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The study book

CIRCULAR ECONOMY AND ENVIRONMENTAL SECURITY IN EUROPE

Andriy Krysovatyy, Oksana Desyatnyuk,
Roman Zvarych & Iryna Zvarych

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EUROPEAN INCLUCIVE CIRCULAR ECONOMY:
POST-WAR & POST-PANDEMIC MODULE FOR UKRAINE

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Authors team:
Doctor of Economics, Prof. **Andriy KRYSOVATY** – general edition, introduction, chapter 4;
Doctor of Economics, Prof. **Oksana DESYATNYUK** – chapter 5;
Doctor of Economics, Prof. **Roman ZVARYCH** – general edition, preface, chapter 2;
Doctor of Economics, Prof. **Iryna ZVARYCH** – general edition, preface, chapters 1, 3.

Reviewers:
Tetyana Viktorivna Orekhova, Doctor of Economics, Professor, Professor of the Department of International Economic Relations, Dean of the Faculty of Economics, Donetsk National University named after Vasyl Stus.
Olha Hryhorivna Melnyk, Doctor of Economics, Professor, Head of the Department of Foreign Economic and Customs Activities, Lviv Polytechnic National University.
Olena Valeriivna Ptashchenko, Doctor of Economics, Associate Professor, Professor of the Department of International Business and Economic Analysis, Semyon Kuznets Kharkiv National University of Economics.

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A feature of the textbook is the emphasis on the theoretical and conceptual basis of the formation of the global circular economy. In addition to revealing the determinants of the formation of a global inclusive circular economy, the guidelines for the construction of a global inclusive circular society were investigated. The methodology of systemic analysis of the global inclusive circular economy is thoroughly covered. The implementation of smart business models in circular cities through circular chains of added value creation and "tax shifts" is substantiated. The model of the global inclusive circular economy has been adapted to the realities of Ukraine and the ways of implementing its strategic priorities in the Roadmap have been substantiated. The world experience of the process of disposal of automobile means of transport was considered and ways of reducing its negative impact on the natural environment were worked out. The existing approaches to the development and validation of methods for the analysis of antihypertensive active pharmaceutical ingredients in medicinal products and biological fluids are analyzed.

The study book is intended, first of all, for students, graduate students and teachers of higher education institutions, as well as practicing specialists in the field of waste management. It will certainly also be useful for specialists in the field of economics, management and international relations.

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INTRODUCTION

The transitive path of the transition from a linear to a circular economy is determined by the change in the positioning of global risks from year to year, which determines the determinants of such a change. Thus, the main risks for 2020 have been defined by the World Economic Forum as those related to the environment and occupying the first positions in the rating for the last 3 years (in particular, in 2019, the risk of extreme weather events was the most influential). The gradual increase in awareness of this risk has led to a change in the attitudes of both producers and consumers. Experts rated climate change as the main risk of 2019, ahead of losses from cyber attacks, financial instability and terrorism. Thus, to mitigate this risk in 2020, the global business community has suggested implementing circular "structures", reducing the use of resources and giving priority to low-carbon materials. The potential consequences of the transition to a circular economy on greenhouse gas emissions are significant, achieved mainly through increased resource efficiency, increased useful life of buildings and assets, increased recycling and reuse, and absolute reduction in the use of primary raw materials. Thus, the circular economy can be considered as an effective strategy to help mitigate climate change.

The polyparadigmatic nature of economic-theoretical knowledge from the standpoint of the existential nature of the imperatives of economic

development in the context of responsibility for the global future causes certain paradigmatic shifts, and greening is the mainstream and imperative that reflects the heterodox beginning of the theoretical and methodological foundations of the global inclusive circular economy. A multidisciplinary epistemological perspective for the analysis of economic phenomena from the standpoint of new pragmatism in the context of the "triad" of sustainability (economic, social and ecological components), distinguishes the humanitarianism of economic science and positions "at the forefront" the role of values in the economic activity of people and society and the positioning of imperative characteristics (acceleration of the exploitation of natural resources; climate change; the formation of a new ecological order; ecological and food security) and domains ant formation of a paradigm (exceeding the ecological limit; the Paris Agreement; changes in the public attitudes of producers, population and business regarding the use of fossil resources; global economic losses; the goals of sustainable development of the United Nations, which have a strong connection with circular practices, the participation of the WTO in supporting new technologies, minimizing waste production and promoting circular trade) . Methodological features of the paradigm of the global inclusive circular economy from the standpoint of postmodernism are the strengthening of social and humanistic guidelines (they reflect its ideology and create a basis for an inclusive-oriented society); ontological non-linearity (emphasizes circularity); consensuality (the need for a global consensus to achieve a goal), which is emulated using an economic-mathematical method.

The study book is intended, first of all, for students, graduate students and teachers of higher education institutions, as well as practicing specialists in the field of waste management. It will certainly also be useful for specialists in the field of economics, management and international relations.

CHAPTER 1

THEORETICAL AND CONCEPTUAL BASIS FOR THE FORMATION OF A GLOBAL INCLUSIVE CIRCULAR ECONOMY

1.1. Determinants of the formation of a global inclusive circular economy

Exploitation of natural resources accelerates in the conditions of their reduction, at the same time, people generate ever-increasing flows of waste and pollutants. Global resource use increased from 23.7 billion tons in 1970 to 70.1 billion tons in 2010, while the global population nearly doubled and the economy tripled. The world population's use of resources per capita increased **from 7 tons in 1970 to 10 tons in 2010,** which indicates an improvement in living standards (their purchasing power) in many countries. However, globally, 11.2 billion tons of municipal waste were collected in 2010, approximately 2 tons for every person on the planet, and a similar amount of uncollected waste is expected to be generated [305; 402].

The ecological limit of the planetary boundaries has been crossed, and humanity risks a complete destabilization of the geological conditions on which our society depends. Nevertheless, increasing resource use has strengthened social foundations, incomes and well-being for many people. However, the long-term well-being of people depends on *a healthy environment* , providing the resources necessary to meet basic human needs, including

access to clean water, food and shelter. Despite this, resource extraction and waste production have reached such a level that they lead to unprecedented environmental degradation, climate change and pollution - thereby violating basic human rights and needs [305].

Climate change is a global problem caused by collective action, and like all such problems, solving it will be extremely difficult. Between 1880 and 2012, the average global temperature increased by 0.85 °C. Oceans warmed, snow and ice decreased, and sea levels rose. Between 1901 and 2010, global average sea levels rose by 19 cm as oceans expanded due to warming and melting ice. The volume of sea ice in the Arctic has decreased during each subsequent decade since 1979, losing 1.07 × 106 km ² of ice for decades [364, 365, 366] .

Limiting global warming to 1.5°C will require "rapid and far-reaching" transitions in land, energy, industry, buildings, transport and cities, according to practitioners. Global net carbon dioxide (CO2) emissions are expected to fall by about 45 percent from 2010 levels by 2030, reaching “net zero” by around 2050. This means that any remaining emissions must be balanced by removing CO2 from the air [364, 365, 366].

By 1995, countries had begun negotiations to strengthen the global response to climate change, and two years later they adopted the Kyoto Protocol. The Kyoto Protocol legally binds developed member countries to emission reduction targets. The first commitment period of the Protocol began in 2008 and ended in 2012. The second commitment period began on January 1, 2013 and will end in 2020. Now there are 197 Parties to the Convention and 192 Parties to the Kyoto Protocol [87, 88, 89].

At the 21st Conference of the Parties in Paris in 2015, Parties to the UNFCCC reached an important agreement to combat climate change and accelerate and intensify the actions and investments needed for a sustainable,

low-carbon future. The Paris Agreement is based on the Convention and - for the first time - unites all countries in a common cause to make ambitious efforts to combat climate change and adapt to its consequences, while providing increased support for assistance to developing countries [122]. As such, it charts a new course in global climate efforts. The main goal of the Paris Agreement is to strengthen the global response to the threat of climate change, keeping global temperature increases this century well below 2 degrees above pre-industrial levels, and making efforts to further limit temperature increases to 1.5°C.

On *Earth Day*, April 22, 2016, 175 world leaders signed the Paris Agreement at the UN headquarters in New York. This was the largest number of countries ever to sign an international agreement in one day. Now there are 186 countries that have ratified the Paris Agreement [87, 88, 89]. On 23 September 2019, Secretary-General Antonio Guterres convened a climate summit to bring together world leaders from governments, the private sector and civil society to support a multilateral process to accelerate climate action and ambition. The summit focused on key sectors where action can make the most difference - heavy industry, green solutions, cities, energy, sustainability and climate finance [87, 88, 89].

In 2007, the Nobel Peace Prize was jointly awarded to former US Vice President Al Gore for their efforts to create and disseminate knowledge about man-made climate change and lay the groundwork for the actions that are needed to counter such change.

