living. The earth was seen as boundless: there was always something to discover, new minerals to be mined, new shorelines on the horizon. Even increasing resource efficiency has not fundamentally changed this model: a product's lifecycle still begins with the extraction of resources, and at the end of its life, the resources used end up in the landfill with the product—or in the air to warm our atmosphere. However, the extraordinary prosperity and welfare it enables cannot much longer hide the consequences arising from the unsustainable and ever weaker foundation on which our current development is built.

A Faustian bargain

In Goethe's rendition of the well-known legend Dr Faust is frustrated by the limits of his knowledge, power and pleasure, and in order to achieve even more he enters into an agreement with Mephistopheles, the Devil. At the moment of Faust's greatest happiness, Mephistopheles finally tries to take his soul to get his part of the deal. It is not surprising that the *Faustian bargain* has been used at times as an allegory for our present-day society.

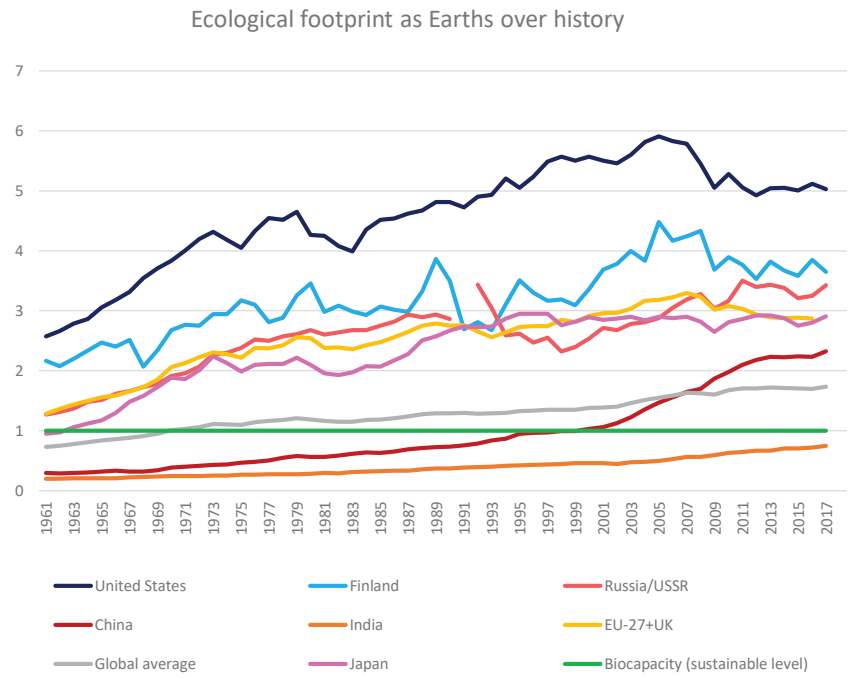

Figure 1. Footprints of various countries and the EU-27+UK. The graphs show how many Earths would be needed if everyone in the world lived like people in the country do. Thus, the increase in global population must also be considered when valuating per capita carrying capacity as more people use the same finite resources every year. York University Ecological Footprint Initiative & Global Footprint Network. (2020). https://data.footprintnetwork.org/

In a limited world, the borders will necessarily be reached. According to York University's Ecological Footprint Initiative, it already takes 1.7 years to renew the resources consumed every year—this is represented by Earths (Figure 1), and if this overconsumption continues to grow as it is does today, it will take even much more to meet demand in the future. Although the ecological footprint of the European Union has peaked and is now in slight decline, we still use 2.87 times our own sustainable share in 2017.[1]

Also, the percentage of circularity in the world economy has lately only decreased, which is due to the fact that consumption grows currently faster than the circular economy.[2] For example, the consumption of textiles is increasing and the number of times a piece of clothing is used is decreasing year by year. It is estimated that by 2050, the textile industry would use a quarter of our carbon budget and the amount of microplastics ending up at sea would have increased by 22 million tonnes.[3]

At the same time, nature is experiencing irreversible destruction. The last 50 years have seen a half of all tropical rainforest lost,[4] and many of the remaining are nearing a final tipping point[5]. Every eighth animal species is on the verge of extinction.[6] The average global temperature has risen by 1.1 °C since pre-industrial times[7] — many times faster than expected in the Arctic[8] —and to limit global

