Building Adult Competences in
Zero Waste Circular Economy in Europe

ZERO-WASTE CIRCULAR ECONOMY

EUROPEAN E-BOOK

Building Adult Competences
in Zero Waste-Circular Economy in Europe

Project Number :2020-1-TR01-KA204-093013

Editor
Prof. Dr. Bedriye TUNÇSİPER

Building adult competences in Zero Waste
circular economy in Europe

Co-funded by
the European Union

This project (*Project title: Zero-Waste/ Building adult competences in Zero Waste circular economy in Europe Project Number: 2020-1-TR01-KA204-093013*) has received funding from the European Commission within Erasmus+ programme. The European Commission does not constitute an endersoment of the contents which reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

ZERO-WASTE CIRCULAR ECONOMY

EUROPEAN E-BOOK

Building Adult Competences in Zero Waste Circular Economy in Europe

Project Number :2020-1-TR01-KA204-093013

Editor

Prof. Dr. Bedriye TUNÇSİPER

ISBN 978-605-72860-9-3

Co-funded by the
Erasmus+ Programme
of the European Union

Building adult competences in Zero Waste
circular economy in Europe

Co-funded by
the European Union

ZERO-WASTE CIRCULAR ECONOMY

EUROPEAN E-BOOK

Building Adult Competences in Zero Waste Circular Economy in Europe

Project Number :2020-1-TR01-KA204-093013

Editor

Prof. Dr. Bedriye TUNÇSİPER

Authors*:

*Authors are listed in alphabetical order.

Adrián MOTA, Anita SPASOVSKA, Bedriye TUNÇSİPER, Daniela ANGELKOVIK, Ergün DEMİR, Fatmagül TOLUN, Ilija VUCKHOV, José Vicente GISBERT, Julia MOREIRA, Kadir DEMİR, Maria VENTURA, Metin AKBULUT, Murat Sabri SARAN, Nurdan ERDOĞAN, Özgür AYCİL, Rosie JAMES, Rükan Kutlu KORLU, Simon SRNKA, Zuzana PALKOVA

This project (*Project title: Zero-Waste/ Building adult competences in Zero Waste circular economy in Europe Project Number: 2020-1-TR01-KA204-093013*) has received funding from the European Commission within Erasmus+ programme. The European Commission does not constitute an endersoment of the contents which reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

Name of The Book : ZERO-WASTE CIRCULAR ECONOMY EUROPEAN HANDBOOK

Editor : Prof. Dr. Bedriye TUNÇSİPER

Authors*
*Authors are listed in alphabetical order.

: Adrián MOTA, Anita SPASOVSKA, Bedriye TUNÇSİPER, Daniela ANGELKOVIK, Ergün DEMİR, Fatmagül TOLUN, Ilija VUCKHOV, José Vicente GISBERT, Julia MOREIRA, Kadir DEMİR, Maria VENTURA, Metin AKBULUT, Murat Sabri SARAN, Nurdan ERDOĞAN, Özgür AYCİL, Rosie JAMES, Rükan Kutlu KORLU, Simon SRNKA, Zuzana PALKOVA

Layout :

1st Printing : May, 2023 - İZMİR

ISBN : 978-605-72860-7-9

PRINTED AND BOUND BY:

BALIKESİR POLİTİKA GAZETESİ
Kadir Ulaş Sürmelioğlu
Eski Kuyumcular Mahallesi Mekik Sokak Sandıkçı İşhanı kat 5 No 9 Karesi Balıkesir

T/ +90 (532) 577 70 97

www.info@politikam.com

Preface

Dear Readers,

This book, which we are honoured to present to you, represents a important step forward the circular economy and zero waste movements. This book, which is the output of the Erasmus+ Project titled "Building Adult Competencies in Zero Waste-Circular Economy in Europe" and numbered 2020-1-TR01-KA204-093013, coordinated by Izmir Democracy University and carried out with the cooperation of seven partner organizations in five different countries, Turkey, Macedonia, Sweden, Spain and Slovakia, aims to raise awareness among adults about zero waste and circular economy.

The book focuses in depth on zero waste, circular economy, smart cities, reduction, reuse, recycling and legislation on zero waste and circular economy concepts in Europe and worldwide. In particular, the main principles set by the European Union Green Deal and the United Nations 2030 Sustainable Development Goals formed the cornerstones of the project.

This book aims not only to provide information but also to offer solutions and possibilities for new ways of working and living. As is well known, our world is struggling with environmental problems caused by the global economic approach based on the "throw-make-use-dispose" principle. For this reason, important steps are being taken towards the transition to zero waste and circular economy, which will radically change our production and consumption approaches as the most important stage of ensuring sustainability. In this sense, education is very important for the establishment of zero waste and circular economy systems for a sustainable environment and for individuals to be involved in these practices.

The book emphasizes the importance of collaborative work at local, national, and international level to move forward in the field of Zero waste and circular economy. The book contains information for different stakeholders such as academics, policy makers and civil society organizations, especially adults, local governments, and the business world.

This project is an important step towards the goal of leaving a more sustainable world to future generations. With your support, awareness on zero waste and circular economy will increase and faster progress will be made in these areas.

I would like to thank our stakeholders SWIDEAS EU, Slovak University of Agriculture In Nitra, Balıkesir University, EMKICE Consultancy, Karesi Municipality, Fundacion Universitat Jaume I-Empresa and all the authors who contributed to the preparation of this book. I invite you to a new journey towards zero waste and circular economy in the pages of this book.

Prof. Dr. Bedriye TUNÇSİPER

Rector of Izmir Democracy University

CONTENTS

LIST OF FIGURES

LIST OF TABLES

Co-funded by the
Erasmus+ Programme
of the European Union

ZERO WASTE INTRODUCTION & PRINCIPLES

Dr. Metin Akbulut, Dr. Rükan Kutlu Korlu
Izmir Democracy University, Turkiye

1. INTRODUCTION

With the industrialization that has developed since the industrial revolution, on the one hand, the needs of the increasing world population are tried to be met, on the other hand, the problems caused by the increased production are tried to be solved. One of the problems caused by production and consumption is waste. Waste, especially in the last half century, has increased to a level that the eco-system cannot tolerate, seriously threatening the physical elements of air, water and soil, as well as the existence of biological elements such as humans, animals, plants and other microorganisms. In particular, the negative impact of plastic production and consumption and carbon emissions on global warming has reached dramatic levels (14).

The world produces 2.01 billion tons of urban solid waste per year, of which at least 33% is not managed in an environmentally friendly way. Worldwide, the average waste generated per person per day is 0.74 kilograms, but this figure ranges widely from 0.11 to 4.54 kilograms. Although they only make up 16% of the world's population, high-income countries produce about 34% of the world's waste, or 683 million tons (15). As of 2018, only 9% of the world's waste can be recycled (16). Even though it is late, human beings have realized these threats and are looking for ways to deal with them. The circular economy has therefore become inevitable, but there is still a long way to go.

Global warming is defined as the increase in heat-trapping greenhouse gas levels in the earth's atmosphere due to human activities, primarily fossil fuels, and the long-term warming of the Earth's climate system, which has been observed since the pre-industrial period (between 1850 and 1900). Global warming is generally measured as the average increase in Earth's global surface temperature.

Figure 1. Climate Change

Source : https://climate.nasa.gov/resources/global-warming-vs-climate-change/

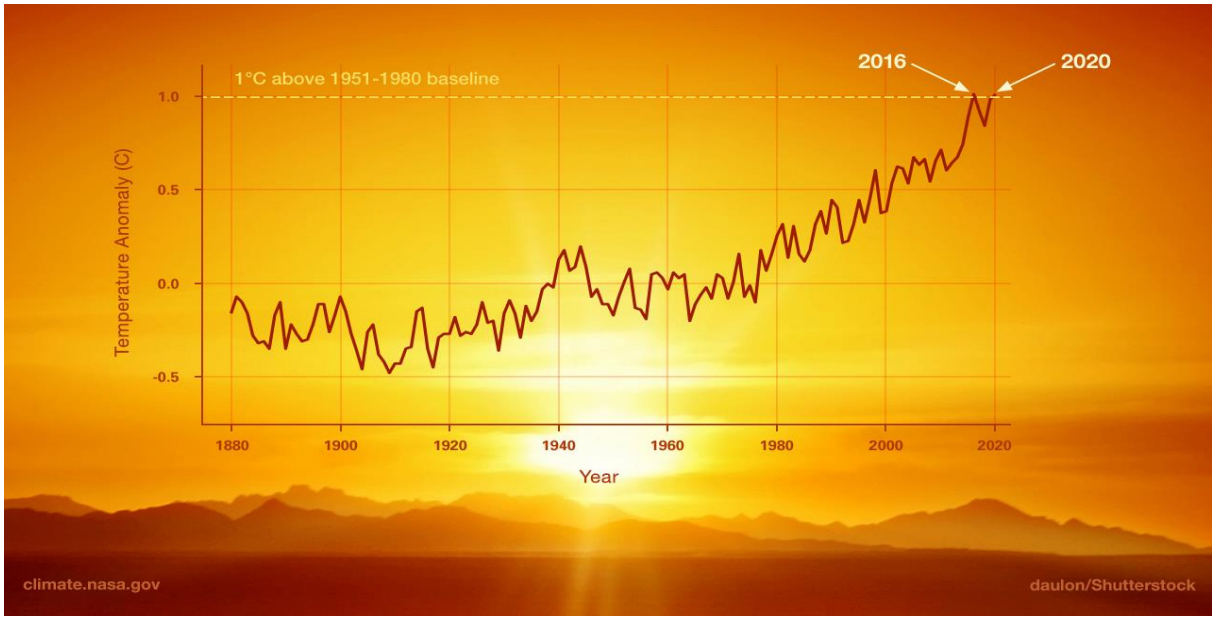


Figure 2. Global Warming (1880-2020)

Source : https://climate.nasa.gov/resources/global-warming-vs-climate-change/

The chart above shows the global surface temperature change between 1880 and 2020. Accordingly, while an increase was observed after 1951, the second increasing trend after 1980 was observed in 2016, and another increase was observed. It is estimated that since the pre-industrial era, human activities have increased the Earth's global average temperature by about 1 degree Celsius (1.8 degrees Fahrenheit). Currently, that rate is increasing by 0.2 degrees Celsius (0.36 degrees Fahrenheit) per decade. Therefore, it is urgently necessary for human beings to reduce their carbon footprint (31).

2. TRANSITION FROM LINEAR ECONOMY TO CIRCULAR ECONOMY

The Linear Economy, which started with the industrial revolution, is a one-way production and consumption model and was formed in a buy-build-use-dispose structure (1). In other words, this model does not have a solution for reclaiming the products produced after their expiration date. It is thought that this model has been adopted because it facilitates continuous growth and does not care about the post-production process. According to the Ellen MacArthur Foundation (2013), this model started when industrialized western societies managed to collect global resources in their development processes. In this way, these societies, which had abundant natural resources, were able to obtain material resources and energy in this way. In this way, producers have adopted the profitability of obtaining natural resources cheaper than the cost of labor in the production process (2). With the global economy adopting the linear economy model, large factories had to be established, sufficient natural resources had to be processed and turned into products, and economic growth had to be continued regardless of the wastes generated. In this sense, it is thought that this production-oriented model ignores the use of natural resources and sees the elimination of wastes as a solution (3). The linear economy model is a model that leaves the raw materials it uses to nature as waste. On the other hand, the circular economy represents an alternative to the linear economy model that dominates today. The circular economy model is defined as a model that has a holistic process, enables the reuse of products and raw materials, recycles waste, uses energy and all resources efficiently, produces clean production in a way that produces almost no waste, and is an important tool for sustainability (1).

Figure 2, which describes the transition from linear economy to circular economy above, shows the transition to circular economy after the linear economy model that started with the industrial revolution. Looking at the circular economy model, it is seen that there is a zero waste oriented approach. According to the figure, with the linear economy process that started in the 18th century, it is seen that the wastes generated after consumption are thrown directly into the nature. In the model shown with the metaphor of metabolism introduced after the 1970s, it is seen that some of the wastes are transformed. In the circular economy model, a flawless cycle is planned and as a result, a waste-free production and consumption process is targeted.

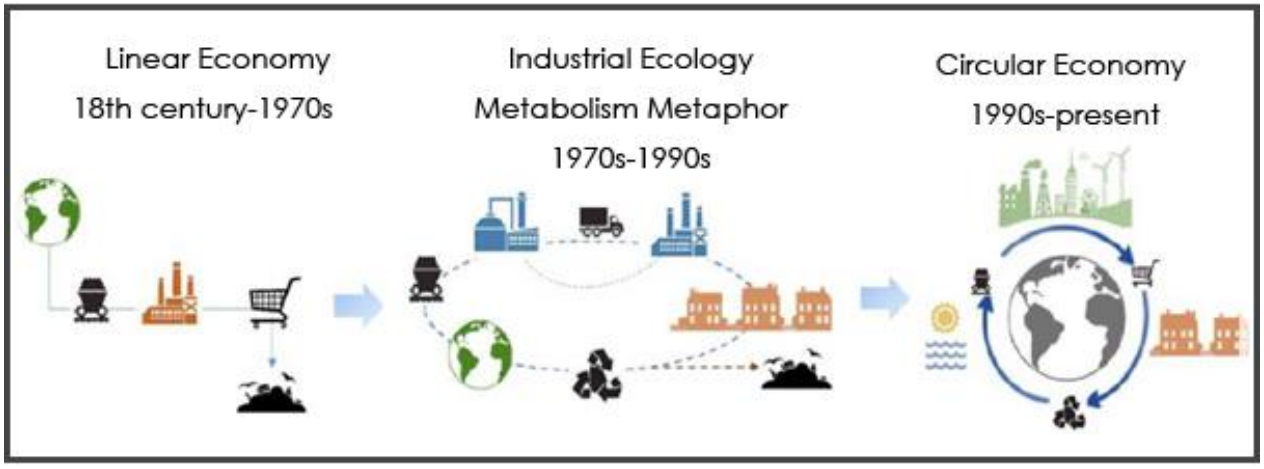
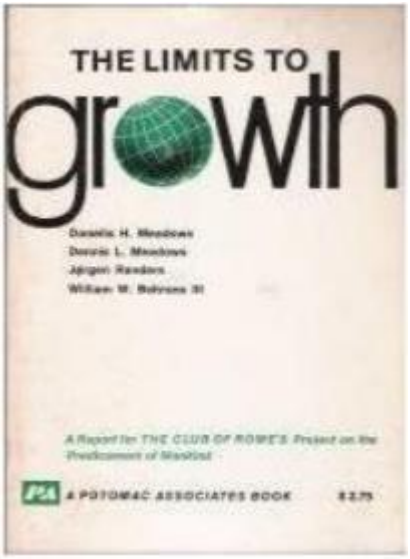


Figure 3. Transition from Linear Economy to Circular Economy

Source: Prieto-Sandoval et al. (2017).

2.1. FIRST STEP TO SAVE THE PLANET: THE LIMITS TO GROWTH

Scientists who realized that the size of the pollution that the world experienced due to linear economy increased in the past and will increase in the coming years, wrote various studies. One of them is the report titled Limits to Growth, which was prepared by a group of scientists from Massachusetts Institute of Technology (MIT), who are specialized in various fields, by the strategy development center called the Club of Rome and published in 1972. This report for the first time revealed the contradiction between unlimited and uncontrolled growth and the world's limited resources and made various recommendations (4). In this report, using a model, the interconnections of the five subsystems (headings) of the global economic system, namely population, food security, production, environmental pollution, and consumption of non-renewable natural resources, were investigated (4). As a result of these studies, the disadvantages of continuing the linear economy model at that time and in the future were revealed. This study also reminds of another recent study. In this study, the concept of Planetary Borders and processes are explained. The concept of planetary boundaries was defined in 2009 by a number of Earth systems and environmental scientists led by Johan Rockström and Will Steffen of the Australian National University as the concept of 9 Earth system processes with boundaries. The concepts included in the figure below are as follows (5):



Loss of biosphere integrity (biodiversity loss and extinctions) (With the rapidly increasing population in the world, the opening and inappropriate use of new agricultural areas, urbanization, fossil fuel use and carbon dioxide emissions are increasing. With this increase, there is a threat of decrease in biodiversity. (Research continues to determine the limits of chemical pollution. clear enough that it does not need to be proven to be high.)

* *Climate* Change (This is the area where change is most evident. Action should be taken so that this limit is not exceeded before its impact on daily life increases.)

* *Ocean* acidification (The oceans slow down the warming of the world by absorbing carbon dioxide, but the level of carbon dioxide has reached levels that the oceans cannot cope with.)

* *Freshwater consumption and the global hydrological cycle* (Water is becoming more and more scarce day by day. By 2050, it seems likely that around half a billion people will have a problem with water consumption. This increases the pressure to intervene in water systems.)

**Chemical pollution and the release of novel entities* (Although there are many examples of the negative contribution and synergistic effects of chemicals, they still have not been adequately analyzed scientifically. Currently, the chemical pollution limit cannot be defined numerically, but it is important that research continues due to the risk of crossing the Earth system thresholds.)

* *Land system* change (It is one of the causes of dramatic declines in biodiversity, as well as the consequences on water flows and the biogeochemical cycle of carbon, nitrogen, and phosphorus, among other elements.)

* *Nitrogen and phosphorus flows to the biosphere and oceans* (Humans have significantly affected the nitrogen and phosphorus biogeochemical cycles as a result of numerous industrial and agricultural processes. Because nitrogen and phosphorus are vital ingredients for plant growth, the manufacturing and application of fertilizers has been an issue of concern.)

* *Atmospheric aerosol loading* (The atmospheric aerosol planetary boundary was proposed because of the significant impact of aerosols on Earth's climate system. Through their interaction with water vapor, aerosols play a critically important role in the hydrological cycle, influencing cloud formation and global-scale and regional atmospheric circulation patterns such as monsoon systems in tropical regions. It also has a direct effect on how much solar radiation is reflected or absorbed in the atmosphere.)

**Stratospheric ozone depletion* (It is seen that the steps taken thanks to the Montreal Protocol remain within this limit. This shows how effective human beings can be.)

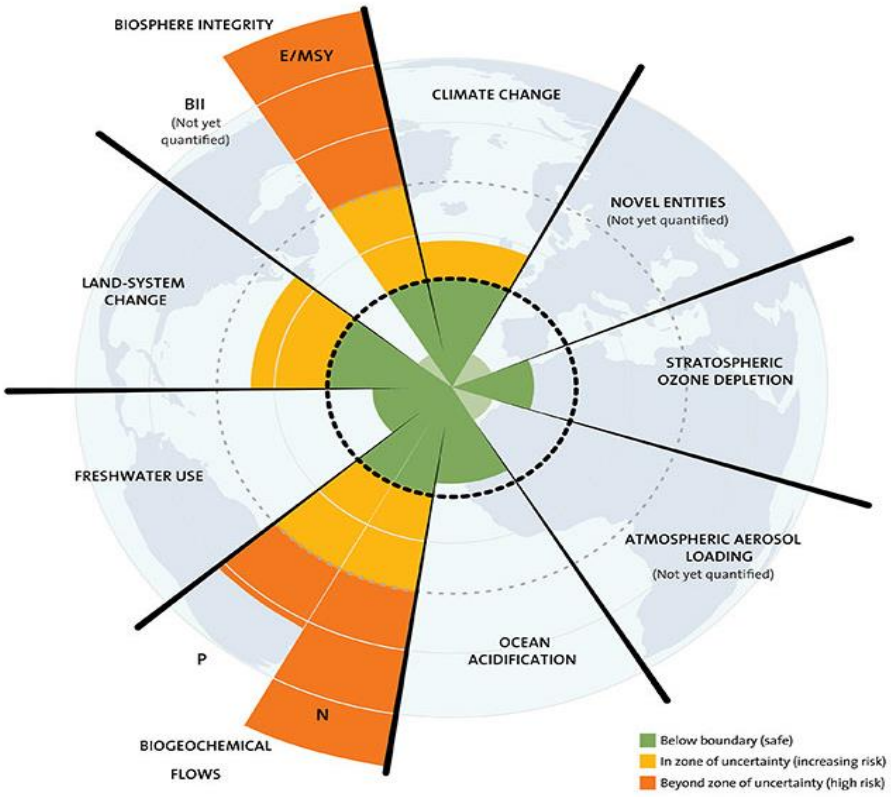


Figure 4. The Nine Planetary Boundaries

Source : https://stockholmresilience.org

2. 2. EUROPE GREEN AGREEMENT (GREEN DEAL)

European Green Deal action plan; It aims to increase the efficient use of resources, restore biodiversity and reduce environmental pollution by moving from a clean, linear economy (LE) to a circular economy (CE). With this action plan and policy areas, it is aimed to invest in environmentally friendly technologies in production, to encourage innovative approaches in this regard, to produce clean energy, to reduce carbon emissions to zero and to end the dependence on natural resource use. While achieving all these goals, an inclusive approach is envisaged to increase the quality of life of societies at the same time. For this reason, it is expected that all stakeholders related to this issue will take action and fulfill their responsibilities.

The European Green Deal emerged as a response to these challenges. This agreement is seen as a new growth strategy aimed at transforming the EU by 2050 into a just and prosperous society with a modern, resource efficient and competitive economy, free of net greenhouse gas emissions and a circular economy (8). The figure below shows the different elements of the green consensus.

Figure 5. The European Green Deal

Green Deal action plan; It envisions increasing the efficient use of resources, restoring biodiversity and reducing pollution by moving to a clean, circular economy. Strategies under the main heading of comprehensive and transformative policies are:

- Increasing the EU's climate targets for 2030 and 2050,
- To provide clean, accessible and safe energy,
- Mobilizing industry for a clean and circular economy
- An energy and resource efficient way to build and renovate
- Accelerating the transition to sustainable and smart mobility
- From farm to fork: designing a fair, healthy and environmentally friendly food system
- Protecting ecosystems and biodiversity
- Zero pollution target for a toxic-free environment

The EU has made some plans and developed mechanisms in the process of realizing the transformation targeted within the scope of the Reconciliation. These are stated below (8).

- Under the heading of mainstreaming sustainability in all EU policies;;

  -To ensure a fair transition by considering green finance and investment,

  -Greening national budgets and sending accurate price signals

  -Mobilizing research and promoting innovation

  -Enabling education and training

  -Green oath -Do no harm spherical one

- leader as the EU
- Europe climate pact

It is not possible for Europe to achieve the environmental goal of the Green Deal by acting alone. Climate change and biodiversity loss are global and not nationally limited. For this purpose, the EU; it wants to use its sphere of influence, expertise and financial resources to act collectively with its neighbors and stakeholders on this path. For this reason, the EU wants to establish alliances by leading on an international scale (8). The European Green Deal will improve the well-being and health of citizens and future generations by providing (9):

Figure 6. Targeted future with the Green Deal

Source : ec.europa.eu

2.3. EU WASTE POLICY GENERAL FRAME

Looking at the general framework of the EU Waste policy, it is seen that the community policy on waste management has five main objectives. These are(19):

- Environmentally friendly waste and/or less waste;
- Producing environmentally friendly products and preventing waste through the promotion of intensive technology and processes;
- promoting the reuse and recovery and reprocessing of waste;
- Developing legislation to improve waste disposal Establishing binding environmental standards at European level;
- Tightening the legislation on the transport of dangerous goods;
- It is the purification of the lands that have been exposed to pollution by reclamation.of waste again use of and back earnings with again to be processed incentive to be made.

Source: http://www.yesilokullar.org/ Blogs/Detail/2/Geri-Donusum-ve-Sifir-Atik

3. ZERO WASTE STRATEGY WITHIN THE FRAMEWORK OF THE EU CIRCULAR ECONOMY ACTION PLAN

In 2015, the European Commission adopted its first circular economy action plan. This action plan covers transitioning Europe to a circular economy, fostering sustainable economic growth, enhancing global competitiveness, and taking steps to create new jobs. The action plan includes clear and ambitious initiatives that cover the full life cycle, from production and consumption through waste management and the secondary raw material market, as well as a revised waste law proposal.

On 4 March 2019, the European Commission adopted a comprehensive report on the implementation of the action plan. The report outlines the key avenues and future challenges to shape the European economy and pave the way for a climate-neutral, circular economy in which consumption and pollution pressures on natural and freshwater resources and ecosystems are minimized (10).

In the past and today made studies it shows of waste This way to increase continue to do our planet tolerance cannot to the results path opens. Therefore, under the leadership of the EU linear

economy in its place cyclical of the economy science circles, governments, NGOs and special sector organizations by adoption with None Waste of strategy development with relating to idea union has been.

Compared to the development of zero waste applications, the concept seems to be old. In 1973, Dr. Paul Palmer first used the term "zero waste" to recycle chemicals (20). Although this is a good start, the issue of zero waste was not on the agenda for a long time, perhaps due to costs and difficulties. The zero waste movement is believed to have started at the turn of the century, about twenty years ago. The concept of "No Waste" advocated by recycling activists has been replaced by the concept of "Zero Waste" as we know it today. Zero waste strategies first emerged at a conference in New Zealand led by campaign member Warren Snow and quickly spread. Another milestone is Bea Johnson's 2013 book "Zero Waste Home: The Ultimate Guide to Simplifying Your Life" in which she describes the Rs 5 method. This book is widely recognized by the public for incorporating the core principles of Zero Waste and emphasizes the active consumer role in reforming waste management practices. Today, it can be said that zero waste is an important social movement that is constantly growing all over the world and is adopted by international organizations (6).

According to the 2018 definition made by the Zero Waste International Alliance (ZWIA), zero waste is the conservation of all resources through the responsible production, consumption, reuse and recycling of all products, packaging and materials without incineration or discharge into the environment or into soil, water or air that threatens human health (7).

Source:https://egirisim.com/2021/04/12/girisimlere-firsat-pepsiconun-turkiyedeki-6 ısıfabrikasina-sifir-atik-sertifikasi-verildi/

4. CIRCULAR ECONOMY BUSINESS MODELS FOR ZERO WASTE

> *Almost all packaging industries are currently dependent on disposable packaging and this comes at a huge cost to the environment and society. Reuse packaging systems offer great opportunities for the environment, people and the economy." – Larissa Copello, Zero Waste Europe Campaigner (18).*

Fundamental changes are needed in the transition from linear business models to circular business models. For this, business models that will be adopted by producers, consumers and all segments must first be tried and then disseminated (1). In the table below, Bocken et al. (2016) include key business model strategies that fit within the framework of slowing down and closing resource cycles approaches (11). When looking at the business model strategies to slow down the cycles in the Table below, it is aimed to use any product on a shared basis instead of being purchased, or to use it on other platforms. For example, car sharing or document sharing from digital media can be given. In the strategy of extending the value of the product, it is aimed that the product produced is returned to the producer after the consumer's use and not to become a waste. In other words, the recyclable parts of the products are reused by the manufacturer. Reusing parts of cars, clothing and electronics. The important issue at this point is the use of recyclable materials in the production of products at the first production stage. Another strategy is to extend the life of products by producing durable products. In this regard, examples of durable white goods or luxury consumer goods are given.

Table 1. Business model innovations to slow and close resource loops.

Business Model Definition	**Strategies**	**Examples of cases**
Business model strategies for slowing loops		
1 Access and performance model	Providing the capability or services to satisfy user needs without needing to own physical products	• Car sharing • Laundromats • Document Management Systems (eg Xerox, Kyocera) • Tuxido hire • Leasing jeans • Leasing phones

2 Extended product value	Exploiting residual value of products – from manufacture, to consumers, and then back to manufacturing – or collection of products between distinct business entities	• Automotive industry – remanufacturing parts • Gazelle offering consumers cash for electronics and selling refurbished electronics (gazelle.com) • Clothing return initiatives (eg H&M, M&S' Shwopping)
3 Classic longlife models	Business models focused on delivering long-product life, supported by design for durability and repair for instance	• White goods (eg Miele's 20 year functional life span of appliances; [4]) • Luxury products claiming to last beyond a lifetime (eg luxury watches such as Rolex or Patek Philippe)
4 Encouragement	Solutions that actively seek to reduce end-user consumption through principles such as durability, upgradability, service, warrantees and reparability and a non-consumerist approach to marketing and sales (eg no sales commissions)	• Premium, high service and quality brands such as Vitsœ and Patagonia [7] • Energy Service Companies (ESCOs)
Business model strategies for closing loops		
5 Extending resource values	Exploiting the residual value of resources: collection and sourcing of otherwise "wasted" materials or resources to turn these into new forms of value	Interface – collecting and supplying fishing nets as a raw material for carpets • RecycleBank – providing customers with reward points for recycling and other environmentally benign activities (recyclebank.com)

6 Industrial Symbiosis	A process- orientated solution, concerned with using residual outputs from one process as feedstock for another process, which benefits from geographical proximity of businesses	• Kalundborg Eco-Industrial Park (http:// www.symbiosis.dk/en) • AB sugar and other sugar refiners – internal "waste = value" practices

Source: *Bochen et al ., 2016.*

The other strategy is to extend the end user's lifetime by increasing the capabilities of the products. It is aimed to extend the time for the end user to buy products again by producing warranty, service and durable products.

"Circular economy approach will also be able to protect from price changes caused by supply shocks experienced by economies dependent on natural resources due to the depletion-depletion of these resources (12)"

When looking at the business model strategies to close the loops, it is aimed to benefit from the residual value of the products. In this way, it is aimed to use the wastes as raw materials instead of sending them to the garbage and to create a new product. Industrial symbiosis strategy is another approach in closing the loop strategy. It is here that the residual outputs of a production are used for production in another facility nearby or evaluated in the same facility as the integrated facility. For example, the waste from the furniture factory is used for heating.

4. 1. ZERO WASTE PRINCIPLES UNDER CIRCULAR BUSINESS MODELS

The principles that will facilitate the perception of it and ensure that both producers and consumers adopt it are included in academic publications and institution publications. These are listed below (13).

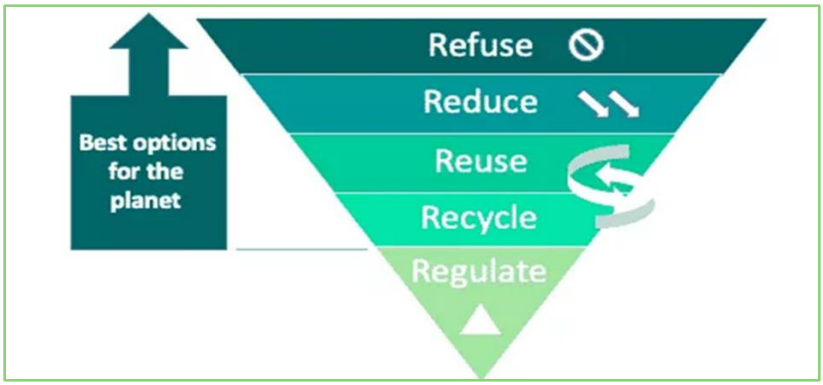


Figure 7. Zero Waste Principles (5R)

Source: puratium.com

Refuse: Before buying a product, rethinking whether we really need that product and refusing to buy the product. If the person does not really need the product, refusing to buy the product will prevent the depletion of the natural resources used to produce the product, while preventing the product from becoming waste after its expiration date. Therefore, the first principle to be followed in order for the planet to protect itself in a healthy way is to refuse to buy the product (13). As an example of this method (23):

- Not receiving certain items such as straws, cutlery and plastic bags.
- Taking photos of business cards or flyers offered to people instead of taking them,
- Not taking free water at various events by keeping free bottled water with them,
- Promotions way with offer of additional products need or not received and need to the thing leaving,
- It may be preferable not to buy plastic-packaged products from the super maker, so that the producer finds other solutions or buys the products directly from the farm,
- It is planning environmentally friendly trips.
- Instead of buying chemical cleaners and air fresheners, people produce their own methods at home or find other solutions,
- Posting an undesirable warning on the post box in order not to receive paper deliveries,

Reduce: Simplifying the lifestyle is crucial in the zero waste journey where the behavior of a single individual is important. Therefore, it is very helpful for people to consume only what they need. It is very normal to have items that have special meaning for people, but more items may not really be needed and this means a lot for a zero waste planet. Therefore, reducing consumption is an important step(13). More often than not, these products quickly end up in the trash, in the back of a closet, or swaddled in unsustainable packaging. Fast fashion, cheap electronics, and processed foods come to mind (24). As an example (23):

Disposable diapers generate approximately 6,731,000 tonnes of waste per year in Europe. The diverse composition of these products makes their recycling after use technically and economically complex and expensive. For this reason, 87% of these products are thrown away and 13% are burned. Today, washable diapers have become the preferred choice in some parts of Europe, as they used to be (17).

- It is possible to donate unused items. Each region has municipalities or charities that buy unused items..
- In case unused items are wanted to be sold, it can be done through local stores or various applications on the internet.

- Consumption from the madness far stop later will not be used the one which of products buy to be taken prevents. therefore to consume in its place other one hobby choice can be

Reuse: The main point of this principle is to buy second-hand items instead of new ones. In this way, it is possible to save money and to help those living in the vicinity to dispose of the products they do not use. Second, go to stores that allow you to bring jars or containers for loose goods[1à] and support the zero-waste trend. In this way, the packaging of products is limited and will greatly reduce plastic consumption and create a sustainable cycle. Third and lastly, it is possible for people to use natural beauty products or to buy used clothes (13). Besides that the following examples should be considered:

Source: https://globalwakecup.com/blogs/latest/start-your-own-zero-waste-community-in-2019

- A glass or stainless-steel water bottle and tap water instead of bottled water,
- Disposable shavers - electric shaver or straight-edge shaver,
- Instead of baking parchment, grease the pan or use a silicone mat,
- Use a lidded lunch box or jar instead of tin foil/stretch film,
- Cotton cloth instead of dish sponge,
- Bring your own cloth bag instead of paper bags/plastic bags,
- Cotton cloths or microfiber instead of paper towels,
- Loose tea and tea strainer instead of tea bags,
- French press instead of coffee capsules preferable.