According to *the World Economic Forum Global Risks Report* 2019, there are 5 risk categories [364] :

- economic,
- ecological,
- geopolitical,

- social,
- technological

Environmental risks have been at the top of this rating for 3 years. Extreme weather events are a common risk in 2019 , reflecting all floods, droughts, fires and storms. These events are mainly the result of an increase in the average global temperature of the planet. Potential projections say temperatures could rise by 5°C by 2100, with an increase of 1.5°C by 2040.

Since *the Paris Agreement,* there has been no significant progress or consensus on environmental policy. Therefore, many questions remain regarding the mitigation of climate change. Biodiversity also remains a major concern. Global landfilling and recycling are also environmental risks and threats. China already does not accept most of the world's waste and plastic (which should be almost perfectly clean), causing serious waste management problems for many Western countries who ignore these problems. That's why the US sent 30% of its plastic to landfill because it can't count on China as an importer of waste.

It is likely that environmental risks will increase in both frequency and severity. Among other consequences, these changes will greatly affect global value chains, weakening their overall resilience. Thus, disruptions in the production and delivery of goods have increased to 29% since 2012, especially in North America due to hurricanes and fires, which is a strong argument for companies that are obliged to develop strategies to mitigate climate change, which in turn cause an influx of "sustainable" investments [18].

The main risk for us in 2020 will be risks associated with the surrounding environment . Regardless of economic or social status, climate change can affect everyone. According to the data of the World Economic Forum Global Risks Report 2019, the main risks for the world economy in terms of their probability and potential impact on 2020 are the following (Table 1.1.) [364].

Table 1.1.

Environmental risks by probability and impact as of 2019

	Major global risks by probability		*Major global risks by impact*
1	Extreme weather	1	Losses from climate change
2	Losses from climate change	2	Weapons of mass destruction
3	Natural disasters	3	Loss of biodiversity
4	Loss of biodiversity	4	Extreme weather
5	Human ecological disasters	5	Water crises

Source: built on [364]

According to *the World Economic Forum*, it is more than we can imagine. The report states that, among many others, natural disasters are becoming more intense and frequent. Although it can be difficult to extrapolate how environmental risks can cause trouble for the global economy and financial system. If the world is to adhere to the 2°C limit on global warming as defined in the Paris Agreement, significant amounts of oil, gas and coal reserves must be left untouched, resulting in the loss of approximately 1-4 trillion yr . dollars for the world economy. Accordingly, the growing awareness of this risk led to a change in the attitudes of producers and partly consumers [365, 366] .

Experts have ranked climate change as the top risk of 2019, ahead of losses from cyber attacks, financial instability and terrorism - drawing strong parallels with the findings of this year's Global Risks Report. These growing concerns are justified, as 2017 was the costliest year ever for natural disasters, at $344 billion. global economic losses.

- Circular economy models offer a clear pathway to achieving our collective climate goals, tackling emissions tied to extraction, processing, manufacturing and landfilling of goods.
- Many innovators are addressing today's challenges, while policymakers are looking at ways to help close the loop on our valuable materials through legislation and incentives.

It is clear that the environmental problems we face are beginning to have an increasingly real impact. Despite growing awareness and early action, such as fossil fuel divestment, the Global Risks Report highlights that many steps need to be taken to reduce risks, including how governments will respond over the next decade to global economic and environmental challenges.

To mitigate the consequences of climate change, business and society in general need [364, 365, 366]:

1. Extend the life of the product and increase the intensity of its use.

It is about making the most of existing products by reusing or sharing them. As a result, emissions reductions in the value chain are reduced in stages. Together, these strategies account for about a quarter of the circular mitigation potential in European industries.

2. Increase recycling to use waste as a resource.

About half of the potential for circular reduction in European industries lies in the use of waste as a resource. By feeding waste back into the recycling phase of the circular value -added chain, emissions from the take-and-treat phases can be reduced, because for the vast majority of products and materials we use, their production from primary materials produces much higher greenhouse gas emissions than their production from secondary materials.

3. Circular construction → reduction in the use of materials .

Lightweight products add another quarter to the circular mitigation potential in European industry, which requires a change in product design [364, 365, 366].

4. Circular construction → priority to low-carbon materials

Another promising , as yet unexplored *strategy is replacing carbon-intensive materials with low-carbon and potentially biological alternatives.* As for biomass, using it for its material properties is a more effective mitigation strategy than using it as a renewable energy source [364, 365, 366].

By 2030, the world aims to achieve **17 UN sustainable development goals** [364, 365, 366] . Some of them have a strong connection between circular practices and reflect a direct direct connection, in particular:

The **Sustainable Development Goals (SDGs)**, also known as the Global Goals, were adopted by the United Nations in 2015 as a universal call to action to end poverty, protect the planet, and ensure that by 2030 all people enjoy peace and prosperity.

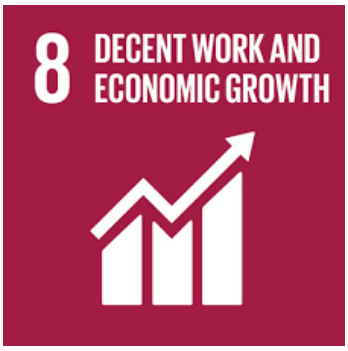
The 17 SDGs are integrated—they recognize that action in one area will affect outcomes in others, and that development must balance social, economic and environmental sustainability.

Countries have committed to prioritize progress for those who're furthest behind. The SDGs are designed to end poverty, hunger, AIDS, and discrimination against women and girls.

SDG 6 : Ensuring the availability and sustainable management of water resources and sanitation [100]: practices such as small-scale water treatment, sustainable sanitation, wastewater treatment, water reuse and recycling, nutrient recovery, biogas systems, etc. can help increase access to safe drinking water and equitable sanitation, reduce pollution and improve water quality.

SDG 7 : ensuring access to inexpensive, reliable, sustainable and modern sources of energy for all [21]: renewable energy systems, incl. small-scale biomass technologies and second-generation biofuels, energy (heat) recovery and improved utilization in industrial systems (eg industrial symbiosis) all contribute to this goal.

SDG 8: promoting progressive, inclusive and sustainable economic growth, full and productive employment and decent work for all [21]: new circular business models are the main potential source of improved efficiency and resource use, waste valorization and green jobs. Various other studies have shown that the implementation of the circular economy is a multi-billion euro opportunity worldwide, with an annual net benefit of 1.8 trillion. euros only in the EU until 2030.



SDG 12: ensuring the transition to rational models of consumption and production [21]: the practical implementation of the circular economy is the separation of economic activity from the use of resources and related impacts on the environment and society, which is also the basis of this goal. Importantly, this goal is an important factor in achieving most of the other goals, making the indirect impact even more profound.

SDG 15: protection and restoration of land ecosystems and promotion of their rational use, rational forest use, combating desertification, stopping and reversing (reversing) the process of land degradation and stopping the process of biodiversity loss [21]: the basis of circular economy practice is the restoration of natural capital . This involves adopting sustainable and regenerative agricultural and agroforestry practices that embrace and protect biodiversity and return biological material back to soils as nutrients – practices that are fundamental to restoring terrestrial ecosystems.

The current linear model, which wastes resources, depletes the Earth's natural capital and the associated pressure on the Earth's ecosystems and their

absorptive capacity, necessary for human survival, brings irreversible and dangerous changes to the environment and climate. Exploitation of natural resources is often associated with loss of biodiversity, as well as water and soil pollution. Ozone depletion and chemical pollution affect the ability of ecosystems to support life in various forms. Environmental protection is a global policy priority of the European Investment Bank, which will certainly benefit from a shift towards circularity. Reducing the intensity of material extraction, sustainable land use and rehabilitation, protecting ecosystems, efficient use of resources and renewable energy sources - all this is connected with the concept of circular economy, which will help preserve natural capital. Climate change is only one of many serious environmental problems that affect human development. Reducing greenhouse gas (GHG) emissions to combat climate change is one of the most important policy goals of the EU, which has committed to achieving transformation to low-carbon production options to limit global warming below 2 °C [364, 365, 366].

The potential consequences of the transition to a circular economy on greenhouse gas emissions are significant and are achieved mainly by increasing the efficiency of resource use, increasing the useful life of buildings and assets, increasing

The **World Trade Organization** (**WTO**) is an intergovernmental organization that regulates and facilitates international trade.[6] With effective cooperation in the United Nations System,[7] governments use the organization to establish, revise, and enforce the rules that govern international trade.[6] It officially commenced operations on 1 January 1995, pursuant to the 1994 Marrakesh Agreement, thus replacing the General Agreement on Tariffs and Trade (GATT) that had been established in 1948. The WTO is the world's largest international economic organization, with 164 member states representing over 98% of global trade and global GDP.

recycling, reuse and absolute reduction in the use of primary raw materials. Thus, the circular economy can be considered as an effective strategy to help mitigate climate change [68; 69; 403].