1 York University Ecological Footprint Initiative & Global Footprint Network. (2020). Ecological Footprint of Countries 2017. https://data.footprintnetwork.org/ **2** Circularity Gap Report 2020. Circle Economy. **3** Ellen MacArthur Foundation. (2017). A new textiles economy: Redesigning fashion's future. http://www.ellenmacarthurfoundation.org/publications **4** IUCN (2017). Issues Brief: Deforestation and forest degradation. https://www.iucn.org/sites/dev/files/deforestation-forest_degradation_issues_brief_final.pdf **5** Lovejoy, T. E. & Nobre, C. (2019). Amazon tipping point: Last chance for action. Science Advances, 5(2). https://advances.sciencemag.org/content/5/12/eaba2949 **6** IPBES (2019). Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. E. S. Brondizio, J. Settele, S. Díaz, and H. T. Ngo (editors). IPBES secretariat, Bonn, Germany. **7** World Meteorological Organization (2020). WMO Statement on the State of the Global Climate in 2019. WMO-No. 1248. https://library.wmo.int/doc_num.php?explnum_id=10211 **8** World Economic Forum (2020). Global warming: Scientists 'stunned' by how much ice we've lost. https://www.weforum.org/agenda/2020/08/arctic-sea-ice-global-warming-climate-change-predictions/

warming to less than 1.5 degrees, emissions need to be reduced by 7% every year.[9]

The physics is therefore indisputable and solving overconsumption and environmental crises is crucial, and necessity of that is not a political question. How to solve them, instead, is.

The longer the necessary decisions are postponed, the more expensive and riskier it will be to build a sustainable economy and society. This unavoidably builds pressure on the ruling parties that have built the current system, making radical and revolutionary solutions increasingly attractive. In particular, the years since the release of the last IPCC report have brought with them a number of grassroots movements increasingly hungry with their demands. These have especially been favoured by young people, which have lost confidence in the ability of the current economic and political system to solve the crisis at hand. As time passes, those who do not offer solutions will inevitably be seen as part of the problem.

To maintain our current level of well-being, by 2050 resource efficiency must be increased four to tenfold, and at the same time, we need to turn nature's deteriorating carrying capacity back into growth.[10] In this light, it is all too easy to argue our only choice is to pull the emergency brake: turn economic growth around and downwards and rebuild the whole society and the political system in line with radical utopias. However, we have come so far that a return may not be possible anymore—nor even desirable.[11] Although we might be able to think of, if needed, being content with our current standard of living or giving up a part of it—if it is even possible in the political-economic reality—this kind of reversal is not realistic for all the 7.8 billion that make up the world's population. But there is another way, if only we succeed in annulling the Faustian bargain.

9 United Nations Environment Programme (2019). Emissions Gap Report 2019. UNEP, Nairobi. **10** Directorate-General for Environment. (2011). Charting a path towards resource efficiency. European Union. https://ec.europa.eu/environment/efe/news/charting-path-towards-resource-efficiency-2011-05-01_en **11** McAfee, A. (6.10.2020). Why degrowth Is the worst idea on the planet. Wired. https://www.wired.com/story/opinion-why-degrowth-is-the-worst-idea-on-the-planet/