Recycle: Even if the practice of recycling per person is limited, it is much easier to support organizations that promote recycling and to buy products made from recycled materials (toilet paper, books, etc.). Especially reducing the use of plastic and increasing the use of glass is a very vital issue today (13). On the other hand, it should not be forgotten that Zero Waste is a way of life as well as acting with conscious thinking. For this, it may be possible to act with various communities (26).

[1à] These are often products that haven't been packaged for a long journey and are sourced regionally or locally. Buying loose means shopping in a more environmentally friendly way.

Source: https://www.pencilforchange.com/zero-waste-community/ Source: https://ideaexchange.org /ideas/idea/zero-waste-and-composting

Regulate: Disposing of the waste generated by the linear economy should be seen as a last resort. For this reason, it is very important that people do not hesitate to come up with creative ideas for zero waste and share these ideas with people. Therefore, before throwing any garbage, it is possible to rethink and find solutions to organize waste (13).

In some sources, ROT is used instead of Regulate. Rot is when people compost their own household waste or participate in a composting program for organic waste (23). The importance of composting is that while allowing waste to decompose naturally, any organic matter that ends up in the landfill is forced to decompose without sufficient oxygen, thereby producing methane, a harmful greenhouse gas. Composting, either through municipal collection or at home, can help divert nearly half of your household waste and feed the environment or your own garden in the process (27).

Source: https://www.organicauthority.com/buzz-news/p45536

5. CONCLUSION

The production model of the linear economy model, which developed in the form of buy-build-use-dispose, has started to cause a clear deterioration of the natural balance today. Many problems such as global warming, forest fires, flood disasters, emerging new viruses directly affect the quality of life of people. For this reason, the linear economic system has reached an unsustainable point for humanity. The circular economy, which is a new model that can replace the linear economy, adopts the zero waste approach instead of the disposal of waste. Zero waste approach is a lifestyle that takes place in both production and consumption stages. In other words, it is a zero waste culture. In order to adopt this culture, it is necessary to create new business models, transform industries and educate consumers on this issue. Therefore, for a world without waste, the adoption of zero waste philosophy in production and consumption processes is inevitable for a more livable world.

REFERENCES/Links

[1] Deviant Veral Evren , (2021), " Circular Economy : Barriers , Strategies and Work Models , Ankara University ecology Journal 8(1), pp.7-18.

(2) Furkan Sariatli , (2017), Linear Economy versus Circular Economy: A comparative and analyzer study for Optimization of Economy for Sustainability, vol. 6, 2017, no. 1, pp.31-34.

(3) PRIETO-SANDOVAL, Vanessa, Carmen, JACA and Marta, ORMAZABAL, (2017). "Circular Economy: Relationship with the Evolution of the Concept of Sustainability and Strategies for its Implementation". Memoria- Investigaciones most Ingenieria , (15), 85-95

(4) Meadows, DH, Meadows, DL, Randers, J., & Behrens III, WW (1972), The Limits to Growth: A Report for The Club of Rome's Project on the Predicament of Mankind, Universe Books, New York.

(5) https://stockholmresilience.org/research/planetary-boundaries/the-nine-planetary-boundaries.html, Accessed: 07.11.2021

(6) https://puratium.com/zero-waste-principles/
(7) https://zwia.org/zero-waste-definition/
(8) https://ec.europa.eu/info/sites/default/files/european-green-deal-communication_en.pdf
(9) https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en
(10) https://ec.europa.eu/environment/topics/circular-economy/first-circular-economy-action-plan_en
(11) Bocken , NM, de Pauw , I., Bakker, CV& Van der Grinten , B. 2016. Product Design and Business Model Strategies for a Circular Economy. Journal of Industrial and Production Engineering, 33(5): 308-320.
(12) Preston, F. 2012. A Global Redesign? Shaping the Circular Economy Briefing Paper. Chatham House, London.
(13) https://puratium.com/zero-waste-principles/
(14) https://blog.policy.manchester.ac.uk/
(15) The World Bank
(16) https://www.circle-economy.com/news/the-circularity-gap-report-our-world-is-only-9-circular
(17) https://zerowasteeurope.eu/our-work/eu-policy/product-redesign/reusable-nappies/
(18) https://zerowasteeurope.eu/our-work/eu-policy/product-redesign/packaging/
(19) CPS 2012. Waste management About EU Acquis Directory . Istanbul & Brussels . http://www.mess.org.tr/media/filer_public/6b/58/6b583c70-1daa-4bc5-96b5-9c988df39db1/mess_atik_yonetimi_ab_mevzuat_rehberi.pdf.
(20) P. Palmer, " Getting to Zero Waste," Sebastopol: Purple Sky Press, 2004.
(21) https://sifiratik.co/
(22) https://www.organicauthority.com/buzz-news/p45536
(23) https://www.unsustainablemagazine.com/the-5-rs-of-zero-waste-living/
(24) https://zerowastexchange.org/551/the-5-rs-of-zero-waste-a-practical-guide
(25) https://www.sayingtruth.com/vancouvers-move-towards-zero-waste-community/
(26) https://www.pencilforchange.com/zero-waste-community/
(27) https://ideaexchange.org/ideas/idea/zero-waste-and-composting
(28) http://www.yesilokullar.org/Blogs/Detail/2/Geri-Donusum-ve-Sifir-Atik
(29) https://sifiratik.co/2018/09/20/gunes-panellerin-nasil-yapildigini-biyor-musuzun/
(30) https://egirisim.com/2021/04/12/girisimlere-firsat-pepsiconun-turkiyedeki-6-fabrikasina-sifir-atik-sertifikasi-verildi/
(31) https://climate.nasa.gov/resources/global-warming-vs-climate-change/

CIRCULAR ECONOMY IN EU UNDER THE ZERO WASTE CONCEPT

Dr. Bedriye Tunçsiper, Dr. Nurdan Erdoğan, Dr. Kadir Demir
İzmir Democracy University

Ilija Vuchkov, Anita Spasovska, Daniela Angelkovik
Emkice Consulting

1. INTRODUCTION

The latest projections by the United Nations suggest that the global population could grow to around 8.5 billion in 2030, 9.7 billion in 2050 and 10.4 billion in 2100 [1]. Despite recent pandemics, economic and energy crises, the world economy is anticipated to continue to expand. As a result, demand for natural resources will continue to rise in the next decades. A reasonable projection is that global material consumption will triple by 2050. Even though there is only one planet, by 2050, the globe will be consuming as if there were three.

According to World Bank figures, the global economy consumes more than 100 billion tonnes of raw materials each year while discarding around 90 billion tonnes as waste [2]. As stated in UN Environment "Global Resources Outlook 2019" report, global usage of resources such as biomass, fossil fuels, metals, and minerals is predicted to double over the next four decades, while annual waste generation is expected to climb by 70% by 2050 [3]. It is claimed that resource extraction and processing cause half of all greenhouse gas emissions and more than 90% of biodiversity loss and water stress.

The world's expanding population and desire for greater affluence are unavoidable facts. To prevent exceeding Earth's limits, humanity must fundamentally alter the way it uses its resources. In this regard, significant strides have been made in recent decades. In 2005, for example, the global economy utilized around 30% fewer resources to produce one unit of GDP than it did in 1980. Nonetheless, the utilization of natural resources is increasing in absolute terms. A 'normal' increase in resource management efficiency is insufficient. It is important to find solutions that increase prosperity for more people overall while reducing the overall amount of environmental stress [4].

The circular economy strategy, defined as a systematic approach to economic development continuity, can be viewed as a tool for tackling pressure on the environment while also addressing critical social needs. In other words, the circular economy addresses the economy, environment, and society—the three fundamental pillars of sustainability and, is seen as one of the key tools for realizing the concept of sustainable development. With the announcement of the action plan for the protection and improvement of people and their environment at the United Nations Conference on the Human Environment in Stockholm in 1972, where the concept of sustainability was first expressed, environmental regulations began to develop in the international arena. The

environment and related issues remained one of the top objectives on the global agenda in the years that followed. However, despite the actions taken during a 30-year period, it was revealed in the Millennium Ecosystem Assessment Report issued in 2005 that human pressure on habitats continues with a rising velocity. This highlighted the necessity for adequate tools to apply the notion of sustainability, which requires a significant compromise between the environment, economy, and social components.

Since the late 1970s, the concept of circular economy, which is viewed as one of these tools, has gained in prominence and momentum [5]. In the last few years, the circular economy has developed as a crucial tenet for industrial and environmental policies in China, Africa, the European Union (EU), and the United States, as well as an increasing number of enterprises and municipal governments. The implementation of the circular economy and circular business models are also frequently questioned in terms of its premises, practicability, and implications [6]. The circular economy concept will be explained in this modul, along with information on application examples.

2. WHAT IS CIRCULAR ECONOMY?

The Circular Economy concept first appeared in academic literature in 1966, when ecological economist Kenneth E. Boulding criticized the linear "cowboy economy" of the past and described a future as a "spaceship economy" in which all used resources were returned to the system, and it has been debated since the 1960s and 1970s, when the modern environmental movement was in its early stages [7]. Although academics and practitioners frequently use the term "circular economy," there is no agreement on what it actually entails. Furthermore, there are unique distinctions, divisions, and exclusions within research communities participating in circular economic study, such as researchers in engineering and business. For this reason, it is far easier to say what the circular economy is not than to say what it is. "The circular economy is not a theory, but an emergent strategy to industrial production and consumption," according to the World Economic Forum [8].

Circular economy can be defined as “an economic system that replaces the ‘end-of-life’ concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes. It operates at the micro level (products, companies, consumers), meso level (eco-industrial parks) and macro level (city, region, nation and beyond), with the aim to accomplish sustainable development, thus simultaneously creating environmental quality, economic prosperity and social equity, to the benefit of current and future generations” [9].

The Ellen Macarthur Foundation devised one of the most commonly used definitions, which is illustrated in the now-famous 'butterfly diagram' (Figure1) [10]. The circular economy is separated into two cycles in this visualisation: a biological cycle and a technical cycle, both of which are made up of actors and actions. The consumer for the biological cycle and the user for the technological cycle are located in the center of the diagram. The service provider, product manufacturer, and parts manufacturer are also stakeholders under this definition. This diagram is

complemented by three concepts dubbed "circular economy principles" by the foundation. The first is the preservation and enhancement of natural capital; the second is the longer circulation of products and materials in both cycles; and the third is the elimination of waste.

The biological cycle, depicted on the left side of the butterfly diagram, is for materials that can biodegrade and safely return to the soil. This cycle is mostly concerned with consumable products, such as food. Other biodegradable materials, such as cotton or wood, may eventually find their way from the technical cycle into the biological cycle after degrading to the point where they can no longer be used to manufacture new products. On the right-hand side of the butterfly diagram is the technical cycle, relevant for products that are used rather than consumed. The diagram depicts smaller inner loops surrounded by larger outside loops. Inner loops are where the most value can be captured because they preserve more of a product's embedded value by keeping it intact. Consider a smartphone: a working phone is worth more than the sum of its components since the time and effort that went into producing it is not wasted. As a result, interior loops such as sharing, sustaining, and reusing should take precedence over outer loops that see the product broken down and recreated. These loops also save money for customers and businesses since they reuse items and materials that are currently in use rather than investing in new ones. In a circular economy, the outermost loop, recycling, is thus the last choice because it involves removing a product's embedded value by reducing it to its fundamental ingredients [10].

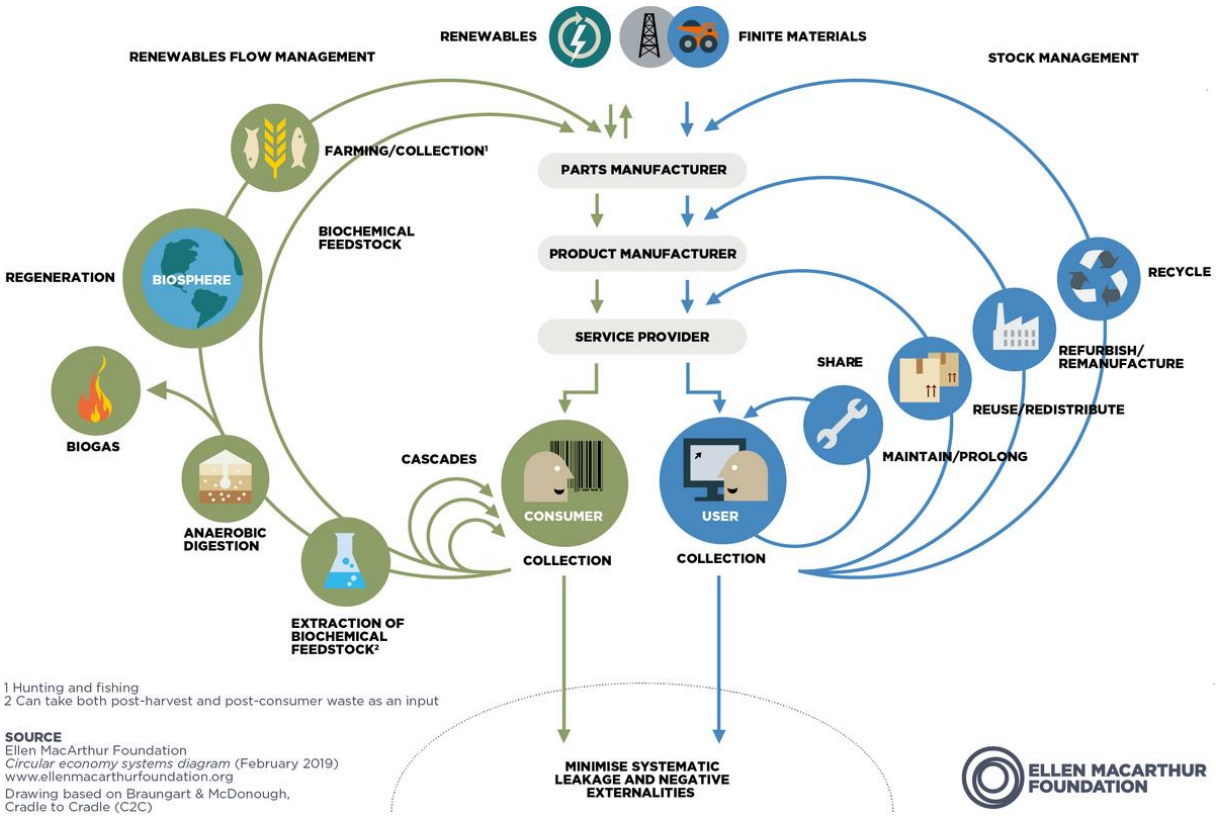


Figure 8. The circular economy system diagram, known as the butterfly diagram [10]

3. RELATION BETWEEN CIRCULAR ECONOMY AND WASTE MANAGEMENT

Solid waste generated by the current linear economy model of take-make-use-dispose is a major impediment to solving sustainability challenges and ensuring long-term economic growth, environmental protection, and social welfare. Linear economy model has become a major contributor to the problem of climate change and ecosystem destruction. This model only prioritizes the production of goods without considering how the goods produced will be used. The linear economy model is unconcerned about whether the end products just become waste and are disposed of in landfills, causing soil damage, or are burned, causing air pollution [11].

Since the 1970s, the notion of waste management has been promoted in order to reduce the waste problem generated by the linear economy. Waste management encompasses all of the activities and actions required to manage waste from generation through disposal. This covers, among other things, waste collection, transportation, treatment, and disposal, as well as monitoring and regulation. It also includes the legal and regulatory framework for waste management, including recycling guidelines etc.. The goal of waste management is to limit the potentially harmful impacts of waste on the environment and human health while also advancing the waste prevention, reduction, and recycling hierarchy.

The circular economy can be seen an alternative to current and predominant linear model by focusing on waste and resource management. It can be defined as a regenerative system that minimizes resource input and waste, emissions, and energy leakage by slowing, shutting, and narrowing material and energy loops. As a result, it is deeply linked to waste management and aims to achieve zero waste. Hence, the R framework is frequently emphasized while defining circular economy. While the 3R framework, which includes the concepts of reduce, reuse and recycle, is usually emphasized, the European Union (EU) Waste Framework Directive introduced "Recover" as the fourth R. The most comprehensive R framework, with 9R, is presented in Figure 2 below [9].

4. CORE PRINCIPLES OF CIRCULAR ECONOMY

Circular economy, as a restorative and regenerative economy model, is required to perform effectively at all implemention scales- for large and small firms, organizations and individuals, worldwide and locally. According to Ellen MacArthur Foundation, in implementation it is based on three principles (Figure 3)[12] [];

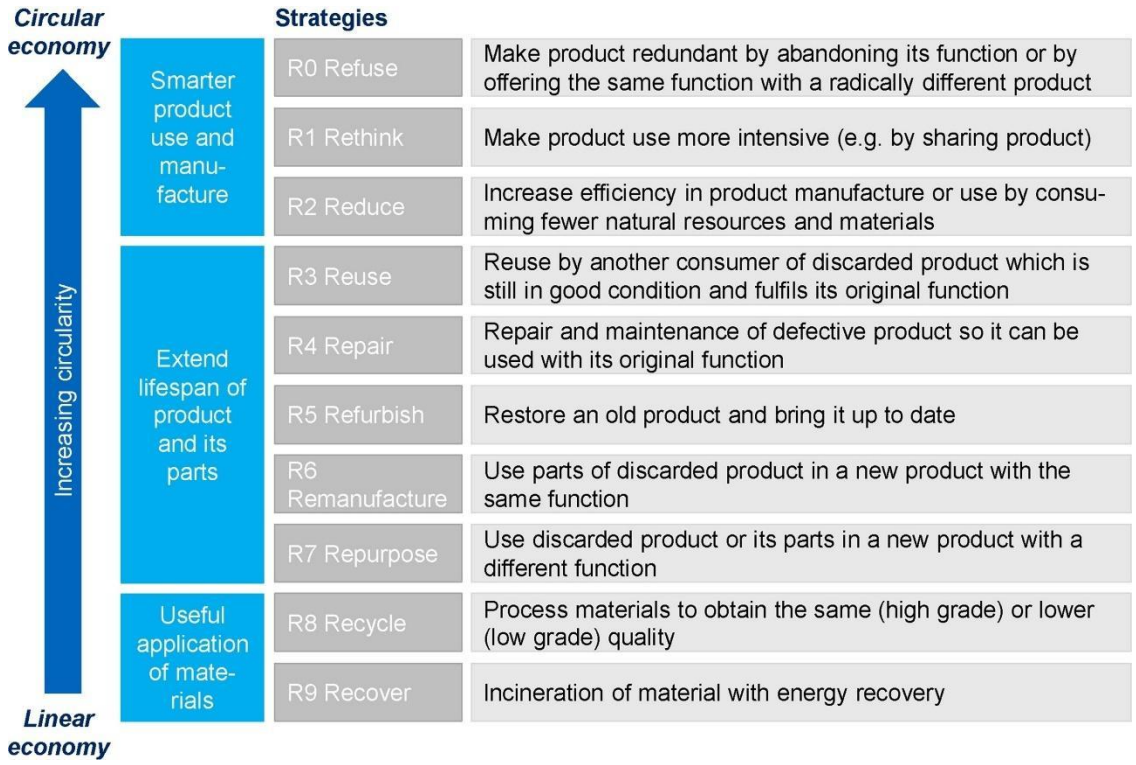


Figure 9. The 9R Framework [9]

Design out waste and pollution: A circular economy identifies and eliminates the negative effects of economic activity that harm human health and ecological systems. This includes the emission of greenhouse gases and dangerous substances, air, land, and water pollution, and structural waste such as traffic congestion. Understanding that waste and pollution are primarily a consequence from the manner in which we build things and discovering new and innovative ways to design out those negative aspects are central to the circular economy's ideas. Around 80% of environmental impacts are determined during the design stage, which means that shifting this sector toward higher circularity might have a greater impact throughout material cycles. We may prevent waste and pollution from occurring in the first place by altering our thinking to consider waste as a design flaw and utilizing new materials and technology.

Keep products and materials in use: A circular economy favors activities that conserve value such as energy, labor, and materials. This entails designing for durability, reuse, remanufacturing, and recycling in order to keep goods, components, and materials in circulation. Circular systems make efficient use of bio-based materials by fostering a variety of uses for them as they cycle between the economy and natural systems. The ideas are based on a basic premise: we cannot continue to waste resources. On a finite planet, the products and materials we make from the resources we extract must be kept in the economy for as long as possible. Some products and components are built with the intention of being reused, mended, or remanufactured. Making things stay longer, however, is only part of the issue; the resources used to create them must be returned to the

system. This is especially true for items and commodities with short lifespans, such as food and packaging, which can produce large amounts of waste if appropriate resource recovery strategies are not adopted.

Regenerate natural systems: A circular economy minimizes the use of nonrenewable resources while preserving or improving renewable ones, such as returning important nutrients to the soil to stimulate regeneration or using renewable energy instead of fossil fuels. There is no meaning of waste in nature; everything is cyclical. All of the great natural cycles - carbon, oxygen, nitrogen, water, and so on - operate in closed loops with little to no resource loss. The circular economy seeks to replicate these natural cycles by establishing an economic model that protects, sustains, and actively improves our environment.

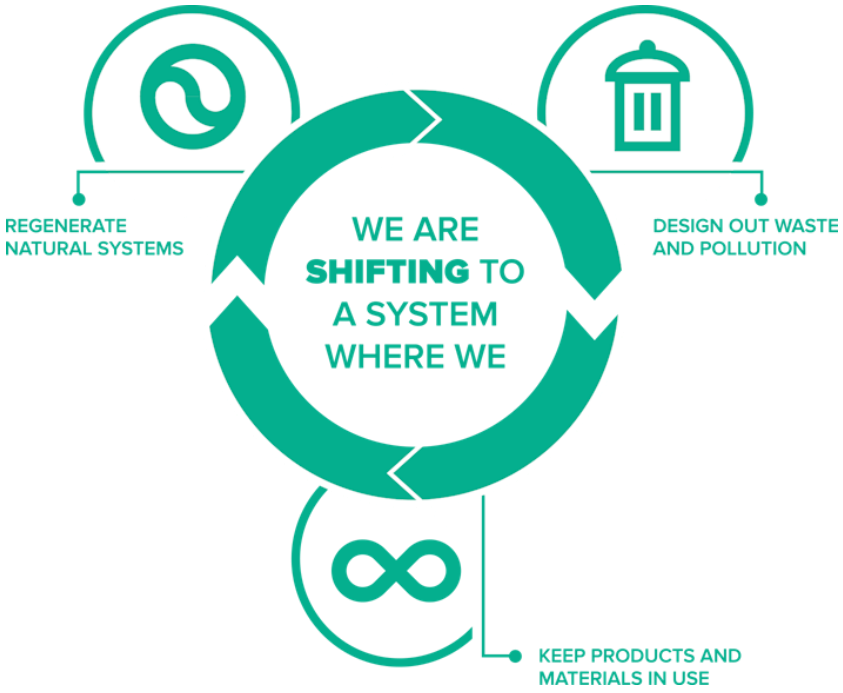


Figure 10. The core principles of Circular Economy

5. BENEFITS OF CIRCULAR ECONOMY

Environmental Benefits: The circular economy has a number of environmental advantages, making it a promising option for increasing sustainability and lowering environmental consequences. By reducing the need for raw materials and avoiding waste, the circular economy can assist to conserve natural resources. This can aid in the conservation of biodiversity and ecosystems, as well as the preservation of natural resources for future generations. According to a research conducted by the European Environmental Agency, the circular economy has the

potential to reduce Europe's consumption of basic raw materials by up to 80% by 2050 when compared to a linear economy model. The circular economy can help to reduce greenhouse gas emissions by conserving natural resources, boosting resource efficiency, decreasing waste, and utilizing renewable energy. This can help to mitigate the effects of climate change. According to the Ellen MacArthur Foundation, the circular economy could reduce global greenhouse gas emissions by up to 45% by 2050 when compared to a linear economy model [14].

Economic Benefits: By reducing waste and enhancing resource efficiency, the circular economy can help businesses and consumers save money. This can result in cost savings for raw materials, energy, and transportation. According to the Ellen MacArthur Foundation (2015), the circular economy could provide $4.5 trillion in economic benefits by 2030 by reducing costs and increasing productivity [15].

The circular economy is also projected to open up new economic opportunities in sectors like recycling, remanufacturing, and sharing economy models. This can result in innovation and employment development, as well as assist firms reach new markets and customers. By transitioning from a linear "take-make-dispose" approach to a circular model, the circular economy might generate $4.5 trillion in new economic opportunities by 2030 [16].

The circular economy can help to increase economic resilience by reducing dependence on volatile commodity markets, and by promoting local sourcing and production. This can help businesses to manage risks and uncertainty, and to adapt to changing economic and environmental conditions. For example, a report by the Ellen MacArthur Foundation (2012) found that the circular economy could help to reduce the risk of supply chain disruptions and price volatility, by promoting closed-loop supply chains and local sourcing [15].

Businesses can boost their brand reputation by demonstrating their commitment to sustainability and lowering their environmental impacts through the circular economy. This can aid in attracting customers and investors, as well as in developing long-term partnerships with stakeholders. According to an Accenture survey (2014), 60% of consumers are willing to pay more for products and services from companies committed to environmental and social sustainability [17].

Social Benefits: The circular economy has the potential to generate new job opportunities in sectors such as recycling, repair, and remanufacturing. This can open doors for people with a variety of abilities and education levels, as well as assist to the creation of more inclusive and sustainable economies. According to an International Labour Organization (ILO) (2018) research, the shift to a circular economy might provide up to 18 million new employment globally by 2030 [18].

Circular economy can support local sourcing and production, which can offer economic opportunities for local communities. This can also aid local businesses, encourage local investment, and improve community resilience. According to an Ellen MacArthur Foundation assessment (2018), the circular economy could assist to rebuild rural economies by increasing the use of renewable energy, organic waste management, and sustainable agriculture [19].

Social equality is another social issue that the circular economy may help with. The circular economy can promote social equity by reducing waste and pollution and enhancing access to resources. This can aid in the resolution of social and environmental inequities such as unequal access to clean air and water and unequal distribution of environmental harms. According to a UNEP assessment, for example, the circular economy could assist to reduce socioeconomic inequalities in low- and middle-income nations by offering access to inexpensive and sustainable products and services [20].

By eliminating pollution and waste and encouraging a more sustainable and healthy environment, the circular economy can improve public health and well-being. As stated in World Health Organization (WHO) report (2017), transitioning to a circular economy could assist to minimize environmental risk factors for noncommunicable illnesses like cardiovascular disease, respiratory disease, and cancer [21].

6. BARRIERS OF CIRCULAR ECONOMY

Transitioning to a circular economy necessitates a total change in the way organizations generate value, which is how they do business—from production to consumption, repair and remanufacturing, waste management, and secondary raw materials feeding back into the system. As a result, the sustainability of the transition process necessitates not just new products, technology, and processes, but also new business models. Because of the circular economy's complex and multi-scale structure, there is a significant gap between the concept and its practical implementation in the industrial sector due to a variety of barriers, all of which can be traced back to a lack of consistent and precise information about resources, products, and processes. This barriers can be classified into seven categories as governmental issues (, economic issues, technological issues, knowledge and skills issues, management issues, circular economy framework issues, market issues (Table 1)[22].

Table 2. Main categories of implementation barriers [22]

Barrier cluster	Examples of barriers
Governmental issues	*Policies that are ineffective, insufficient, or unsupportive; a lack of performance indicators; and an unclear vision*
Economic issues	*Weak incentives, a lack of internalization of external costs; large upfront expenses and insufficient short-term rewards restrict investment; resource-efficient options might be more expensive.*
Technological issues	*Product complexity makes material separation difficult, making recycling more difficult; difficulties monitoring product quality throughout the lifecycle and sustaining product quality with recovered or remanufactured materials; insufficient reliable information in tracking product material composition to enable recycling and remanufacturing*
Knowledge and skills issues	*Lack of public knowledge and awareness to encourage participation in reuse/recycle/remanufacturing; workforce shortages; consumer*

	awareness of refurbished or remanufactured products - perception of lesser quality
Management issues	*Lack of management interest or leadership in circular economy; higher importance given to other supply chain challenges; organizational structures inside enterprises impede implementation of CE practices*
Circular economy framework issues	*Lack of viable business models, difficulty navigating global supply chains, including waste management, and propensity to prioritize recycling over other CE measures that might be more advantageous*
Market issues	*Lack of standards and inconsistent quality of remanufactured products; lack of consumer acceptability of'service' rather than ownership models; difficulties managing take-back systems with several companies involved; legal issues for service providers who keep the product sold; Remanufacturing calls for training and expertise.*
Culture and social issues	*Negative customer impressions of remanufactured products; poor supply chain interactions; strongly ingrained linear technology and procedures; the "thrill" of newness*

According to the literature, the most major challenges to circular economy implementation are technical and economic barriers. However, research have indicated that cultural barriers are the most significant impediment to a circular economy transition (Figure 4). Changing consumers' choices within the context of fashion may endanger companies' focus on longer-lasting products, which is one of the fundamental components of circular economy. As a result, a lack of consumer interest and awareness makes it difficult for businesses to internalize circular economy. On the other hand, "hesitant Company culture," which is considered as another social/cultural barrier, is seen as a company's failure to fully adopt the circular economy and instead considers it as a corporate social responsibility or environmental sensitivity approach. It is obvious that the majority of organizations have not yet integrated circular economy into their vision, mission, goals, and performance indicators. Companies that could really overcome company culture confront the additional challenge of operating in a linear system. Only if a company's entire supply chain is circular, it can deliver a circular product. However, because of the conservative character of the supply chain, even if a company takes the circular economy strategy, it will be unable to put it into practice. When the economic/financial constraints are considered, the low prices of virgin raw materials are one of the most important barriers to companies implementing CE. This is because recycling many materials is not economical relative to the production of virgin material. Furthermore, high upfront investment costs, particularly investments in learning and innovation, have been identified as a barrier to the transition to CE. This indicates that the provision of suitable financial support for enterprises attempting to transition to CE is crucial. Circular economy barriers are typically interconnected, which can cause a chain reaction leading to CE failure, with the economy then continuing on as usual [23].

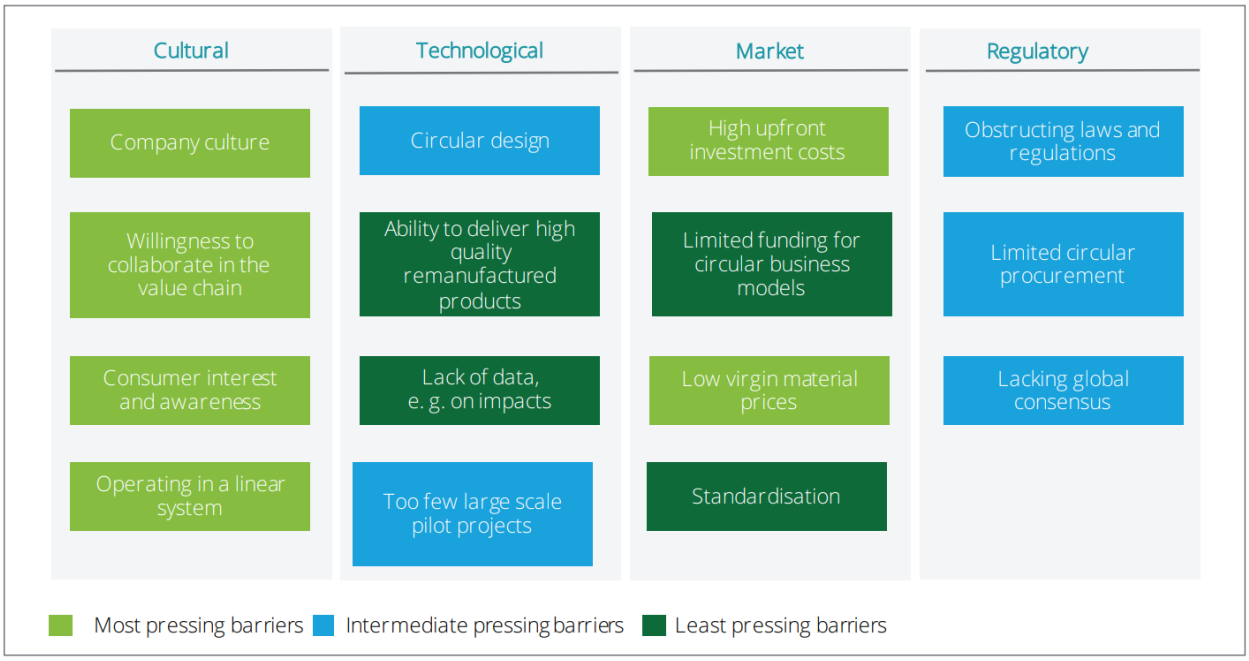


Figure 11. Heatmap of circular economy barriers [23]

7. DRIVERS OF CIRCULAR ECONOMY

The world's nations are being pressured to make the transition to a circular economy by a number of driving forces. The most significant of these factors are environmental problems like climate change, resource depletion, and waste generation. Countries all over the world have agreed to meet climate change mitigation goals. One of the goals is to keep global warming below 1.5 C° below pre-industrial levels by reducing carbon emissions by 45% by 2030 and reaching carbon neutrality by 2050, as specified in the Paris Agreement, which was adopted by 196 parties at the 21st summit of the parties. Countries should implement economic and social reforms to achieve their climate change goals.

Scarcity of resources is another driving force behind the circular economy. As the world's population expands and resource demand rises, it is becoming increasingly necessary to find ways to use resources more efficiently and reduce waste. The circular economy can help to reduce the demand for new resources and enhance resource efficiency by promoting circular behaviors such as reusing and recycling items [16].

The potential for economic benefits, such as employment creation, cost savings, and new business models, is another driver of the circular economy. Linear extraction, production, consumption, and waste generation paradigms are inherently incompatible with long-term development. Businesses can save costs, generate new revenue sources, and boost their competitiveness by implementing circular processes. The circular economy has the potential to generate new opportunities in fields such as recycling and remanufacturing. [24].

Policies and regulations can also serve as a driver for the circular economy. Governments can support the use of circular practices through policies such as waste reduction objectives, resource efficiency incentives, and product design and waste disposal laws [25]. Furthermore, global or continental legislation such as the UN Sustainable Development Goals and the European Union's Green Deal require the adoption of more sustainable economic and social systems.