WTO can play an important role in supporting new systems that minimize the production of waste and that constantly use a lot of resources in their production. It is important that members of the organization take advantage of the organization's toolkit to support the circular economy and thus contribute to reducing environmental risks and strengthening climate action. Proactive, forward-looking trading approaches are key elements of coordinated and effective solutions to manage these risks. Yes, trade can help reduce the adverse effects of climate change on food security. According to one study, malnutrition caused by climate-related increases in crop prices would be 15 % higher among households in certain parts of the world if trade stopped rather than allowed to flow freely. Trade can also help countries gain access to the goods and services needed to solve pressing environmental problems. A WTO study found that if 18 major countries removed their barriers to importing green goods, they could import 63% more energy-efficient lighting, 23% more wind energy equipment, and 14% more solar energy equipment [358].

Waste reduction through *reuse* , sharing, repair, refurbishment, reconstruction and disposal is an available practice, but not widely considered necessary in application. Awareness of such a need is summed up in the concept of the "circular economy", which minimizes the creation of waste and harmful by-products, keeping products, equipment and infrastructure in use longer, increasing productivity as a social goal, not just an economic one. The WTO-UN Joint Dialogue has been instrumental in facilitating a focused discussion on this issue, particularly the efficiency and sustainability goals that underpin the circular economy:

➢ **WTO** rules do not limit the ability of governments to promote sustainable development, not least through circular economy strategies. These rules give EU members plenty of room to pursue environmental and other policy goals while maintaining protectionism. Over the past two decades, the WTO dispute settlement system has tested several environmental measures. These measures aim to achieve a variety of policy objectives, from reducing the health risks associated with retreaded tires to controlling air pollution. These disputes have confirmed that members of the Organization can apply environmental measures, even those that restrict trade. But these measures must meet certain conditions to ensure they are fit for purpose, rather than being adopted for protectionist reasons. Under Article 20 of the GATT, known as the General Exceptions , it has long been recognized that when a measure is necessary for the environment or the health of a country's citizens, it can be maintained provided it is applied fairly.

➢ promotion of transparency and sponsorship policy. The WTO's Environmental Database shows that a wide range of trade measures affect key activities at the heart of the circular economy, from reuse and repair, to refurbishment, recycling and eco-design. Of all trade measures related to this activity contained in the database, 44% consist of state support measures, 28% - technical regulations and conformity assessment procedures, and 22% - prohibitions and licensing requirements; other measures make up the rest [358] . Many of these measures actively support the circular economy - for example, by setting standards for green design or recycling, or by requiring governments to purchase goods that meet green standards. But others may inadvertently oppose circular trade, reflecting the fact that trade policy has traditionally been based on the principles of a traditional linear rather than circular economy. This can lead to a mismatch between trade policies on the one hand and circular economy strategies on the other. WTO transparency and

policy dialogue tools can help improve understanding of the overlap between trade policies and circular economy strategies and avoid such mismatches, producing mutually supportive solutions (actions on imported products, sustainable consumption, combating illegal waste trade). The lack of a well-functioning national or regional quality infrastructure to ensure circular trade meets safety and quality requirements. And limited participation of developing countries in the development of international standards related to circular economy activities.

➢ standardization. Although the WTO itself does not develop any standards, its rules and day-to-day work push regulators to adopt international standards, adhere to best practices and cooperate across borders. In this way, the WTO helps governments improve the coherence between trade and other legitimate regulatory policy objectives. The WTO TBT Agreement requires that technical regulations be based on international standards. When a technical regulation is based on a relevant international standard, it is considered WTO-compliant and no more trade-restrictive than necessary. This pragmatic work builds trust both between regulators and between regulators, producers and consumers. Trust and confidence are key components to enable trade to play its full role in strengthening circular economy value chains and ensure the participation of all countries.

It is now increasingly clear that no country can choose between open trade and environmental sustainability. Both are critical to ensuring people's well-being. This improved

The WTO facilitates trade in goods, services and intellectual property among participating countries by providing a framework for negotiating trade agreements, which usually aim to reduce or eliminate tariffs, quotas, and other restrictions; these agreements are signed by representatives of member governments and ratified by their legislatures.

understanding provides a solid foundation for ongoing work on trade and environment issues.

In addition to the clearly expressed potential advantages of the implementation of the circular economy, the proposal that appears on the current market indicates the difficulty of implementing the circular economy, because it is much more difficult than the traditional linear economy, as :

- the circular economy involves greater environmental and financial costs;
- circular strategies require more intensive cooperation and cooperation within borders existing supply chains and creation of new ones on a circular basis;
- circular strategies require the use of secondary markets, which arise as a result of the activation of circular activities.

Considering the fact that according to all possible studies, in particular according to the UN, the world population will increase by 2 billion by 2050, which leads to even greater pressure on the ecological state. This, in turn, will require the acceleration of the formation of a global circular economy on an inclusive basis. As the transition to circularity is currently far from desirable on a global scale, as evidenced by a significant circularity gap (gap) with a small number of regions with specific circularity targets.

1.2. Conceptual basis of the global inclusive circular economy

The polyparadigmatic nature of economic theory knowledge from the standpoint of the existential nature of the imperatives of economic development in the context of responsibility for the global future causes certain

paradigmatic shifts, and environmentalization is the mainstream and imperative that reflects the heterodox beginning of the theoretical and methodological foundations of the global inclusive circular economy [6]. A multidisciplinary epistemological perspective for the analysis of economic phenomena from the standpoint of new pragmatism in the context of the "triad" of sustainability (economic, social and ecological components) [65], distinguishes the humanitarianism of economic science [20; 65] and positions "at the forefront" the role of values in the economic activity of people and society and the positioning of imperative characteristics (acceleration of exploitation of natural resources; climate change; the formation of a new ecological order; ecological and food security) and dominant paradigm formation (exceeding the ecological limit; the Paris Agreement; changes in the public attitudes of producers, the population and businesses regarding the use of fossil resources; global economic losses; the goals of sustainable development of the United Nations, which have a strong connection connection with circular practices, participation of WTO in support of new technologies, minimization of waste production and promotion of circular trade) . Methodological features of the paradigm of the global inclusive circular economy from the standpoint of postmodernism are the strengthening of social and humanistic guidelines (they reflect its ideology and create a basis for an inclusive-oriented society); ontological non-linearity (emphasizes circularity); consensus (the need for a global consensus to achieve the goal), which is emulated using economic-mathematical modeling and the evolutionary method [20].

Studying the process of formation and development of the global inclusive circular economy, it is appropriate to talk about the new pragmatism of Grzegorz V. Kolodko . This scholar considers a multidisciplinary epistemological perspective for the analysis of economic phenomena,

providing new, enriched cognitive and analytical methods and tools. His concept posits a reasonable compromise between the economic policies of national states and policies conducted at the regional and international levels. An important rule governing the economy of the future is moderation or the conscious adjustment of the size of human, material and financial flows to the requirement to maintain a long-term dynamic balance. [11, 260] This development describes the so-called "triad", that is, it is sustainable in economic, social and environmental aspects. That is, in the normative plan, the new pragmatism indicates the goals of economic activity, which should include:

Today, we are using about 1.6 earths; meaning we're using about 60% more of the earth's resources than it can regenerate every year. By 2050, with an increased global population and a resulting rise in consumption, that "overshoot" could get to 3-4 earths, which is clearly unsustainable.

- *economically sustainable growth* , that is, sustainable with respect to goods and capital markets, as well as investment, finance and labor;
- *socially sustainable growth* , i.e. sustainable relative to socially acceptable, fair distribution of incomes, which contributes to the accumulation of capital, and corresponding participation of the main population groups in public services and access to public goods;
- *ecologically and spatially sustainable growth* , i.e. relatively sustainable maintenance of appropriate relations between human economic activity and nature, both on a current and long-term basis.

Kolodko wondered how economists avoid any analysis of values in their discussions. Thus, in 2010, he brought "to the fore" the role of values in the economic activity of people and society and asserted that "there is no economy without values", that "the economy is society, always" [260]. Already on the first page of "Whither World" (2014), he presents a kind of manifesto of his

views and beliefs, and in "Acta Oeconomica" he claims that "Good economics is more than a description of the world."

In continuation of the opinion, we note that the laureates of the Nobel Prize in Economics for 2018 were the American economists **William Nordhaus** and **Paul Romer** [96]. If Nordhaus's interest is focused on climate change and its impact on the economy, Romer is busy studying the impact on the economy of technological progress. Nordhaus became one of the first economists who drew attention to global warming and climate change. He began to deal with the topic of global warming back in the 1970s, as a graduate student. Now he is called the founder of modern ecological economics [96].

Nordhaus became one of the first to talk about the need for a tax on carbon emissions. In fact, carbon dioxide, which enters the atmosphere and heats the Earth, is not included in ordinary market transactions [96] . He argues that climate change is part of a special kind of economic activity known as global public goods. To solve this problem, at a minimum, all countries should agree on a penalty for carbon dioxide and other greenhouse gas emissions at an agreed minimum price. In the 1990s, Nordhaus developed the first integrated evaluation model, DICE (Dynamic Integrated Climate-Economy). It allows economists to analyze the costs of climate change [96]. In this model, economic and climatic indicators are linked together [10] (the relationship between economic growth and carbon emissions and warming) [96].