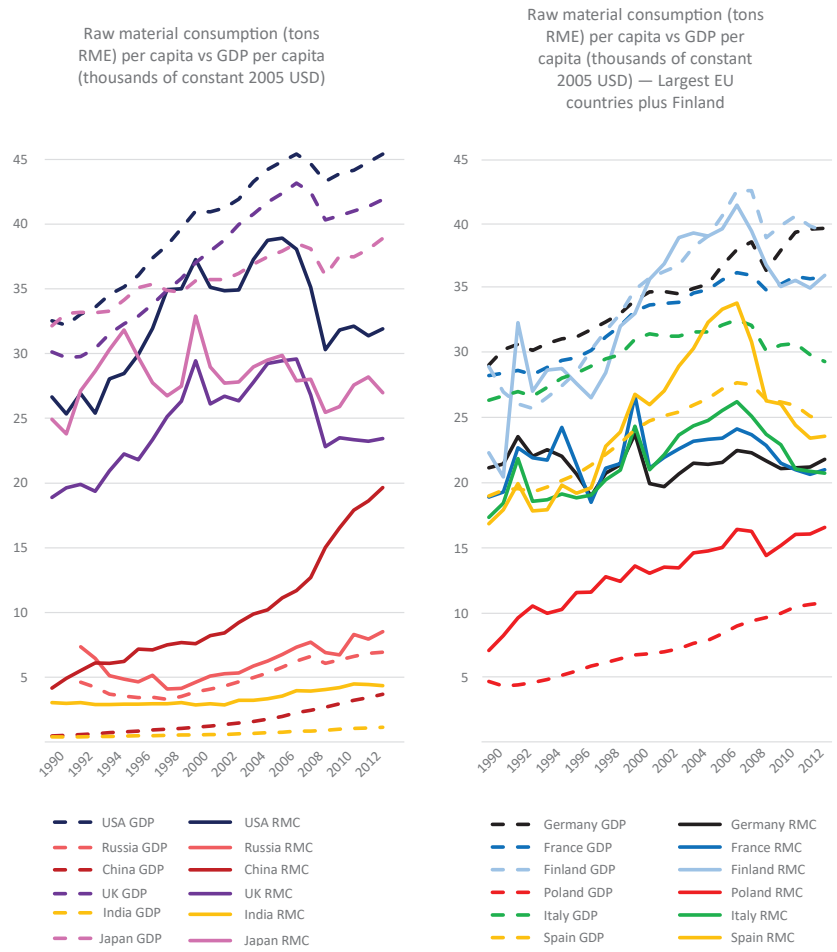

Figure 2. Comparing changes in countries' raw material consumption and GDP is a good way to measure decoupling economic growth from material burden. RMC is calculated as the sum of domestic extraction and the imports minus the exports, all measured in "raw material equivalents" (RME) which also take into account all the raw materials needed to feed the supply chains ending in a country's consumption. All numbers are measured in per capita, as we are not investigating population growth here but the actual impact on people's lives. Our aim—an absolute decoupling—is achieved when the RMC decreases even when the economy grows, but as we can see, we have still a long way to go. materialflows.net / UN IRP Global Material Flows Database. 2020.

Towards a circular future

The paradigm must change. The linear model of economy must be bent into a circle: the end of a product's life cycle must be connected to the beginning. By tackling the resource challenge, we can also achieve another important goal, climate change mitigation, as the circular economy makes it possible to reduce emissions in non-energy sectors, which account for almost a half of greenhouse gas emissions.[12]

According to the Ellen MacArthur Foundation, the circular economy, i.e., circularity, pursues three goals: planning out of waste and pollution, preservation of products and materials, and restoration of natural systems.[13] The transition to a circular economy is not possible by only making recycling more efficient, as the products themselves must be made durable, repairable, upgradable and reusable. Only at the end of this life cycle is there the actual reuse of materials.

Currently, about 12% of the EU's material flows remain circulating in cycle and reuse, with the Netherlands leading the way with a circularity rate of 24.5%.[14] In Finland, the rate has fallen to only 7%, while in the world it is 8.6% on average.[15] Why, despite all its advertised functionality, has the circular economy not yet taken off on a larger scale than this?

12 Ellen MacArthur Foundation. (2019). Completing the Picture: How the Circular Economy Tackles Climate Change. https://www.ellenmacarthurfoundation.org/publication. **13** Ellen MacArthur Foundation. (2017). What is the circular economy? https://www.ellenmacarthurfoundation.org/circular-economy/what-is-the-circular-economy **14** Circularity Gap Report 2020. Circle Economy. **15** Statistics Finland, preliminary statistics 2020. Indicators for circular economy.

According to the Finnish Government's strategic development program for the circular economy, there are three reasons for this: inadequate pricing of the use of natural resources, which does not generate sufficient demand for circular economy products, decades of investment in linear economy structures and incompatibility of the current legislation with circularity.[16]