8. INDICATORS OF CIRCULAR ECONOM

The circular economy concept, which evolved as a policy aimed at sustaining the economy while limiting environmental impacts, is considered as an umbrella phrase that encompasses lowering material use and waste production [26]. Different countries, such as China, Germany, and Japan, are seeking to translate this political strategy into concrete programs [27]. Three components must be identified in the process of converting the circular economy (CE) concept from policy to practice: a) what is the 'desired' outcome (i.e. primary dimensions and desirable objectives), b) how can we interfere in existing systems to induce change (strategies and policies), and, c) How can we track and monitor progress toward it in order to evaluate the effectiveness of current methods and, if required, implement corrective or preventive measures?[22] CE indicators, on the other hand, are still in the early stages of development. As a result, effective and specific procedures, and indicators for evaluating operation performance at various implementation scales are urgently needed.

When the studies conducted across the world to reveal the indicators of the circular economy are evaluated, it is obvious that there is a close relationship between the indicators and the circular economy implementation scales. CE activities are related on one of three levels [28]: the macro level, which focuses on regions, cities, municipalities, or provinces; the meso level, which focuses on eco-industrial networks, in which waste (material or energy) from one company becomes raw material for another; and the micro level, which focuses on improving the environmental performance of a specific organization. Due to the broad scope of the micro scale, Saidani et al. (2017) introduced a new product-centered term to the CE context, the nano level. According to this definition, the nano level is a more refined level that focuses on the circularity of products, components, and materials that are included in three wider systemic levels and used throughout the value chain and their entire lifecycle (Figure 5) [29].

Macro-level indicators can provide information that can be used to make decisions concerning national waste management and resource conservation initiatives, as well as economic, trade, and environmental policies. They primarily concentrate on the material exchanges between the environment and the economy, on international trade, and on the material buildup in national economies. Under this paradigm, macro-scale CE monitoring uses techniques like Material Flow Analysis (MFA), Emergy Analysis, and Input-Output Analysis [30]. Macro-level indicators highlight a country's or region's characteristics, mainly in relation to exchanges with the rest of the world via trade flows.

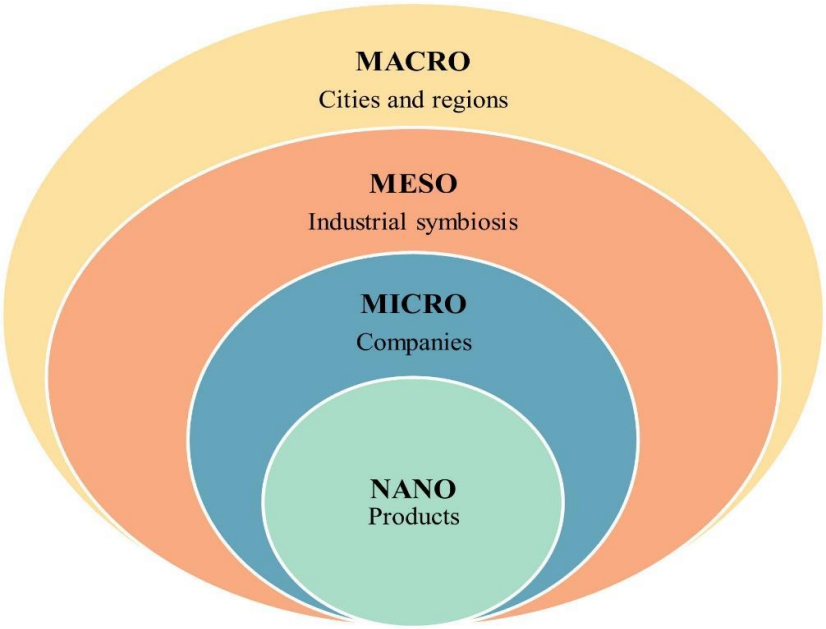


Figure 12. Systematic implementation scales of circular economy [29]

Meso-level indicators provide more differentiated information tracking and a more detailed assessment of material flows across the economy, distinguishing not only material categories but also industries or production branches and consumption categories. These meso-level indicators focus on a specific industry, consuming activity, or material level, assisting in the detection of waste, pollution causes, and the possibility for efficiency increases in specific sectors or consumption domains. Despite the fact that the meso-scale appears to be centered on the concepts of eco-industrial parks or industrial symbiosis, these structures remain limited globally. As a result, cities, regions, and the networks that connect them, which are commonly studied at the macro size, are also significantly related with the use of meso-scale. Meso-scale indicators represent the economic, environmental, or social performance of a region, product category, or industry. The indicator can zoom in on individual material categories or emissions, for example.

Micro level indicators provide precise data for specific corporate or local decision-making processes, as well as for specific substances or individual products. Micro level indicators assist policymakers and decision-makers in areas such as product policy, energy efficiency, and integrated waste management in implementing policies and decisions. Microeconomic indicators, for example, represent a city's, product's, or company's economic, environmental, or social performance.

The focus of nano level indicators is on operational and product-level including components and materials. They might serve as a common denominator within these three levels, and could enable not only to create the links between these levels but also to have a closer look at the successful performance of circular economy implementation.

Table 3. Categorisation of indicators according to the nano, micro-, meso- and macro- levels of the CE

SCALE	APPLICATION	Examples
Macro	Cities, Regions, Nations	Evaluation of CE Development in Cities (ECEDC) Regional CE Development Index (RCEDI) National CE Indicator System (NCEIS)
Meso	Businesses, Industrial Symbiosis	Sustainable Circular Index (SCI) Circular Economic Value (CEV) Circle Assessment (CA)
Micro	Products, Components, Materials	Circular Economy Indicator Prototype (CEIP) Product-Level Circularity Metric (PCM) Material Circularity Indicator (MCI)
Nano	Product	Multi-Criteria Evaluation Method of Product-Level Circularity Strategies (MCEM-PLCS) Resource Efficiency Assessment of Products (REAPro) Circular Building Assessment Prototype (CBA)

Unfortunately, individual indicators mentioned within the scope of the application scales are frequently insufficient to evaluate the complex nature of CE. These add-ons, indicator systems, indexes, and computational tools are being created with a focus on various aspects of CE (Table 3, Table 4, Table 5).

Table 4. Main evaluation indicators system of CE [30]

Criteria		Sub-Criteria
EU indicator systems	Input indicators	Direct Material Input (DMI) represents the total direct input of materials; Total Material Input (TMI) includes both DMI and unused domestic extraction; Total Material Requirement (TMR) includes indirect material flows in addition to TMI.
	Consumption indicators	Domestic Material Consumption (DMC), which counts all materials used directly in the economy; Total Material Consumption (TMC), which takes into account the whole amount of materials needed for household consumption; Net Additions to Stock (NAS) and Physical Trade Balance (PTB) are the main balance indicators. (Pintér, 2006).
	Output indicators	The primary output indicator used for monitoring all material outflows is Domestic Processed Output (DPO).
Japan indicator systems	Resource productivity (RP)	Material reuse (the ratio of Gross Domestic Product (GDP) to Direct Material Input(DMI))
	Recycling rate	The ratio of "total amount of recycled and reused material" to "total amount of DMI"
	The rate of waste	The ratio of total amount of waste for final disposal to total amount of DMI.

EIS2017	Comprehensive indicators	Main resource productivity; main waste recycling rate
	Special indicators	Productivity in the following areas: energy, water, and land for construction; Comprehensive utilization rate of crop, general industrial solid waste; Repeated water use rate of large industrial companies; Rate of recovery of major renewable resources; Recycling rate of kitchen waste from urban meals; Processing rate of urban construction waste; Utilization rate of urban recycled water; production value of resource recycling industry.
	Reference indicators	Disposed industrial solid waste amount; Wastewater emissions from industry; Urban solid waste processing capacity; Major pollutant emissions

Table 5. Review of some of the available circular economy assessment frameworks [31]

CE Assessment Tool (CEAT)	Description	Levels covered			Targeted category	Method
		Macro	Meso	Micro		
Circulytics® (Ellen MacArthur Foundation, 2017)	An organization can use this tool to determine the level of circularity throughout their entire operation			✓	Companies and organizations	Undefined
Material Circularity Indicator (MCI)(Ellen MacArthur Foundation, 2021)	MCI can assist businesses by recognizing additional value in their products and materials, as well as lowering the risk of material price fluctuation and material supply.			✓	Companies and products	Material Circularity Indicator (MCI) + Life Cycle Assessment (LCA)
Modified Material Circularity Indicator (MCI)(Rocchi et al., 2021)	The Material Circularity Indicator (MCI) tool, developed by The Ellen MacArthur Foundation and Granta Design, is used to assess the			✓	Biological cycles (Agriculture)	Material Circularity Indicator (MCI) + Life Cycle Assessment (LCA)

	circularity of biological processes.					
BS: 8001:2017 (The British Standards Institution, 2017)	The purpose of this tool is to identify potential methods for obtaining cost savings, generating new revenue streams, and making businesses more robust to external shocks and disruptions as a result of implementing circular economy principles.			✓	Products	Indicators selection
Cradle to Cradle (MBDC, 2021)	It is a framework for assessing material health, circular economy, renewable energy, and water stewardship.			✓	Products and materials	Undefined
Waste management tool for CE(Laso et al., 2016)	A life cycle assessment-based environmental performance evaluation tool used to evaluate the efficacy of waste management strategies in the anchovies canning business.		✓	✓	Canned anchovy industry	Life Cycle Assessment (LCA)
Product Recovery Multi-Criteria Decision Tool (PR-MCDT) (Alamerew and Brissaud, 2019)	A decision-making tool for evaluating end-of-life product circularity choices at strategic levels.			✓	Products	Product Recovery Multi-Criteria Decision Tool (PR-MCDT)
Intermediate bulk containers re-use in the circular economy(Biganzoli et al., 2018)	Evaluates the environmental effects linked to the Intermediate Bulk Container life cycle to aid in the transition to the Circular Economy (CE)			✓	Bulk containers	Life Cycle Assessment (LCA)

Towards sustainable circular economies: A computational framework for assessment and design (Thakker and Bakshi, 2021)	A computational framework that carries out pathway design for value chain networks by selecting the most advantageous route from a list of possibilities throughout the course of a product's whole life cycle.			✓	Products	computational approach of life cycle assessment (LCA) with optimization-based approaches for process synthesis and network representation
Circular city analysis framework (Ferreira and Fuso-Nerini, 2019)	A framework of evaluation indicator system to measure cities' performance in the circular economy.		✓		Cities	Indicators selection and CE index
Circular Economy Indicators as a Supporting Tool for European Regional Development Policies (Avdiushchenko and Zajac, 2019)	Provides a case study for monitoring CE progress with a set of designed indicators.	✓			worldwide or at the country level	Indicators selection

9. CIRCULAR ECONOMY AND EUROPEAN UNION

On 11 December 2019, the European Commission presented the European Green Deal as a response to the challenges posed by global warming, pollution, and biodiversity loss. The EU Green Deal is a comprehensive plan to make the EU's economy more sustainable, while also improving the quality of life of EU citizens. The Green Deal covers a wide range of areas, including climate change, energy, biodiversity, agriculture, and the circular economy. It is defined as "a roadmap for making the EU's economy sustainable by turning climate and environmental challenges into opportunities across all policy areas and making the transition just and inclusive for all" [32].

The EU Green Deal's political ambition is that the EU becomes the world's first climate neutral continent by 2050. The EU Green Deal sets an ambitious roadmap including actions to promote more efficient use of resources to address climate change, an idea to which the circular economy

is central. Thus, the circular economy is seen as a key component of the EU's efforts to make its economy more sustainable. The EU has set ambitious targets for the circular economy, and is developing a range of policy tools and initiatives to support the transition to a more circular economy model. These efforts are supported by funding and support for businesses and organizations that are working to promote the circular economy. The Green Deal aims to promote the transition to a circular economy by supporting measures such as eco-design, product durability, repairability and recyclability, and the use of secondary raw materials [25].

As part of the Green Deal, the EU has set a number of particular targets for the circular economy. These include boosting the EU's recycling rate to 65% by 2035, lowering waste generation, and promoting the use of environmentally friendly products and services. In addition, the EU intends to promote the circular economy globally by collaborating with other countries and international organizations [25]. To attain these goals, the EU has developed a number of policy tools and initiatives, including the 2018 Circular Economy Package. The package contains a variety of measures targeted at fostering the circular economy, such as new recycling objectives, eco-design requirements, and waste reduction measures [33]. The EU also provides funds and assistance to businesses and organizations who are promoting the circular economy. The EU's Horizon 2020 initiative, for example, funds research and innovation projects in areas including circular design, waste reduction, and resource efficiency [34].

According to Eurostat, the European Union's statistical agency, the monitoring framework for the circular economy established by the European Commission consists of ten indicators divided into the following four thematic areas, some of which are further subdivided into sub-indicators (Figure 6) (Tablo). Monitoring the production and consumption thematic area is essential for understanding progress towards the circular economy. The area of waste management focuses on boosting recycling, which is a key component of the transition to a circular economy, and on the percentage of waste that is recycled and really returned to the economic cycle to continue providing value. Secondary raw materials area emphasizes the quantity of recycled materials, which replace natural resources and reduce the environmental impact. The area of competitiveness and innovation monitors two aspects. The first is the new job opportunities that the circular economy is predicted to create, as well as its contribution to growth. The other is the development of innovative technologies that allow for easier reuse of product designs and support innovative industrial processes (https://ec.europa.eu/eurostat/web/circular-economy/indicators).

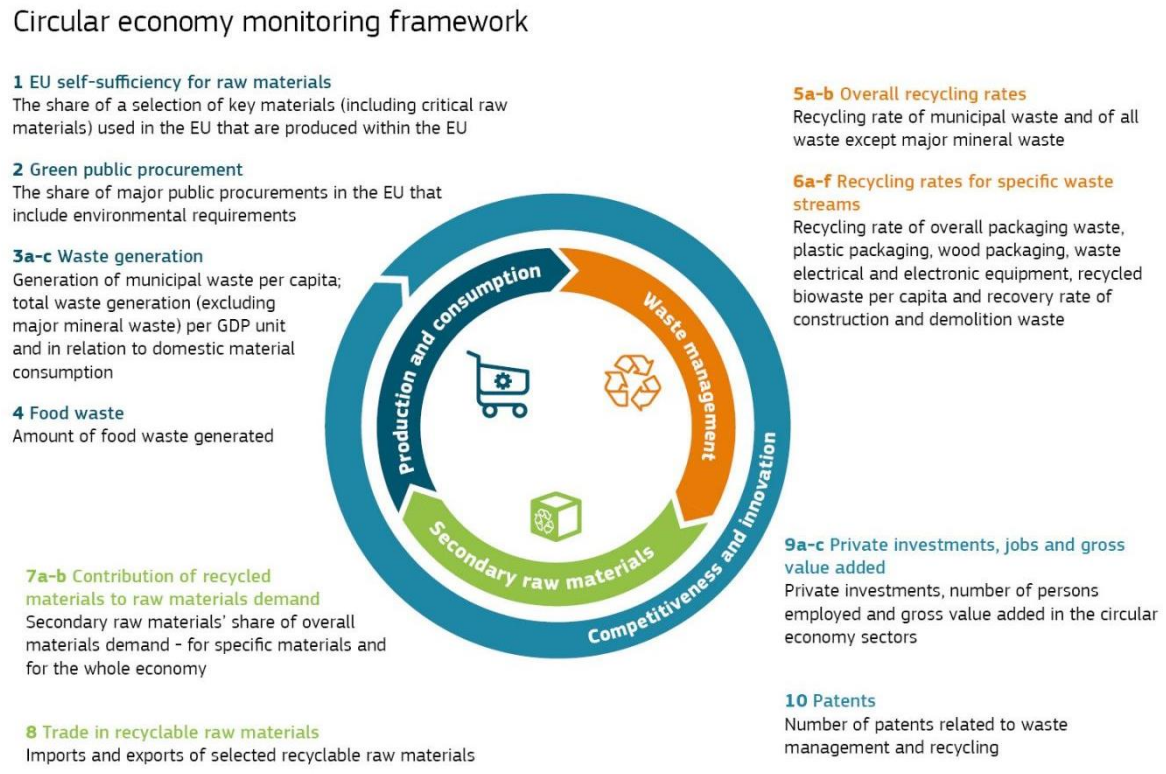


Figure 13. Circular economy framewok of EU

Table 6. Indicators for monitoring circular economy in European Union

Thematic areas	Indicators
Production and consumption	• Self-sufficiency of raw materials for production in the EU; • Green public procurement (as an indicator for financing aspects); • Waste generation (as an indicator for consumption aspects); • Food waste.
Waste management	• Recycling rates (the share of waste which is recycled); • Specific waste streams (packaging waste, biowaste, e-waste, etc.).
Secondary raw materials	• Contribution of recycled materials to raw materials demand; • Trade of recyclable raw materials between the EU Member States and with the rest of the world.
Competitiveness and Innovation	• Private investments, jobs and gross value added; • Patents related to recycling and secondary raw materials as a proxy for innovation.

REFERENCES

[1] UN DESA 2022 Revision of World Population Prospects, https://www.un.org/development/desa/pd/sites/www.un.org.development.desa.pd/files/wpp2022_summary_of_results.pdf

[2] The World Bank. 2022. Squaring the Circle: Policies from Europe's Circular Economy Transition © World Bank. https://documents1.worldbank.org/curated/en/099425006222229520/pdf/P174596025fa8105a091c50fb22f0596fd1.pdf

[3] Oberle, B., Bringezu, S., Hatfield-Dodds, S., Hellweg, S., Schandl, H., & Clement, J. (2019). Global resources outlook: 2019. International Resource Panel, United Nations Envio, Paris, France. https://orbi.uliege.be/handle/2268/244276

[4] Bastein, A. G. T. M., Roelofs, E., Rietveld, E., & Hoogendoorn, A. (2013). Opportunities for a Circular Economy in the Netherlands (pp. 1-13). Delft: TNO. https://www.tno.nl/media/8551/tno-circular-economy-for-ienm.pdf

[5] Geissdoerfer, M. and Savaget, P. and Bocken, N.M.P. and Hultink, E.J. (2017) 'The circular economy a new sustainability paradigm?', Journal of cleaner production., 143 . pp. 757-768. (https://dro.dur.ac.uk/29108/1/29108.pdf)

[6] Corvellec, H., Stowell, A. F., & Johansson, N. (2022). Critiques of the circular economy. Journal of Industrial Ecology, 26(2), 421-432. (https://onlinelibrary.wiley.com/doi/full/10.1111/jiec.13187)

[7] Grafström, J., & Aasma, S. (2021). Breaking circular economy barriers. Journal of Cleaner Production, 292, 126002. https://www.sciencedirect.com/science/article/pii/S0959652621002225

[8] Korhonen, J., Honkasalo, A., & Seppälä, J. (2018). Circular economy: the concept and its limitations. Ecological economics, 143, 37-46.

[9] Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. Resources, conservation and recycling, 127, 221-232. https://www.sciencedirect.com/science/article/pii/S0921344917302835

[10] Ellen MacArthur Foundation. (2019). The butterfly diagram: visualising the circular economy. https://ellenmacarthurfoundation.org/circular-economy-diagram

[11] Purwanto, E., & Prasetio, T. (2021). Changing the Paradigm of a Linear Economy into a Circular Economy in Residential Waste Management. In IOP Conference Series: Earth and Environmental Science (Vol. 945, No. 1, p. 012054). IOP Publishing.

[12] https://ellenmacarthurfoundation.org/topics/circular-economy-introduction/overview

[13] https://planetark.org/newsroom/news/three-core-principles-of-the-circular-economy

[14] Ellen MacArthur Foundation, 2019. Completing the Picture: How the Circular Economy Tackles Climate Change, https://www.solvay.com/sites/g/files/srpend221/files/2022-10/Completing%20the%20Picture%20-%20How%20the%20circular%20economy%20tackles%20climate%20change.pdf

[15] Ellen MacArthur Foundation, 2015. Towards the Circular Economy: Economic and Business Rationale for an Accelerated Transition, https://www.werktrends.nl/app/uploads/2015/06/Rapport_McKinsey-Towards_A_Circular_Economy.pdf

[16] Ellen MacArthur Foundation, 2014. Towards the Circular Economy: Accelerating the Scale-Up Across Global Supply Chains, World Economic Forum, 2014.

[17] Lacy, P., Keeble, J., McNamara, R., Rutqvist, J., Haglund, T., Cui, M., & Buddemeier, P. (2014). Circular Advantage: Innovative Business Models and Technologies to Create Value in a World without Limits to Growth/Accenture.

[18] International Labour Office. (2018). World employment and social outlook 2018: Greening with jobs. International Labour Organisation (ILO). https://www.voced.edu.au/content/ngv:79683

[19] Ellen MacArthur Foundation, 2018. Circular Economy in Rural Areas: Opportunities and Challenges.

[20] UNEP, 2019. Global Environment Outlook – GEO-6: Healthy Planet, Healthy People. Nairobi. DOI 10.1017/9781108627146.

[21] World Health Organization. (2017). Preventing noncommunicable diseases (NCDs) by reducing environmental risk factors (No. WHO/FWC/EPE/17.01). World Health Organization. https://apps.who.int/iris/bitstream/handle/10665/258796/WHO-FWC-EPE-17.01-eng.pdf

[22] Ekins, P., Domenech, T., Drummond, P., Bleischwitz, R., Hughes, N. and Lotti, L. (2019), "The Circular Economy: What, Why, How and Where", Background paper for an OECD/EC Workshop on 5 July 2019 within the workshop series "Managing environmental and energy transitions for regions and cities", Paris. https://www.oecd.org/cfe/regionaldevelopment/Ekins-2019-Circular-Economy-What-Why-How-Where.pdf

[23] Kirchherr, J., Piscicelli, L., Bour, R., Kostense-Smit, E., Muller, J., Huibrechtse-Truijens, A., & Hekkert, M. (2018). Barriers to the circular economy: Evidence from the European Union (EU). Ecological economics, 150, 264-272.

[24] McKinsey Center for Business and Environment, 2015. Europe's circular-economy opportunity. https://www.mckinsey.com/~/media/McKinsey/Business%20Functions/Sustainability/Our%20Insights/Europes%20circular%20economy%20opportunity/Europes%20circulareconomy%20opportunity.ashx

[25] European Commission, 2020. A New Circular Economy Action Plan. ://environment.ec.europa.eu/strategy/circular-economy-action-plan_en

[26] EASAC, 2016. Indicators for a circular economy, EASAC Policy Report 30. https://easac.eu/fileadmin/PDF_s/reports_statements/Circular_Economy/EASAC_Indicators_web_complete.pdf

[27] Geng, Y., Sarkis, J., Ulgiati, S., & Zhang, P. (2013). Measuring China's circular economy. Science, 339(6127), 1526-1527.

[28] Yuan, Z., Bi, J., & Moriguichi, Y. (2008). The circular economy: a new development strategy in China. Journal of Industrial Ecology, 10(1–2), 4– 8. https://doi.org/10.1162/108819806775545321

[29] Saidani, M., Yannou, B., Leroy, Y., & Cluzel, F. (2017). How to assess product performance in the circular economy? Proposed requirements for the design of a circularity measurement framework. Recycling, 2(1), 6.

[30] Wang, N., Lee, J. C. K., Zhang, J., Chen, H., & Li, H. (2018). Evaluation of Urban circular economy development: An empirical research of 40 cities in China. Journal of Cleaner Production, 180, 876-887.

[31] Ahmed, A. A., Nazzal, M. A., Darras, B. M., & Deiab, I. M. (2022). A comprehensive multi-level circular economy assessment framework. Sustainable Production and Consumption, 32, 700-717.

[32] European Commission, 2019. https://ec.europa.eu/commission/presscorner/detail/en/ip_19_6691

[33] European Commission, 2018. Circular Economy Package. https://ec.europa.eu/environment/circular-economy/first_circular_economy_action_plan.html

[34] European Commission, 2018. Horizon 2020 Work Programme 2018-2020. https://ec.europa.eu/research/participants/data/ref/h2020/wp/2018-2020/main/h2020-wp1820-intro_en.pdf

[35]Eurostat, Circular Economy Monitoring Framework. https://ec.europa.eu/eurostat/web/circular-economy/indicators/monitoring-framework

SMART CITIES& ZERO WASTE CONCEPT

Ilija Vuckov
EMKICE, Macedonia

Özgür Aycil
Karesi Municipality, Turkiye

1. INTRODUCTION

By 2050, the world's urban population is predicted to double. By 2030, six out of every ten people will live in a city, and by 2050, seven out of ten will. In real terms, the urban population is increasing by approximately 60 million people per year. Cities must grow smarter as the world becomes more urban. Major urbanisation necessitates new and inventive approaches to managing the complexity of urban living; it necessitates new approaches to addressing issues such as overcrowding, energy consumption, resource management, and environmental protection. In this environment, Smart Cities emerge not only as a novel mode of operation for future urban living, but also as a critical tool to combat poverty and inequality, unemployment, and crime.

Although the intense debate about the value, function, and future of Smart Cities, the notion defies straightforward explanation. At its foundation, the concept of Smart Cities is based on the development and integration of human capital, social capital, and information and communication technology (ICT) infrastructure in order to achieve greater and more sustainable economic development and a higher quality of life. Smart Cities are further classified along six axes or dimensions:

· Smart Economy

· Smart Mobility

· Smart Environment

· Smart People

· Smart Living

· Smart Governance

Policy coordination along these dimensions illustrates the positive feedback loop between growth and development of a city; cities attract people, while the availability of populations and infrastructure supports economic and societal development. However, this feedback and the growth it generates are insufficient to provide the desired results, as the challenges linked with the uncontrolled growth of megacities indicate.

The nexus of economic, societal, and environmental growth is not scalable as cities grow and is impossible to forecast, let alone regulate. As a result, their beneficial evolution must be aided by a combination of framework circumstances and information and communication infrastructures. In this approach, a platform is offered for governments, corporations, and individuals to interact and collaborate, as well as track the progress of the city.

The Smart City is emerging as a crucial foundation for future city expansion in the global profile of urban development. Global competitors in the emerging economies are exploring significant Smart City initiatives. India intends to invest EUR 66 billion in seven Smart Cities along the Delhi-Mumbai Industrial Corridor through a combination of public-private partnerships (80%) and nationally sponsored trunk infrastructure investment (20%). As part of its attempts to encourage economic development and reduce poverty, China is also pursuing a Smart Cities initiative. Because poverty is mostly a rural phenomenon in China, the program aims to entice rural people to Smart Cities, which can subsequently function as massive urban employment centres. This approach, centered on modernizing existing cities, involves at least 54 Smart City initiatives totaling EUR 113 billion as of March 2012. In 2010, the South Korean government established the Smart Korea IT Plan, with the goal of interconnecting and improving the ubiquitous infrastructure constructed through the u-strategy until 2030. The goal is to link physical infrastructure, such as broadband internet and RFID technology, with a variety of devices, software, platforms, and network technologies. Customized service portals for residents and enterprises are examples of implementation.

While over half of the world's population lives in cities, the proportion is over two thirds in the EU28 and rising. Due to the increased demands high density cities impose on resources like energy, transportation, water, and structures, it is critical to discover "smart" solutions that are both highly efficient and sustainable on the one hand, as well as fostering economic prosperity and social wellness on the other. This is best accomplished by utilizing new technologies and forward-thinking integrated policies to mobilize all of a city's resources and coordinate its actors.

2. WHAT IS A SMART CITY?

ICT (information and communication technology) is a critical facilitator for cities to solve these difficulties in a'smart' way. A Smart City is one that has at least one effort addressing one or more of the six characteristics listed below: Smart Governance, Smart People, Smart Living, Smart Mobility, Smart Economy, and Smart Environment are all examples of smart governance. ICT connects and strengthens networks of people, businesses, infrastructures, resources, energy, and locations, while also offering intelligent organizational and governance capabilities. As a result, a Smart City can be defined as follows:

"*A Smart City is a city seeking to address public issues via ICT-based solutions on the basis of a multi-stakeholder, municipally based partnership*'.

According to a smart city mapping research conducted across the EU-28, 240 (51%) of EU28 cities with at least 100,000 people have implemented or proposed a Smart City program. Despite having

100,000 to 200,000 residents, just 43% of European Smart Cities fall within this size range, compared to over 90% of cities with 500,000 or more residents. This situation clearly shows that smart city initiative is a big city phenomenon and big cities have more smart city initiatives compared to small cities. However, only half of the European Smart Cities such initiatives are actually piloted or implemented, the rest are only in the planning stage and are therefore still relatively immature.

All of the EU's 28 member states have smart cities, however their distribution varies. The UK, Spain, and Italy are the nations with the highest numbers, but Austria, Denmark, Norway, Sweden, Estonia, and Slovenia have the highest percentages. All six criteria are covered by smart city programs, however the two that are commonly highlighted are smart environment and smart mobility. Geographically, the distribution is likewise pretty uniform, while Smart Governance initiatives are primarily found in France, Spain, Germany, the United Kingdom, Italy, and Sweden, which are Older Member States. It's also important to notice that some traits, like smart people and smart living, are frequently seen together.

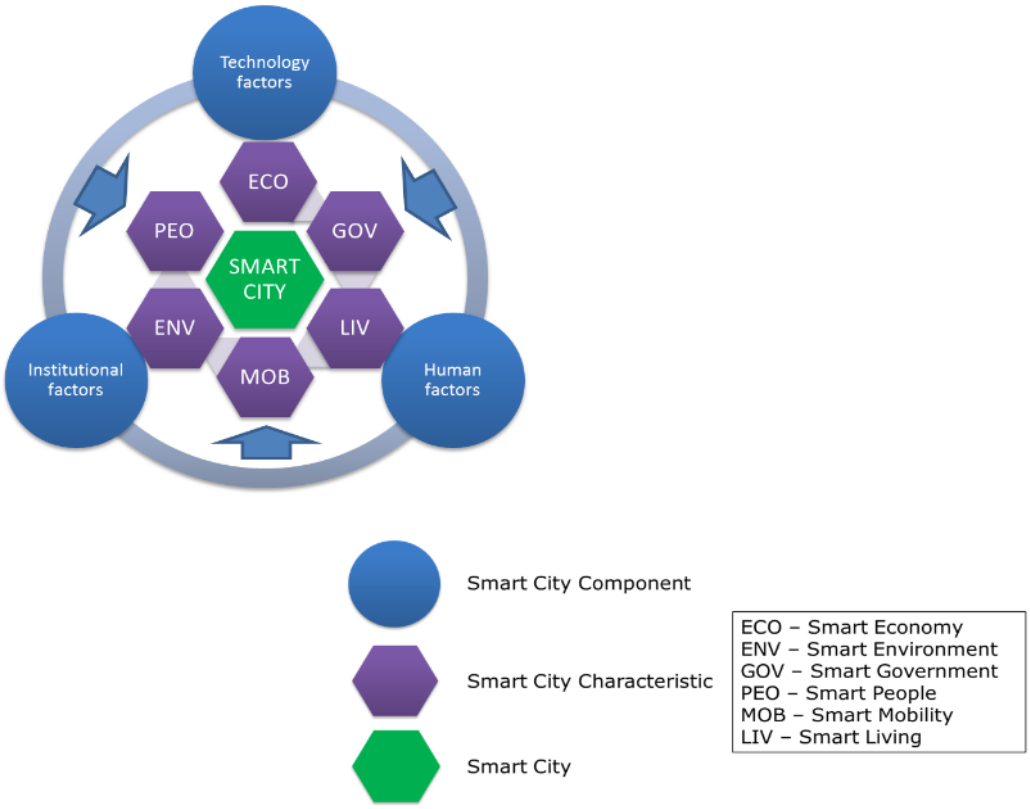


Figure 14. The framework of smart city concept

A representative sample of 50 Smart City initiatives from 37 cities were subjected to these definitions, which took into account factors including city size, location, characteristics, goals, stakeholders, governance, funding, and accomplishments. This sample's study revealed five

primary categories of objectives: participation platforms, resource management systems, intelligent traffic systems, testbed micro infrastructures, and neighbourhood units for Smart Cities. Since more than two-thirds of the sampled Smart City projects are still in the development or pilot testing stages, there aren't many mature, effective programs. However, our study demonstrates that effective initiatives are those with clear objectives, goals, targets, and baseline assessment methods in place from the outset (i.e., those that accomplish their objectives and contribute to the attainment of Europe 2020 goals).

Although Europe does not experience the same levels of rural poverty or rogue megacity growth as China or India, the concept of the "Smart City" is still quite relevant. To effectively compete with other global economies, it will be important to harness the power of smart cities. In addition, knowledge gained from the construction of smart cities can help Europe help developing nations manage megacity growth in a way that increases their welfare, lowers the danger of issues being exported, and makes them better trading partners for Europe. Most importantly, Europe has unique requirements for thinking about smart cities. Cities in the European Single Market have been able to develop into centers for the creative economy, technological and societal innovation, welfare enhancement, and sustainable development thanks to the market's openness and interconnectedness. They accomplish this by utilizing resources, both human and non-human, from all around Europe and the world and provide ideas, money, and other advantages in return. Although this intricate ecosystem is strong and resilient, it nonetheless faces significant obstacles like societal and economic inequity, environmental change, and a significant demographic shift. Other developments like improved access to information and mobility could both aid and impede its development. These changes have a direct impact on urban settings' sustainability and contributions to Europe as a whole; smart cities could benefit from them.

A commitment made as part of the Europe 2020 strategy is to support the growth of smart cities across the continent and to invest in the essential ICT infrastructure, human and social capital development, and a broader agenda to address issues such as economic recovery, poverty, unemployment, and environmental harm. This is done in view of both the pressing need to address these concerns and the difficulties brought on by the rapid urbanization of Europe. Smart Cities may assist in achieving the objectives listed in Europe 2020 by deploying scalable solutions that leverage ICT technology to boost effectiveness, reduce costs, and improve quality of life.