This model made it possible to calculate how much money everyone involved in emissions into the atmosphere and possible climate changes should pay. Nordhaus believes that approximately $40. per ton It can be said that thanks to the works of Nordhaus, the world community learned to assess the economic consequences of global warming [96]. And Romer in his works tried to explain the role of technical achievements in ensuring economic growth, to understand the impressive acceleration of economic growth that

began with the industrial revolution [96] . If traditional economics considers only two factors of production - capital and labor, Romer adds a third - technology. Romer changed the approach to macroeconomics, proposed another way of modeling economic processes, reflecting growth taking into account the climate [96] .

The Nordhaus model is now widely used to model how the economy and climate develop in dependence on each other. It is used to study the effects of climate policy changes, such as carbon taxes. Nordhaus "was one of the pioneers" in the issue of the impact of climate on the economy.

Michael Kremer from Harvard and his followers and colleagues, the wives of Esther Duflo and Abhijit Banerjee from the Massachusetts Institute of Technology, developed a new approach to finding recipes for fighting poverty (Nobel Prize 2019) . They broke down a big problem into many small questions and proved that the best way to find answers to them is through field experiments. The young economic science decided to follow the path of its older sister - medicine, in which similar experiments have long been used in clinical studies of the effectiveness of drugs.

"Economic science in the 21st century must repeat the path taken by medicine in the 20th century. This is a difficult path of trial and error, discussions and experiments," said Duflo. In search of a panacea, Duflo and Banerjee created the Poverty Action Lab to attract scientists from around the world to field experiments. They proved that only through experience can you find out which measures of economic and social policy best reduce poverty and its consequences. And for this, you will have to descend from the political and academic heavens to earth, leave the comfort of your office and go to an Indian village. And then - in African [133]. Their work, and the considerable amount of research that followed it, has informed the fight against poverty in many developing countries. And they are constantly expanding their horizons

of contributions, which now also include climate and environmental policy, social networks, and cognitive science.

The history of the beginning of the circular economy goes back to the concept of regenerative design. In the USA, John T. Lyle began to develop regenerative design ideas that could be applied to all systems (beyond agriculture) for which the previously formulated concept of regeneration already existed. Today it is the Center for Regenerative Research. Thus, Walter Stechel, an architect and economist, described in his 1976 research report for the European Commission the potential of substituting labor for energy, co-authored with Genevieve Redy, a vision of the economy in the cycle (or circular economy) and its impact on job creation, economic competitiveness, resource conservation and waste prevention.

Landfills are even deadlier than we thought. Why are landfills especially insidious? In addition to taking up otherwise productive land, this explanation from Waste Dive is especially helpful: "When trash is packed into a pile, the oxygen-free environment supports bacteria that thrive in those conditions. As the microbes degrade the waste, they release carbon dioxide and methane. The latter is… 84 times more potent of a global warming agent than carbon dioxide in the first 20 years of its release."

By proposing the term ***Cradle-to-Cradle*** **(C2C)** in the late 1970s, Steil worked to develop a "closed" loop approach to manufacturing processes and established the Life Product Institute in Geneva more than 25 years ago. It pursues four main objectives: product life extension, durable goods, reconstruction and waste prevention. He also emphasizes the importance of selling a service rather than a product as such. The idea called the "functional service economy" is now more broadly covered by the concept of "efficiency economy". Cradle-to-Cradle design perceives the safe and productive processes of nature's biology, metabolism "as a model for the development" of

technical metabolism - the flow of industrial materials. In this way, product components can be designed to continuously recover and reuse both biological and bioengineered nutrients within these metabolisms. The C2C concept is about energy and water use. At the same time, two main directions are distinguished [335]:

• eliminating the concept of waste;

"Waste equals food." The design of products and materials with life cycles, safe for human health and the environment, and which can be continuously used through biological and technical metabolisms. Create and participate in systems to collect and recover the value of these materials after their use.

• use of renewable energy capacity.

That is, to use the current solar income, maximizing the use of renewable energy sources.

The next concept when considering the etymology of the circular economy is industrial ecology [335] . Focusing on the connections between operators within the "industrial ecosystem", this approach aims to create closed-loop processes where waste serves to eliminate the concept of an unwanted by-product. Industrial ecology involves designing production processes according to local environmental constraints, looking at their global impact from the outset and trying to shape them to perform as closely as possible to living systems. Sometimes it is called "the science of stability (sustainability)", taking into account its interdisciplinary nature, as well as its principles, which can be applied in the service sector. With an emphasis on restoring natural capital, industrial ecology also focuses on social well-being.

In particular, the introduction of the idea of industrial ecology and the next stage of the development of the circular economy is biomimicry - the design and production of materials, structures and systems modeled on

biological formations and processes [335]. Janine Benues, author of biomimicry, argued that nature-inspired innovation defines her approach as a new discipline that studies nature's best ideas and then imitates those designs and processes to solve human problems. So an example is the study of leaves to invent a better solar battery. That is, it is an "innovation inspired by nature." Biomimicry is based on three key principles:

- Nature **as a Model** : To study the patterns of nature and imitate these forms, process, systems and strategies to solve human problems.
- Nature **as a measure** : using an environmental standard to measure the sustainability of innovation.
- Nature **as a teacher** : to appreciate nature not based on what we can extract from the natural world, but what we can learn from it.

Many different definitions of the circular economy are used in scientific literature and professional journals. The concept is used by various groups of researchers and specialists (Kircher, Reike, Heckert, 2017)[335]. Thus, philosophers emphasize one aspect of a concept, while a financial analyst sees other aspects that are important to him. The variety of definitions also makes it difficult to measure.

According to Nuur, Feldman, Birke (2018) [335], definitions that focus on system change often emphasize three elements:

- closed cycles;
- renewable energy;
- systemic thinking;

1. Closed cycles

In the circular economy, material cycles are closed following the example of an ecosystem. There is no such thing as waste, because every residual stream can be used to create a new product. Toxic substances are removed, and residual flows are divided into biological and technical cycles. Manufacturers

take back their products after use and repair them for a new useful life [404] . Therefore, in this system it is important not only that the materials are recycled properly, but also that the products, components and raw materials remain of high quality in these cycles (Nuur, Feldman, Birke, 2018).

2. Renewable energy

Like raw materials and products, energy also lasts as long as possible in a circular economy. The circular economy system is powered by renewable energy sources. Since it is impossible to recycle energy, energy cycles are not mentioned here, but "cascade-type energy flows" [404] . An example of this is cogeneration of heat and electricity.

3. Systems thinking

The circular economy requires not only closed material cycles and renewable energy, but also systemic thinking. Each subject of the economy (company, person, state) is connected with other subjects. Together, this forms a network in which the actions of one player affect others. To account for this, it is necessary to take into account the short- and long-term consequences of the choice, as well as the impact of the entire value chain [404] .

The modern idea *of regenerative* and *responsible* product design, characterized by the concept of circular economy, derives from a number of concepts of whole system design. The concept is influenced by renowned architect Walter Schell, sustainability pioneer Gunter Pauli, and Natural Step founder Karl-Hendrik Robert.

Among the influences on this concept, it is worth highlighting the Hanover Principles, [1]published in 1991, compiled and written by architect

[1] The Hanover Principles are a set of statements about the design of buildings and facilities with a preconceived notion of their impact on the environment, their impact on sustainable growth and their overall impact on society.

William McDonough and chemist Michael Braungart, founders of Cradle to Cradle [335].

So, **the Hanover Principles**:

* insist on the right of humanity and nature to coexist in a healthy, supportive, diverse and sustainable state;
* recognize interdependence;
* respect the relationship between spirit and matter;
* accept responsibility for the consequences of design decisions for human well-being, the viability of natural systems and their right to coexistence;
* create safe objects of long-term value;
* exclude the concept of waste;
* rely on natural energy flows;
* understand design limitations;
* pursue continuous improvement through knowledge sharing.

Over the years, these principles have been expanded into what are now called Cradle to Cradle (C2C) design protocols or standards [335] . The C2C standard assesses and evaluates the criteria for product development, processing and manufacturing, and certifies the final product. These products are specially designed to flow efficiently through the various channels of the circular economy system.

Organizations including **the Circular Economy Club**, **Circle Lab**, **Ellen MacArthur Foundation, C2C Center, McDonough Braungart Design Chemistry, Environmental Promotion Agency, Cradle to Cradle (C2C), Future Forum** and many others are fully involved in the education, support and implementation of circular economy and C2C activities on a global scale.

To support and facilitate the transition to a current circular economy model, businesses and consumers can already purchase and interact with C2C certified circular economy-ready products. The *Cradle to Cradle Products* Innovation Institute has a registry of CE-ready products already certified by C2C. Since C2C design takes into account the material health of the product and the entire cycle of its use at the design stage, the circularity of the product is inherent, and use within the framework of the circular economy model is ensured. The C2C standard ensures a rigorous assessment of product ingredients to ensure full circular design, minimize waste, promote reuse and have a positive impact on the environment.