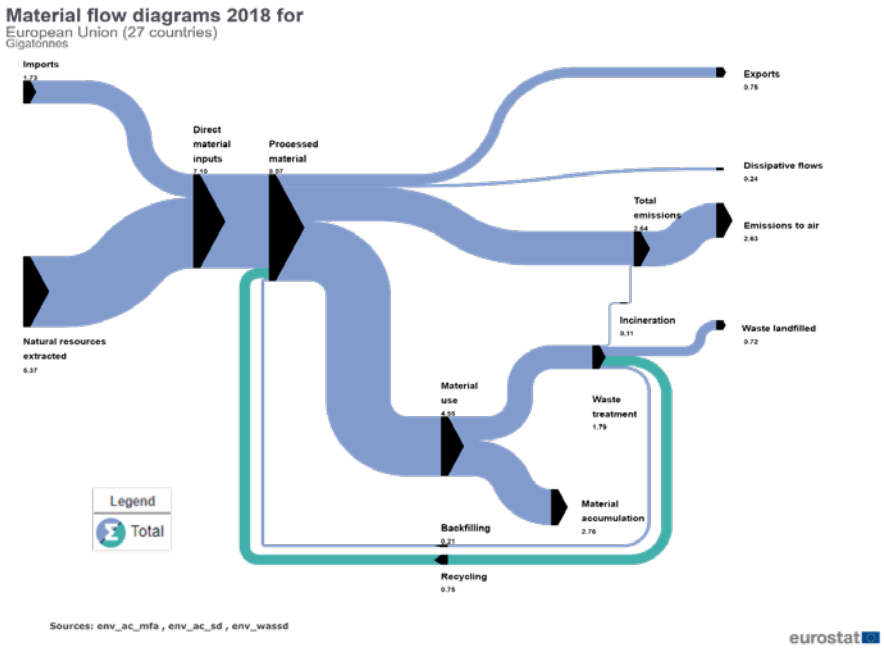

Figure 3. The European Union is a typical modern economy—predominantly linear. Eurostat. (2020).

16 Finnish Government, steering group for the circular economy promotion program (2020). Kiertotalous – taloutemme uusi perusta. [The circular economy - the new foundation of our economy]. https://figbc.fi/wp-content/uploads/sites/4/2020/11/001.-KARHINEN-Kiertotalous-ohjelma.pdf

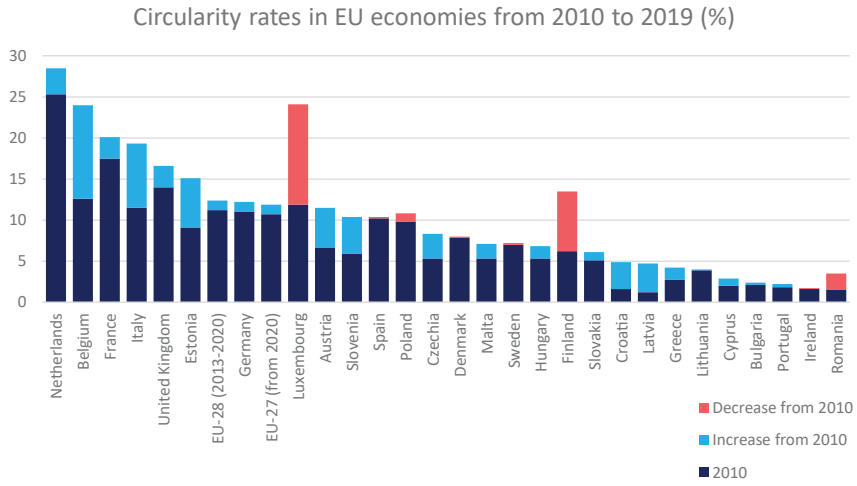

Figure 4. Eurostat. (2020).

How can these goals be achieved in various sectors of the economy? The guest authors of this book, Mrs. Sirpa Pietikäinen, Mrs. Saara-Sofia Sirén, Mrs. Laura Eiro, Mr. Samuli Patala and Mr. Jonne Hirvonen, have written what exactly needs to be done in sectors such as transport and materials, and what policies have to be used to achieve the set goals. Let us make a brief recap of these essays and thus conclude this book by summarising what actions are required in each sector.

Raw materials and energy

An ideal economy would run as a fully closed loop. However, new raw materials need to be constantly fed into the system, and behind this there are at least two clear root causes. First, materials wear out in a cycle and their chemical and physical properties change with use and over time, so they must be constantly replaced. Second, not all products are designed to be recycled: they may contain additives, components, or mixtures that are difficult to recycle economically. In order to close the raw material cycle, it is necessary to constrain these factors.

That is why we still need significantly new raw materials in order to build a new economic model, materials that are preferably renewable, high-quality and recyclable. Therefore, it is also instrumental new products are designed with this in mind. For example, if we are to achieve rapid growth in the production of electric cars, it must be ensured that, at the same time as recycling becomes more efficient, battery technology also develops in accordance with the principles of sustainability and recyclability.

The same change must also be brought about in more commonplace areas, as e.g., plastics, textiles, and electronics often contain difficult-to-reuse materials. It is therefore not enough to merely develop recycling technologies, as tackling the challenge also requires state-level measures and cross-border co-operation, such as legislation and new standards to support circularity already at the design phase.

All processes from plastic recycling to recovering nutrients from sewage require a lot of energy. In general, producing from recycled materials is always more energy-intensive and expensive than the use of virgin raw materials, and this is also an economic challenge in bringing about circularity. Processing the materials is not the only expenditure, but a significant amount of energy is also spent on collecting and sorting recycled materials.