Discussions about the concept of a smart city's success require careful analysis. The easiest method for assessing the success of smart cities would be to quantify its success in terms of activities across all of the six axes because this is how the present debate on smart cities is framed.

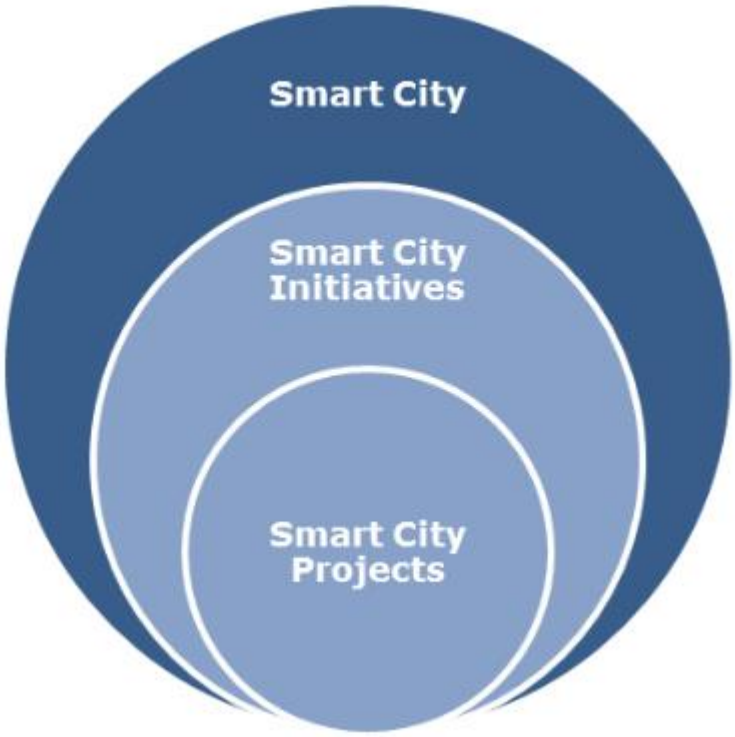


Figure 15. The framework of smart city concept

The Smart Cities portfolio consists of a number of initiatives with a variety of (sometimes overlapping) objectives, approaches, participants, and backers. In contrast to ideal Smart Cities, true Smart Cities are a process rather than a finished good. Since many programs are still in the design or early implementation stages, it is impossible to predict with surety or certainty the outcomes and implications of these programs in the long run. Here, in addition to individual activities, a city-level strategy is utilized. The effect assessment application can be used as a model to follow the logic of an intervention or the evolution of a smart city.

A variety of questions can be taken into account while evaluating the design and implementation of certain initiatives: Are the objectives relevant, suitable, and consistent with more general city development goals? Does the initiative deal with issues that are significant to the city in question? Is it likely that the combination of funds, involvement, elements, and qualities will lead to the desired results?

The anticipated impacts can be taken into account as well, if possible. It should be determined whether the initiative is achieving its objectives (or is on the way to progress) in cities and in Europe as a whole.

2.1.PROBLEMS OF DEFINITIONS

Examples of smart cities come in a wide range of shapes, sizes, and varieties. This is due to the fact that the concept of the "Smart City" is extremely broad, fresh, and changing. Each city has a distinct history of growth, present characteristics, and future potential. Cities that identify as "Smart" or that have been described as so by others differ greatly. The development of the idea of a "smart city" is influenced by a complex interplay of technologies, social and economic variables, governance structures, and policy and business drivers. Therefore, depending on the unique policies, goals, funding, and scope of each city, the implementation of the smart city concept takes very different paths.

In order to understand good practice examples, the potential for scaling and the creation of pertinent policy frameworks, a number of requirements must be included in the description of the smart city idea. Additionally, there is a lot of overlap between the description of the smart city concept and other city concepts that are connected, such as:

· 'Intelligent City'

· 'Knowledge City'

· 'Sustainable City'

· 'Talented City'

· 'Wired City',

· 'Digital City'

· 'Eco-City'.

However, the Smart City concept has grown prominent among these variants, particularly at the city policy level, both internationally and in Europe, thus we will focus on the specific definitions and characteristics of the Smart City here.

2.2.SMART CITIES DEFINATIONS

Numerous descriptions of the Smart City center largely on the critical role of ICT in connecting city-wide services. For instance, one suggestion is that a city is wise when:

'The use of ICT [makes] a city's vital infrastructure components and services, such as city administration, education, healthcare, public safety, real estate, transportation, and utilities, more intelligent, integrated, and efficient'.

Similarly, according to another viewpoint, cities are sum of complex systems, and there are developing opportunities to add digital nervous systems, intelligent responsiveness, and optimization at all levels of system integration.

While other definitions maintain the importance of ICT in the notion of smart city, this one provides a broader perspective as follows;

'a city may be called 'Smart' 'when investments in human and social capital and traditional and modern communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance'.

These definitions typically strike a balance between diverse economic and social factors, as well as the dynamics of urban development. They also serve to widen the term, maybe encompassing smaller, less developed cities that may not be able to purchase cutting-edge technology. Several sources also stress the following final point: Even though megacities [defined as having more than 5 million residents] have received a lot of attention from the public, the majority of the new growth will occur in smaller towns and cities, which have fewer resources to adapt to the magnitude of the change.

3. SMART CITY CHARACTERISTICS

As previously said, a wide range of Smart City elements may emerge as a result of the multiple projects now underway in the EU's dynamic socioeconomic, technological, and regulatory setting. These can be linked to a variety of objectives (such as general, specific, and operational objectives), as well as various patterns of actor relationships and roles, policy instruments, and implementation strategies. Then, each of these characteristics can be linked to various geographic locations, city sizes, funding configurations, framework conditions, and framework outcomes.

A framework of characteristics can be provided to capture as many of these circumstances as possible. This will allow us to identify relevant projects and initiatives that, when executed, will contribute to the development of a Smart City. The projects and efforts highlighted in this study may then be used to fill a structured evidence base. Thus, potential relationships between characteristics can be examined, causal inferences drawn, and recommendations for best practices and strategies developed.

The concept of a smart city can be summarized as being strongly founded in the enabling power of ICT, which connects systems and stimulates innovation to enable a variety of policy goals. This conclusion can be reached by combining the previously mentioned definitions of smart cities with the additional data offered above. Given the competitiveness of cities, such policy objectives include economic expansion, which is supported by well-developed human capital.

It is also vital to make economic development environmentally sustainable. This could entail leveraging ICT-based "Smart Networks" to dynamically match supply and demand in order to reduce energy transmission costs and improve utility network resilience. Such networks would also benefit from the ability to enable local cogeneration to meet local energy needs. Furthermore, they could provide accurate and timely information to each individual utility user, allowing them to select and use appliances while keeping costs and environmental impact in mind.

City mobility systems, for example, use sensors, processors, and ICT-driven traffic controls to deliver smart and efficient arteries. However, as previously stated, other factors (social, welfare, cultural, and quality of life) are also important for balanced Smart City development. Each of these characteristics is supported by the need for innovative bottom-up and top-down holistic governance models that permit and encourage broad engagement and participation of all stakeholders in all parts of a city's life. Six Smart City elements are suggested based on the work of the European Smart City Project and numerous other resources:

· Smart Governance

· Smart Economy

· Smart Mobility

· Smart Environment

· Smart People

· Smart Living

A lot of studies have used these six features to build indicators and Smart City development strategies.

An increasing number of cities and policy makers are already using this type of characterization framework, which is fully justified and documented. By defining a relatively small set of qualities that distinguish these initiatives and encompass the breadth of existing programs, the framework tries to capture the major elements of European Smart Cities stated above while maintaining simplicity. In the current study, a Smart City project or effort must have at least one of the six qualities to qualify as a Smart City. However, this is merely a starting point, and it is important to keep in mind the definitions and summary of a smart city provided above. These point to the implementation of multidimensional strategies, which comprise numerous initiatives and projects intended to work in concert. Indeed, it may be expected that the most effective Smart City strategies will adopt a multi-faceted approach to maximize such synergy and reduce adverse spillover effects, as might happen, for instance, if a Smart Economy strategy that was detrimental to the environment was prioritized. Therefore, it is reasonable to anticipate that the most prosperous Smart Cities will exhibit multiple characteristics.

Smart Governance: In order for the city to function effectively as a single organism, smart governance refers to coordinated internal and external city government, encompassing services and interactions that connect and, when appropriate, combine public, commercial, civil, and European Community organizations. ICT (infrastructures, hardware, and software) is the primary tool for achieving this, and it is powered by data and smart processes for interoperability. Given that a Smart metropolis might be characterized as being fundamentally a globally networked center, international, national, and hinterland links are also significant (outside of the metropolis). This calls for collaboration with many stakeholders to pursue intelligent goals at the local level

through public, private, and civil partnerships. Transparency and open data are smart goals, as are co-created e-services, including apps, and participatory decision-making using ICT and e-government. As a transversal factor, smart governance can also coordinate and incorporate some or all of the other smart qualities.

Smart Economy: Increased productivity, ICT-enabled innovation, sophisticated manufacturing and service delivery, new goods, new services, and new business models are all examples of what is meant by the term "smart economy." Additionally, it creates eco-systems and smart clusters (such as those for entrepreneurship and digital business). Incorporating international embeddedness with physical and virtual flows of products, services, and knowledge is another aspect of the smart economy.

Smart Mobility: Smart mobility refers to the integration and support of transportation and logistics systems by ICT. For instance, in scenarios involving one or more modes of transportation, sustainable, safe, and integrated transportation networks can include trams, buses, trains, metros, vehicles, bicycles, and pedestrians. Clean and frequently non-motorized choices are given priority in smart mobility. The public has access to pertinent information that is updated in real-time, which helps commuters get to their destinations faster, save money, save CO2 emissions, and help network transport management give better services and feedback to customers. Users of mobility systems may also provide their own real-time data or help with long-term planning.

Smart Environment: The above objectives are served by smart environment, which includes smart energy such as renewables, ICT-enabled energy grids, metering, pollution control and monitoring, renovation of buildings and amenities, green buildings, green urban planning, and resource use efficiency, re-use, and resource substitution. Urban services like street lighting, trash management, drainage systems, and water resource systems that are observed to assess the system, minimize pollution, and enhance water quality are also excellent examples.

Smart People: Smart people have e-skills, operate in ICT-enabled environments, have access to education and training, manage human resources and capacity, and live in inclusive societies that encourage innovation and creativity. It can also enable individuals and communities to input, utilise, customize, and personalize data to make decisions and generate goods and services, for example, through the use of appropriate data analysis tools and dashboards.

Smart Living: ICT-enabled lifestyles, behavior, and consumption are referred to as smart living. Along with high-quality housing and lodging, smart living includes living in a place with a vibrant culture and a variety of cultural amenities. High levels of social capital and cohesiveness are also correlated with smart living.

The Relationship Between Characteristics and Components

Smart City initiatives must consider institutional factors such as stakeholders' and funders' roles, as well as human or social factors such as education and social capital, because they go beyond the development and application of technology in attracting participants and delivering impacts.

Only in this way can the practical relationship between components and attributes be conceptualized:

Technology factors	Human factors	Institutional factors
Physical infrastructure	Human infrastructure	Governance
Smart technologies	Social capital	Policy
Mobile technologies		Regulations and directives
Virtual technologies		
Digital networks		

REFERENCES/Link to online resources and specific imagesific images

[1]. https://www.businessart.at/download/EEB-ZeroWasteEU_%20Waste-timeline.pdf
[2]. https://op.europa.eu/en/publication-detail/-/publication/5d4f8cde-de25-11e7-a506-01aa75ed71a1
[3]. https://zerowasteeurope.eu/wp-content/uploads/2020/07/zero_waste_europe_policy-briefing_achieving-the-eu%E2%80%99s-waste-targets.pdf
[4]. https://www.britishecologicalsociety.org/wp-content/uploads/2017/05/An-introduction-to-policymaking-in-the-UK.pdf
[5]. https://www.eea.europa.eu/publications/trends-and-projections-in-europe-1
[6]. https://www.eea.europa.eu/publications/92-9167-052-9-sum/page005.html
[7]. https://www.eltis.org/in-brief/legislation-policies
[8]. https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52015DC0614&from=EN
[9]. https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1588580774040&uri=CELEX:52019DC0640
[10]. https://ec.europa.eu/commission/presscorner/detail/en/ip_19_6691
[11]. https://www.zerowasteeurope.eu/wp-content/uploads/2017/07/Rethinkingeconomic-incentives2.pdf.
[12]. https://eitrawmaterials.eu/wp-content/uploads/2020/07/EIT-RawMaterials-project-POLICE-Final-report.pdf
[13]. https://ec.europa.eu/eurostat/statistics-explained/pdfscache/1183.pdf
[14]. https://www.un.org/en/conferences/environment
[15]. https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement
[16]. https://ec.europa.eu/environment/topics/plastics/single-use-plastics_en
[17]. InterregEurope, 2020. Sustainable waste management in a circular economy - A Policy Brief from the Policy Learning Platform on. Environment and resource efficiency
[18]. Kirchherr, J., Piscicelli, L., Bour, R., Kostense-Smit, E., Muller, J., Huibrechtse-Truijens, A. and Hekkert, M., 2018. Barriers to the Circular Economy: Evidence From the European Union (EU). Ecological Economics, 150, pp.264-272.
[19]. Nylén, E. J. A. and Salminen, J. M. (2019) 'How does the circular economy discourse affect policymaking? The case of streamlining waste utilisation in Finnish earthworks', Resources, Conservation and Recycling. Elsevier B.V., 149, pp. 532–540. doi: 10.1016/j.resconrec.2019.06.029.
[20]. Rajendran, Karthik & Björk, H. & Taherzadeh, Mohammad. (2013). Borås, a Zero Waste City in Sweden. Journal of Development Management. 1. 3-8.
[21]. Watkins, E. et al. (2012) Use of Economic Instruments and Waste Management Performances
[22]. Watkins, E. et al. (2017) EPR in the EU Plastics Strategy and the Circular Economy: A focus on plastic packaging
[23]. World Business Council for Sustainable Development (2020) Circular Economy Action Plan 2020 Summary for businesses: Implications and next steps.
[24]. https://www.businessart.at/download/EEB-ZeroWasteEU_%20Waste-timeline.pdf, European Environmental Bureau and Zero Waste Europe: A timeline for the EU's transition to a circular economy.

[25]. https://op.europa.eu/en/publication-detail/-/publication/5d4f8cde-de25-11e7-a506-01aa75ed71a1, "The ABC of EU Law" (Borchardt, 2018)
[26]. Whalen, K. A., Milios, L. and Nussholz, J. (2018) 'Bridging the gap: Barriers and potential for scaling reuse practices in the Swedish ICT sector', Resources, Conservation and Recycling. Elsevier, 135, pp. 123–131. doi: 10.1016/J.RESCONREC.2017.07.029
[27]. https://zerowasteeurope.eu/wp-content/uploads/2020/07/zero_waste_europe_policy-briefing_achieving-the-eu%E2%80%99s-waste-targets.pdf, Zero Waste Europe, 2020 "Achieving the EU's waste targets"
[28]. https://www.eltis.org/in-brief/legislation-policies, Eltis, n.d. "EU legislation & policies"
[29]. https://www.eea.europa.eu/publications/92-9167-052-9-sum/page005.html, EEA, 2016. "Case Study 2: Sweden"
[30]. https://www.eea.europa.eu/publications/trends-and-projections-in-europe-1, EEA, 2019. "Trends and projections in Europe 2019"
[31]. https://www.britishecologicalsociety.org/wp-content/uploads/2017/05/An-introduction-to-policymaking-in-the-UK.pdf, British Ecology Society, 2017 "Policy Guide"
[32]. https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52015DC0614&from=EN, European Commission, 2015 "Closing the loop - An EU action plan for the Circular Economy"
[33]. https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1588580774040&uri=CELEX:52019DC0640, EUR-LEX, 2019 "The European Green Deal"
[34]. https://ec.europa.eu/commission/presscorner/detail/en/ip_19_6691, European Commission, 2019 "The European Green Deal sets out how to make Europe the first climate-neutral continent by 2050, boosting the economy, improving people's health and quality of life, caring for nature, and leaving no one behind"
[35]. https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal/finance-and-green-deal/just-transition-mechanism_en, European Commission, n.d. "The Just Transition Mechanism: making sure no one is left behind"
[36]. https://www.euractiv.com/section/circular-economy/news/circular-economy-is-number-one-priority-of-european-green-deal/, Simon, 2019 "Circular economy erected as 'number one priority' of European Green Deal"
[37]. https://ec.europa.eu/environment/topics/circular-economy/first-circular-economy-action-plan_en, European Commission, n.d.1 "First circular economy action plan"
[38]. https://www.researchgate.net/publication/256298319_Boras_a_Zero_Waste_City_in_Sweden, Rajendran, Karthik & Björk, H. & Taherzadeh, Mohammad. (2013). Borås, a Zero Waste City in Sweden. Journal of Development Management. 1. 3-8.
[39]. https://docs.wbcsd.org/2020/11/WBCSD_Circular_Economy_Action_Plan_2020%E2%80%93Summary_for_business.pdf , World Business Council for Sustainable Development (2020) Circular Economy Action Plan 2020 Summary for businesses: Implications and next steps.
[40]. Kirchherr, J., Piscicelli, L., Bour, R., Kostense-Smit, E., Muller, J., Huibrechtse-Truijens, A. and Hekkert, M., 2018. Barriers to the Circular Economy: Evidence From the European Union (EU). Ecological Economics, 150, pp.264-272.
[41]. https://eitrawmaterials.eu/wp-content/uploads/2020/07/EIT-RawMaterials-project-POLICE-Final-report.pdf, EIT Raw Materials, 2020. "Policy instruments and Incentives for Circular Economy. Name of the author/Responsible partner: Teuvo Uusitalo, Elina Huttunen-Saarivirta, Jyri Hanski, Maria Lima-Toivanen, Jouko Myllyoja, Pasi Valkokari.
[42]. https://www.zerowasteeurope.eu/wp-content/uploads/2017/07/Rethinkingeconomic-incentives2.pdf. , Mitjans Sanz, V. et al. (2017) 'Rethinking economic incentives for separate collection'
[43]. https://ec.europa.eu/eurostat/statistics-explained/pdfscache/1183.pdf, Eurostat data, 2016b. Waste statistics, statistics explained
[44]. https://www.interregeurope.eu/policy-solutions/policy-briefs.html, InterregEurope, 2020. Sustainable waste management in a circular economy - A Policy Brief from the Policy Learning Platform on. Environment and resource efficiency
[45]. Watkins, E. et al. (2012) Use of Economic Instruments and Waste Management Performances
[46]. Watkins, E. et al. (2017) EPR in the EU Plastics Strategy and the Circular Economy: A focus on plastic packaging
[47]. Nylén, E. J. A. and Salminen, J. M. (2019) 'How does the circular economy discourse affect policymaking? The case of streamlining waste utilisation in Finnish earthworks', Resources, Conservation and Recycling. Elsevier B.V., 149, pp. 532–540. doi: 10.1016/j.resconrec.2019.06.029.
[48]. https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement, Unfccc.int. 2022. [online] Available at: <https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement> [Accessed 7 April 2022].

[49]. https://www.un.org/en/conferences/environment, United Nations, 2022. Conferences | Environment and sustainable development | United Nations. [online] United Nations. Available at: <https://www.un.org/en/conferences/environment> [Accessed 7 April 2022].
[50]. https://ec.europa.eu/environment/topics/plastics/single-use-plastics_en, European Commission, Environment. n.d. Single-use plastics. [online] Available at: <https://ec.europa.eu/environment/topics/plastics/single-use-plastics_en> [Accessed 7 April 2022].
[51]. Source: Joyita Ghose, Shilpi Kapur (The Energy and Resources Institute (TERI), 2019

REDUCE

Zuzana Palkova, Simon Srnka
SUA in Nitra, Slovakia

1. INTRODUCTION

"A circular economy is a sustainable model of producing and consuming. It is focused on use, reuse, repair, refurbishe, share, and recycle. This supports the max value is obtained from objects with minimum influence and minimum waste.

For food producing, the restoration we see in the nature is optimal. Zero waste is produced, because it becomes an essential part of next lifecycle.

For example, fruits grow and produce food in the wilderness. Animals and other beings eat from the tree (and the ground as well). Then, any not eaten fruit decomposes to fertilize the ground, sustaining new growth. The natural world is recurrent, and the life and rotting of plant and matter is a perpetuating, contained system.

Shortly, a circular economy would be mimicking this. The basic principle could be used for different specific industries, like fashion, where each piece of clothing is made with its future use and possible recycling in mind.

A circular economy is the opposite of what we have now, which is a linear economy. Production of items, use and discard them. The linear model has a disproportionate impact on the environment, exacerbates resource scarcity, and compounds social and economic inequality worldwide." [1]

Source: https://www.weforum.org/whitepapers/circular-economy-in-cities-evolving-the-model-for-a-sustainable-urban-future

2. ENDING THE LINEAR ECONOMY

"Firstly, it will help us to understand what our current economic model looks like, which is unfortunately the opposite of a circular economy. In a traditional 'linear' economy, our resources have a 'take-make-dispose' life cycle: we extract raw materials to produce products, we use the products and, after use, we dispose of them as waste. This is either because the products are difficult to recycle, either because of the design of the product or the difficulty of collecting the material, or simply because society does not recycle them.

The existing "take, make, dispose" paradigm physically throws away a lot of material. This system is unsustainable for people, the environment, and profit since it depends on a globe with finite resources for our economy and environment. According to estimates, for instance, more than 70% of plastic packaging reaches landfills or, worse still, our streets and oceans. However, the majority of plastics can actually be recycled numerous times; as a result, when plastic is thrown away, not only is the material itself lost, but also its potential value in the future.

Since the 1950s, only 9% of the 8.3 billion tonnes of plastic produced has been recycled. According to researchers, 6.3 billion metric tons of material have been discarded. According to recent studies, 29 million metric tonnes of plastic will enter the ocean year if we continue on current "business as usual" trend. And that only includes plastics; it excludes other materials like glass, aluminum, and building supplies like steel and cement.

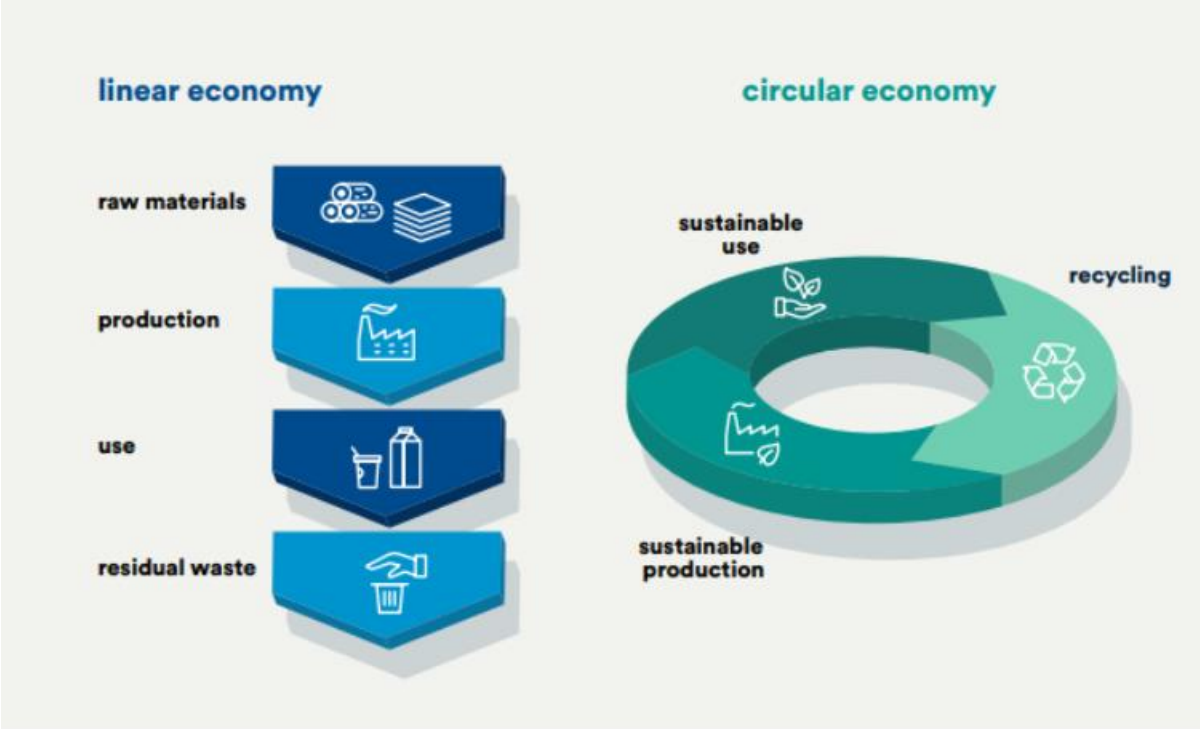


Figure 16. Differences between linear and circular economy approaches

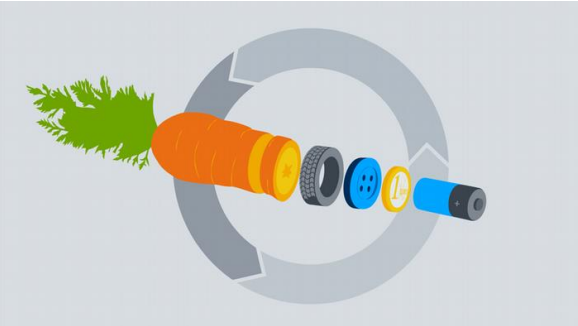
Source: https://newsroom.tomra.com/what-is-the-circular-economy/

A systems design approach that promises much-needed transformation is the circular economy. The phrase is frequently used in a variety of contexts since it refers to a style of conceptualizing or organizing a system rather than a specific technology or object. The circular economy is a regenerative system where we rethink what growth is and ensure that we create economies that have a beneficial influence on environmental, social, and economic capital. Three principles form the foundation of the circular economy:

- Design products to avoid waste and pollution
- Store used products and materials
- Regeneration of natural systems

One straightforward approach to grasp this idea is to compare our economy—our systems of what we buy, consume, and wear—to a tree. A tree generates oxygen by using carbon dioxide, soil nutrients, and sunshine to create its green leaves. These leaves drop to the ground in the autumn. The nutrients from the leaves are returned to the soil after the winter and can be used by the same tree or the tree next to it. Everything serves a purpose, nothing is wasted, and thus the infinite cycles continue. Simply said, the circular economy aims to mimic these natural cycles.

The concept of "design for recycling" is crucial to the circular economy. The primary idea behind recycling is that materials and products have several life cycles because they are made to maintain their value and quality. Recycling can refer to a variety of procedures. When creating a new bottle, a bottle manufacturer would think, "How can I make this bottle so it can be recycled when it is empty and have the highest value for the manufacturer and recyclers?"



Source: https://www.dw.com/en/global-ideas-in-focus-circular-economy/a-59855315

A recent study emphasizes the value of recycling for reducing production-related emissions as well as for material reasons. In terms of plastic materials specifically, one metric tonne of recycled plastic material typically offsets 1.9 tonnes of CO2 in terms of greenhouse gas emissions. Additionally, as opposed to landfilling and incineration, true circular economy models for materials like reuse, recycling, and production of green jobs all produce income. One of the main tools of the circular economy is recycling, which prevents material waste and lowers the environmental costs of consumption. [2]

3. 3R WASTE MANAGEMENT HIERARCHY

“The 3R (Reduce-Reuse-Recycle) concept is basically a sequence of steps on how to manage waste properly. The top priority is to Reduce, which means to reduce waste generation, then Reuse and then Recycle, to give waste material a second chance before it goes to landfill.

After the 3R concept, the 5R concept is being introduced at the same time. The 5R concept adds two more phases to the waste management process: the first is Recover, the recovery of materials that can no longer be recycled into energy sources/environmentally friendly materials to avoid landfill. The last stage is Disposal, which is the separation of waste that can no longer be recycled or recovered in a landfill.

The inverted triangle 3R (Reduce-Reuse-Recycle) concept illustrates the amount of waste volume that should be treated in each sequence.

This basically means that most waste production should be reduced from the start. Only when waste can no longer be prevented are items reused, one method of reuse being the upcycling process or the production of craft products.

When materials can no longer be reused, the waste is recycled, melted down, chopped up to make a new product that can be reduced in quality.

The reduction in the quality of recycled materials, as well as the energy and resources needed to recycle waste, are two of several reasons why recycling is not a top priority for proper waste management. The main priority is always to reduce/prevent waste from the beginning (reduce).

The 5R (Reduce-Reuse-Recycle-Recovery-Disposal) inverted triangle concept with the following details:

- Reduce waste - reduce waste from the start by bringing your own shopping bags, using reusable products, etc.
- Reuse - the reuse of materials that can be and are safe for reuse, one of which is the production of craft products or the upcycling process.
- Recycling - Recycling waste by melting, chopping to re-create new products that are most likely to experience a decline in quality.
- Recycling - if it cannot be recycled, find a way to produce energy or new material by processing non-recyclable waste (residue).
- Disposal - the by-products of the recovery process, which are usually in the form of ash or other waste material, are taken to a landfill where they are treated in a way that does not harm the environment"[3].

4. DEFINITION OF REDUCTION

"The concept of reducing the amount of waste produced and consumed is at the heart of the waste hierarchy. Its logic is simple to understand - if there is less waste, then there is less waste to recycle or reuse.

"Reduce" primarily means to use fewer resources. This is the most effective of the three R's and is the one to start with. It's also the hardest because it requires letting go of some very American ideas, such as the bigger the better, new takes precedence over old, and convenience comes first. However, you don't have to give it up completely or all at once. "Downsize" is a comparative word. It says: reduce what you have now.

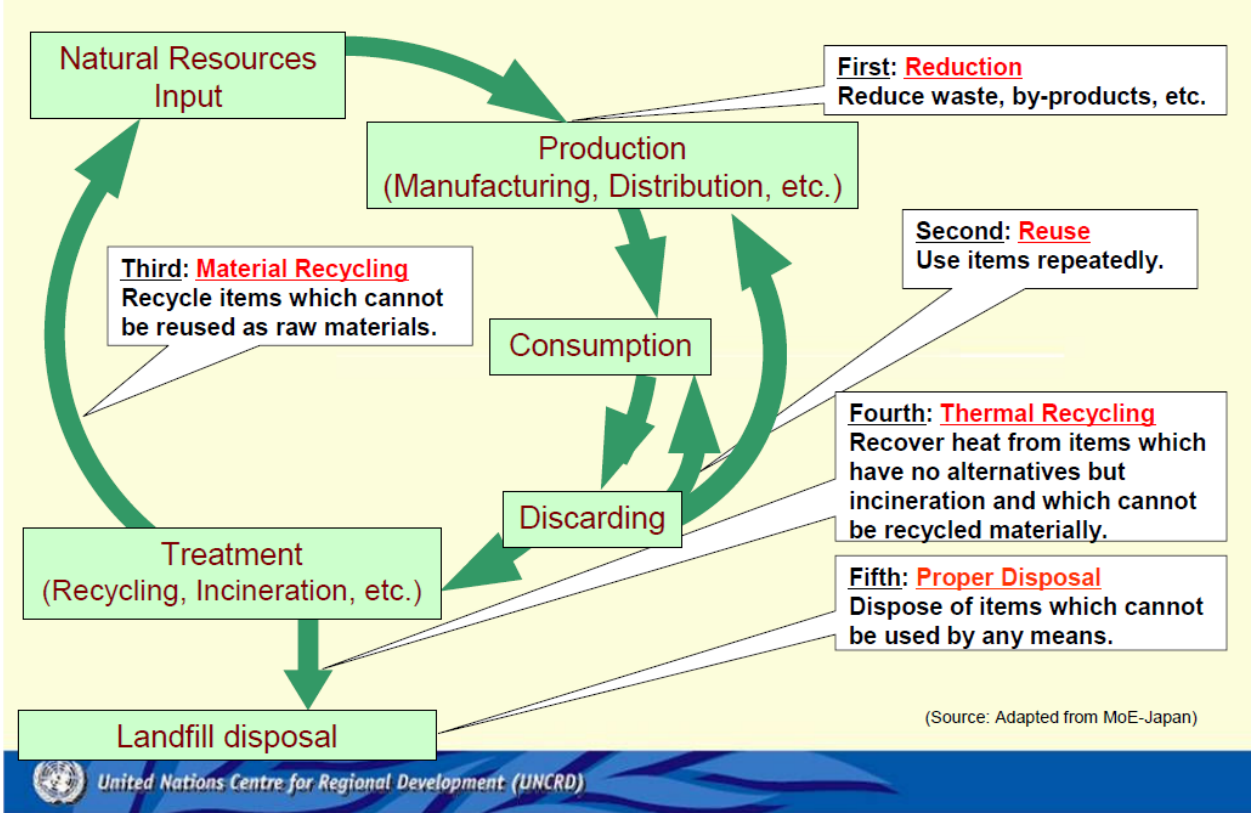


Figure 17. 3Rs Approach of Japan to Resource Efficiency and a Zero Waste Society

Source: https://sustainabledevelopment.un.org/content/dsd/csd/csd_pdfs/csd-19/learningcentre/presentations/May%209%20am/1%20-%20Learning_Centre_9May_ppt_Mohanty.pdf

When you shop, shop differently. Look for things that will last, things that are not only durable and well made, but also useful and beautiful enough to keep you happy for a long time. The extra money you spend on acquiring them will be offset by the money you don't spend on replacing them. Don't chase the latest fashion trends. These will become obsolete the fastest.

With electronics, extravagance can pay off. A super-powerful computer will run on software that will be out in two years, and a large monitor will fit on the ever-widening web pages that companies will be creating even then. Similarly, a mobile phone with a full-text keyboard (or an iPhone) will guide you through the era of text messaging that is coming. When you buy, find out how to keep the item in shape. Then maintain it appropriately and repair it when necessary." [4]

Figure 18. **Responsible waste management hierarchy**

Source: https://waste4change.com/blog/waste4change-supports-3r-reduce-reuse-recycle-green-concept/

4.1. ASSESSING THE REDUCTION VALUE OF AN ITEM OR PROCESS

- "Step 1: Is there anything else that can be used for this purpose?