> We waste food every day, even as millions go hungry. 22% of global emissions and 30% of energy consumption come from the food sector. At the same time, nearly one-third of all food produced is wasted, and food waste continues to be the top product found in landfills.

Circular economy-ready products can be purchased through web portals such as Cradle to Cradle Marketplace (UK/US) or Cradelution (EU), which partner with specific C2C-certified manufacturers and product suppliers to access the good stuff. By purchasing finished products from the C2C market, there is a promotion of more certified C2C products on the world market. The company reinvests up to 50% of its profits to support other manufacturers and businesses that certify products and create healthier products in global circulation. The founders of C2C, Brandon and Paul, believe that this in turn will create a spiral of wealth and prosperity in business, industry and the environment and create a positive approach in the transition to a circular economy.

High-impact companies such as *Google, Unilever, Phillips, Renault, Nike, ECOR, Stella McCartney* and many others are part of the CE100 Foundations initiative, which aims to encourage and support circular economy practices

across all supply chains, contributing to the socio-economic, environmental and financial benefits of circular economy activities for businesses and customers worldwide.

So, **circular economy** is a relatively new system of operation that aims to "close the loop" and project waste out of the system. This means moving from an outdated linear operating model of 'take, make, dispose', which is very costly and damaging to the environment, to a more responsible comprehensive resource management system. This operating system extracts resources, uses them in the production of a product, and then disposes of these valuable materials at the end of their use, usually in landfills or incineration, meaning that a large amount of the resource is wasted. On the other hand, the circular economy closes this resource loop, ensuring a functioning that projects waste outside the system, avoiding landfills and incineration altogether and keeping resources in use as long as possible by reusing and regenerating new products.

Circular economy is a vital system to help reduce resource depletion. The reuse of resources includes their reclamation by the original manufacturer for use in new products, which allows manufacturers to significantly save financial resources. This activity preserves material value and dramatically reduces undesirable environmental consequences [114].

The circular economy is **a model of production and consumption, which involves sharing, leasing, reusing, repairing, refurbishing and recycling existing materials and products as long as possible.** In this way, the life cycle of products is extended.

As with any new idea or concept, defining and aligning the new idea with current behavior and activities may sometimes not be fully accepted by society right away. In some cases, the concept of a circular economy is understood as responsible recycling or efficient and effective waste management or reduction. These measures complement and improve the

results of the circular economy, but they are by no means an adequate definition.

Each circular economy project will have its own parameters, requirements and criteria. Applying the baseline definition to these projects provides an entrenched culture of such an economy with quantifiable results.

Developing countries have great potential in implementing an economic model that is effective for both society and the environment. The implementation of the circular economy paradigm is the implementation of a production model aimed at supporting sustainable economic development without harming the environment. The issue of maintaining natural ecosystems while simultaneously offering benefits to the poorest sections of society remained a point of discussion [185].

It is about increasing overall efficiency, not about how to reduce inefficiencies and waste in the production system as a whole. If we are really going to implement a holistic circular economy in terms of the goals of sustainable development, then we should be fully inclusive and ensure everyone's access to the benefits of such development. In a true circular economy, each entrepreneur is a separate link in a chain that forms a circle in which there are no redundant ones [307; 309].

Academic research focuses on how the principles, practices and technologies of Industry 4.0 [116] make it possible to unlock the potential of the circular economy and sustainable production (Jabbour et al., 2018; Stock et al., 2018). Digitization *Digitalisation* (Ellen Macarthur Foundation, 2016; Antikainen et al., 2018) and the use of big data (Big Data) (Hazen et al., 2016; Nobre & Tavares, 2017; Jabbour et al., 2017) [116, 164, 239] are considered as the main drivers for increasing sustainability and implementing the circular economy. It is obvious that the combination of the circular economy and Industry 4.0 defines the latest philosophy of the "green" economy [71; 116].

Table 1.2

Development of the idea of circular economy

The founders	Concepts	Content
	the concept of regeneration	
John T. Lyle (USA)	**regenerative design ideas**	Center for Regenerative Research
Walter Stechel, (architect and economist), Genevieve and Redy 1976 _	**a vision of the economy in a cycle**	saving resources and preventing waste, the potential of replacing labor with energy
William McDonough (architect), Michael Braungart (chemist)	**Cradle-to-Cradle design**	metabolism "as a model for development" - technical metabolism
	Hanover and principle and	
Janine Benues	**biomimicry**	design and production of materials, structures and systems modeled on biological formations and processes
1992 as part of the adoption of the "Agenda for the XXI Century" (Agenda 21) at the International Conference on Environment and Development in Rio de Janeiro (Earth Summit)	**implementation of the sustainable development strategy**	the concept of "circular economy"
In 2009, Dame Ellen MacArthur established the Ellen MacArthur Foundation (EMF)	**Spreading the idea of a circular economy**	focused on education and support of circular economy efforts worldwide

Source: constructed by the author based on [110; 335; 404]

It should be noted that the scientific literature that examines sustainable development and Industry 4.0 is mostly optimistic. The focus is on the opportunities for increased sustainability that arise from the use of new technological opportunities in combination with new business models. Improved tracking of smart products through the supply chain during the use phase of these products enables manufacturers to continuously optimize the performance of both products and production, which ensures a more efficient

use of resources [164; 306]. For industrial producers, sustainability, environmental and social opportunities are also an incentive to implement the positive results of Industry 4.0 (Müller et al., 2018).

The closed-loop economy or circular economy is a model of economic development based on the restoration and rational consumption of resources, an alternative to the traditional linear economy [107; 141]. It is characterized by the creation of new alternative economic approaches, the task of which is to minimize the negative human impact on the environment [2; 11; 107; 142; 404].

The closed cycle economy is designed to change the classic linear model of production, focusing on products and services that minimize waste and other types of pollution [107; 141]. Accordingly, the main principles of the closed-loop economy are based on the restoration of resources, the processing of secondary raw materials , the transition from fossil fuels to the use of renewable energy sources .

This type of economy is considered as part of the Fourth Industrial Revolution , as a result of which the rationality of the use of resources, including natural ones , will generally increase , the economy will become more transparent and predictable, and its development will be rapid and systematic [107; 197].

According to other studies, **the circular economy** is an approach based on the secondary processing of almost any product. By developing and further implementing innovative business models, it will be possible to guarantee that technical and biological materials will continue to actively "participate" in the economy, and valuable stocks and natural resources will be preserved [97; 98; 99].

This type of economy is becoming more and more popular in Europe: in the Netherlands and Finland there are national programs of transition to it. The EU encourages such a transition with hundreds of millions of euros per

year [81] and one of its main trump cards is that it not only preserves nature, but also ensures further economic growth without increasing consumption (and increasing landfills). Proponents of this economic model claim that thanks to it, 100,000 jobs can be created in Europe in 5 years, and 2 million by 2030 [2; 247]

The circular economy assumes that all participants in the economic chain participate in the creation of a new product or service. Professional public associations, associations, the government, and socially responsible business should promote a careful attitude towards nature and awareness. Under pressure from the community, Western giant companies announced the transition to completely recycled packaging by 2025 [81] .

Business needs to review the supply chain and begin to perceive it not as a set of separate organizations, but as an interconnected network of companies moving in the same direction. One of the ways to implement such an approach is to use the principle of social networks - this will allow enterprises to interact with suppliers and customers on a single cloud platform and "speak the same language".

Circular economy allows companies to think less about the purchase of raw materials, since after a certain period of use it can again be launched into the production process. In landfills and in polluted waters, there is an innumerable amount of material that can be breathed new life into and returned to the market. Companies already apply the principles of the circular economy, which in the future will help to obtain economic benefits and recognition from conscious consumers [115].

ICC International Chamber of Commerce and Industry uses the term circular economy. In contrast to the traditional economy, the circular model is the most successful way to conserve resources and materials, and therefore the

way to permanent, sustainable economic growth. This is essentially a new economic model in which waste is transformed into secondary raw materials.

Circular economy is the basis for solving economic problems and environmental problems. The average person consumes 29 kg of natural resources per day (which corresponds to the weight of a 10-year-old boy). The European Investment Bank annually provides financial funds in the amount of hundreds of millions of euros to companies that carry out developments in the field of recycling and mass utilization and recovery of discarded goods and consumer waste. However, countries produce sewage waste and scrap at such a rate that today it cannot be recycled or usefully disposed of in full. However, technological improvements are not a panacea for all ills. For example, the practice of digitization made it possible to reduce the amount of paper consumption, but at the same time, the extraction of rare earth metals used in electronics increased. In addition, a joint study by Erasmus University scientists confirmed that 8.1% (810,000) of jobs in the Netherlands are currently created based on the implementation of innovative technologies by start-up companies in the circular economy. They cover all types of work in various fields, starting from waste management to the application of creative and creative ideas in the branches of the country's economy.