The simple solution is to minimize unnecessary transport. This is why at the very heart of the circular economy are local closed loop systems. For example, agriculture produces a lot of nutrient-rich waste and simultaneously consumes a lot of nutrients in the same location, so closed loops could be easily built on-site. Furthermore, local nutrient cycle and e.g., outselling of biomethane would create new economic opportunities for rural areas. However, such modernization requires significant public guidance and funding,[17] and therefore a clearly larger share of the EU's agricultural budget should be spent on developing both economic and material self-sufficiency.

It is also possible to reduce transport by pre-treating the materials. Often this means condensing and drying the substances. However, this too requires a lot of low-cost energy, and it therefore must be said that maintaining cycles in any case requires a lot of sustainably produced energy.[18] In the future, though, we won't be able to rely on as stable and demand-responsive energy production as we have long been accustomed to.

Energy production based on fossil fuels has declined in Europe, and although a part of it has been replaced by biomass use, a significant load of clean energy is nowadays highly weather-dependent solar and wind, supported by nuclear energy that is contrarily steady but difficult to adjust to electricity demand.[19] While hydropower and some temporary combustion can still be used for load following and storage and battery technology is evolving, we will nevertheless need to adapt to much more significant fluctuations in energy production and electricity market prices in the future. This will require new and closer co-operation between producers, consumers and storers. Legislators must also answer this call.

17 Ministry of Economic Affairs and Employment of Finland. (28.1.2020). Työryhmältä ehdotukset biokaasun kannattavuuden kohentamiseksi. [Proposals from the working group to improve the profitability of biogas]. https://tem.fi/-/tyoryhmalta-ehdotukset-biokaasun-kannattavuuden-kohentamiseksi **18** VTT. (26.8.2019). Circular economy of the future requires a lot of clean energy. https://www.vttresearch.com/en/news-and-ideas/circular-economy-future-requires-lot-clean-energy **19** Eurostat. (2020). Energy statistics - an overview. https://ec.europa.eu/eurostat/statistics-explained/index.php/Energy_statistics_-_an_overview

Industry and textiles

Most of the change needs to happen in industry. The circular economy creates many new business models for companies: industry can e.g., use recycled materials as raw material and also provide its own by-products to customers for recycling. Companies can also reverse the supply chain: collect used products from their customers and either resell the products or use them as raw material. The change is not quite simple: challenges to be overcome can be found in the cross-industry flow of information, transparency of quality and product information, lack of technology and scalability of solutions.

The textile industry is a particularly challenging sector for sustainable development with its long production chains. Firstly, the production of textiles is very raw material-intensive, for example, cotton production requires huge amounts of water and land area. The clothing sector also accounts for one-tenth of industrial CO2 emissions and produces more than a third of marine microplastics. Moreover, its social impact cannot be forgotten: much of the industry is outsourced to low-cost countries, where human rights violations, wage ambiguities and inhumane working conditions are undeniable problems. Likewise, the rate of circularity in the industry is still extremely low: only 1% of textile material is reused in a true closed-loop manner.[20]

In Finland, the textile and fashion industry has undergone considerable structural change in recent decades. The sector, firstly growing fast after the war, has since, with rapid globalisation, moved almost entirely to low-cost countries.[21] However, innova-

20 Ellen MacArthur Foundation. (2017). A New Textiles Economy: Redesigning fashion's future. **21** Tekstiiliteollisuusmuseo. (2006). Suomen tekstiiliteollisuuden tarina. [Story of the Finnish textile industry]. http://www.tkm.fi/lehdistokuvat/tekstiiliteollisuusmuseo/Lue_historia.pdf

tions in digitalisation, materials and business models are creating growth potential for the sector in Europe as well. The potential is most significant in the transition to the circular economy.

Several pioneers have emerged in Finland in the 2010s. One example has appeared in the intersection of the textile and forestry industries, where new types of fibres have been created from wood-based materials. New business models have also emerged around recycled textiles, chemical recycling and the utilisation of surpluses.[22] With the new EU directives obliging the collection of textile waste, the recycling infrastructure has also developed, and this development has extended from consumer waste to industrial waste collection.[23] Brand new solutions are not always even required as the trade of second-hand clothing and renting clothes[24] can also be considered part of the circular economy, since they significantly extend the lifespan and increase utilisation of products. These developments show that the circular economy has already begun to develop in the textile sector and created new industry in Europe, but there is still a long way to go for the business to become mainstream.