  The use of reusable items is essential to start reducing consumption. One example is the coffee and cappuccino maker. They both do different things, but you can buy a coffee pot that has a steaming attachment so it can do both.

  Buying one item means you don't use two. This will reduce the amount of production and the amount of waste packaging material that is generated.

- Step 2: Is this something that needs to be done?

  A lot of our waste comes from items that are considered 'disposable'. Not in the sense that you use something once and then throw it away, this can actually be part of environmental responsibility when working with medical devices - disposable in this sense means whether or n

- Step 3: Is the subject part of something you need or want to do in your life?

There is a limit that you have to be prepared for in life. Chances are you won't need a car that is equipped to handle a sandstorm in the desert.

Buying it encourages production, wastes resources and creates more waste than you can imagine. Always make sure that what you consume - or keep in your life as preparation - matches the reality of the potential opportunities in your life." [5]

4.2. REDUCTION STRATEGIES FOR MUNICIPALITIES AND BUSINESSES

- "Reducing and saving materials

  Waste - Encourage manufacturers to provide products or packaging that limit waste or emissions.

  Take-back - Introduce systems that require producers to take back products and packaging that generate waste or emissions.

  Reduce the use of toxic substances - eliminate the use of toxic chemicals; replace them with less toxic or non-toxic alternatives.

  Eliminate waste - find out why materials are being thrown away and redesign the system to make it more efficient so that these materials are no longer thrown away.

  Reduce consumption and packaging - Use less, buy less and with less packaging, avoid disposables, bring your own.

- Encouraging circular use of resources and changing incentives to stop wastage

  - Shift government funds or financial incentives (at all levels) from promoting the extraction and use of primary natural resources to promoting the circular economy.

  - Government and business should make sustainable purchases that support social and environmental goals.

  - Providing incentives for material cycling and disincentives for waste (policies, research funds, regulations, etc.)

- Put systems in place to support local economies (e.g. use of proximity principle, marketing support, policies, incentives, social and environmental purchasing practices, information exchange, etc.)

- Manufacturers design products for sustainability and take-back

  - The structure shall be durable, repairable, reusable, disassembled, fully recyclable, made of reused, recycled or sustainably sourced renewable materials, designed for easy disassembly.

  - Label the products to find out who made them and what they are made of.

  - Minimize the volume and toxicity of materials used in manufacturing.

  - Renting services and products, not just selling products to customers.

  - After using the products and packaging, take them back and reuse or recycle them and return them to the economy or nature. "[6]

4.3. REDUCING STRATEGIES FOR HOUSEHOLDERS

"The best way to manage waste is not to produce it. This can be done by shopping carefully and following a few principles:

- Buy products in bulk. Larger, economy-size or concentrated products use less packaging and usually cost less per ounce.
- Avoid excessively packaged goods, especially goods packaged in multiple materials such as foil, paper and plastic. These are difficult to recycle and you will pay more for packaging.
- Avoid disposable goods such as paper plates, cups, napkins, razors and lighters. Disposable items contribute to the problem and are more expensive because they must be replaced repeatedly.

Source: https://www.wastesorted.wa.gov.au/blog/10-ways-to-reduce-waste-at-home

- Buy durable goods - well constructed or with a good warranty. They will last longer, save money in the long run and save space in the landfill.
- Make double-sided copies at work if possible.

- Maintain central files instead of using multiple files for individuals.
- Use e-mail or the main bulletin board.
    - Remove your name from lists of materials you no longer wish to receive: write to Mail Preference Service
    - Use cloth napkins instead of paper ones.
    - Use a dish towel instead of paper towels. "[7]

5. REDUCTION OF WASTE MATERIALS

"Waste reduction, also known as resource reduction, is the practice of using less material and energy to minimise waste and conserve natural resources. Waste reduction has a broader scope than recycling and includes ways to prevent materials from ending up as waste before they reach the recycling stage. Waste reduction includes reusing products such as plastic and glass containers, buying more durable products and using reusable products such as dish towels instead of paper towels. Donating products, from office equipment to glasses and clothing, reduces the total amount of material produced. Buying products that replace hazardous materials with biodegradable components reduces both pollution and waste. Reducing waste in general has several environmental benefits. Greater efficiency in the production and use of products means less energy consumption, which leads to less pollution. More natural resources are conserved. Products that use less hazardous materials are used. Finally, less solid waste ends up in landfills.

Reducing waste also means economic savings. When waste reduction practices are applied, less materials and less energy are used. Instead of the traditional cradle-to-grave approach, a cradle-to-cradle system is used. In this cradle-to-cradle system, also called industrial ecology, products are not used for a certain period of time. Instead of disposing of the materials or components of a product after one use, the products are passed on for further use. This is considered a flow of materials. It can be applied within an organisation or between organisations, which may be considered unrelated, on a collaborative basis. "[8]

Figure 19. Basic principles of waste reduction

Source: https://www.southpasadenaca.gov/government/departments/public-works/environmental-programs/waste-reduction

5.1. REDUCING FOOD WASTE

"Around one third of all food intended for human consumption is lost or thrown away. In cities, food often makes up the bulk of the waste that ends up in landfills, where it gradually decomposes and releases methane, a potent greenhouse gas.

Methane emissions from organic waste such as food and plant waste are largely preventable. Measures to reduce these emissions - preventing waste at source, diverting waste from landfill and introducing separate collection, treatment and energy recovery - create further social and economic opportunities.

By reducing the amount of food wasted in cities, governments can tackle landfill, combat food insecurity and mitigate climate change. To take advantage of these opportunities, the Climate and Clean Air Coalition's Clean Air Initiative supports cities around the world in managing food and other organic waste.

Most people don't realise how much food they throw away every day - from uneaten leftovers to spoiled produce. The EPA estimates that in 2018, approximately 68% of the total amount of food thrown away ended up in landfills or incinerators, or about 42.8 million tonnes. By managing food sustainably and reducing waste, we can help businesses and consumers save money, provide a bridge in our communities for those who don't have enough to eat, and preserve resources for future generations.

Source: https://losspreventionmedia.com/collaboration-food-waste-reduction/

Ways to Reduce Food waste

Planning, preparing and storing food can help your household waste less food. Below are some tips to help you do this:

Tips for planning

By simply making a list with weekly meals, you can save money and time and eat healthier. If you don't buy more than you expect to consume, you'll be more likely to keep the food fresh and use it all up.

- Make an ongoing list of dishes and their ingredients that your household already likes. That way you can easily choose, shop and prepare meals.
- Make a shopping list based on how many meals you eat at home. Will you be eating out this week? How often?
- Plan your meals for the week before you go shopping and only buy the things you need for those meals.
- In the shopping list, indicate the quantity and write how many meals you will prepare from each item to avoid overpayment. For example: green salad - enough for two lunches.

- First, take a look in your fridge and cupboards to avoid buying food you already have, make a list of what needs to be consumed each week and plan your next meals accordingly.
- Only buy what you need and will use. Buying in bulk only saves money if you can use the food before it goes bad.

Storing Tips

It's easy to overpay or forget about fresh fruits and vegetables. Store fruits and vegetables to keep them as fresh as possible; they will be tastier and last longer, which will help you eat more of them.

- Find out how to store fruit and vegetables to keep them fresh for longer in or out of the fridge.
- Freeze, can or preserve excess fruit and vegetables - especially rich seasonal produce.
- Many fruits give off natural gases as they ripen, which cause other produce in the vicinity to spoil more quickly. Store bananas, apples and tomatoes separately and store fruit and vegetables in different containers.
- Wait to wash the berries until you want to eat them to prevent mould.
- If you like to eat fruit at room temperature, but it should be stored in the fridge for maximum freshness, take what you will eat during the day out of the fridge in the morning.

Preparation Tips

Prepare perishable food immediately after purchase. It will be easier to prepare meals or snacks later in the week, saving time, effort and money.

- When you get home from the store, take the time to wash, dry, cut, dice, slice, and store fresh foods in clear containers for snacking and easy cooking.
- Make friends with your freezer and visit it often. For example,
- Freeze foods such as bread, cut fruit or meat that you know you won't be able to eat in time.
- Reduce the time spent in the kitchen by preparing and freezing meals in advance.
- Prepare and cook perishables and then freeze them for use throughout the month.
- For example, bake and freeze chicken breasts or fry and freeze taco meat.

Tips for thriftiness

Keep an eye out for old raw materials and leftovers that need to be used up. You'll waste less and you might even find a new favourite food.

- Shop in the fridge first! Cook or eat what you already have at home before you buy more.
- Do you have a product that is no longer in the best condition? It may still be suitable for cooking. Think soups, dips, stir-fries, sauces, pastries, pancakes or smoothies.
- If it's safe and healthy, use edible parts of foods you don't normally eat. For example, old bread can be used to make croutons, beet tops can be used to make a tasty side dish and leftover vegetables can be used to make stock.
- Learn to differentiate between use-by date, best before date, use-by date and use-by date.
- Are you likely to have leftovers from any of your meals? Plan a night each week when you will eat leftovers.
- Casseroles, stir-fries, frittatas, soups and smoothies are also great uses for leftovers. Check out the website for suggestions on how to use leftover ingredients.
- In restaurants, order only as much as you can finish, and ask about portion sizes and side dishes that come with main meals. Take leftovers home and save them for your next meal.
- In all-you-can-eat buffets, take only what you can eat." [9]

5.2. REDUCTION OF PLASTIC WASTE

"We all know that plastic is a problem. Although it has many positive qualities - it is cheap, easy to produce, flexible and available - it is becoming increasingly clear that plastic waste is spiralling out of control and causing huge damage to the environment. For example, 12 million tonnes of plastic are spilled into the ocean every year, and scientists have recently discovered microplastics embedded deep in Arctic ice. But what is the solution?

Figure 20. Simple ways of waste reduction

Source: https://www.treehugger.com/easy-ways-reduce-your-plastic-waste-today-4858814

How can plastic waste be reduced?

And now the most important thing - how can we make a difference? Fortunately, there are several changes you can make as an individual that can have a positive impact. However, it is important to mention that individual steps alone are not enough.

Legislation and policy are key to tackling global plastic pollution. This can range from pollution laws to legislation on waste transport and waste management.

Avoiding single-use plastics

Single-use plastic items are one of the biggest offenders when it comes to plastic pollution. It may be harder than you'd think to avoid them, but being aware of how prevalent they are in everyday life is a good first step.

Common examples of single-use plastics include vegetables in plastic packaging in supermarkets, wet wipes, cotton buds, plastic cutlery, coffee cups, straws, sanitary products and cigarettes. Fortunately, there are plenty of alternatives if you're looking for them.

Using alternative packaging

If you own a small business, it can be really important for you to look around for alternative packaging options. Whether you own a cafe or have a small shop on Etsy, you can try more sustainable packaging options including paper and cardboard.

Sometimes we need packaging that at least mimics plastic to protect products, especially when it comes to food. Bioplastics are plastics made from bio-based renewable materials such as cellulose and have the potential to biodegrade faster than conventional plastics.

Conduct a waste audit

A waste audit is basically taking a look at your rubbish and keeping track of what you frequently throw away. We often throw things away without thinking, so it's a great way to understand exactly how much waste we're creating. A waste audit also allows us to find replacements for our most frequently thrown away items.

For example, if you find a lot of coffee cups in your trash, you know it's time to buy a reusable cup. Alternatively, if you have lots of packets of crisps, consider buying a bigger packet next time and see if you can find packaging that can be recycled.

Find reuse opportunities

We've covered this topic in previous sections on single-use plastics, but finding reusable alternatives is the best way to ensure you stop using so many single-use plastic items. It doesn't just have to be fancy bamboo alternatives - just put plain metal cutlery in your bag or take an old plastic water bottle to work with you." [10]

5.3. REDUCTION OF PAPER WASTE

"Paper waste accounts for a significant proportion of the total waste in landfills, around 26%. More than two million trees are cut down every day to meet global paper consumption. This means that four billion trees are cut down every year just to serve our need for paper! Did you know that preventing just one ton of typical office paper can save approximately 24 mature trees? Paper use is now one of the major contributors to climate change and environmental degradation; and as paper becomes an increasingly cheaper commodity, its use is only increasing at a rapid rate.

That's why we offer you some ways you can reduce paper consumption in all areas of your life: at home, at school, in the office and on the go.

Reduction of Paper Use at Home

- Do not use paper towels. Use reusable, washable towels instead.
- Store important documents online in the cloud.
- Recycle like you mean it.
- Keep your brown paper scraps for compost.
- Reject junk mail.
- Do not use a coffee machine that requires paper filters. Instead, try a French press.

Source: https://www.forafinancial.com/blog/small-business/reduce-paper-waste-at-business/

Reducing Paper Use At School

- Instead of the traditional brown paper bag, use a lunch box or reusable bag.
- Pack sandwiches in reusable containers, not paper or plastic.
- Encourage children to take only what they need to avoid throwing things away.
- Save leftover paper for home craft projects.
- Create a paper reuse centre where children can deposit paper that has only been used on one side. Reuse it for calculations or designs!
- Allow and encourage children to send assignments via email.
- Use a projector or whiteboard to reduce the amount of photocopied information that is shared in class.
- Buy durable classroom materials that contain recycled content or that can be recycled later.

Reducing Paper Use In the Office

- Go digital. Use email instead of printing or faxing to exchange documents and notes.
- Adjust the formatting of the document to fit more text on one sheet.
- When sharing messages, print two pages on a standard sheet and print on both sides of the paper.
- Don't be afraid to store files on paper. Use electronic storage instead!
- Eliminate duplicates in paper mailing lists or remove yourself from junk mail lists altogether.
- Use recycled chlorine-free paper products. And try soy or other agricultural inks for printing.
- Routing messages and publications. Instead of sending out individual printed messages to all employees, make one copy and attach a routing sheet to it.

- Recycle all used paper and paper products, including cardboard packaging and boxes.

Reducing Paper Usage On the move

- Refuse paper napkins in restaurants and cafes.
- Don't pick up a newspaper, but look it up online.
- Bring your own reusable travel mug to cafes.
- Use a digital app rather than a paper planner for planning.
- Reading from Kindle. "[11]

6. CIRCULAR ECONOMY BUSINESS MODELS FOR REDUCE PROVIDING OPPORTUNITIES

"To contribute to a circular economy, companies may consider integrating the following circular objectives into their business models:

- reducing the consumption of supporting resources - water, energy, etc. - and the generation of waste in the production of raw materials, thereby increasing the efficiency of processes;

- Increasing the production of recycled materials from waste and integrating material recycling into the production of new materials, thereby closing the material loop;

- Reduce the volume of materials production by shifting to materials services that are less dependent on maximizing production and sales based on weight and volume.

The first way to increase circularity is to reduce the use of supporting resources - energy, water, soil, chemicals, etc. - and to reduce waste production. In this case, the existing business model is further optimised by reducing production costs and waste management costs. This path does not require a fundamental change to the existing business model, as the strategies for creating, designing and extracting value remain the same. Nevertheless, it usually requires technical innovation to increase the efficiency of the production process. Process changes need to be designed and implemented, for example, to recirculate process water, recover process heat, regenerate chemicals, or enable direct recycling of production waste in the manufacturing process.

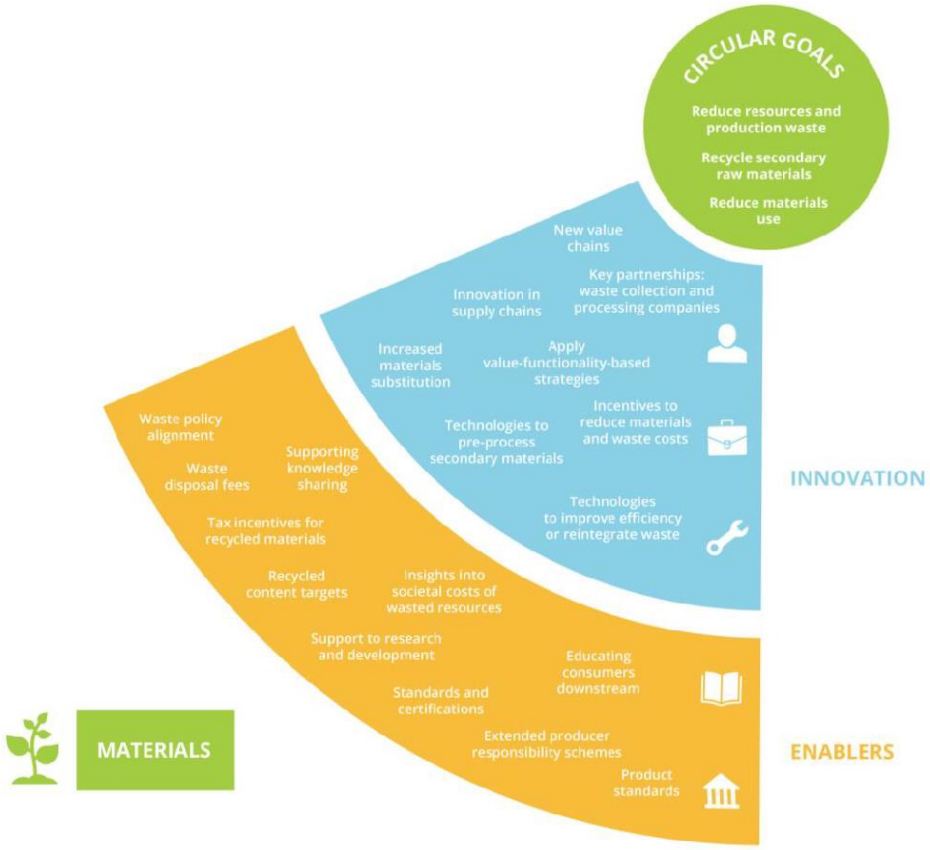


Figure 21. Key innovation and enabling actions to stimulate circular business models to meet circular goals in the materials phase

Source: Eionet report - Business Models in a Circular Economy published by Jeroen Gillabel (VITO), Saskia Manshoven (VITO), Francesca Grossi (CSCP)

In many cases, a more efficient production process makes good economic sense, and although there may be practical obstacles, this strategy can easily be implemented by companies in a variety of industries. However, policy measures can provide additional incentives to incorporate this circular objective into existing business models. Project support for research and development of resource-efficient production processes can support technical development. Investment support for the adoption of best available technologies can overcome financial barriers. The introduction of charges or bans on the disposal of production waste provides incentives for businesses to address their waste problems, as well as contributing to less land use and pollution associated with the extraction of raw materials. Taxes on the use of virgin resources can incentivise product developers to switch to the use of recycled materials. In addition, creating awareness and providing education to companies about the business and societal benefits of reducing resource use and waste is an important part of the successful adoption of this pathway. "[12]

REFERENCES/Link to online resources and specific imagesific images

[1] https://www.livekindly.co/what-is-a-circular-economy/

[2] https://newsroom.tomra.com/what-is-the-circular-economy/

[3] https://waste4change.com/blog/waste4change-supports-3r-reduce-reuse-recycle-green-concept/

[4] https://www.thebalancesmb.com/the-3-r-s-reduce-reuse-and-recycle-3157809

[5] https://www.conserve-energy-future.com/reduce-reuse-recycle.php

[6] https://zerowasteeurope.eu/2013/04/zero-waste-hierarchy/

[7] https://www.sustainablesanantonio.com/practices-technology/reduce-reuse-recycle/

[8] https://www.encyclopedia.com/earth-and-environment/ecology-and-environmentalism/environmental-studies/waste-reduction

[9] https://www.epa.gov/recycle/reducing-wasted-food-home

[10] https://www.futurelearn.com/info/blog/how-to-reduce-plastic-waste

[11] https://zerowastememoirs.com/baby-step-15-paper-waste/

[12] Eionet report - Business Models in a Circular Economy published by Jeroen Gillabel (VITO), Saskia Manshoven (VITO), Francesca Grossi (CSCP)

[13] Case studies on Circular Economy models and integration of Sustainable Development Goals in business strategies in the EU and LAC" published by Yanina Kowszyk and Rajiv Maher in 2018

REUSE

Dr. Fatmagül Tolun, Dr. Ergün Demir, Murat Sabri Saran
Balıkesir University, Turkiye

1. INTRODUCTION

The linear economic model, called the "take, make and dispose" model, has achieved an unprecedented level of growth, but has also placed serious emissions supply risks and waste generation pressures on the anthroposphere [1]. The new trend, circular economy (CE), is at the highest of the political agenda, especially in Europe. This new trend is predicted to form new jobs and job opportunities, save on material costs, and at the identical time support economic process by reducing greenhouse emission emissions, environmental pressures and impacts. it's estimated that eco-designs, waste prevention and reuse may end up in net savings of up to €600 billion for EU businesses. it's estimated that this may increase resource efficiency by 30% by 2030 and also create 2 million additional jobs [2]. While the waste generation from all economic activities within the EU is 2.5 billion tons annually, or 5 tons per capita, each citizen generates about half plenty of municipal waste per annum [3].

The ***New Circular Economy Action Plan*** is one in all the most building blocks of the **European Green Deal**, which sets an ambitious roadmap towards a climate-neutral circular economy. The New Plan will make circularity mainstream in our lives and accelerate the green transition of our economy [4]. Zero waste brings us into the 21st century by shifting the main target removed from waste management and towards the correct management of Earth's precious resources. the foremost important lesson to be learned from the COVID-19 pandemic is that to forestall new pandemics, we must stop the environmental destruction that feeds them. we want to market reusable solutions that employment within the short and long run.

Zero waste is "the conservation of all resources through responsible production, consumption, reuse and recovery of products, packaging and materials, without burning and with none discharge into the soil, water or air that threatens the environment or human health" [5]. Reduce, reuse, and recycle—the "**three R**'s" of solid waste management—are listed so as of importance for actions that ought to be taken to manage solid waste. **R**educe, **R**euse, **R**ecycle – these three 'R' words are a very important a part of sustainable living, as they assist to chop down on the quantity of waste we've got to throw away. Sometimes, two more 'R's is added to the three basic ones, **R**ethink and **R**ecover, will be added to the beginning of the list. The Three Rs saves money and energy and reduces landfill [6].

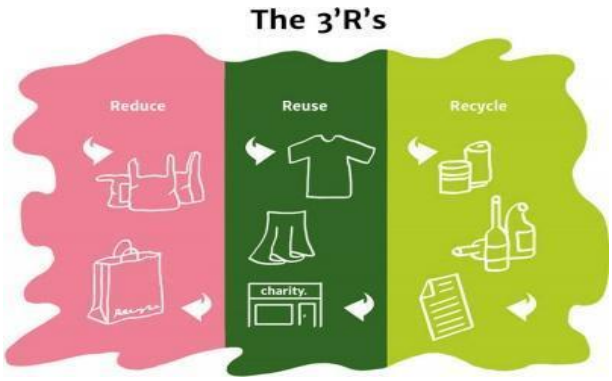


Figure 22. The 3'R's

Source: Link: https://www.solarschools.net/knowledge-bank/sustainability/reduce-reuse-recycle [6].

Aproximately 2 169 million tons of waste were processed in the EU in 2018 [7]. According to the EU Waste Hierarchy, waste prevention measures followed by reuse are top priorities when it comes to waste management and policy. The order of priority is outlined in the waste management hierarchy [3].

Approximately 2 169 million loads of waste were processed within the EU in 2018 [7]. in keeping with the EU Waste Hierarchy, waste prevention measures followed by reuse are top priorities when it involves waste management and policy. The order of priority is made public within the waste management hierarchy [3].

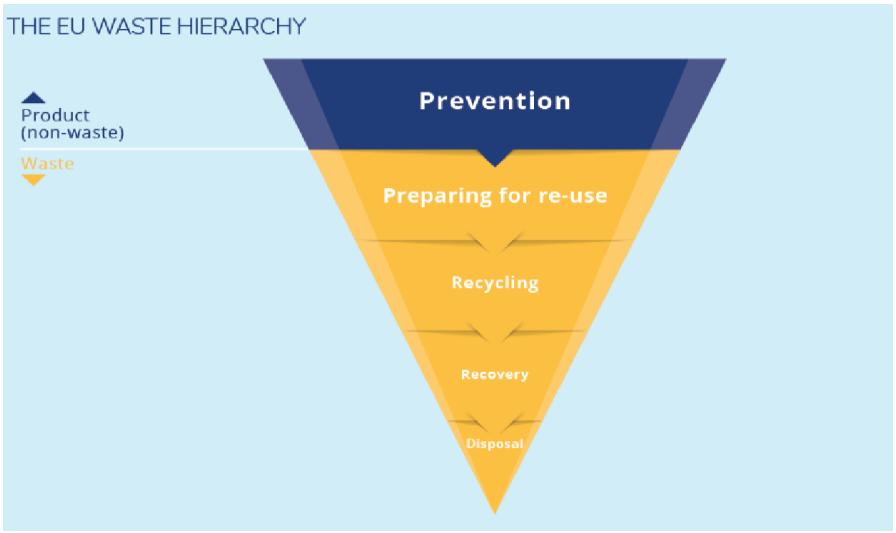


Figure 23. EU waste hierarchy

Source: EEB, Link: https://eeb.org/ [3]

2. DEFINITION OF THE CONCEPT OF REUSE

The **second "R" reuse** means taking products that might well be thrown away and reusing them in their current form or with few repairs or modifications. This 'R' relies on how one can use it again (ideally multiple times) before changing certain elements. Reuse is that the act or practice of using an item for its original purpose (traditional reuse) or to perform a distinct function (creative reuse or reuse) [8].

People often say they recycle something after they actually reuse something [9]. Reuse is recognized as distinct from recycling, both in doctrine and within the treatment of materials that this unique industry removes from the waste stream. Re-users, on the opposite hand, keep the materials out of the waste stream by passing the products they collect to others with little or no treatment. There also are kinds of managing materials like repair and remanufacturing that don't seem to be fully reused and fully recycled [10].

The distinction between the terms reuse, recycling and recovery is vital for understanding and implementing the objectives embarked on in ***EU Waste Legislation***. The definitions of recycling and reuse within the Waste-specific Directives differ somewhat from the corresponding definitions of the Waste Framework Directive [11]:

1. The term ***recycling*** laid out in waste specific Directives does particularly not include backfilling operations.

2. ***Reuse*** as defined within the Packaging Directive 94/62/EC and also the WEEE Directive 19/2012 of the eu Parliament and of the Council of 4 July 2012 on waste electrical and equipment (WEEE) comprises specifications the Waste Framework Directive doesn't include.

The EU Circular Economy Package emphasizes the importance of extending product life and aims to repair and reuse products in its action conceive to make sure that products reach their optimum lifespan. the flexibility to reuse products and materials is at the center of the zero waste approach as a fundamental prerequisite for the event of a circular economy. To reuse within the mainstream, variety of local and national systems must be both designed and activated [12]. The reuse process begins with the idea that used materials, valid throughout our lives, will be a resource instead of a waste. One person's trash is another person's treasure. If we actually take a look at the items we throw away, we are able to learn to determine them as materials which will be reused to resolve everyday problems and meet daily needs. Reusing saves money, saves resources, and satisfies the human urge to be creative [13]. Every community needs more reuse thanks to an existing type of reuse and economic difficulties today. Volunteer efforts, for-profit businesses and charities are all making reuse happen, including [14]:

- thrift stores and charitable drop-off centers,
- reuse centers, equipment and materials,
- "drop & swap" stations at landfills,

- used equipment stores and salvage yards,
- local and regional material exchanges.

3. BENEFITS OF REUSE

The purchase and use of reusable items supports the waste management targets set by the EU. it's important to acknowledge that the sustained growth in reuse efforts, furthermore because the continued interest of the reuse industry, is essentially thanks to the solid waste reduction hierarchy: reduce, reuse, then recycle. Reuse could be a thanks to prevent solid waste from entering landfills, improve our communities, and increase the fabric, educational and professional well-being of our citizens by buying and making useful products discarded by people who not want them. In many cases, reuse provides tax benefits and reduced disposal fees to donor businesses while supporting local people and social programs [10].

Reuse has several main ***advantages*** over recycling [9]:

- It saves or delays acquisition and disposal costs,
- Protects resources,
- Reduces waste flow,
- Causes less pollution than recycling or making new products from pure materials,
- Provides necessary materials for those that cannot afford to shop for new.

Some ***benefits*** of reuse [9]:

- Prevents pollution by reducing the necessity for brand new staple harvesting,
- It saves energy,
- Reduces greenhouse emission emissions that contribute to global global climate change,
- Helps protect the environment for future generations,
- It provides savings,
- It ensures that the products are accustomed the fullest.

3.1. ENVIRONMENTAL BENEFITS

Many reuse programs have evolved from local solid waste reduction goals because it requires less resources, less energy and fewer labor than reuse, recycling, disposal or manufacturing new products from virgin materials. Reuse provides a wonderful and environmentally preferred alternative to other waste management methods because it reduces air, water and soil pollution and limits the requirement for brand new natural resources like timber, oil, fibers and other materials. Waste reduction is a very important method of reducing greenhouse emission emissions, which may be a contributing factor to warming [10].

Reusing a product can reduce ***CO_2 emissions*** and ***carbon footprint*** by quite 50% over the whole product lifecycle. a comparatively unknown effective thanks to reduce CO2 emissions and carbon footprint is to reuse products. Often the relative carbon footprint of the manufacturing and provide chain is unknown. As producing new products depletes our limited natural resources and therefore the disposal of unwanted materials pollutes our surroundings, our communities are struggling to search out the affordable products they have. Reusing something uses little or no water, energy, or other resources, and is additionally unlikely to cause pollution. additionally to those benefits, reuse eliminates the environmental damage that will occur if the merchandise was destroyed rather than reused. Conversely, producing a product from raw materials (and to a lesser extent recycling) consumes resources, causes pollution and produces waste [14].

3.2. COMMUNITY BENEFITS

For many years, reuse has been used as a critical thanks to provide needed materials to several existing disadvantaged populations. Reuse provides a wonderful way for people to urge food, clothing, building materials, work equipment, medical supplies, and other items they desperately need. Reuse also can be very beneficial for disadvantaged those who can't afford to shop for new goods. However, there are other ways in which reuse benefits society. Many reuse centers that collect and distribute reusable goods may also provide community benefits by participating in job training programs, general education for the long-term unemployed, disability and disability programs, or youth at-risk programs. additionally to creating a positive contribution to the reduction of solid waste, many reuse programs are considered by charities as a method of providing products to low-income or disadvantaged people. Donating our surplus items may help equip a nonprofit office and further support the community we board by providing a college with essential supplies [10,14]. Reusing something uses little or no water, energy, or other resources, and is additionally unlikely to cause pollution. additionally to those benefits, reuse eliminates the environmental damage that will occur if the merchandise was destroyed rather than reused. Conversely, producing a product from raw materials (and to a lesser extent recycling) consumes resources, causes pollution and produces waste [14].

3.3. ECONOMIC BENEFITS

Reusing materials instead of creating new products from raw materials places less of a burden on the economy as a full. With reuse, there's a decrease in imports of raw materials and products. Reuse is a cheap way for several people to get the products they have. Buying a second user product is sort of always cheaper than a replacement one [10,14].

Businesses can save significantly on disposal by reselling or donating products that are not any longer needed. Many chemicals and solvents that are not any longer useful to 1 organization are often employed by other organizations in other applications. This "***material exchange***" method ends up in savings on disposal by the manufacturing company and savings in purchasing the fabric by the purchasing organization.

4. REUSE STRATEGIES

The reuse process begins with the attitude of being useful to products and materials beyond the initial intention of the owner. Reuse means minimizing waste and maximizing resources. this implies getting more for money, whether it's a personal, home, business, institution, authority or industry [9].

It is well-known that the simplest thanks to manage waste isn't to supply it. There are many opportunities that may be applied during this context [15]:

- Considering reusable products,
- Maintenance and repair of durable products,
- Reuse of baggage, containers and other items,
- Borrowing, renting and sharing,
- Sales and donations.

4.1. REUSE STRATEGIES FOR INDIVIDUAL AND HOUSEHOLDS

The easiest thanks to reuse materials that visit waste is to save lots of and reuse them for his or her original purpose. Some suggestions for people and households during this regard are as follows [16,17,18,19].

- Buy used, reusable items rather than disposable items.
- Prefer products that may be maintained and repaired.
- Buy products that use less packaging.
- Rent or borrow belongings you rarely use.
- Buy reusable products like rechargeable batteries.
- Have empty containers to store leftovers and other household and store items.
- Reuse plastic or glass containers to store food or other home items.
- Reuse shopping bags, boxes and lumber.
- Reuse packaging materials or donate them to shipping stores.
- divulge your unwanted items.
- Repair broken or worn products rather than replacing them.
- Donate usable, unwanted items to thrift stores, charities, and work organisations.

- Give your magazines, newspapers, catalogs and books to neighbors, hospitals, libraries, schools and nursing homes.
- Make paper from mag and magazine pages or reuse old wrapping paper.
- Wash and reuse foil and plastic bags.
- Wrap postal packages with paper shopping bags.
- Have a cut-rate sale.

4.2. REUSE STRATEGIES FOR BUSINESS AND OTHER ORGANISATIONS

The new action plan to increase the recycling and reuse of products within the EU will accelerate the EU's transition to a circular economy [20]. During this context, the subsequent are going to be provided:

- Strengthening the EU industry,
- Assisting to fight temperature change,
- Protecting the EU's natural environment.

Circular economy strategies aim to scale back the entire resources from the environment and reduce the waste produced by human activities for human well-being [21]. we are able to reuse our materials and equipment in our own business or another organization can reuse our waste. Reusing our own business waste can reduce our costs because it allows us to buy raw materials or pay to eliminate the waste. we are able to also generate income from materials and goods that are valuable to a different organization. Goods and materials that you just can reuse may differ betting on the sort of labor [22].

Office-based businesses: as an example, they can:

- refilling toner and inkjet cartridges,
- using paper as note paper,
- Using durable glasses, mugs, glasses and cutlery rather than disposable alternatives,
- reusing envelopes and other packaging,
- donating used equipment and furniture to charities,
- using gray water recycling systems for his or her toilets.