The world's population is growing and with it the demand for raw materials. However, the supply of crucial raw materials is limited.

Finite supplies also mean some EU countries are dependent on other countries for their raw materials.

In addition, extracting and using raw materials has a major impact on the environment. It also increases energy consumption and CO2 emissions. However, a smarter use of raw materials can lower CO2 emissions.

A demonstrative fact is that the relevance of the economic concept, phenomenon or process of the circular economy is mostly emphasized by

practitioners, large corporations, analysts in TNCs from the point of view of specific actions, startups, implemented policies or long-term goals. In some countries, leading companies such as *General Electric, General Motors, 3M, Du Pont, Ford, Nike, Panasonic, Hitachi* and others try to take into account the impact of environmental and social factors when evaluating the effectiveness of this or that innovative project. The expansion of the ideas of "greening" of the economy is characteristic of many countries *in Europe, the USA, Canada, Japan, China, South Korea, India, Australia, and Brazil.* The concept of "eco-innovation" has been introduced into scientific circulation only recently. The first mention of this concept is contained in the monograph of F. Claude and P. James. F. Dekker, H. Krotova, J. Kramer, J. Dajain, L. Hongyan and L. Artemenko studied the problems of the circular economy in different countries. The impact of resource efficiency on economic development in countries that are leaders of "green" modernization was studied by the following scientists: K. Geiser, B. Danylyshyn, L. Musina, T. Kvasha, D. Pujari, S. Morch, K. Summers. The implementation of the circular economy in China has been described by Peng, Zhang and Huang, Chen, Wang, Jia and Zhang, Wen and Meng.

The circular economy model is based on the principles of sustainable development, the main tools of which are environmental innovations (eco-innovations) and "green" technologies, i.e. "environmentally clean" technologies, of the environment. But at the same time, the circular economy is not traditional recycling in a new way [11] . This process begins before the product becomes unusable and needs to be recycled or repaired. The concept of circular economy involves our direct participation in the stages of planning and development of products to ensure a long-life cycle and high potential for further reuse, modernization, recovery and recycling.

The concept of **"circular economy"** introduced in 1990 with the implementation of the strategy of sustainable development and proposed to

solve the current problems of environmental degradation and lack of resources. The circular economy operates according to the principles of 3R: reduction (Reduce), reuse (Reuse) and recycling of materials (Recycle) [42; 121]. In the context of the investigated issues, we suggest considering the fourth principle - the principle of global social corporate responsibility *(Responsibility*) as mandatory in the formation of global circular chains of creation of added value [42].

The concept of the circular economy with its principles of reduction, reuse and utilization of energy, materials and waste is considered as a viable strategy of alternative development in order to settle the issue of national economic development and environmental protection. The circular economy also makes it possible to solve the problems of resource scarcity and environmental pollution. At the same time, it enables manufacturers to improve their competitiveness by removing "green" barriers in the process of establishing their international economic relations.

Scientists O. B. Vovk, V. V. Voytsekhovska, O. Ya. Zagoretska, L. I. Lesyk, V. Z. Pashkevich, A. V. Simak in the work "Algorithm of secondary processing of paper in the conditions of natural resource management" [14] use additional terminology in parallel, which is tangential to the issues of the circular economy. In particular, destruction is the process of eliminating waste by means of burial or incineration (Vidkhody, 2019; Vovk, 2018). Recycling (from the Latin unilis - useful) covers direct reuse and use after recycling. Direct reuse (English reusing) is the use of waste without preliminary or additional processing in cases where it is technically possible, technologically necessary and permitted by law. This can be reuse of clothing (after disinfection and/or heat treatment) or glass containers (if they are intact and reusable). Recycling (English recycling) is an activity that consists in handling waste with the aim of its safe destruction or ensuring its repeated use in the national economy as

raw materials, energy, products and (or) materials. Regeneration is the process of returning waste to the production cycle after appropriate preparation. Recovery is the process of extracting useful components from waste for their reuse (Retsyklinh, 2019) [14] .

Measures such as waste prevention, ecodesign and re-use could save EU companies money while also reducing total annual greenhouse gas emissions. Currently, the production of materials we use every day account for 45% of the CO2 emissions.

Moving towards a more circular economy could deliver benefits such as reducing pressure on the environment, improving the security of the supply of raw materials, increasing competitiveness, stimulating innovation, boosting economic growth (an additional 0.5% of gross domestic product), creating jobs (700,000 jobs in the EU alone by 2030).

Consumers will also be provided with more durable and innovative products that will increase the quality of life and save them money in the long term.

In 2009, Dame Ellen MacArthur founded the Ellen MacArthur Foundation (EMF), an organization entirely focused on education and support for circular economy efforts around the world. Since then, the Ellen MacArthur Foundation has become a pioneer in the field of education and global implementation of circular economy principles [404].

According to the Helen MacArthur Foundation, the concept of a circular economy has deep roots and cannot be traced to a single date or author. Its practical application in modern economic systems and production processes is traced, however, they have been gaining momentum since the late 1970s, led by a small number of academics, thought leaders and businesses.

Thus, on the one hand, the production of additional products by the 3D printing method leads to a kind of disruption of the supply chain and a decrease in the need for large inventories, for example, at aviation companies

(Khajarvi et al., 2014), increasing efficiency and reducing waste at the same time, that is, the chains are modified into circular ones, simultaneously defining them as inclusive [241]. On the other hand, except in specific supply chains where every part and product can be manufactured anywhere and at any time, it is difficult to imagine a significant reduction in product life cycles and an overall increase in consumption. Some scholars (Kellens et al., 2017 & Holmström & Gutowski, 2017) question whether this is a guarantee of more sustainable production and consumption, and suggest that the production of individual necessary elements to order causes a stronger impact on the environment than linear production processes. Some researchers (Kohtala, 2015) have concluded that custom manufacturing promotes environmental sustainability. But does this mean a new paradigm of production.

Some researchers argue that **social inclusion** is also a necessary part of the circular economy (Korhonen, Honkasalo and Seppälä, 2018).

If the conceptual ideas, principles and drivers of the circular economy are determined by the Ellen MacArthur Foundation [404], then the inclusive economy is "lobbied" by the Rockefeller Foundation [2]. The Rockefeller Foundation defines an inclusive economy as one that "…expands opportunities for shared prosperity, especially for those who face major obstacles to their well-being."

The latter proposed five basic characteristics of an inclusive economy:

- **participation →**

people should take an active part in economic life and have more chances for a better future. People have access to markets as workers, consumers and business owners. Transparency and general knowledge of rules and

[2]The mission of the Rockefeller Foundation - unchanged since 1913 - is to promote the well-being of humanity in the world. Together with partners and grantees, the Rockefeller Foundation seeks to catalyze and scale transformative innovation, creating partnerships that span diverse high- risk sectors in .

regulations make it possible to start a business, find a job, and the spread of technology contributes to the improvement of the well-being of the individual and the community in general;

❖ **own capital →**

more opportunities *increase* the mobility of *more* people. All sections of society, especially poor or disadvantaged groups, can benefit from these opportunities. At the same time, inequality is decreasing, not increasing. People have equal access to relevant public goods, services and infrastructure, such as public transport, education, clean air and water;

❖ **growth →**

a developed economy makes it possible to produce enough goods and services to meet the growing consumption and needs of people. The circular economic system provides for the improvement of the situation of poor communities. Economic growth and transformation are not only captured by aggregate indicators such as GDP, but should be measured by other outcomes and indicators reflecting overall well-being;

❖ **stability →**

individuals, communities, businesses and governments have a sufficient degree of confidence in their future and an increased ability to predict the results of economic decisions. All of them are secure enough to invest in their future. Economic systems are increasingly resilient to shocks and stresses, especially disruptions that disproportionately affect poor or vulnerable communities;

❖ **sustainable development →**

economic and social wealth is conserved incrementally, thus sustaining intergenerational well-being. Economic and social wealth is the social value of a set of assets that contribute to the improvement of people's well-being,

including production, financial, human, social effects and natural capital. In the case of natural capital, a person is obliged to preserve or restore such an ecosystem that contributes to the general well-being. Thus, decision-making should consider long-term costs and benefits, not just short-term gains from the full use of all available assets [136].

Therefore, **inclusion** (eng. " *inclusion* " - "entry") is a process of increasing the degree of participation of all citizens in society [235]. And first of all, those who have difficulties in physical or mental development. It provides for the development and application of such concrete solutions that will enable every person to participate equally in academic and social life. The term "inclusion" is close in meaning to the concept of "integration" and is the opposite of "segregation". With inclusion, all interested parties should actively participate in the process to obtain the desired result.

The gold in our trash bins. Today we're throwing away over 50 million tonnes of electronic and electric goods, worth over $62 billion, every year, including rare earth minerals, gold and copper.

Inclusion in a broad socio-philosophical sense is understood as a form of being, common life of ordinary people and people with disabilities (disabled), for or against which society and its subsystems (including educational institutes) advocate and regarding which these and other members of society have the right to free choice [57; 113].