How the transition of the fashion and textile sector to a circular economy be promoted in the EU? The simplest step is to extend the life cycle of textile products. By changing VAT, it would be possible to encourage the use of repair services and second-hand clothing as a competitive alternative to the purchase of new clothing. Secondly, consumption must also be directed towards circular economy products. In addition to financial incentives, it is possible to support consumer decision-making with standards and labels that make it easier to guarantee the environmental performance of

22 e.g. new Finnish innovators Pure Waste Textiles, Infinited Fiber and Ioncell and the large manufacturer Finlayson. **23** Tekstiilien kiertotalous etenee: Poistotekstiilien jalostuslaitos avataan Paimioon 2021. [Circularity in textiles is progressing: A textile waste processing plant will be opened in Paimio in 2021]. (18.8.2020). https://www.stjm.fi/uutiset/poistotekstiilien-jalostuslaitos-paimioon/ **24** e.g. Finnish Vaatepuu and Lindström.

products. The public sector is also a major buyer of workwear,[25] so adding circular economy criteria for public procurement is an easy way for politicians to promote development of the market. Facilitating the development of cross-industrial recycling ecosystems[26] and ensuring the free flow of information can also improve product traceability and at the same time promote the recycling of materials and the treatment of textile waste in the clothing sector.

Transport and logistics

The transport sector is responsible for almost a quarter of Europe's greenhouse gas emissions and is the main source of air pollution in cities. Despite its large impact, the sector has not yet achieved the same emission reductions as other sectors.[27] It's not surprising indeed that the EU's current objectives call for an immediate systemic change in transport. The main goal in bringing circularity into transport is to achieve the same coverage and convenience more sustainably and with less materials.

At present, passenger cars cover more than 80% of passenger traffic, almost half of urban land is reserved for transport, and transport is the second largest household expenditure. However, the average car spends 95% of its time parked, and the necessary emission and cost efficiency is not achieved in logistics either.[28]

25 Dodd, N. & Gama Caldas, M. (2017). Revision of the EU Green Public Procurement (GPP) Criteria for Textile Products and Services. European Commission. https://ec.europa.eu/environment/gpp/pdf/criteria/textiles_gpp_technical_report.pdf **26** Patala, S., Salmi, A., Bocken, N. (2020). Intermediation dilemmas in facilitated industrial symbiosis. Journal of Cleaner Production, 261. https://doi.org/10.1016/j.jclepro.2020.121093
27 European Environment Agency, https://www.eea.europa.eu/data-and-maps/indicators/transport-emissions-of-greenhouse-gases/transport-emissions-of-greenhouse-gases-12, The European strategy for low-emission mobility. (2016). European Commission. https://ec.europa.eu/transport/themes/strategies/news/2016-07-20-decarbonisation_en
28 Material Economics. (2018). The Circular Economy a Powerful Force for Climate Mitigation - Transformative innovation for prosperous and low-carbon industry. https://media.sitra.fi/2018/05/04145239/material-economics-circular-economy.pdf

However, the opportunities in the transport sector are vast. Considering *Mobility as a Service* (MaaS), it is a growing market that is estimated to grow to USD 1.75 trillion by 2028.[29] MaaS is one of the means to facilitate a fair transition to a low-emission, safe, automated and highly consumer-oriented transport system.

A lot of development is already happening in Europe, but there is still work to be done. Politicians must set clear target levels for emission reductions and circularity and thus ensure companies a predictable operating environment. Compatibility and integration of everything with data is essential in the development of smooth, diverse travel and logistics chains. Close monitoring and traceability will help achieve the set circular economy goals. Therefore, the development of a digital internal market and an advanced data policy will enable European companies to develop scalable circular economy services for the global market as well.

Incentives imposed by fiscal policy also play a particularly important role. This includes e.g., enhanced construction of charging infrastructure, incentives for electric vehicles, personal incentives for choosing alternative transport methods and reducing subsidies favouring private cars. Pricing should also encourage efficiency in logistics. However, the policies must also advance a fair transition, as public acceptance for the new economic model is essential. Environmentally friendly vehicles typically require higher initial investment than conventional vehicles and may therefore be beyond the reach of many consumers and businesses.