Manufacturing businesses: as an example, they will reuse packaging and cut products and reuse the waste heat generated in production processes for heating or reuse elsewhere in production.

we should always visit employees and ask them to think before throwing their waste that somebody else might want it and so. we will offer waste materials, second-hand products, end-of-life products and obsolete equipment to other organizations which will use them without replacement.

Business-to-business: we are able to try business-to-business online waste exchanges that trade a good sort of used industrial supplies and equipment. We can also sell goods and materials on online auction sites.

- Scrap dealers can take a number of our waste materials. They will use scrap material for children's play activities, which saves us on recycling costs.
- Through websites, businesses can access charities and community projects that require donated goods and materials.
- Donating goods and supplies to varsities and charities can improve the image of our business and demonstrate our corporate social responsibility policy.

The following could be a list of reuse activities which will be undertaken by business and other organizations [16]:

- Design products for reuse.
- Reuse or donate packaging materials.
- Ask suppliers to use reusable cartons, pallets and crates.
- Create gift programs for damaged materials, pallets and lumber.
- Use reusable containers for distribution on product lines.
- Order folders with snap backs and flap pockets as they will be reused.
- Repair or donate old furniture and equipment to charities.
- Recover and reuse waste heat, scraps, plastic scrap, coolants, solvents and other manufacturing materials.
- Use refillable, reusable toner cartridges.
- Buy refillable pens.
- Turn Manila folders over so that they is reused.
- Use old letterhead for internal notes.
- Use old titles as internal memos.

- Use an erasable note or chalkboard for messages.
- Use mugs rather than disposable cups.
- Reuse paper that's printed on one side.
- Buy erasable, reusable wall calendars.
- Use two-sided envelopes and postal bags.
- Turn scraps and scraps into note and answering pads.
- Create an office supply clearinghouse.

5. REUSE OF WASTE MATERIALS

Natural resource extraction and processing account for about half global gas emissions. A circular economy approach is crucial to reducing greenhouse gas emissions and ensuring communities don't bear the environmental impacts of resource use. A circular economy approach reduces materials use, redesigns materials to be less resource-intensive, and recaptures "waste" as a resource which will function feedstock to manufacture new materials and products. the foremost effective because of reduce waste is to not create it within the primary place. As a result, reduction and reuse are the foremost effective ways you'll save natural resources, protect the environment and save money. Reuse of waste means any operation by which products or components that are not waste are used again for the identical purpose that they were conceived. The differentiation between the terms reuse, recycling, and recovery is significant for the understanding and application of the targets stated in EU waste legislation.

5.1. REUSE OF ORGANIC WASTE

Food scraps

Food waste is organic matter which is most of the fabric filling our landfills. a major a part of the food scraps within the world goes to waste. When the waste material gets buried within the dump, it decomposes anaerobically and releases methane, a gas 25x more harmful than greenhouse gas. the simplest thanks to minimize refuse is to avoid generating it in firstly. We can't completely ensure all our produce gets eaten, but we will transform scraps into valuable resources, including fertilizer, energy, and a bunch of innovative products. The food recovery hierarchy classifies waste matter strategies into avoid, reuse, recycle, reprocess, energy recovery and dispose [23].

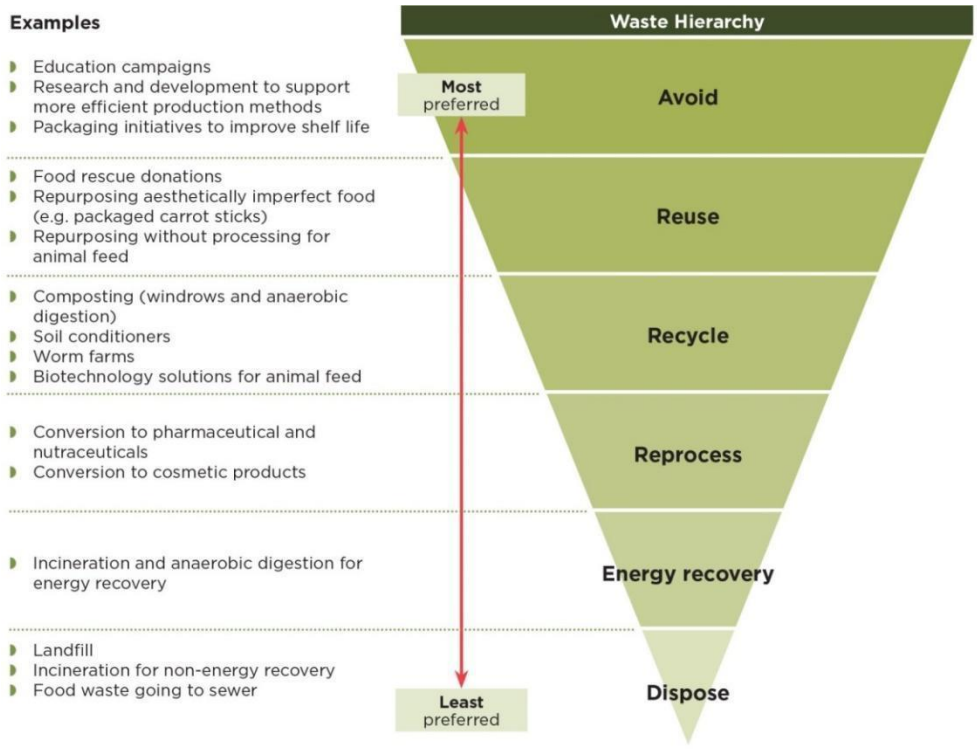


Figure 24. The food recovery hierarchy classifications

Source: *National Food Waste Strategy 2017, Department of the Environment and Energy; CC0* [23]

There are variety of how you'll be able to repurpose these scraps within the kitchen and round the house. Here are some ideas to reuse food scraps rather than tossing them within the trash [24,25]:

- Garlic skins or onion skins is added to soups or bone broth will add extra vitamins and minerals.
- Coffee grounds is used as pest control to assist keep ants and slugs away.
- Eggshells will be sprinkled below the soil to spice up the expansion of plants with its high calcium content.
- Because of the rich in fiber and antioxidants, avocado seeds is dried, delve pieces, and ground into a fine powder then added to smoothies or shakes.
- Meat bones is used great for creating homemade broth and broth is stored within the freezer to be used until cooking food.
- Orange and lemon peels will be frozen or dried for later use. Combining them with water and vinegar is made a good homemade multi-purpose cleaner.

- Banana peels can help skin to be moisturize.
- There are many uses for milk that's expired. Before rinsing your silverware with water it can soak them in some expired sour milk for a shiny clean. Pouring sour milk at the bottom of your plants or garden will make it act sort of a great fertilizer. Sour milk is additionally a second hand ingredient for several dishes.

Extracts and oils obtained from fruit and vegetable wastes are utilized in cosmetic products. The anti-cancer benefits of skin are researched. Additionally, the assembly of ***bioplastic*** from potato skin is being investigated by fight garbage CRC. Converting scraps into bioplastics can reduce food and plastic waste, in addition as reduce emissions during plastic production. Compounds extracted from waste material can even be wont to create liquid biofuels like biodiesel and bioethanol [23].

Compost

Composting is finished purpose of organic solid waste which is generated from different sources, with the aim of recovery, stabilization, and volume reduction of waste product within the variety of compost [26]. There are two varieties of composting, cold (slow) composting and hot composting. Greens, food leftovers, browns, recyclable packaging material is employed in compost:

- Fruit and vegetable scraps, leaves, mown grass clippings,
- Egg shells, hazelnut husk and shell,
- Coffee grounds and filters, tea bags and tea processing waste,
- Cardboard, paper etc., straw, sawdust and wood chips, cotton and wool pieces,
- Pistachio processing waste, vegetable oil production waste (excluding black water),
- Waste foods, potable factory pulp, sugar beet head and leaves etc. materials.

Black nut tree leaves or branches, coal or charcoal ash, milk and dairy products, diseased and insectivorous plants or plant particles, oils, greases, oils, meat scraps, fishbone and other scraps and waste, cat dog feces or used cat litter, decomposed leaves on the garden treated with pesticides, twigs on the garden, other plant residues, wild plants containing seeds, plastic, glass, metal-containing materials, cleaning materials, tea and occasional bags, processed and aluminum papers, medical waste, citrus fruits, newspapers, magazines, and glossy paper aren't suitable for composting [27-29].

The following advantages of compost could also be listed [30]:

- Compost make evaluate of organic waste.

- The atmospheric phenomenon is tackled as methane emissions from landfills are prevented.
- With the employment of compost in agriculture, soil quality may be restored or enhanced.
- Compost can provide nutrients as fertilizer when plants need it.
- Compost may replace peat in horticulture and residential gardening.
- Anaerobic digestion has the extra advantage of producing biogas to use as fuel.
- Compost is accelerated growth and strengthens plants.
- Compost has disease-suppressive properties.
- Pesticide use will be reduced by proper use of the properties of compost.

5.2. REUSE OF WASTE BATTERIES

Batteries and accumulators play a significant role to form sure that plenty of daily-used products, appliances and services work properly. Every year, approximately 800.000 many automotive batteries, 190.000 numerous industrial batteries, and 160.000 plenty of consumer batteries enter the eu Union. The Commission proposed a innovative ***Batteries Regulation*** on 10 December 2020. This Regulation aims to form sure that batteries placed within the EU market are sustainable and safe throughout their entire life cycle. After the waste batteries are purified from harmful metals like mercury and lead, they're recycled and so the precious is obtained [31]. However, waste batteries are reused again, without being recycled. it's seen that electric engines use from scooters to motorcycles, sports cars, school buses, trucks, trains to even planes. this will be largely due to falling costs and so the improved performance of ***lithium-ion batteries***. By 2030, it's predicted that the batteries which are end-of-service could exceed over 2 million metric tonnes annually. Reuse of batteries extends the lifetime of batteries and also decrease the use of recent batteries in some application. In some cases, batteries could also be renewed and used directly in another vehicle. For this reason, when battery dies too early, functioning modules and cells is recombined to create refurbished battery packs for another vehicle.

When the service lifetime of the batteries employed in electric cars is end-of-service, they have the capacity to store 70% of their original capacity. Thus, they'll be repurposed for "***second life***" energy storage uses in new applications. they'll be reused in some areas like electrical grids and communications towers, likewise as energy storage for solar farms, wind farms, and other renewable sources [32].

The '***EV BATTERY RECYCLING & REUSE 2022 Expo and Conference***' are visiting be held in Detroit, Michigan to explore leading automotive companies' end-of-service battery recycling and reuse initiatives for next-generation EV batteries.

5.3. REUSE OF METAL AND COMPOSITE WASTE

Metals

Metals are recyclable endless. for instance, steel is that the most recycled material within the World. Also, the energy wont to recycle aluminum is 95% but the energy required to supply it from ore. Usually, metals are reused after recycling. But it must be thought reused of metals without recycling. Reuse offers an excellent greater environmental advantage than recycling. There are not any (or very few) environmental impacts associated reprocessing. The reuse of metals no need energy.

Some scrap metals are reused in some sectors. for instance, metal car parts are being reused all the time, especially when a car is being taken all the way down to parts. Also, metal containers are often used at cargo shipments and tin foil are often reused. Other Metals-Empty cans may be used as canisters, pencil holders, cookie cutters, muffin/cupcake molds, or measuring cups [33].

Copper wire can use easily bent and shaped into beautiful art. Also, it will be made many things like towel holders pot lid holders, magazine wrack, tablet holder, flora holder, bowls wreaths and decorations, frame for vines, tomatoes and other plants, from coat hangers the tip of their life. yet as extending the product's life cycle, reuse avoids the necessity to move and re-melt the steel, and to make new products [35]. Already some industries like the agricultural sector commonly reuse steel structures and cladding components. Steel structures and steel construction products are highly and essentially demountable. Many steel construction products and components like piles, light gauge products like purlins and rails, and structural members are highly re-usable [36,37].

Composites

Source:http://www.radikal.com.tr/radikalist/geri-donusumle-evde-yapabileceginiz-15-yaratici-esya-1220210/ [41]

Today, the employment of ***composite*** materials in several sectors is increasing day by day. Commercial aviation, wind energy, defence, aerospace, automotive, construction and other industrial areas are at the forefront of those sectors. Composite materials, which are produced by the employment of materials like plastic, paper, metal, glass, wood, are widely employed in the packaging industry. While trying to destroy composite wastes by processes like incineration or burial, they cause great harm to the environment. additionally, waste of resources is prevented by including it in re-production [38,39].

In recent years, significant events like have taken place that added immensely to developing sustainable composite recycling solutions. The ban on composite storage in Germany in 2009, the top of lifetime of the primary large composite wind turbines and decommissioning in 2019-2020, the acceleration of aircraft decommissioning because of the COVID-19 pandemic and also the increasing use of thermoplastic composites within the automotive industry, the recycling of composite materials made it necessary to develop transformation solutions [40].

Source:http://www.radikal.com.tr/radikalist/geri-donusumle-evde-yapabileceginiz-15-yaratici-esya-1220210/ [41]

Composite wastes are recycled and reused like metal wastes. However, they will be reused by arranging with simple techniques reception without recycling. for instance, a table or a pouf are often made of car tires with simple arrangements. Milk or drink cans will be was a wallet with an easy arrangement. Chip boxes may be used as boxes to store various items by simply cleaning without making any changes reception [41].

5.4. REUSE OF ELECTRONIC WASTE

Electronic waste (***e-Waste***) is increased by 21% within the last five years, consistent with the worldwide E-waste Monitor 2020 report. E-waste because the fastest-growing waste stream globally is predicted to extend twofold by 2045. it's dangerous for the environment and human health, as e-waste contains toxic additives and dangerous substances like mercury. Europe ranks second only behind Asia in terms of e-waste with over 12 million a lot of broken equipment yearly. consistent with a report by UNEP, "E-waste could be a broad term that features a spread of electrical and equipment which may be rendered because the end of life electronic devices and don't incur value to their owners. E-waste is electronic products that are unwanted, not working, and nearing or at the top of their "useful life." Computers, televisions, VCRs, stereos, copiers, and fax machines are everyday electronic products [42-44].

Source: https://ewasteaus.com/process/ [45]

Most consumers think that it'll cost you almost the identical to repair it on buy a brand new one. ***The Repair Cafés*** what there are over 1.500 within the world are meeting points that emerged within the Netherlands in 2009, where people bring broken items from home and a team of volunteers helps them repair them. Thus, they'll avoid the rapid cycle of shopping for, using, discarding while creating a community of repairers.

The European Union was taken a vital step in promoting the reparability of electronic devices by implementing the new ***EU Ecodesign Measures***, which oblige manufacturers of certain electronic products to form the repair easier on March 1, 2021. The EU legislation on ecodesign may be a tool that sets up mandatory minimum standards for the energy efficiency of the products that are sold within the ecu member states. thanks to this, it's ensured that the low-performing items not be sold within the EU countries. These measures apply to four varieties of electrical appliances like televisions or other electronic displays, fridges, washing machines, and dishwashers. These measures are designed for repair and reuse applies, this implies the merchandise must be designed during a way it may be disassembled. the opposite repair requirements availability of spare parts, access to repair information are going to be acquire effect on March 1 2023.

It was also introduced new tax laws tax cut for repair services for a few appliances like refrigerators and washing machines in Sweden and Austria in 2017. Also in Spain, the extension of the legal guarantee period for products up to a few years and to extend the minimum time within which manufacturers must have spare parts once up to 10 years was approved in April 2021[42-45].

CDs and DVDs are e-waste. E-waste is donated to numerous charities or associations, so those that are in working condition are often utilized by people in need. By making some simple arrangements with electronic old or damaged CDs and DVDs, some simple items like coasters, garden ornaments, photo frames will be made that may be used reception.

Some benefits of e-Waste reuse and recycling are [46,47]:

- Natural resources are conserved. E-waste recycling and reuse make sure that valuable materials from expired electronic goods are recovered and utilized in new products.
- Energy savings are achieved, environmental pollution is prevented, gas emissions are reduced and natural resources are protected.
- E-waste recycling ensures the protection of the environment by recycling toxic substances like mercury, lead and cadmium in wastes without harming the environment.
- E-waste recycling, as a growing sector, creates new job opportunities and a second marketplace for recycled materials.
- E-waste recycling prevents our fertile lands from being stuffed with waste unnecessarily, reducing our need for landfills.

5.5. REUSE OF GLASS WASTE

Waste glass is that the main element of solid waste. It is found in many forms including, sheet, glass bottles, windows glass and glass containers, bulb glass. Glass has excellent and aesthetic properties like can being recyclable, high performance. The landfill of waste glass is undesirable because it's not biodegradable and not friendly to the environment [48].

Glass waste bottles are employed in the development industry. The thought of building walls from bottles dates back to earlier period. it's known that vacant ***amphorae*** were employed in construction during the traditional Roman period. due to these amphoras, the utilization of concrete on the upper parts of the buildings has been reduced. The Circus of Maxentius is one in every of such structures. the primary "bottle house" is assumed to inbuilt Nevada by William F. Peck in 1902. Ten thousand waste glass bottles were employed in the development of the house. The house, which stood for several years, was demolished within the 1980s. Today, there are many samples of buildings made with walls made from waste glass bottles [49].

Figure 25. Bottle wall examples

Source: http://yapiguncesi.blogspot.com/2011/04/sise-duvar.html [49]

For instance, it had been investigated that its properties when used for replacement of cement, fine aggregate, and coarse aggregate within the concrete mix. The test results of the study show that it's possible to use waste glass as a fine aggregate with the identical characteristics as those of natural sand aggregate concrete provided [48]. In another study, the employment of glass waste rather than frit utilized in glaze compositions within the ceramic industry was evaluated. As a result, using 3% glass waste by weight rather than the frit within the production of ceramic tableware is suitable has been determined [50]. From the results obtained within the other investigation, the viability of production of building brick materials that include waste glass made up our minds [51].

Waste glass is recycled and reused persistently. Glass containers are perfect for reuse. Glass jars, bottles, and other styles of glass containers can all be reused or repurposed in an exceedingly sort of ways. as an example, you'll be able to reuse glass containers for crafts, lampshades, storage, or DIY projects or as a vase, glass, or planter [52,53].

5.6. REUSE OF PAPER WASTE

Worldwide paper consumption has increased 400% within the last 40 years. Paper constitutes approximately 26% of the overall waste in landfills. Although new trees are planted worldwide, most tree planting is monoculture. this case creates its own environmental problems. Also, the pulp and paper industry are the fifth largest energy consumer, accounting for four percent of all energy use within the world.

From 2010 to 2060, global consumption of pulp and paper is anticipated to be doubled. Increasing paper production will further increase the already critical and constantly worsening pressure on the world's forests. From 2001 to 2019, a complete of 386 million hectares of forest were lost globally. This loss represents an almost 10% reduction in tree cover since 2000. For 1 ton of pulp, 2 heaps of trees are required and 20 trees are slow down for this. It should be known that only 200,000 pages, that is, 80 boxes of A4 copy paper, may be produced with 20 trees block. Recycling paper saves energy and reduces environmental pollution during production. However, while 1 ton of raw paper requires 24,000 gallons of water to make, recycled paper still requires 12,000 gallons of water per ton. In other words, reducing paper consumption and reusing paper are as important as recycling paper [55-56].

Waste paper is generally recycled, produced as paper again, and offered for reuse. However, there are areas where paper will be used without being recycled. There are academic studies on the utilization of paper as a filling material within the production of various composite materials. consistent with the results of the research, it's appropriate to feature paper within the production of composite materials [57,58]. There's also a pursuit on the employment of paper as a ground material in Pleurotus ostreatus cultivation. The results of the study are successful [59].

The amount of paper employed in offices is incredibly large. However, there are some ways to reuse paper. as an example, we will use the opposite side of the paper, which is employed only on one side. It will be saved a document as a PDF rather than printing.

There are many great ways to re-purpose paper. If you get creative and make you'll made amazing and useful woven baskets and trays out of magazines and newspapers. outdated newspapers, magazines and used grocery bags is used as paper. paper will be accustomed make notes. It may be teared up and add it to the cumulus. paper after tearing are often used as pet bedding. Newspaper is best for this purpose, paper may be reused as wrapping paper. Old magazines could donate to community places [60-62]. Egg cartons will be donated to local farmers so this fashion it is reused [63].

A significant amount of waste from empty towel and toilet tissue rolls are sent to landfills. consistent with the EPA, around 9, 600 heaps of “used” paper towels are sent to the landfill daily (3.5 million every year). It will be employed in alternative routes reception rather than throwing them away. for example it is stored holiday lights by wrapping them around empty rolls to forestall tangling or may be donate to communities who may have empty rolls for craft projects [63].

5.7. REUSE OF PLASTIC WASTE

All plastic wastes consisting of petroleum derivatives are called plastic waste. Water and potable bottles, bottle caps, water demijohns, packaging, nylon bags, plastic boxes, pet cups, and cleaning material packaging constitute the most plastic wastes. Since 1970, the employment of plastic has increased fivefold. Especially because of the Covid-19 epidemic, there has been a major increase within the amount of plastic waste originating from the hygiene materials employed in the globe and in our country.

Recycling and reuse of plastic waste are important in terms of keeping our natural resources for future generations and protecting the ecological balance of our world. Legislation banning disposable plastic plates and cups in EU countries entered into force as of July 3, 2021. By 2029, it's planned to scale back the recycling rate of plastic bottles on the continent to 90 percent. In Turkey, the Zero Waste Regulation published on 12 July 2019.

With 1 ton of plastic waste recycling, 16 barrels of oil, 7774 kWh of energy, 41 plenty of greenhouse emission reduction, and 23 m3 of space for storing are saved. However, there are good practices for the reuse of waste plastic materials without recycling them with simple regulations [64-65]. Waste plastic boxes is cleaned and wont to store legumes within the kitchen. Pencil boxes or storage boxes is made of waste bottles by attaching a zipper. It may be recycled into a bird feeder, bird house, and pet feeder. A bottle sprinkler to be used for garden irrigation may be made of waste plastic beverage bottles. Waste plastic bottles are often utilized in various crafts to form beautiful works of art like mosaics. Decorative ottomons will be made by bringing together waste plastic beverage bottles and covering them. Waste plastic bottles are often become a greenhouse [66].

Figure 26. Examples for upcycling plastic waste at home

Source: [66] https://www.thebetterindia.com/58509/reuse-plastic-bottles-reduce-pollution-waste/

There also are many academic studies on the reuse of waste plastics. With the rise of the quantity of solid wastes worldwide and requires the utilization of sustainable and eco-friendly materials in construction projects, many studies were conducted to research the employment of solid waste materials as construction materials, especially in asphalt pavements. Supported the results of studies, utilizing plastic waste by weight of aggregates in asphalt would make flexible pavement design eco-friendlier and more sustainable, since an enormous amount of plastic waste may well be incorporated without affecting the performance of hot mix asphalt [67-70]. In another study, plastic bottles were examined both structurally and thermally to be used as building units to exchange traditional concrete blocks. Though the gross strength of those plastic bottles is far but conventional blocks, calculations showed that air-filled bottle blocks can still be used as suitable structural units for partition walls or load-bearing walls for a roof sheet. Thermally, the air-filled bottles showed better thermal insulation than traditional block construction, which could act as a thermal insulation material [71].

5.8. REUSE OF TEXTILE WASTE

It consists of wastes from artificial yarn factories, textile manufacturing wastes and consumer wastes. It takes 8 tons or more of water to provide an easy t-shirt and jeans. At the identical time, unpredictable chemical materials and energy are accustomed turn fabrics into clothes. an outsized amount and form of chemicals are released to the environment from the material dyes used while creating the garments.

The carbon footprint, which shows the quantity of carbon released per person, decreases with the re-introduction of clothing into the assembly cycle. It helps to reuse 32 kg of carbon and 400 MJ of energy released into the air by recycling one pair of jeans into production, thus keeping the quantity of carbon released into the air constant instead of increasing. Waste clothing is donated to varied organizations and reused for people in need. Or clothes that we not use is sold in second-hand shops. additionally, with simple arrangements, patchwork blankets, mats which will be used reception, and similar things is made of old clothes. Old towels may be used as cleaning cloths [72-75].

6. CIRCULAR ECONOMY BUSINESS MODELS FOR REUSE PROVIDING OPPORTUNITIES

A successful transition to a circular economy will significantly contribute to achieving the Sustainable Development Goals, the Paris Climate Agreement goals, the goals of the EU Green Deal and carbon neutrality in Europe by 2050. Achieving this transition to a circular economy in Europe depends on reducing the resources used for production. It's necessary to increase the useful lifetime of products, reuse and co-use of products, repair and remanufacturing, and promote this by adopting the recycling of materials.

6.1. CIRCULAR ECONOMY BUSINESS MODELS

Circular economy business models, by design, keep products and materials in use for as long as possible to derive maximum value from them [76]. the most circular business model principles are [77]:

- To get products and materials from the ***economy***, not from ecological reserves.
- Creating value for purchasers by adding value to ***existing products*** and materials.
- Generating valuable input for ***businesses*** outside of your client.

Circular business model categories also encompass [78]:

1. Coordinating circular value chains through data.

2. Circular product design.

3. Use, reuse, share and repair.

4. Collection and reverse logistics.

5. Sorting and preprocessing.

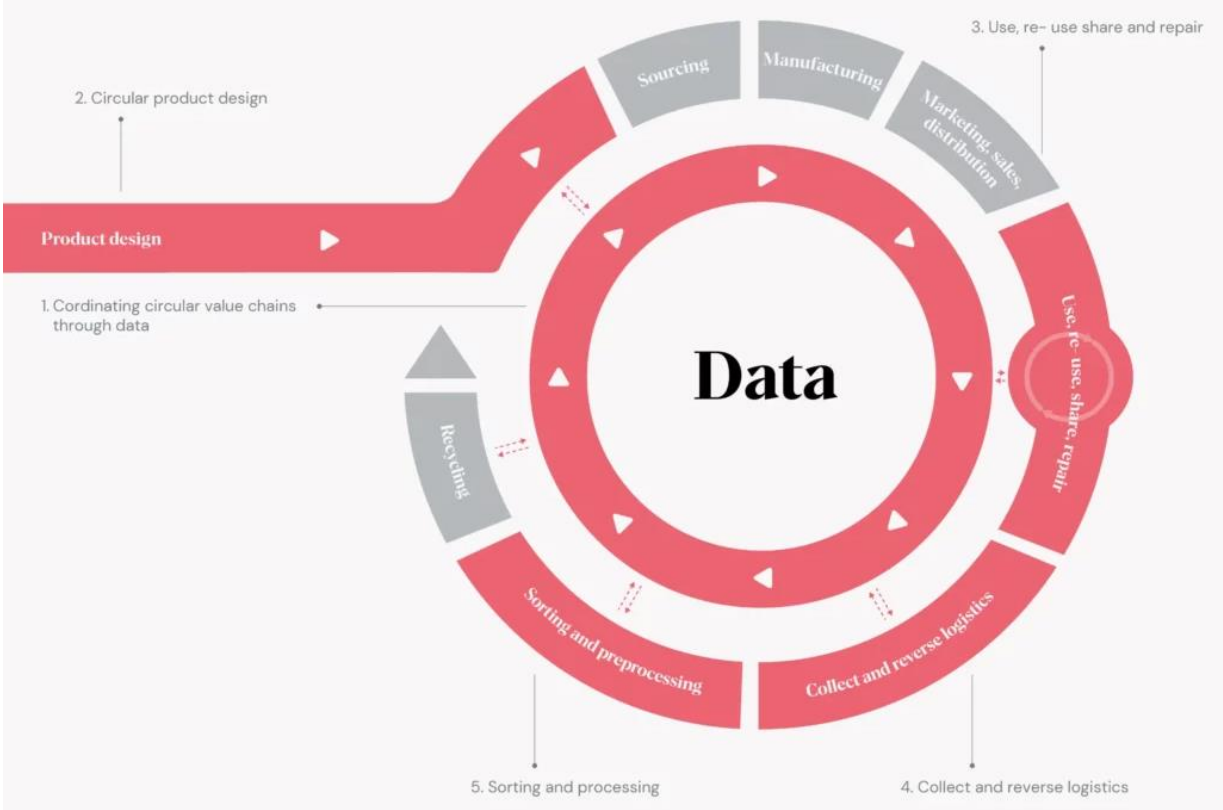


Figure 27. Different types of circular business models

Source: World Economy Forum (2019) ve Accanture (2018)

These circular economy business models will enable:

- to supply new commercial opportunities,
- Contributing to the expansion and sustainability of the business,
- to get new sources of income,
- Transforming a business's relationship with its customers,
- Protecting the economy against resource scarcity and rising material costs.

The design and sharing of waste for reuse can become value creators within the circular business models described below [79]:

Waste value model: The waste value model may be a fairly simple way of incorporating circular principles into a business model. Waste generated during a linear production model is collected and every one recoverable residual value is subtracted from it. Waste management and recycling companies typically use the waste value model.

Reverse loop model: The transition to the circular economy requires circular thinking to succeed in manufacturers and products designers. This has to maximize the worth and duration of the complete life cycle of the products, from the assembly stage to the subsequent few use cycles and at last to disposal. With the circular design, end-of-life products simply become "end of cycle". Companies can concentrate on preparing them for the following cycle and using them as inputs, thus adopting the reverse loop model.

Circular input model: The circular input model aims to attenuate the depletion of our natural resources. during this model, it's seen that product designers maximize the share of total input that's circular. this implies using reused or recycled inputs, also as using renewable resources that the ecosystem can replenish faster than it's depleted.

Integrated circular model: A more integrated approach is crazy the employment of life cycle analysis (LCA), where designers aim to eliminate negative impacts on natural capital in the least stages of a product's lifecycle. This model focuses on sourcing and production. LCA also measures and minimizes the expected adverse effects of use and final disposal during the merchandise design phase. That's why product designers specialise in the repairability, upgradeability, reusability, simple disassembly, and recyclability of all components of a product.

End-of-life responsible model: during this model, people return products after use to the manufacturer, who incorporates a direct economic interest in extracting all their recoverable values. Product design will concentrate on making value recovery after use easy and effective. Users can either be offered incentives to return products or contractually decide to this in their "Product as a Service" (PaaS) plans. These agreements are the foremost successful type of the lifetime responsibility model: ownership of the products never leaves the manufacturer. Users only buy temporary access to the performance offered by the products and so return it. This could also encourage more people to depend upon the identical products to fulfill their needs ("sharing economy").

6.2. REUSE CIRCULAR ECONOMY BUSINESS MODELS

Typically, there ***are two types of reuse processes***. The first provides some sort of brokerage and listing services, and the other provides the physical space (warehouse or storefront) to store existing materials for reuse. Some examples of reuse operations are [80]:

- ***Swap shops*** take used materials that would normally be thrown away and make them available to employees or the public at little or no charge. Barter shops in businesses and industries can be designated as areas where employees can collect used items. Local

governments can set up barter shops at landfills or collection centers where the public can drop off non-hazardous reusable items and buy supplies they can use.

- ***Surplus stores*** accept unwanted products and offer them for sale internally to other agencies or to the public. Surplus stores are often run by large institutions such as universities and governments. It provides a good source of used equipment, tools and supplies for surplus stores, institutions and local governments.

- ***Scrap exchanges*** accept surplus industrial scrap or printers and distribute them free of charge or sell them at nominal cost to schools, day care centers, specialist centers and nonprofits with arts programming. Schools and other organizations can contact businesses directly or use a scrap exchange to get scrap supplies.

- ***Industrial material exchange services*** are waste exchange programs for businesses and industries that associate producers of reusable "waste" with other companies that can use these items or materials. Such programs exchange information at the waste site by collecting information about available or desired waste and surplus materials and publishing them in newsletters, catalogs or electronic bulletin board services. Companies either communicate directly with each other or go through the exchange service.

- ***Individual material exchange*** reuse processes target specific materials and run them on an ongoing basis or as one-day events.

- ***Secondhand stores*** can be of the private or non-profit type, and some have used items they sell, while others get consignment. Many nonprofits set up thrift stores to benefit local schools, hospitals, and other community projects. While thrift stores are not traditionally seen as a waste reduction option, they do provide an outlet for items that can be reused rather than thrown away.

These reuse models have potential in the following areas [81]:

- reducing costs,
- build brand loyalty,
- adapt to individual needs,
- improve the user experience,
- optimizing operations and collecting information.

6.3. SOME EXAMPLES OF CIRCULAR ECONOMY BUSINESS MODELS FOR REUSE PROVIDING OPPURTUNIES

Reusable shipping containers: one amongst the largest impacts business and industry can have in reducing waste that winds up in landfills is replacing disposable shipping containers with reusable ones. Over its lifetime, a 2 cubic feet of plastic, reusable shipping container for 250 times will replace 250 disposable cardboard boxes, reducing waste by 98.5 percent and costs per use by up to 92 percent [80].

Reusable packaging: Reusable packaging may be a critical a part of the answer to eliminating plastic pollution. Organizations recognize that, wherever appropriate, reuse business models should be explored to scale back the requirement for single-use plastic packaging. Globally, replacing only 20% of single-use plastic packaging with reusable alternatives presents a chance of a minimum of 10 billion USD [81].

Closed-loop programs: These apply primarily to packaging items, as an example, where a corporation is involved within the regular transportation of products from a central manufacturing facility to warehouses or from warehouses to stores. In these cases, there are significant benefits to using reusable "transport packaging" like plastic crates or pallets. The advantages of closed-loop reuse are mainly because of the low additional transportation costs related to returning vehicles with empty crates [8].

Refillable bottle programs: Refillable bottles are widely utilized in many European countries; as an example in Denmark 98% of bottles are refillable and 98% of them are returned by consumers. These systems are typically supported by deposit laws and other regulations [8].

Reuse centers and virtual shopping: These services facilitate the exchange and redistribution of unwanted but perfectly usable materials and equipment from one entity to a different. Organizations that like each side of this service (as donors, sellers, buyers or buyers) will be businesses, nonprofits, schools, community groups, and individuals. Some provide a physical space (reuse center) et al act as an identical service (virtual exchange). Reuse centers usually protect both warehouses and trucks [8].