In the concept of global *inclusive circular economy* a significant place is given to "inequality", its increase is a significant threat to sustainable economic development. However, the relevance of the issue expressed by the concept of "justice" for the economy is quite controversial. Over the past decade, studies by scientists, think tanks, the International Monetary Fund, and other financial institutions, such as Standard and Poor's, have confirmed that inequality actually inhibits growth (AG Berg & Ostry, 2011; Eberts, Erickcek & Kleinhenz,

2006; Irwin, 2014). In 1955, economist S. Kuznets developed the idea that a certain level of inequality, at least initially, is necessary for economic growth. Using what we now call the "Kuznets curve," which indicates inequality associated with stages of economic development, the scientist theorized that in the early stages of development, both per capita income and income inequality rise as certain sectors of the economy and population benefit from new forms of economic growth. At some point, however, inequality declines as the benefits of this economic boom spread. Based on this, S. Kuznets and other scientists concluded that initial inequality is both a natural byproduct of growth and a necessary factor that stimulates it [54; 55; 57; 239].

For decades, this trade-off theory was taken for granted. Since the last few decades, researchers have debated the idea of the Kuznets curve both theoretically and empirically, with some pointing to an almost complete lack of evidence to support the idea (Piketty, 2014). As R. Kanbur (2000) explains in a review of the post-war literature on income distribution and development, a large number of empirical evaluations that test the relationship between income distribution and its level do not confirm the hypothesis of S. Kuznets [57]. In fact, in the post-war era, researchers found that in many developing countries, rising inequality and poverty did indeed accompany growth, but the predicted "turnover" never occurred. In addition, the literature review by R. Ranieri and R. Ramos highlights the facts that indicate the development of the situation in Hong Kong, Singapore, South Korea and Taiwan in the 1970s, 1980s and 1990s, debunking the idea that society must sacrifice justice for economic growth, and that wealth naturally "flows" from the rich to the poor during increased economic development. (Ranieri & Almeida Ramos, 2013). Based on a critical analysis of the theory, two interrelated approaches are distinguished:

- involvement of the poor population as a partner in ensuring growth and achieving well-being ("exit" from poverty);
- inclusive growth.

Thus, **inclusive growth** is growth that makes it possible to attract most of the labor resources for effective economic activity and provide a higher standard of living for the majority of the population. Considerable attention is paid to distributional aspects of welfare and exclusion in the growth of anti-discrimination orientation. People can benefit from economic growth as passive participants, not actively participating in increasing income or GDP, but only through redistributive policies. This is a fairly common practice in most countries: not only in poor countries, but also in developing countries. In fact, the difference between these two perspectives (people as active or passive participants, as producers and consumers, as actors or clients) is not as obvious as it seems, since inclusive development involves people taking an active part in the process of political, social and economic change [113].

The growing prospects for the poor population indicate that this alone will not benefit this stratum, so strategies should accordingly be aimed at reducing poverty in general.

This perspective arose as a reaction to the experience of macroeconomic structural restructuring in the 1980s and 1990s in developing countries. To restore fiscal balance and economic efficiency (as well as ensure debt repayment to international financiers), the distributional losses were too great to ignore, necessitating consideration of new welfare policies and more equitable growth strategies (Williamson, 1990, 2003).

The second definition, formulated by researchers N. Kakwani (Kakwani) and M. Pernia (Pernia), outlines that growth is bad if the incomes of the poor grow faster than the rich [286]. This means that relative income inequality is decreasing (Kakwani, Pernia, 2000). In order to prove this, these

authors developed a population gap index that describes the distribution of growth benefits among the rich, the poor, and the "invisible" (beyond the poverty line), although this does not affect the actual growth rate [113].

The principles of the circular economy model are to design out waste and pollution, keep products and materials in use and regenerate natural systems. As the below circular economy facts show, moving towards a circular economy will not only help undo the environmental and social damage of the linear economy. But it will also ensure that future generations do not suffer resource scarcity as a result of our consumption habits today.

In contrast to the assessment of the growth of the level of poverty among the poor, another direction of research focused on inclusive growth was formed. There are many similarities between pro-poor growth and inclusive growth (Ali & Son, 2007). For the first time, the use of the term "inclusive" in relation to growth can be traced in the description of poor sections of the population and minors in the studies of N. Kakwani and M. Pernia (2000). Inclusive growth, however, goes beyond pro-poor growth in several ways. Let us highlight the main differences [286].

First, inclusive growth goes beyond the growth dimension alone, that is, attention should not be focused exclusively on the conditions of the poor, but should take into account the relative conditions of both the poor and other sectors of society (Aoyagi & Ganelli, 2015).

Second, all members of society should be able to contribute to economic growth and enjoy its benefits (Lanchovichina, Lundstrom (Lanchovichina & Lundstrom), 2009). Therefore, this is a departure from the analysis of the growth of the working population, which emphasizes precisely the benefits for the poor. Such an approach makes it possible to determine progress in

overcoming other factors that somewhat exacerbate disadvantage in society - these are race, gender and region (Klasen (Klasen, 2010).

Third, at least some options for inclusive growth are seen as both a process and an outcome (de Mello and Duc, 2012). On the one hand, it makes it possible to consider the political and social aspects mentioned above. On the other hand, it makes it difficult to measure: growth among poor people can be measured in terms of earnings, but in the long run, inclusive growth allows us to see whether those gains are contained through authoritarian dictates or democratic distribution.

Those scholars who study *inclusive growth* as a result, the main emphasis is placed on the concept that growth should benefit all members of society. This is typically reflected in a reduction in income inequality, but may also include non-profit welfare measures for groups of people with disabilities, such as educational attainment and access to health services (Thorat & Dubey, 2013).

The methodology for measuring inclusive growth according to these types of structures consists in developing the idea of the functioning of social opportunities, which makes it possible to measure the distribution of opportunities of the population, paying special attention to educational and medical ones (Ali, San, 2007). In general, the definition of inclusive growth inherent in process-oriented frameworks is generally more inclusive than that of those that focus on end results. According to the researchers, the emphasis on the participation and contribution of all groups takes different forms. For example, E. Lanchovichina and S. Lundstrom (2009) also consider investment opportunities, and R. Klasen (2010) mostly focuses on education, health, nutrition and social integration (table 1.3).

Table 1.3

Filling the concept of "inclusive growth"

Organizations	The content of the concept
OECD	Stable and comprehensive in terms of employment opportunities, which requires support from public institutions to solve labor market problems
International Policy Center for Inclusive Growth	There is both a result and a process. On the one hand, both providing the opportunity to participate in the growth process from the point of view of decision-making, and in creating growth. On the other hand, the result of inclusive growth is a fair distribution of income
European Commission (European Commission)	Ensuring a high level of employment, investing in education, fighting poverty and modernizing labor markets, the social protection system and promoting the unification of society
Strategy "Europe 2020"	Full use of labor potential, reduction of poverty and its consequences, development of social inclusion, elimination of regional disparities
IMF	Increasing growth rates by providing a single space for investments and productive employment of the population

Source: built by the author.

According to the updated classification of countries' incomes for the fiscal year 2019, the World Bank divides the world's economies into the following four income groups: high, above average, below average, and low.[3]

In this way, inclusive economics is based on the idea of growth in the interests of the poor population, but it also extends to other areas, such as feminist and environmental politics, political economy and theories of social welfare and economic development, which define aspects of economies that are not sufficiently captured in traditional indicators of economic progress [166]. It is worth noting that there are critics of the theory of gross domestic product (GDP) as an indicator of progress (Waring, 1990), because it does not allow assessing the unpaid work of women and the impact on the

[3] New country classifications by income level: 2018 – 2019. URL: https://blogs.worldbank.org/opendata/new-country-classifications-income-level-2018-2019.

environment, which leads to unforeseen and severe consequences in terms of the deterioration of the ecological situation [166]. The identified perspectives are implemented in the form of an indicator of real progress, which was developed in the early 1990s by K. Cobb, T. Halstead, and J. Rowe based on a rethinking of the role of progress in San Francisco (Cobb, Halstead & Rowe, 1995). They developed an empirical method for adjusting gross domestic product to account for the value (and loss of value) of unpaid labor and subtracting the costs of environmental destruction and consumption of non-renewable resources.

Amartya Sen's approach is a significant contribution to the knowledge base about social welfare and economic development. In the 1980s, the basis of the theory of capabilities was a holistic view of economic development. The basic principle was based on the morality and ability of a person to live in prosperity through the achievement of the desired, which can also be important for his participation in social development and in ensuring security (Sen, 1992). A. Sen argued that "freedom of choice" among available actions is of fundamental importance, and therefore, "freedom to pursue goals" (Sen, 1988, Xi, 1992 p.). There are two well-known indicators of well-being: the Human Development Index and the Multidimensional Poverty Index. Both indices differ from traditional monetary measures of well-being by integrating important considerations of social and human development. They reflect the general state of economic development based on indicators of health, education and quality of human life [239] .