We also need a coherent policy on investment in digital infrastructure and RDI. Public sector funding at both national and EU level should always be linked to the promotion of the circular economy and the green economy. It is important to develop a common framework for measuring and evaluating project selection and the results, as well as overall progress in the EU. Public procurement

29 BIS. (2018). Global Mobility as a Service Market. https://bisresearch.com/industry-report/mobility-service-market.html

and the know-how required for circularity procurement also play a major role. Examples of this are the modernization of public transport and the construction of circularity-based transport systems at the local level. Here, cities have a lot of leeway.

Cities and local policy

Urbanization is a global megatrend and one of the most essential developments of our time. According to the World Bank, more than a half of the world's population live in urban areas, and this share will increase to two-thirds by 2050.[30] At the same time as cities are gathering population and acting as engines of the global economy—accounting for 85% of global GDP generation—they are also aggregating resources and food. Globally cities consume more than 75% of natural resources, produce more than 50% of waste and emit 60-80% of greenhouse gases.[31] Therefore, the role of urban development in building a sustainable future will continue to grow in the future and it can be directed by zoning, infrastructure and use of technology.[32]

Alongside with urbanisation, a more culturally and politically independent role has also strengthened for the cities. This was seen for example when President Trump withdrew the United States from the Paris Climate Agreement, when major U.S. cities still decided to continue their policies of building a sustainable future whatsoever the federal level decides.[33] The city of San Francisco, for example, set a goal of zero waste as early as 2002, and the city has since taken the lead in the ecological transition having nearly reached its goal.[34]

30 The World Bank. (2020). World Development Indicators. https://datacatalog.worldbank.org/dataset/world-development-indicators **31** Ellen MacArthur Foundation. (2017). Cities in the Circular Economy: An Initial Exploration. https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Cities-in-the-CE_An-Initial-Exploration.pdf **32** Williams, J. (2019). Circular cities. Urban studies, 56(13), page(s): 2746-2762. **33** Reuters. (2017). #WeAreStillIn: 'America will meet the Paris Agreement despite Trump'. https://www.reutersevents.com/sustainability/wearestillin-america-will-meet-paris-agreement-despite-trump **34** San Francisco Department of Environment. (2020). Zero waste FAQs. https://sfenvironment.org/zero-waste-faqs#practices

A few years later, San Francisco and several other megacities founded the C40 network, its nearly 100 cities now representing more than 700 million people and a quarter of the world economy. [35]

The cities in the C40 network are committed to mitigating climate change and promoting sustainable solutions. In San Francisco itself, material efficiency, reuse, recycling, and composting have created thousands of jobs and halved the amount of waste between 2000 and 2015. Amsterdam, part of the network as well, is in turn seeking leadership in the transition to circularity and is now working towards mapping out all the material flows in the city. [36]

Although there are no cities of the C40 network in Finland, good examples are found, nonetheless. The city of Turku aims for carbon neutrality already in 2029, when the city turns 800 years old.[37] The target is one of the most ambitious in the world and shows how cities can sometimes set even more ambitious target levels than governments. The city also wants to be an international pioneer in circular economy solutions, with a special focus on promoting participation.[38]

Turku believes that success in the circular economy is based on the participation of citizens, communities and companies. Through common goals, different participants have found that smart solutions lead not only to a safer and more sustainable future, but also to new business and growth opportunities. Indeed, cities around the world have shown that concrete action is not only possible but also profitable. However, the circular economy cannot be left to the sole responsibility of a few cities, and there is no room for free riders. A more sustainable future requires system-level planning, strategic cooperation and decisions at every political level.

35 C40. (2018). Municipality-led circular economy case studies. https://www.c40.org/researches/municipality-led-circular-economy **36** C40. (2018). **37** City of Turku. (2019). Turku vastaa vahvasti ilmastonmuutokseen. [Turku answers climate change strongly]. https://www.turku.fi/blogit/kohti-vuotta-2029/turku-vastaa-vahvasti-ilmastonmuutokseen **38** Circular Turku. (2020). A blueprint for local governments to kick start the circular economy transition. https://e-lib.iclei.org/publications/Turku-report-web.pdf

Concluding thoughts

The private sector has already begun to show increasing interest in the business opportunities opened up by the circular economy transition, which are a win-win for both the economy and the environment. By 2018, jobs related to the circular economy in the EU have grown to four million, and the application of the principles of the circular economy to the whole economy is estimated to create 700,000 new—and more sustainable—jobs by 2030. A study by McKinsey calculates the grown resource productivity and the externality benefits achieved by this would at the same time increase the Union's GDP by extra 0.5% a year[39]. Similarly, the creation of closed material loops in Europe will also reduce our dependence on imported raw materials and can thus further strengthen our own economy. The transition to a low-carbon and sustainable economic model thus need not mean impoverishment—circular growth is also an economic opportunity.