Product as a Service (PaaS): PaaS prioritizes experience over ownership of a product. it's a mixture of products followed by the manufacturer's services. Such a business model is applied to a large range of products, like electronic products, original equipment manufacturers, and furniture [82].
Shared wardrobe reuse business model: This reuse business model has been implemented for many years mostly in nonprofit installations like charities and municipal services. This model has recently spread to profit-oriented online marketplaces like the Australian Clothing Exchange and Danish TrendSales, which connect private users who want to sell, buy or trade clothes. These marketplace models can take many forms, like the shared wardrobe, including business models supported the sharing platform [83].

Some good examples of reuse business models are at these links:

- **Loop:** https://loopstore.com/
- **Globelet**: https://www.globelet.com/
- **Repack**: https://www.repack.com
- **reCIRCLE** : https://www.recircle.ch/en/
- **Vrhnika:** https://vrhnika.si/
- **Refill:** https://www.refillapp.com/
- **Ooobject:** https://ooobject.com/
- **EME**: https://excessmaterialsexchange.com/en_us/

REFERENCES/Link to online resources and specific imagesific images

[1] Zhang, C., Hu, M., Di Maio, F., Sprecher, B., Yang, X., Tukker, A., 2021. An overview of the waste hierarchy framework for analyzing the circularity in construction and demolition waste management in Europe. Science of the Total Environment, 803 (2022): 1-13.

[2] Kalmykova, Y., Sadagopan, M., Rosadoc, L., 2018. Circular economy – From review of theories and practices to development of implementation tools. Resources, Conservation & Recycling, 135 (2018): 190–201.

[3] EEB, Link: https://eeb.org/

[4] Interreg Europe, 2020: Link: https://www.interregeurope.eu/

[5] https://zerowasteeurope.eu/about/about-zero-waste/

[6] https://www.solarschools.net/knowledge-bank/sustainability/reduce-reuse-recycle

[7] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Waste_statistics

[8] https://en.wikipedia.org/wiki/Reuse

[9] https://content.ces.ncsu.edu/before-you-recycle-choose-to-reuse

[10] https://loadingdock.org/redo/Benefits_of_Reuse/body_benefits_of_reuse.html

[11] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:_Reuse_of_waste

[12] https://zerowastecities.eu/webinar/creating-effective-systems-for-reuse/

[13] Abdul-Rahman, F., 2021. Reduce, Reuse, Recycle: Alternatives for Waste Management. Guide G-314. NM State University. Link: https://aces.nmsu.edu/pubs/_g/G314/welcome.html

[14] https://www.open.edu/openlearncreate/mod/oucontent/view.php?id=80574&printable=1

[15] https://lessismore.org/materials/30-reuse-tips/

[16] Sherman, R., 2021. Before You Recycle, Choose to Reuse. NC State Extension Publications. Link: https://content.ces.ncsu.edu/before-you-recycle-choose-to-reuse

[17] https://www.epa.gov/recycle/reducing-and-reusing-basics

[18] https://recyclingnearyou.com.au/education/25-things-to-reuse

[19] http://www.dec.ny.us/website/dshm/redrecy

[20] https://ec.europa.eu/

[21] Foster, G., 2020. Circular economy strategies for adaptive reuse of cultural heritage buildings to reduce environmental impacts. Resources, Conservation and Recycling, 152 (2020): 1-14.

[22] https://www.netregs.org.uk/environmental-topics/waste/reduce-reuse-and-recycle-your-business-waste/reusing-waste/

[23] https://www.science.org.au/curious/earth-environment/transforming-food-waste-making-something-out-rubbish

[24] https://myheartbeets.com/reuse-13-things-normally-throw-away/

[25] https://moveforhunger.org/reusing-food-waste-scraps-leftovers

[26] Quazi, H. B., Koenig, A. 2001. Effect of air recirculation and reuse on composting of organic solid waste. Resources, Conservation and Recycling, 33 (2001) 93–111.

[27] https://www.conserve-energy-future.com/smart-ways-recycle-food-waste.php

[28] https://webdosya.csb.gov.tr/db/cygm/editordosya/Kompost.pdf

[29] TC. Tarım ve Orman Bakanlığı, Gıdanı Koru Sofrana Sahip Çık, Gıda Artık ve Atıklarından Kompost Yapımı, Bursa Gıda ve Yem Kontrol Merkez Araştırma Enstitüsü'nün destekleriyle hazırlanmıştır, 2021

[30] Editor(s): P Lens, B Hamelers, H Hoitink, W Bidlingmaier, Resource Recovery and Reuse in Organic Solid Waste Management, IWA Publishing, 2004, ISBN13: 9781843390541 eISBN: 9781780402765

[31] https://ec.europa.eu/environment/topics/waste-and-recycling/batteries-and-accumulators_en

[32] https://www.usa.ev-battery-recycling.com/?utm_medium=ppc&utm_source=adwords&utm_term=electrical%20waste&utm_campaign=BTE+2020+All&hsa_grp=130639420512&hsa_net=adwords&hsa_cam=15359186573&hsa_src=g&hsa_ad=564002039717&hsa_acc=7549439803&hsa_tgt=kwd-329795233195&hsa_ver=3&hsa_kw=electrical%20waste&hsa_mt=b&gclid=Cj0KCQiAwqCOBhCdARIsAEPyW9ldFy1PWeFocFUKAKNE6lqhB2jTSwv9dBHsV0h-EdN_UM58YmsgRBIaArllEALw_wcB

[33] https://transmetal.co.uk/reduce-reuse-recycle-metals/

[34] https://www.metalmenrecycling.com.au/3-ways-to-reuse-household-metals/

[35] Steel - The permanent material in the circular economy, World Steel Association, 2016. ISBN 978-2-930069-86-9 Design by double-id.com

[36] https://www.steelconstruction.info/Recycling_and_reuse

[37] Branca, T.A., Colla, V., Algermissen, D., Granbom, H., Martini U., Morillon, A., Pietruck, R., Rosendahl, S., 2020. Reuse and Recycling of By-Products in the Steel Sector: Recent Achievements Paving the Way to Circular Economy and Industrial Symbiosis in Europe, Metals 345(2020) 10, doi:10.3390/met10030345.

[38] https://www.cevremuhendisligi.org/index.php/sifir-atik/1103-kompozit-atiklarin-geri-kazanimi#:~:text=Kompozit%20at%C4%B1klar%20geri%20kazan%C4%B1m%20tesislerinde,haline%20getirilir%2C%20mobilya%20yap%C4%B1m%C4%B1nda%20kullan%C4%B1l%C4%B1r.

[39] https://www.compositesworld.com/articles/reselling-reusing-composite-materials-and-parts

[40] Krauklis, A.E., Karl, C.W., Gagani, A.I., Jørgensen, J.K., 2021. Composite Material Recycling Technology—State-of-the-Art and Sustainable Development for the 2020s, Journal of Composites Science, J. Compos. Sci. 28(2021) 5, https://doi.org/10.3390/jcs501002

[41] http://www.radikal.com.tr/radikalist/geri-donusumle-evde-yapabileceginiz-15-yaratici-esya-1220210/

[42] https://outride.rs/en/the-repairers-how-europeans-are-fighting-e-waste-through-circular-economy-initiatives/

[43] Barapatre, S., Rastogi, M., 2021. e-Waste Management: A Transition Towards a Circular Economy, Chapter , Springer Nature Singapore Pte Ltd. 2021 C. Baskar et al. (eds.), Handbook of Solid Waste Management, https://doi.org/10.1007/978-981-15-7525-9_68-1

[44] Rene, E.R., Sethurajan, M., Ponnusamy, V.K., Kumar, G., Dung, T.N.B., Brindhadevi, K., Pugazhendhi, A., 2021. Electronic waste generation, recycling and resource recovery: Technological perspectives and trends, Journal of Hazardous Materials, 416(2021) 125664, https://doi.org/10.1016/j.jhazmat.2021.125664

[45] https://ewasteaus.com/process/

[46] http ://www.gclcevre.com/e-atik-geri-donusum-faydalari

[47] Geraldo Cardoso de Oliveira Neto⁎ , Auro de Jesus Cardoso Correia, Adriano Michelotti Schroeder, Economic and environmental assessment of recycling and reuse of electronic waste: Multiple case studies in Brazil and Switzerland, Resources, Conservation & Recycling 127(2017) 42-55, https://doi.org/10.1016/j.resconrec.2017.08.011

[48] Rabnawaz juj, Farhan Hussain Wagan, Abdullah Sand, Ghulam Hussain Wagan, Reuse of glass in concrete analysis with minimizing impact of solid waste on environment, MOJ Civil Engineering, 2018, 4(3):131–134, DOI: 10.15406/mojce.2018.04.00109

[49] http://yapiguncesi.blogspot.com/2011/04/sise-duvar.html

[50] Gol, A., Yilmaz, A., Kacar, E., Simsek, S., Sarıtas, Z.G., Ture, Ç., Arslan, M., Bekmezci, M., Burhan, H., Sen, F., 2021. Reuse of glass waste in the manufacture of ceramic tableware glazes, Ceramics International, 47(2021) 21061-21068, https://doi.org/10.1016/j.ceramint.2021.04.108

[51] Demir, I., 2009. Reuse of waste glass in building brick production, Waste Management & Research 27(2009) 572–577, ISSN 0734–242X, DOI: 10.1177/0734242X08096528

[52] https://www.techni-glassinc.com/2019/04/sustainable-glass-reuse-and-recycle/#:~:text=Glass%20jars%2C%20bottles%2C%20and%20other,sanitize%20the%20glass%20between%20uses!

[53] https://www.forgerecycling.co.uk/blog/reuse-glass-jar/

[55] https://sustainability.uic.edu/green-campus/recycling/paper-waste-reduction/

[56] https://www.larton.com.tr/tr/bizden-haberler/dunyada-kagit-uretimi-ve-tuketimi

[57] Calegari, E.P., Porto, J.S., Angrizani, C.C., de Oliveira, B.F., Duarte, L.d.C., Amico, S.D., 2017. Reuse of waste paper and rice hulls as filler in polymeric matrix composites, Revista Materia, 22(2017) 2, ISSN 1517-7076 artigo e-11846, 10.1590/S1517-707620170002.0179

[58] Ojo, E. O. Okwu, M., Edomwonyi-Out, L., Oyawale, W.A., 2019. Initial assessment of reuse of sustainable wastes for fbreboard production: the case of waste paper and water hyacinth, Journal of Material Cycles and Waste Management 21(2019) 1177–1187 https://doi.org/10.1007/s10163-019-00871-z

[59] https://www.sciencedirect.com/science/article/abs/pii/S0960852403000282 makale

[60] https://www.forgerecycling.co.uk/blog/paper-how-to-reuse-it/

[61] https://www.ecoideaz.com/showcase/10-ways-re-use-waste-paper

[62] https://www.bioenergyconsult.com/tag/reuse-of-paper-waste/

[63] https://myheartbeets.com/reuse-13-things-normally-throw-away/

[64] https://sifiratik.gov.tr/plastik-atik

[65] https://www.centerforecotechnology.org/plastic-pollution/

[66] https://www.thebetterindia.com/58509/reuse-plastic-bottles-reduce-pollution-waste/

[67] Abu Abdo,A.M., 2017. Investigation the effects of adding waste plastic on asphalt mixes performance, ARPN Journal of Engineering and Applied Sciences, 12(2017) 15 4351-4356, ISSN 1819-6608, Asian Research Publishing Network (ARPN).

[68] Abu Abdo, A.M., Khater, M.E., 2018. Enhancing the performance of asphalt binders by adding plastic waste, Proceedings of the International Conference on Civil and Infrastructure Engineering, ICCIE - 2018 March 13 – 15, 2018, Ras Al Khaimah, UAE

[69] Hayat, U., Rahım, A., Khan, A.H., Rehman, Z.U., 2020. Use of plastic wastes and reclaimed asphalt for sustainable development, The Baltic Journal of Road and Bridge Engineering 15(2020) 2, 182-196, ISSN 1822-427X/eISSN, https://doi.org/10.7250/bjrbe.2020-15.479

[70] Angelone, S., Casaux, M.C., Borghi, M., Martinez, F.O., 2016. Green pavements: reuse of plastic waste in asphalt mixtures, Materials and Structures 49(2016), 1655–1665, DOI 10.1617/s11527-015-0602-x

[71] Mansour, A.M.H., Ali, S.A., 2015. Reusing waste plastic bottles as an alternative sustainable building material, Energy for Sustainable Development, 24(2015) 79-85, https://doi.org/10.1016/j.esd.2014.11.001

[72] https://nonwoventechnology.com/tekstil-geri-donusumu-hem-ekonomiye-hem-dogaya-buyuk-katki-sagliyor/

[73] https://www.escarus.com/tekstil-sektorunde-atik-yonetimi

[74] https://www.textiletoday.com.bd/recycling-textile-wastes/

[75] https://www.bbc.com/future/article/20200710-why-clothes-are-so-hard-to-recycle

[76] https://www.zerowastescotland.org.uk/

[77] Gillabel, J., Manshoven, S., Grossi, F., Mortensen, L.F. and Coscieme, L., 2021. Business Models in a Circular Economy. Eionet Report - ETC/WMGE 2021/2.

[78] Shahbazi, K., 2021. 10 circular business model categories. Link: https://www.boardofinnovation.com/blog/circular-business-model-examples/

[79] https://www.triodos-im.com/articles/2017/remodeling-circular-economy-business-models

[80] Rothenberg, S., Ryen, E.G., Sherman, A.G., 2019. The Evolution of Research on Sustainable Business Models: Implications for Management Scholars. Journal of Environmental Sustainability, 7(1):28-51.

[81] https://plasticsmartcities.org/products/reuse-models

[82] https://waste4change.com/blog/5-circular-economy-business-models/

[83] Guldmann, E., 2016. Best Practice Examples of Circular Business Models. The Danish Environmental Protection Agency. ISBN no. 978-87-93435-86-5.

RECYCLING

José Vicente Gisbert, Adrián Mota, Maria Ventura
FUE-UJI, Spain

1. INTRODUCTION

The circular economy is based on the modification of the way of generation and conservation of the value of resources through techniques based on the analysis of the life cycle and the consideration of waste as a product; hence the concept of zero-waste.

From this perspective, the concept of garbage or waste is removed from economic terminology and therefore the result of production flows must be considered as a new product that, according to the definition, must become part of the production cycle in some of its different phases through the appropriate techniques. Recycling is one of these techniques.

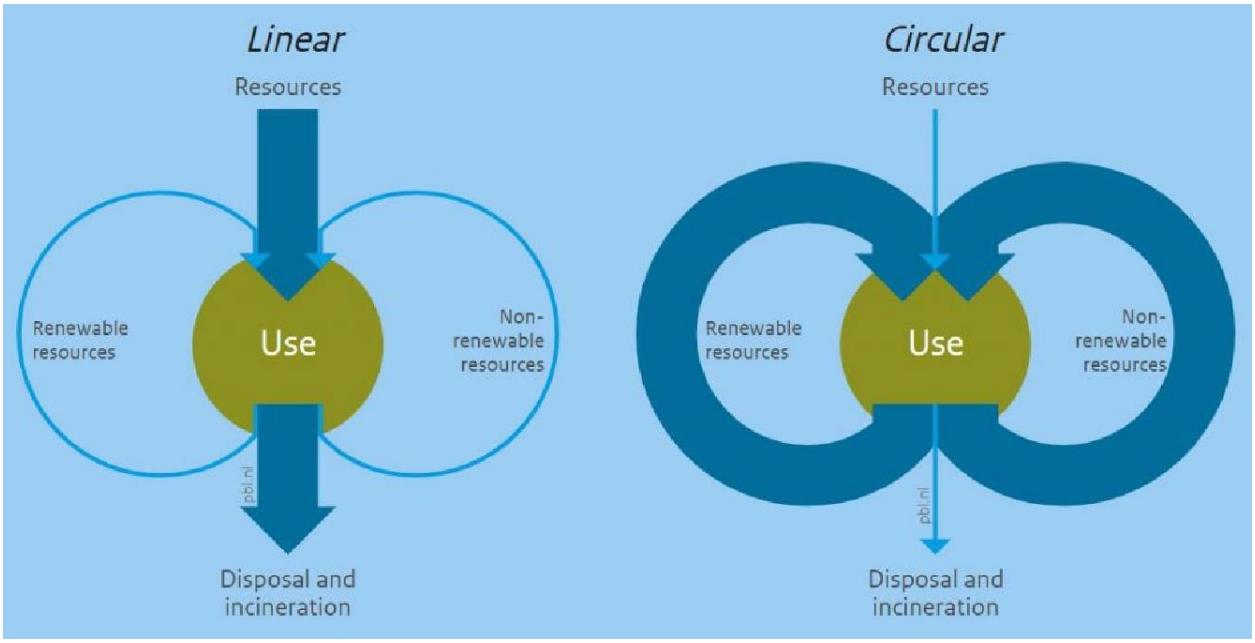


Figure 28. Linear and circular economy approaches

Directive 2008/98/EC defines recycling as: "any recovery operation by which waste materials are reprocessed into products, materials or substances, whether for the original or other purposes. It includes the reprocessing of organic material but does not include energy recovery and the reprocessing into materials that are to be used as fuels or for backfilling operations."

According to the doctrine of the European Commission, "waste prevention should be the first priority of waste management and the reuse and recycling of the material should be preferred to the energy recovery of waste, insofar as they are the best ecological options".

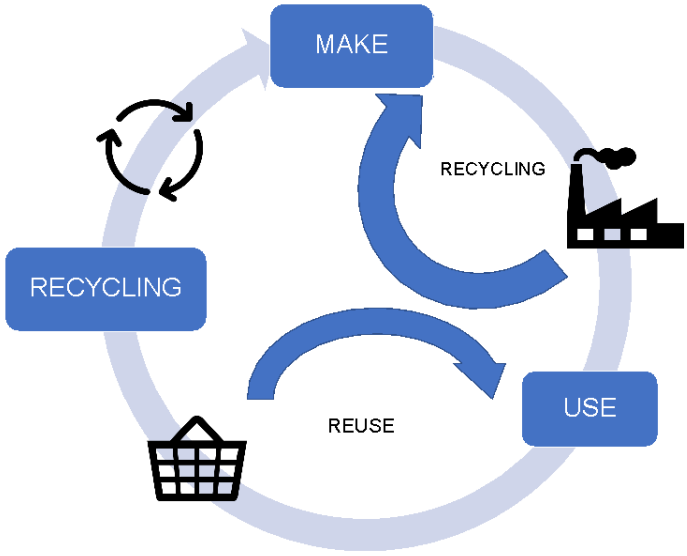


Figure 29. Key components of the circular economy

In this sense, the EU has defined as waste hierarchy an order of priorities for the prevention and management of waste:

1. Prevention
2. Preparation for reuse
3. Recycling
4. Other types of recovery (e.g., energy recovery)
5. Disposal

At the same time, it instructs the Member States to adopt measures to promote high-quality recycling by establishing separate waste collection for the relevant recycling sectors.

In this sense, it sets as an objective to guarantee before 2020 to increase at least to 50% of its global weight, the preparation for reuse and recycling of waste materials such as: paper, metals, plastic and glass from household waste and other sources.

The Ellen Macarthur Foundation defines recycling as:

"Transform a product or component into its basic materials or substances and reprocessing them into new materials. Embedded energy and value are lost in the process. In a circular economy, recycling is the last resort action".

2. EUROPEAN LEGISLATION ON RECYCLING

Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives (Text with EEA relevance) (consolidated text) and Directive (EU) 2018/851 of the European Parliament and of the Council of 30 May 2018 amending Directive 2008/98/EC on waste (Text with EEA relevance) are main legislations.

Law 22/2011, of 28 July, on waste and contaminated soils Order MAM/304/2002 of 8 February, by which publish the operations of valorization and elimination of waste and the European list of waste.

3. THE RECYCLING PROCESS FOR DIFFERENT MATERIALS

Paper recycling process

The used paper must be collected and separated from other waste to avoid staining and contamination.

The paper goes through the following phases:

1. Conversion into cellulose pulp

The paper is converted back into cellulose pulp by chemical and mechanical processes. The paste coming from all the material recovered in an instrument called a pulper, where it is mixed with water. Next, it is treated with different substances and minerals so that it has the desired properties.

2. Sifting

This cellulose pulp is passed through a sieve, which is responsible for expelling it in a thin layer on the fabric of the paper machine, where the paste circulates. It forms a sheet that, placed on the fabric or mesh, begins to dry.

3. Cleaning the pulp

Next, all the material is centrifuged so that its different elements are separated by their density. The next step consists of eliminating the ink with air bubbles. Next, all this paper pulp is washed to remove small particles that may remain by cleaning, deinking, and separation of the clean pulp from the residues.

4. Refining and bleaching

Next, the paper pulp is purified by filtering and centrifuging to eliminate possible particles of non-fiber elements such as wires, lacquers, sands, or ropes, among others. Subsequently, the paper is bleached usually using hydrogen peroxide or sodium hydrosulfite.

5. Preparation of the recycled paper

The paste passes through a series of rollers and holes whose outer part is formed by a mesh. The goal is to remove the rest of water. When it has obtained a certain consistency, the rest of the moisture is eliminated by pressure and heat. Once dried, the originally separated and wet fibers are brought together and dried to form the final paper.

Plastics recycling process

1. Receipt of raw materials

Different plastic materials can be recycled (HDPE, LDPE, PP, PET, PS, ABS ...). The quality of the material must be pre-classified and can come from different applications.

2. Selection process

Plastic materials which are unsuitable because of a low quality of the typology (labels, ferrous materials, particles, etc), are separated. Then, plastics are also separated according to the colors.

3. Shredded

The pieces are broken and shredded using a set of rotating knives, reducing them to small pieces. The granulometry of the plastic is homogeneous.

4. Washing

The plastic is placed in industrial laundries. In the bottom of the sink, possible impurities such as dirt, stones, metals, cardboard, PVC, etc. will be deposited.

5. Drying and spinning

The material extracted from the laundries goes to the centrifuges, where, in addition to performing the drying functions, they will eliminate any impurities that could still escape from the laundries.

6. Homogenization

Once crushed, washed, and dried, the plastic is stored in a large silo. A mechanical process will mix it until the material is homogeneous in color, texture, and behavior.

7. Extruded

Heat and friction allow the plasticization and uniformization of the particles.

8. Filtering

With the necessary texture and fluidity, the plastic still is filtered to avoid impurities adhered to the material: remains of cardboard, small pieces of wood, cloth, etc.

9. Granced

The plastic leaves the extruder head in the form of monofilaments or threads that cool down in contact with the water deposited in the tub. The threads pass to the noodle, where a rotating blade cut them, obtaining the appropriate grain or pellets.

10. Analytics and quality control

The production of pellets is divided into batches, where main characteristics are analyzed (fluidity, density, ash, etc.).

11. Packaging

The pellets are moved by means of a pneumatic installation to a tank where a cyclone will remove residual moisture. Subsequently, the product is packaged according to the client requirements.

12. Storage

Good storage of the finished product is essential to avoid possible damage: blows, inclement weather, deterioration, etc.

13. Logistics

The material is ready to be delivered.

Glass recycling process

Deposit the glass in the containers.

Citizens introduce the jars and bottles in the corresponding containers.

Selective collection

The trucks load all the glass in the containers to transport it to the treatment plant.

Arrival at the treatment and cleaning plant

The trucks unload the used glass. Then, impurities (lids, stoppers, metal, or plastic remains, as well as ceramics and porcelain) are removed.

Glass crushing

Once selected, a grinding process is carried out where the use of water is not necessary.

Elimination of remains and obtaining the raw material

The crushed glass passes through machines with optical readers that eliminate any opaque residue, obtaining the calcine. These are small pieces of clean glass that become raw materials to generate new objects.

4. INNOVATIVE RECYCLING PROCESSES

Plastic

Making polypropylene more widely recyclable

PureCycle Technologies developed a revolutionary process to remove color, odour, and contaminants from polypropylene plastic waste and transform it into a malleable and pure resin is the basis for plastic products. Polypropylene is the second-most used plastic in the world, yet only 1% is currently recycled.

Developing plastic roads

Companies are now trying a new strategy of melting plastic products, combining additives, and using the mixture to pave roadways. MacRebur is one of the pioneer companies in building plastic roadways using single-use plastics.

Eco-Bricks

With Ecobricks, empty plastic bottles are filled with clean, dried, and single-use plastics stuffed inside to the brink. This makes them resistant and like a brick, which can then serve as reusable building blocks for several purposes like building tables, beds, stages, or even walls.

Plastic made of wood

The Technical Research Centre of Finland VTT has created a compostable material from agricultural and forestry by-products that can be used for packaging items like muesli, nuts, dried fruit, and rice. These wood by-products plastic alternatives are great at reducing the plastic consumption we have in the packaging industry.

3D Printing Street Furniture

Parts from recycled plastic products are used to 3D print urban furniture such as benches. Companies like 'The New Raw have done this'. However, this is just one use for 3D printing with wasted plastic – think about what else we could 3D print; the possibilities are endless.

Using magnets to make recyclable plastic a more effective packaging material

Aronax Technologies has found that using a magnetic additive to recyclable plastic can create better air and moisture insulation. The additive will provide plastics with much better abilities to block gases such as oxygen but can be identified and separated at the recycling stage. This makes it suitable to protect sensitive products such as coffee and medical products while still recycling.

Refugee Shelters from Plastic

The number of refugees and homeless persons in the world has been increasing. This raises the need for coming up with affordable housing solutions. Researchers from the University of Bath have worked with plastic engineering company Protomax to design and test reusable shelters. The material used for the shelters is called Storm Board and is made up of recycled waste plastic. Such low-cost and easy-to-construct housing will be more and more in demand in the coming days and can indeed be part of a solution to the big plastic waste pandemic.

Flower pots made from recycled plastic

A Dutch success story: the Elho company from Tilburg has been using plastic waste as a raw material for several years. Their motto: "Give room to nature". From watering cans to pots in all possible colours: every thumb turns green by itself! For instance, a watering can from Elho is made from 12 plastic bottles of liquid detergent.

Straw instead of Styrofoam

The Landpack company from the Bavarian city of Alling produces insulating materials from straw. The straw mats insulate just as well as polystyrene and can be used in food shipping, but are much more environmentally friendly and inexpensive. And the farmers also get something out of it: a buyer for their straw that they don't need.

Disposable crockery made from plant residues

Bio-Lutions, based in Hamburg and Bangalore, has developed an effective solution to plastic waste: Compostable packaging made from plant residues. Agricultural waste can be used for such packaging, i.e., components of plants that are no longer used for other purposes, e.g., tomatoes, peppers, zucchini, hops or hemp plants, and straw and grasses. Chemical additives are not used in the entire production process of disposable tableware. In Germany, the Bio-lutions products are now available from PapStar, the party disposable tableware manufacturer.

Glass

Fluidised bed dryer

Glass can be produced by melting down cullet as a substitute material; it saves energy and is gentler on the environment because fewer raw materials require extraction: each tonne of cullet used can save 1.2 tonnes in raw materials.

But the challenge of glass recycling is that it can be hard to know exactly what is in the cullet. Standard industry practice now is to pass cullet through a series of operations that detect and remove foreign objects.

Optical sorting uses digital video cameras equipped with sensors to distinguish glass from non-transparent materials such as ceramic, porcelain, and stone. If detected, these are ejected. Unfortunately, though, these sensors often become obstructed by organic residues on the glass.

G.R.L.-Glasrecycling (Belgian-based company) settled on a new combination of technologies. Before undergoing an optical separation, the glass is sent through two additional units. The first is the fluidised bed dryer, which pumps large quantities of hot air through the glass. This process completely dries out any organic material present in the batch, causing it to cling to the glass.

This may seem counterproductive, but it allows the glass to be more easily cleaned in the second unit, essentially, a large drum in which the desiccated organic matter is polished from the glass.

Optical glass separation

The glass packaging waste is separated, cleaned without water, freed of impurities, and crushed into small fragments.

To facilitate this process, the company PICVISA offers the ECOGLASS optical separation equipment. Thanks to its applied technology based on Artificial Vision and Deep Learning, it identifies and separates materials according to their chemical composition, shapes, and colours with versatility, speed, and precision. These machines receive refining rejects, from which they can separate glass from materials such as CSP (ceramics, stones, and porcelain) and other unsuitable materials.

The quality of the resulting product is glass with less than 5% fines of less than 10 mm, with less than 0.7% of porcelain, stone, and ceramics, and less than 2% of impurities.

Paper

One key challenge has been determining the overall efficiency of the recycling process from start to finish. Current tools can determine how efficient a recycling plant is processing raw material at any given time, but achieving a global picture of the entire process has been difficult to capture. The EU REFFIBRE project has developed new tools to achieve exactly this.

The project's concept is that by gathering information on the potential impact of new processes, raw material input, and product innovations – and combining this information with key processing data – paper makers will be equipped to make the most informed decisions on how to run their operations as efficiently as possible.

REFFIBRE began by identifying and then testing various production and process modelling tools. As raw material selection and stock preparation can influence pulp properties, tools for predicting this have been developed. This means that key parameters, such as the Mean Fibre Age (number of times a fibre has been used before entering a paper mill) and the Mean Number of Uses (number of times a fibre will be used after leaving the paper mill), can now be calculated.

REFFIBRE partners have also worked on tools to help paper makers consider issues such as the impact on energy use outside the paper mill and what happens if reduced quality recycling material is fed into the process.

5. CIRCULAR ECONOMY BUSINESS MODELS FOR RECYCLING PROVIDING OPPORTUNITIES

Resource recovery models recycle waste into secondary raw materials, thereby diverting waste from final disposal while displacing virgin natural resource extraction and processing. In the case of the resource recovery business model, producing raw materials via recycling, rather than from non-renewable natural resources, can reduce greenhouse gas emissions by as much as 90% (mainly observed in aluminium cans).

Recycling, reuse, and repair have existed for millennia. The sharing of under-utilized household possessions also has a long history. Providing access to products, rather than ownership of them, is not so different from traditional product leasing. What is new is the growing diversity and sophistication of these business models and the range of sectors they are adopted in.

Table 7. Market share of circular business models "Waste as value: recycling"

Sector	Market penetration
Pulp and paper	38%
Steel	25%
Plastics	13%
Rare earth element (REE) metals	<1%

As the World Economic Forum website indicates, the Circular Economy Handbook demonstrates the superiority of the business model of born-circular companies:

Circular inputs

In a circular economy, renewable, recycled, or highly recyclable inputs are used in production processes. Born-circular manufacturers can expect lower costs for their production input as it does not have to be mined from scarce resources. They also benefit from high material and components recovery rates in original quality and increased material flow control. Born-circular designed products do not become end-of-life. Instead, they become the end-of-current-usage loop.

For example, when a tyre reaches its recycling phase, they extract all its original materials and use them to produce new tyres. It is significantly better to recycle used tyres into rubber floor tiles, ink, carpets or car parts than to export them to India, increasing one of the world's worst pollution crises. But in both cases we see a loss of value, as the high strength steel, kevlar and fibre are gone forever.

Sharing economy concept

Born-circulars maximize how idle assets are used across a community while providing customers with affordable and convenient access to products and services. This includes sharing industrial assets like a conveyor belt, forklift, machinery and warehouses. Access to an asset no longer requires buying or renting from traditional suppliers but is provided by individual people and companies. Born-circulars, therefore, have a higher utilization percentage of their expensive assets.

Product as a service

The customer purchases a service for a limited time while the provider maintains ownership of the product and remains incentivized for its ongoing maintenance, durability, upgrade, and treatment at the end of its use. The born-circular shifts focus from volume to performance, thus maximizing the usage factor and useful life. The born-circular benefits from continued customer contact and insights into how their products are used. The born-circular gains access to potential untapped opportunities for businesses, for example, a new remanufacturing/refurbishment market.

For example, SKF's Oil as a service (RecondOil) changes the use of industrial oils to a circular business model. Traditionally removing contaminant particles smaller than a micron out of industrial oil has been nearly impossible, wherefore the quality of lubrication oil is continuously degraded. RecondOil keeps the oil in circulation constantly clean by capturing and separating particles and other impurities down to nano-size.

Product use extension

The born-circular designs their products for repairability, upgradability, reusability, ease of disassembly, reconditioning, and recyclability of all components. In the linear economy, you sell your product to the next in line, and the primary interest is in selling as many new products as

possible. In comparison, the born-circular designs their business models to have a continuing income stream throughout the product's usage cycles.

Resource recovery

The born-circular has a direct economic interest in extracting all their products' recoverable value. Their design focuses on making value recovery easy and effective. Their business model ensures that users are incentivized to return the products, for example, contractually, through deposits or in the product-as-a-service model. The future material flows are controlled by the born-circular, not by the mining industry.

For example, Vodafone's trade-in service encourages customers to return their old mobile and tablet devices in exchange for a discount on a new gadget or store credit. The returned items are refurbished and resold, or the components are stripped and recycled.

Companies must adapt to survive

For many companies founded in the linear economy, the shift to a circular economy will be as tricky as the brick-and-mortar transition to a digital business. We will see many legacy companies, unable to adapt in time, lose out to born-circulars who offer: lower costs, recurrent income sources throughout the usage cycles, more climate-friendly and attractive products, higher customer intimacy, and increased resilience due to better control of material flow. Companies must adopt circular elements in their business models, start pilot initiatives, and build a transition strategy with the circular economy concept as a key driver.