39 McKinsey & Company. (2015). Growth within: A circular economy vision for a competitive Europe. https://www.mckinsey.com/business-functions/sustainability/our-insights/europes-circular-economy-opportunity

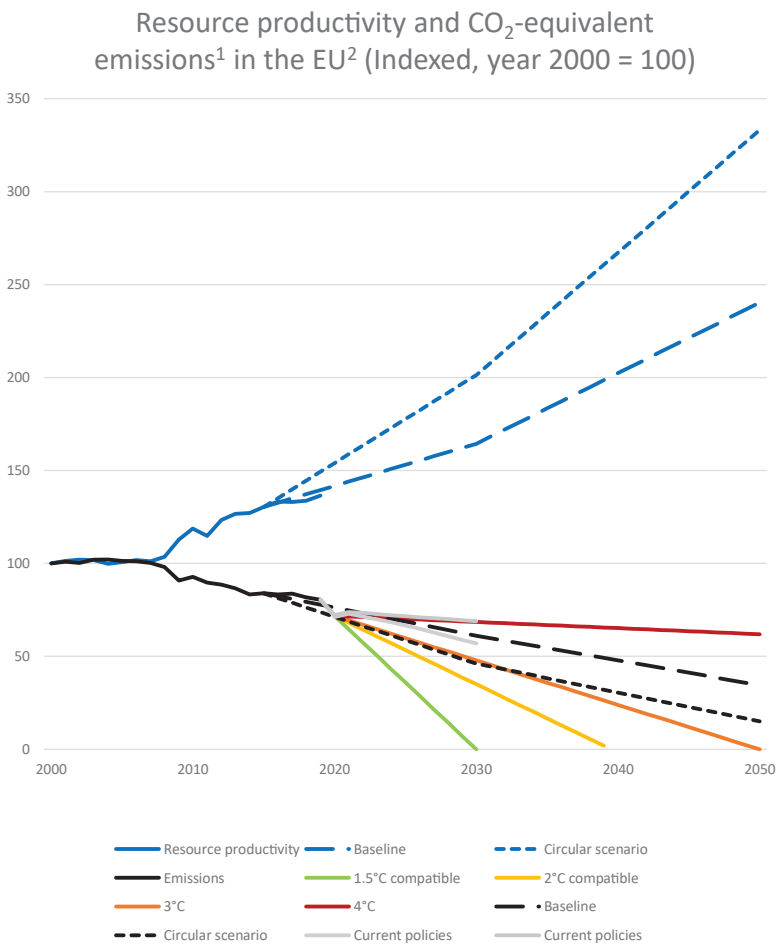

Figure 5. Although other measures are needed too, according to a scenario by McKinsey and the Ellen McArthur Foundation, applying circular economy principles in the EU can help bridge the emissions gap and increase resource productivity significantly at the same time. Resource productivity estimates are calculated from the GDP scenario and includes domestic material consumption of mobility, food, built environment, virgin automotive and construction material, virgin synthetic fertiliser, pesticides, agriculture land and water use, car and heating fuel, land for residential and office buildings and non-renewable electricity. Historical data for productivity by Eurostat (2020) and emissions and targets by Climate Action Tracker (2020). Estimates by McKinsey & Company. (2015).

1 gross emissions, not including LULUCF in 2018 compensating for 6,5% of the emission
2 historical data EU-27 excluding the UK, estimations pre-Brexit but based on percentual change

It is estimated that meeting the climate and energy targets in the EU will require € 260 billion a year.[40] However, the funding does not have to be new investment or tax money, as a significant impact can be made by redirecting existing private investment—tens of trillions of euros—to projects that are building a more sustainable future. By making the political decisions that will enable Europe to become a forerunner in circular economy solutions and, if required, by providing actors with the needed push, the necessary investments will follow suit.

At the edge of a new paradigm the winners are those who, in their politics, do not remain on the defensive to protect the old world from inevitable change, but welcome the new world, the way of thinking, and the opportunities they open up with open arms. In the case of a systemic change, we really need to measure development and investment not at the level of election periods and quarters only, but over decades, while at the same time being able to make decisions of the future already in the present. I hope this book has been helpful in this.

We might only be at the beginning of a long and rocky path, but we know where we are heading. All we have to do now is to take the necessary steps.

40 Communication "United in delivering the Energy Union and Climate Action - Setting the foundations for a successful clean energy transition" COM(2019) 285

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