REFERENCES/Link to online resources and specific imagesific images

[1]. https://www.20minutos.es/noticia/4865411/0/el-ayuntamiento-de-estepona-se-suma-a-la-campana-solidaria-de-reciclaje-de-vidrio-contra-el-cancer-de-mama/

[2]. https://www.leonoticias.com/alfoz/sanandresdelrabanedo/ecovidrio-ayuntamiento-andres-20211015122648-nt.html

[3]. https://www.lanuevacronica.com/reciclar-vidrio-para-investigar-el-cancer-de-mama

[4]. https://www.puertollano.es/puertollano-competira-con-catorce-ciudades-en-sumar-mas-reciclado-de-vidrio/

[5]. https://www.diariodealmeria.es/vivir/Ayuntamiento-Ecovidrio-Recicla-Vidrio-Cancer_0_1621339641.html

[6]. https://www.larazon.es/medio-ambiente/20211026/kwmj3byu7ve6xgsbfnt2p2koqm.html

[7]. https://forococheselectricos.com/2021/10/leon-primera-planta-de-reciclaje-de-baterias-de-coches-electricos-de-espana.html

[8]. https://forococheselectricos.com/2021/10/leon-primera-planta-de-reciclaje-de-baterias-de-coches-electricos-de-espana.html

[9]. https://www.linkedin.com/pulse/decathlon-eliminate-plastic-paper-bags-all-stores-garc%C3%ADa-fern%C3%A1ndez/

[10]. https://www.boe.es/buscar/doc.php?id=BOE-A-2018-6651

[11]. http://eko3r.com/reciclaje-de-aceite-domestico/

[12]. https://ec.europa.eu/environment/topics/plastics/plastic-bags_en

[13]. https://ecoalf.com/es/p/materiales-80

[14]. https://www.comercialaviles.com/blog/proceso-de-reciclaje-del-papel/

[15]. https://hablandoenvidrio.com/la-cadena-del-reciclado-de-vidrio-1-la-planta-de-tratamiento/

[16]. https://www.bbva.com/es/sostenibilidad/descubre-cual-es-el-proceso-de-reciclaje-del-vidrio/

[17]. http://www.recicladoslared.es/proceso-de-reciclaje-de-plasticos/

[18]. https://www.ecoagricultor.com/el-reciclaje-del-vidrio-proceso-aplicaciones-y-ventajas/

[19]. https://www.cheaperwaste.co.uk/blog/innovations-in-plastic-recycling-new-technology-and-initiatives/

[20]. https://www.17goalsmagazin.de/en/9-innovations-to-up-cycle-plastic-waste/

[21]. https://ec.europa.eu/environment/ecoap/about-eco-innovation/good-practices/eu/759_en

[22]. https://picvisa.com/en/glass-recycling-efficient-process/

[23]. https://phys.org/news/2016-09-methods-efficient-paper-recycling.html

LEGISLATIONS AT EU AND NATIONAL LEVELS

Julia Moreira, Rosie James
SwIdeas AB, Sweden

1. INTRODUCTION

A zero-waste circular economy has potential to create new jobs, practices, modes of production, consumption and living, which reflects ambitions of local, national, and international governments. These governments are crucial in supporting the transition towards a zero-waste circular economy, especially when it comes to setting up rules and regulations that can offer investment opportunities and create incentives for innovation. However, changes in the political sphere often relate to society's emerging demands, which means that it is necessary that both citizens and academics in Europe are aware of current legislation in the EU and their own countries that either hinder or support a zero-waste circular economy. Through this raised awareness, we can work towards demanding for political change.

The political sphere is crucial to promote and support a sustainable adoption of measures that encourage zero-waste and circular economy. It can drive both producers' and consumers' behaviors, while also establishing the necessary incentives to making these shifts possible. In a world that is led by economic incentives and the goal of maximizing profit and exploring economic advantages, legislation makes the difference in making something go from being unlikely, to being possible and advantageous for businesses, communities, and the environment. Noteworthily, within the current capitalist and profit-oriented system, economic incentives still often rive producers to a linear approach, while driving consumers to the least costly product. Therefore, policies play an important role in shifting profit outcomes by internalizing environmental costs, which are mostly externalized in industrial production. This may include taxing CO2 emissions for instance or decreasing taxation on renewable resources. Furthermore, legislations can also encourage the transition towards new solutions and standards by promoting innovation by creating a encouraging the emergence of new markets that have a circular economy approach (Vinnova, 2019).

Therefore, transmitting information about legislation related to the Circular Economy and Zero Waste to people in a way that encourages them to sustainably adopt concepts and practices as well as to support a transition from the linear economy is cricual for citizens to start reflecting on legislations that are in place and demand improvements. Learning about legislations such as the Circular Economy Action plans and how they developed is critical to improve the understanding of how legislation can change rapidly and the effects that this can have on the environment and on further innovations. In fact, results from the 2017 Eurobarometer on environmental attitudes show that EU citizens consider legislative measures to be the most effective in tackling

environmental problems, indicating the perceived importance of governmental decisions. This further highlights the importance of spreading accessible information about what these legislations represent and the effects that they can have on environmental protection.

It is important to clarify that legislations set out the law and therefore, the procedure or standard that people and organisations must follow, while a policy is a course or principle of action adopted or proposed by an organization or individual, and a directive is a legal act of the European Union that requires Member States to achieve certain goals, without constraining them in the way to achieve it. You can see the procedure for adopting legislatice acts in the European Union in Figure 29.

Governments around the world currently have a duty to set and implement measures that can help tackling climate change, which is believed to be a serious problem by 93% of the EU citizens (Eurobarometer, July 2021). In relation to this, resource consumption and the consequent waste disposal represent important challenges which need to be addressed if we are to align our societies' development with the planetary boundaries and start reversing the climate crisis. Indeed, "the annual global extraction of materials tripled from 1970 to 2017" and "about half of total greenhouse gas emissions and more than 90% of biodiversity loss and water stress come from resource extraction and processing" (EUR-LEX, 2019). Zero waste and the circular economy have consequently emerged as increasingly relevant in climate discussions as promising solutions.

2. CIRCULAR ECONOMY AND CLIMATE CHANGE - WHAT HAS BEEN DONE BY GOVERNMENTS SO FAR

Implementing measures at the European level is essential to create common ground to transition into a zero-waste circular economy, to minimize loss of materials in the European Union, promote job creation, and improve transparency among regulations which can facilitate circular practices, such as recycling and reuse. Globally, this has the potential for an even bigger impact. Transparency is key to ensure that different actors throughout the world will be able to reuse or recycle materials from products at a larger scale. Furthermore, support circular design is essential to minimizing waste, as it extends the life of products and makes the use of materials for new purposes possible.

The European Union already has a background of implementing environmental measures which, while promoting economic growth, have succeeded in reducing emissions of greenhouse gases. In fact, over 28 years, while GDP increased by 61%, emissions were lowered by 23% in the EU (1990-2018) (EEA, 2019). However, by 2020 at least 50% of the EU's 27 Member States were not on track to achieve the 50% recycling rate target for that year, which raises the need for increased speed and ambition of governments to deliver circular economy and zero waste policies (Zero Waste Europe, 2020).

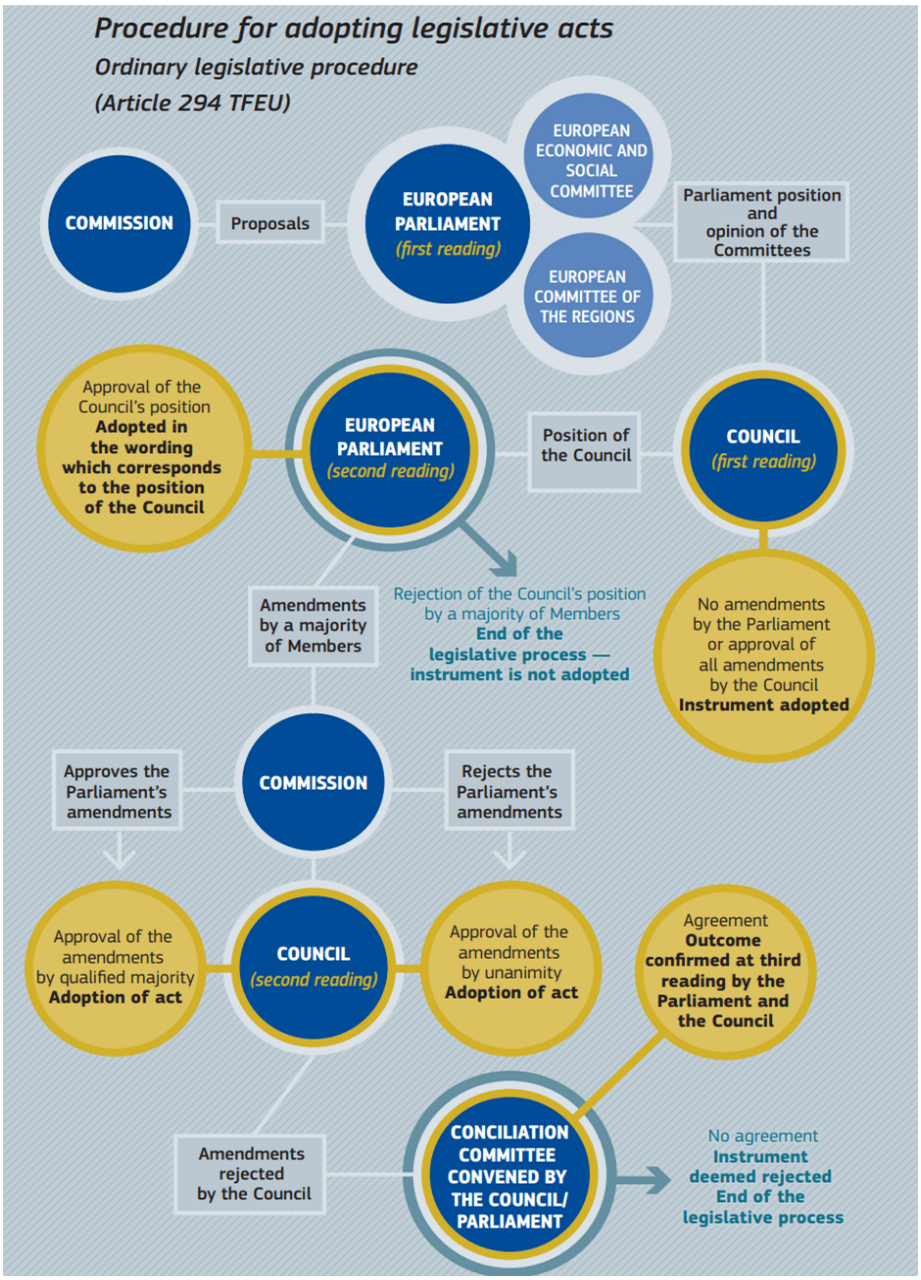


Figure 30. Procedure for adopting legislative act

Source: (Borchardt, 2018) https://op.europa.eu/en/publication-detail/-/publication/5d4f8cde-de25-11e7-a506-01aa75ed71a1

Furthermore, the European Commission announced in 2019 the investment of €11 billion in new solutions that address societal challenges and drive innovation-led sustainable growth. This budget further include an investment of €1 billion to support the circuclar economy (European Commission, 2019).

"In 2020, €206 million is earmarked for projects to transform sectors that are traditionally energy intensive into competitive, low-carbon and circular industries and to significantly lower their environmental footprint. €132 million will support the development and production in Europe of the next generation of batteries, as part of the drive towards a low-carbon, climate-resilient future. Ten new topics on plastics with a total budget of €135 million contribute in different ways to the EU Plastics Strategy." (European Commission, 2019).

2.1.ENVIRONMENTAL LEGISLATIONS WORLDWIDE

Worldwide, governments have come together to reach common ground concerning climate change and environmental protection. Environmental conferences have seen their start in the United Nations Conference on the Human Environment, held in Stockholm, Sweden, in 1972. Since then, world leaders have met every 20 years to discuss matters of sustainability, environmental protection, and clcimate change.

In 1972, the Stockholm Declaration and Plan of Action was adopted, setting out "principles for the preservation and enhancement of the human environment, with recommendations for international environmental action. The Conference also created the United Nations Environment Programme (UNEP), the first UN programme focused solely on environmental issues" (United Nations, 2022).

In 1992, world leaders met in Rio de Janeiro, Brazil, in the Earth Summit. During this summit, leaders came together to rethink economic development and realize solutions to address pollution and the depletion of the planet's natural resources. During the summit, 172 Govvernments adopted three major agreements, including:

- Agenda 21, "an official global consensus on development and environmental cooperation. (…) Agenda 21 was meant to reflect an international consensus to support and supplement national strategies and plans for sustainable development. It called for all States to participate in improving, protecting and better managing ecosystems, and taking common responsibility for the future" (United Nations, 2022).

- Rio Declaration which, with its 27 principles, emphasized the need for State cooperation and partnership to "conserve, protect and restore the integrity of the Earth's ecosystem" (Ibid).

- "Statement of Forest Principles, a set of principles to underpin the sustainable management of forests worldwide" (Ibid).

During the Summit, two legally binding instruments were also opened for signature: the United Nations Framework Convention on Climate Change and the Convention on Biological Diversity.

The Summit was followed by a Special Session of the General Assembly held in 1997, the 'Earth Summit + 5', which sought to examine the implementation of Agenda 21 and propose a

programme for further implementation. In 2000, the Millennium Summit established the eight Millennium Development Goals (MDGs), which were reviewed in 2005, 2008, and 2010.

A new Action Plan was created in 2002 during the World Summit on Sustainable Development held in Johannesburg. In 2012, Rio was once again home to the United Nations Conference on Sustainable Development, the Rio + 20, after which the United Nations Environment Assembly was established, the world's high-level decision-making body on the environment. The Environment Assembly meets to set priorities for global environmental policies and develop international environmental law.

Two years before the 2015 deadline to meet the Millenium Development Goals, a Special Event was held in New York. During this event, Member States agreed to adopt a new set of goals which would build on the foundations laid by the Millennium Development Goals. The 2015 United Nations Summit on Sustainable Development gave birth to Agenda 2030 and its seventeen sustainable development goals.

In the same year, the first legally binding agreement brought nations together to "undertake ambitious efforts to combat climate change and adapt to its effects" (Unfccc.int. 2022). This agreement is known as the Paris Agreement, adopted on 12 December 2015 by 196 Parties at COP 21 in Paris.

"Its goal is to limit global warming to well below 2, preferably to 1.5 degrees Celsius, compared to pre-industrial levels (…) The Paris Agreement works on a 5-year cycle of increasingly ambitious climate action carried out by countries. By 2020, countries submit their plans for climate action known as nationally determined contributions (NDCs)." (Ibid)

2.2. THE EUROPEAN LEVEL

THE FIRST CIRCULAR ECONOMY ACTION PLAN (2015)

The first Circular Economy Action Plan established in 2015 broke policy silos and set 54 concrete actions across 7 policy areas: Chemicals; Circular economy; Circular economy at the global level; Industry; Plastics; Sustainable development; Waste and recycling . It also revised legislative framework on waste (Rizos, 2019) and adopted a Circular Economy Monitoring Framework "to measure progress towards a circular economy at EU and national level" (SB Insight, 2019). It focused on cooperation and comprehensive action, covering the entire product's cycle, which made it suitable for different political and economic contexts. (European Commission's "Circular Economy Action Plan" - United Nations Partnerships for SDGs platform, 2020).

The plan was fully completed by 2019, and its 54 actions have been delivered, even if the work on some of them continues beyond 2019 (European Commission, n.d.)

THE EUROPEAN GREEN DEAL (2019)

On 11 December 2019, the European Commission presented the **European Green Deal** as a response to the challenges posed by global warming, pollution, and biodiversity loss. The EU Green Deal sets an ambitious roadmap including actions to promote more efficient use of resources to address climate change, an idea to which the circular economy is central. It is defined as "a roadmap for making the EU's economy sustainable by turning climate and environmental challenges into opportunities across all policy areas and making the transition just and inclusive for all" (European Commission, 2019). As part of the EU Green Deal, the local contexts of EU member states are considered in the Just Transition Mechanism, ensuring that countries with more carbon intensive activities are better supported during the transition to protect the citizens, local companies, and the country's infrastructure (European Commission, n.d.).

The EU Green Deal's political ambition is that the EU becomes the world's first climate neutral continent by 2050. According to EU officials, the circular economy as well as new waste and recycling laws, can represent half of the EU's effort to achieve this goal (Simon, 2019). The transition to a circular economy – where the value of products, materials and resources is maintained in the economy for as long as possible, and the generation of waste minimized – is indeed recognized by the European Commission as "an essential contribution to the EU's efforts to develop a sustainable, low carbon, resource efficient and competitive economy" and as an "opportunity to transform our economy and generate new and sustainable competitive advantages for Europe" (European Commission, 2015). For this reason, in 2015 the EU adopted its first circular economy action plan that contained 54 concrete and ambition actions across 7 policy areas (Chemicals; Circular economy; Circular economy at the global level; Industry; Plastics; Sustainable development; Waste and recycling) which have been delivered by 2019 (European Commission, n.d.1). Following this successful endeavor, a second circular economy action plan has been set in 2020 as one of the main building blocks of the EU Green Deal.

With the EU Green Deal's aim to promote growth within a resource-efficient and competitive economy, several EU waste laws are being reviewed. This was the case of the main European legislation on waste, approved in May 2018, which aims at taking Europe towards a circular economy and has revised the following pieces of legislation: Directive on Waste (2008/98/EC); Directive on Packaging and Packaging Waste (1994/62/EC); and Directive on the Landfill of Waste (1999/31/EC). The Waste Directive from 2008 established a legal framework for treating waste in the EU as well as a waste hierarchy which places prevention as the preferred practice, above reuse, recycling, recovery, and lastly, disposal. Within the new Directive on Waste, Member States are obliged to "make use of economic instruments and other measures to provide incentives for the application of the waste hierarchy" (Zero Waste Europe, 2020). According to the EU law, after the directives are in force, Member States have up to 24 months to adapt and transpose them into national legislation. July 2021 was the deadline set by the European Commission for EU Member States to transpose a legislative package on waste which contains requirements that help build foundations for a circular economy in Europe, including the landfilling of waste and packaging.

Although the national governments are responsible for transposing EU Directives, oftentimes local authorities are the ones holding the competency and responsibility for waste management and should therefore consider the minimum targets established by the EU. In relation to this, almost 400 European municipalities are working with the Zero Waste Europe's Cities programme, having committed to ambitious zero waste strategies. They provide methodologies that can be replicated across Europe to support the transition towards a circular economy and the achievement of zero waste goals.

In practice, the goals set by the EU Green Deal is written into law through the European Climate Law. It reflects the target of reducing emissions by 55% compared to the levels of 1990 by 2030 and enshrine the 2050 climate neutrality objective. It entered into force on 29 July 2021 (Regulation (EU) 2021/1119)

"The European Climate Law requires that all EU policies contribute to achieving the EU Green Deal objective. As a result, the EU Commission are reviewing every EU law to ensure its alignment with the EU emission reduction targets, under an exercise termed the "Fit for 55 package".
(Norton Rose Fulbright, 2021)

It involves a revision of a selection of key legislations:

- the Renewable Energy Directive;
- the Energy Efficiency Directive;
- the Emissions Trading System;
- the Effort Sharing Regulation;
- the Land Use, Land Use Change and Forestry Regulation;
- the Energy Performance of Buildings Directive; and
- the Energy Taxation Directive.

More information about the EU Green Deal:

Main elements:

- Climate action.
- Clean energy.
- Sustainable industry.
- Buildings and renovations.

- Sustainable mobility.
- Eliminating pollution.
- Farm to Fork.
- Preserving biodiversity.
- Research and development.
- Preventing unfair competition from carbon leakage.

It addresses key policy areas through strategies such as:

- "From farm to fork", which seeks to ensure more sustainable food systems;
- "Clean energy", which envisions opportunities for alternative, cleaner and renewable sources of energy;
- "Sustainable industry", which targets more sustainable, environmentally-respectful production cycles;
- "Building and renovation", which acknowledges the need for a cleaner construction sector;
- "Eliminating pollution", which seeks to efficiently cut pollution (European Commission, 2020c).

THE NEW CIRCULAR ECONOMY ACTION PLAN (2020)

Following the first Circular Economy Action Plan, a new one was established in 2020 to give continuity to what started in 2015. The new plan emphasizes the active involvement of citizens and empowers consumers, based on the Eurobarometer survey of March 2020, which highlighted that:

- 83% of EU citizens believe EU legislation to be necessary to protect the environment
- Citizens are willing to be more involved in the objective of environmental protection
- Citizens consider changes in consumption and production patters to be the "most effective ways of tackling environmental problems" (European Commission, 2020).

The 2020 plan contains 35 actions across 7 policy areas and focuses on the sectors that use most resources and where the potential for circularity is high such as: electronics and ICT, batteries and vehicles, packaging, plastics, textiles, construction and buildings, food, water and nutrients. It also seeks to ensure less waste. In this regard, the focus will be on avoiding waste altogether or transforming it into highquality secondary resources that benefit from a well-functioning market for

secondary raw materials. The Commission aims to ensure that the EU does not export its waste challenges to third countries and will explore setting an EU-wide, harmonised model for the separate collection of waste and labelling.

It further promotes entrepreneurship and SMEs by offering a competitive edge while promoting health and labour to the market. This includes regulatory alignment to allow SMEs to better compete, for which purpose governments should reward products based on their different sustainability performance, including by linking high performance levels to incentives.

It also encourages fiscal measures to incentivize circular economy initiatives and deter unsustainable behaviours encouraging SMEs to provide innovative solutions to meet public demand for greener products and services e.g. This includes: subsidies such as VAT exemption to improve the competitiveness of recycled materials and the implementation of an EU-wide one-stop-shop for EPR (European Pressurized Water Reactor); Taxes on pollution and natural resources, rules on corporate financial responsibility and transparency

Finally, the SME strategy will focus on fostering partnerships among SMEs through training, advice from the Enterprise Europe Network (EEN), and knowledge transfer via the European Resource Efficiency Knowledge Centre.

3. INITATIVES AROUND ZERO-WASTE

- Zero Waste Europe, created in 2014, is "the European network of communities, organisations, local leaders, experts, and change agents working towards the elimination of waste in our society." They have played a role in influencing some of the key legislative processes in the EU concerning waste reduction.

- Zero Waste Europe's Cities program involves almost 400 European municipalities which have committed to ambitious zero waste strategies. They provide methodologies that can be replicated across Europe to support the transition towards a circular economy and the achievement of zero waste goals.

- Amendments to the Waste Framework Directive in 2018: it now states that EU Member States shall take measures to prevent waste, such as by promoting and supporting sustainable production and consumption models and by encouraging the design, manufacturing and use of products that are resource-efficient, durable, reparable, re-usable and upgradable.

4. THE POLITICAL FRAMEWORK&ZERO-WASTE

A few political initiatives have been put in place to promote zero-waste. These include:

- The Landfill Directive: No more than 10% of waste may go to landfills by 2035. Currently the EU28 average is 28% with very mixed realities across countries. Estonia, Greece, Croatia,

Latvia, Malta, Romania and Slovakia secured a five-year extension, providing they reduce the level of municipal waste going into landfills to below a quarter by 2025. The Commission will then consider, by 2024, setting a quantitative per capita target on landfilling.

- New EU harmonised methodology to count recycling rates for municipal waste: The European Commission is imposing on all Member States a harmonized methodology of measuring the recycling rates for municipal waste. The methodology only allows those materials to count towards the recycling targets that do not undergo further processing before entering a recycling process, such as for example a glass furnace, a pulping operation, or an extrusion process. Hence the recycling rates are not established anymore according to the amounts collected for recycling but on the amount of waste that is de-facto directly entering recycling processes as secondary raw material. This new way of counting will set countries back several percentage points in their recycling performance and will make achieving the new targets even more ambitious.

- 2018 – ambition within the EU Waste Framework Directive was increased

    - Through it, EU member states and institutions agreed on a comprehensive set of laws aimed at preventing household waste and boosting recycling. The Directive sets out recommendations regarding the introduction of economic instruments such landfill and incineration taxes, deposit-return-schemes, fees and more.

    - European households and businesses will have to recycle at least 55% of their municipal waste by 2025 and to reach 65% in 2035. Stricter rules will be put in place to guarantee separate collection of additional waste streams, including all bio-waste (by 2023) and used textiles (by 2025).

- Reducing the incineration of valuable resources: the European Commission emphasised the importance of framing new investment in future waste treatment facilities in a long-term circular economy perspective and in coherence with the EU waste hierarchy and the EU targets.

- High rates of incineration are inconsistent with more ambitious recycling targets. Waste incineration with or without energy recovery has been classified as "other recovery" and "disposal" and will not help with the fulfilment of the recycling targets.

- 2019 – adoption of the EU Single-Use Plastics Directive, a pioneer legislation to curb the consumption of one of the biggest sources of plastic pollution. It established that where sustainable alternatives are easily available and affordable, single-use plastic products cannot be placed on the markets of EU Member State. Through the directive, different measures are being applied to different products, also considering if more sustainable alternatives are available (European Commission, Environment, n.d.). The 10 items being addressed by the Directive are:

- Cotton bud sticks
- Cutlery, plates, straws and stirrers
- Balloons and sticks for balloons
- Food containers
- Cups for beverages
- Beverage containers
- Cigarette butts
- Plastic bags
- Packets and wrappers
- Wet wipes and sanitary items

➢ Ecodesign Directive: "sets a framework for performance criteria which manufacturers must meet in order to legally bring their product to the market. It does not yet, however, prescribe specific measures or standards and sets no overall energy saving targets. A revised Directive extends the scope of the existing Directive by covering in principle all energy-related products." (https://www.eceee.org/ecodesign/process/)

➢ Ecodesign Working Plan 2016-2019: sets out an indicative list of prioritised product groups. (Ibid)

➢ Extended Producer Responsibility (EPR): a set of instruments to be implemented through administrative, economic, and informative policy instruments. In EPR, the producer's responsibility for a product is extended to after the use stage of a product's life cycle (InterregEurope, 2020).

➢ EU Ecolabel: established in 1992, "the EU Ecolabel is a label of environmental excellence that is awarded to products and services meeting high environmental standards throughout their life-cycle: from raw material extraction, to production, distribution and disposal." (https://ec.europa.eu/environment/ecolabel/)

SWEDEN

Circular Economy Strategy for the Transition in Sweden

It describes the steps the country is taking to promote the transition towards a circular economy, in line with the European Union Commission's Action Plan, which focuses on establishing a

sustainable product policy legislative initiative. The strategy is closely related to the principles of zero-waste, for instance for having at its core "the widening of the Eco-design Directive to, for instance, achieve more sustainable product design and increased consumer information"[2]. This strategy has been in place since July 2020.

Swedish Government bill 2016/17:104 A national food strategy for Sweden – more jobs and sustainable growth throughout the country

It explicitly evokes the importance of zero-waste principles by recognizing that "waste must be reduced throughout the food supply chain – from producer to consumer. Clever solutions should be found for the use of production residues in ways that stimulate a closed-loop system so that they constitute a resource in a growing circular, bio-based economy. There is great potential for the agricultural sector to contribute to such an economy"[3].

TURKIYE

Turkiye Zero Waste Regulation[4]

This Regulation was published on 12 July, 2017. The objective of the zero-waste regulation is to establish and develop zero waste management system which aims to protect the environment and human health and all resources in waste management processes in line with the principles of sustainable development with effective management of raw materials and natural resources. It regulates the principles and procedures concerning the establishment of zero waste management system and zero waste certificate to be issued for the places where the establishment of zero waste management system is mandatory and for those who wish to establish zero waste management system on a voluntary basis. The Regulation forces buildings and premises where zero-waste management systems will be established to comply with the general principles specified in the regulation, among other compliances.

5. OBSTACLES FROM THE LEGISLATIVE FRAMEWORK TO THE TRANSITION

Although the legislative and political frameworks play a crucial role in supporting the transition, there are several factors that currently pose an obstacle to it. These include:

[2] https://www.government.se/4ad42c/contentassets/d5ab250cf59a47b38feb8239eca1f6ab/circular-economy--strategy-for-the-transition-in-sweden

[3] https://www.government.se/498282/contentassets/16ef73aaa6f74faab86ade5ef239b659/livsmedelsstrategin_kortversion_eng.pdf

[4] https://www.resmigazete.gov.tr/eskiler/2019/07/20190712-9.htm

- Different national legislations regarding issues such as recycling and reuse, which lead to more waste
- Inconsistent "best before" and VAT legislations for donated food, which increase food waste
- High administrative burden and costs of shipment of waste for materials' recovery within the EU;
- Uncertainty about substances included in products;
- Low progress in setting eco-design requirements for non-energy related products;
- Wide differences in waste management performance across member states and a lack of waste collection and processing infrastructure in several countries.
- Circular economy measures often require partnerships and networks across key resource users and stakeholders
- Achieving resource efficiency and transitioning towards a circular economy requires inter-agency co-ordination to align policies in diverse sectors
- The low availability of information on best practices and available technologies can hinder the development of circular business models and imported technologies are imported may not be adequate to domestic capacity
- There's a focus on the effectiveness and relevance of recycling systems among waste generators

It is worth mentioning that the market itself presents barriers such low virgin material prices and high upfront investment costs of circular economy business models. However, recent research show that cultural barriers play a key role in hindering a Circular Economy, especially consumers' preferences, such as preferring to buy new products. Additionally, market and cultural barriers appear to be more pressing than technological barriers.

6. SUPPORTING THE TRANSITION

Nevertheless, the framework can support the transition towards a zero-waste circular economy through several initiatives, such as:

- Establish funding/investments
- Help countering countries' reliance on carbon heavy activities
- Help shifting the focus from incentives to research and innovation

- Set incentives to lower the costs of virgin material.
- Provide upfront investment, which may encourage crucial cultural changes.

EXAMPLES

Some examples of how this support can look in practice include (Kirchherr et al., 2018):

- Take-back incentives
- Monetary incentives
- Mechanisms to reduction of labour costs (lowering labour taxes)
- Legislative, legal and regulatory frameworks
- Extended Producer Responsibility
- Tax incentives
- Legal waste definitions affecting product end-of-life
- Skills development (training and educational activities) - e.g. training for refurbishers
- [Obligations to] provide spare parts
- [Obligations to] provide product information to repairers, refurbishers, remanufacturers
- Enforcement of longer warranty periods for consumers
- Support to innovative, circular economy-focused business models
- Development of infrastructure for consumers to hand in used products
- Introduction of material efficiency and durability in product design regulation
- Legal framework to facilitate trade of repaired and refurbished goods
- Reduction of value-added tax (VAT) for refurbished products
- Creation of subsidies for reuse that could help reduce operational costs and assist reuse operations.

REFERENCES/Link to online resources and specific imagesific images

[1]. https://www.zerowasteeurope.eu/wp-content/uploads/2017/07/Rethinkingeconomic-incentives2.pdf.
[2]. https://eitrawmaterials.eu/wp-content/uploads/2020/07/EIT-RawMaterials-project-POLICE-Final-report.pdf
[3]. https://www.government.se/4ad42c/contentassets/d5ab250cf59a47b38feb8239eca1f6ab/circular-economy--strategy-for-the-transition-in-sweden
[4]. https://www.government.se/498282/contentassets/16ef73aaa6f74faab86ade5ef239b659/livsmedelsstrategin_kortversion_eng.pdf
[5]. https://www.resmigazete.gov.tr/eskiler/2019/07/20190712-9.htm
[6]. https://ec.europa.eu/eurostat/statistics-explained/pdfscache/1183.pdf
[7]. https://www.businessart.at/download/EEB-ZeroWasteEU_%20Waste-timeline.pdf
[8]. https://op.europa.eu/en/publication-detail/-/publication/5d4f8cde-de25-11e7-a506-01aa75ed71a1
[9]. https://zerowasteeurope.eu/wp-content/uploads/2020/07/zero_waste_europe_policy-briefing_achieving-the-eu%E2%80%99s-waste-targets.pdf
[10]. https://www.eltis.org/in-brief/legislation-policies
[11]. https://www.eea.europa.eu/publications/92-9167-052-9-sum/page005.html
[12]. https://www.eea.europa.eu/publications/trends-and-projections-in-europe-1
[13]. https://www.eltis.org/in-brief/legislation-policies
[14]. https://www.britishecologicalsociety.org/wp-content/uploads/2017/05/An-introduction-to-policymaking-in-the-UK.pdf
[15]. https://www.eea.europa.eu/publications/trends-and-projections-in-europe-1
[16]. https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52015DC0614&from=EN
[17]. https://www.euractiv.com/section/circular-economy/news/circular-economy-is-number-one-priority-of-european-green-deal/
[18]. https://ec.europa.eu/environment/topics/circular-economy/first-circular-economy-action-plan_en
[19]. https://ec.europa.eu/commission/presscorner/detail/en/ip_19_6691
[20]. https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1588580774040&uri=CELEX:52019DC0640
[21]. https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement
[22]. https://www.un.org/en/conferences/environment
[23]. https://ec.europa.eu/environment/topics/plastics/single-use-plastics_en
[24]. InterregEurope, 2020. Sustainable waste management in a circular economy - A Policy Brief from the Policy Learning Platform on. Environment and resource efficiency.
[25]. Kirchherr, J., Piscicelli, L., Bour, R., Kostense-Smit, E., Muller, J., Huibrechtse-Truijens, A. and Hekkert, M., 2018. Barriers to the Circular Economy: Evidence From the European Union (EU). Ecological Economics, 150, pp.264-272.
[26]. Nylén, E. J. A. and Salminen, J. M. (2019) 'How does the circular economy discourse affect policymaking? The case of streamlining waste utilisation in Finnish earthworks', Resources, Conservation and Recycling. Elsevier B.V., 149, pp. 532–540. doi: 10.1016/j.resconrec.2019.06.029.
[27]. Rajendran, Karthik & Björk, H. & Taherzadeh, Mohammad. (2013). Borås, a Zero Waste City in Sweden. Journal of Development Management. 1. 3-8.
[28]. Watkins, E. et al. (2012) Use of Economic Instruments and Waste Management Performances
[29]. Watkins, E. et al. (2017) EPR in the EU Plastics Strategy and the Circular Economy: A focus on plastic packaging
[30]. Whalen, K. A., Milios, L. and Nussholz, J. (2018) 'Bridging the gap: Barriers and potential for scaling reuse practices in the Swedish ICT sector', Resources, Conservation and Recycling. Elsevier, 135, pp. 123–131. doi: 10.1016/J.RESCONREC.2017.07.029
[31]. World Business Council for Sustainable Development (2020) Circular Economy Action Plan 2020 Summary for businesses: Implications and next steps.