Analyzing the evolution of the theory of development, especially with regard to overcoming inequality, we can conclude that the concept of the growth of the poor population led to the emergence of the concept of inclusive growth, which accordingly defined the concept of an inclusive economy. However, conceptual evolution is not so linear [292]. In addition, we currently

have few studies that use the term "inclusive economy," and those that do use the term are not as comprehensive as the concept developed by the Rockefeller Foundation. Thanks to a clear and comprehensive definition of an inclusive economy, the Rockefeller Foundation outlines the conceptual provisions of inclusion and the economy [113].

Yes, Charles Handy, an Irish author and philosopher specializing in organizational behavior and management, is one of the most influential thinkers on living resource management. It was Handy, led by Sir Anthony Cleaver, the then chairman of IBM, who encouraged business leaders to review the sources of sustainable business success. And it was the results published in 1995 that introduced the concept of an inclusive approach to business success, in which the company:

- defines the goal;
- develops a unique success model that adds value to its clients;
- works in partnership with key stakeholders, including its employees, customers, suppliers, investors, the environment and the community;
- exchange of experience with developing countries.

Thus, Luke Robinson's (2011) seminal work "Tomorrow's Inclusive Development: a new architecture for reducing global poverty" for Tomorrow's Company confirms Handy's approach to an inclusive approach to business. That is, we are talking about the urgent need to rethink ways to overcome global poverty.

The potential and capacity of business to contribute to the reduction of global poverty is widely recognized, but many companies find themselves struggling to meet the rising expectations of the private sector. Transforming global international development and poverty reduction requires all actors to work together across sectors and across sectors in an inclusive manner. Each

sector has something to offer: no sector can succeed alone. That is, a new dialogue and a new architecture for cooperation between companies and governments is needed to achieve the necessary systemic change at the pace and scale that the urgency of global poverty demands. In this way, we need to move from 'today's development' to 'tomorrow's inclusive development', adapt faster and come together to realize the potential of 'inclusive development' to transform the scale, speed and effectiveness of the collective response to global poverty. And it is this approach to doing business that demands inclusive capitalism is a critical foundation for successful business models.

From time immemorial, humans have depended on the resources available in the natural environment. The earth provides us with raw materials that make quality living possible. Technological advancement has made it possible for humans to extract resources from the planet swiftly, in large quantities.

This has resulted in a robust economy but there are downsides. The prevailing system of production and consumption operates on a linear economy. In this kind of system, products travel along the supply chain once and end up in the rubbish heap. The Ellen MacArthur Foundation dubs it a ***take-make-waste*** model.

Linear consumption and production processes lead to the waste of natural resources. Some of these resources are not renewable and those that are, cannot keep up with the rate of human consumption. The circular economy model is a system of production and consumption that aims to reduce waste by innovative design and reuse.

We believe that one of the most vivid examples of an initiative with a clear theory of change within the indicator infrastructure of the economy is the study of the Asian Development Bank. In the Inclusive Growth Indicators Framework 2014: Key Indicators for Asia and the Pacific, it focuses on just two dimensions – poverty reduction and inequality, both of which are measured

using monetary and non-monetary indicators. To achieve this result, measurements are based on indicators defined in three main areas: economic growth, social integration and social security. They are characterized by indicators that determine the effectiveness of management in general and the activity of institutions in particular. In addition to the factors of inclusive growth, in the process of forming a global inclusive circular economy paradigm, it is worth focusing on circular growth.

A sustainable growth model by accelerating structural transformations in five main economic systems [298]:

→ clean energy systems:

before decarbonizing energy systems through decentralization and digital electrification technologies, which will allow access to modern energy services for many people who do not have them; strengthening energy security and reducing the impact of energy on price volatility in the world;

→ "smart" development of cities:

through smart urban planning and strategic investment in infrastructure, including the expansion of public and non-motorized transport networks, which will help overcome bottlenecks to economic growth such as congestion and air pollution in cities. Large cities can save up to 17 trillion. dollars USA by 2050 and stimulate economic growth by increasing jobs and housing. This will strengthen resilience to natural risks and can provide up to 3.7 gigatons per year of CO_2 emissions reduction over the next 15 years;

→ sustainable land use:

through the transition to sustainable forms of agriculture in combination with forest protection, which can provide economic benefits of more than 2 trillion. dollars per year, will make it possible to create jobs, mainly in developing countries; as well as strengthening food security, including by

reducing food loss and waste (a third of all food produced is lost or wasted in the food chain).

So, at the current stage, 44% of the volume of bread produced is wasted. In 2015, the British brewing company "Toast Ale" (Toast Ale) revived the ancient process of brewing, setting up the production of beer from food waste (edges of bread). Food waste is now the third largest source of global greenhouse gas emissions. However, bakeries continue to create a lot of surplus bread. Toast Ale, which has expanded from a homebrewing facility in London to breweries in New York, Rio de Janeiro, Cape Town and Reykjavik, works with local bakeries to source bread for its beer. She even made her recipe publicly available so that homebrewers could recycle stale bread scraps instead of sending them to landfill [121, 167, 183].

In early 2019, the DoorDash food delivery service launched the DASH project (DoorDASH Acts for Sustainable Development and Ending Hunger) to reduce food waste. The initiative not only aims to reduce food waste, but also the number of hungry people in the communities it serves. DoorDash has partnered with Feeding America to leverage powerful food delivery and logistics technology. DoorDash offers food delivery from restaurants on demand (to homeless shelters).

An average-sized restaurant can produce up to 100,000 pounds of excess food annually, and its transportation is problematic. According to data, 1 in 8 people in the United States experiences hunger. Accordingly, logistics technology should be applied to transfer surplus food to local non-profit organizations that provide for the needs of people who are starving.

Restoration of natural capital, including forests, degraded lands and coastal zones, will also strengthen the country's defense capabilities and increase adaptation to climate impacts – extreme weather conditions and sea level rise;

→ water resources management:

today, 2.1 billion people live without accessible, safe water resources, and 4.5 billion live without managed sanitation. Regions, especially in the Middle East, the Sahel, Central Africa, and East Asia, may experience a 6% decline in GDP by 2050 as a result of climate change, migration, and conflict [364-366]. Halting these impacts is possible through efficient water use or the introduction of improved technologies (from drip irrigation to remote sensors), planning and management, using fixed water prices to target the poor, or investing in public infrastructure. Today, improper management of water resources and their underestimation of water leads to excessive use and incorrect distribution of resources in the economy. Solving the problems of interaction "water-energy-food" is an important issue, especially in regions that need such resources;

The destructive effects of global warming are not restricted to extreme weather events and poor food production. It can slow down productivity and widen the inequality gap. Air pollution for instance cuts down short and long-term productivity as it causes health deterioration in workers. According to the ILO, 23 million working lives were lost between 2000 and 2015 due to environmental hazards caused by humans.

→ circular industrial economy:

from 1970 to 2010, the annual global extraction of materials increased from almost 22 to 70 billion tons. Every year at least 8 million tons of plastics are dumped into the ocean, which causes a new challenge of the 21st century. Microplastics were found in 114 aquatic species, many of which are used for cooking. However, this challenge is not only a social or ecological issue, but also an economic one [339] . Today, 95% of the cost of plastic packaging material is up to 120 billion dollars. USA annually - lost after first use. A policy that encourages *circular, efficient use of materials* (especially metals,

petrochemicals and construction materials), will primarily contribute to global economic activity, as well as reducing the amount of waste and environmental pollution. The transition to a circular industrial economy can "decouple" economic growth from the use of the resource as such and lead to the decarbonization of industrial activity.

Shifting to a low-carbon path to sustainable growth could provide $26 trillion in direct economic benefits. dollars by 2030 compared to business as usual [236] . The U.S. generated 6.4 metric tons of e-waste in 2016. That number continues to grow, as e-waste is one of the fastest-growing segments of the nation's waste stream. A popular eco-style business model is offering a product as a service, and Dutch company Gerrard Street is applying this model to one of the sources of e-waste – headphones. E-waste is growing rapidly due to the increasing demand for electronics due to the constant updating of technology and the inability to recover many types of electronics. This is typical for headphones. Company founders J. Galam and T. Leenders admitted that headphones often fail after one year of use and mostly for the same reason. To solve the problem, they developed modular headphones, the parts of which can be replaced and modernized.

Similar to a Spotify or Apple Music subscription, headphone users pay a monthly fee for the internet service. With some headphones starting at $300, they offer a cheaper and legal option for the music head. Headphones are a bit of a niche market, but the 'Gerrard Street' circular headphone design proves that modular electronics and a subscription to a product model can work.

Every year, more than 1 billion tires are disposed of worldwide, with 50% of these tires either ending up in landfills or being burned in incinerators, wasting a valuable resource. Since 2007, Lehigh Technologies has been recovering valuable resources from used tires using a cryogenic turbocharger. This process is based on freezing raw rubber from used tires and turning it into

powder. The resulting micronized rubber powder (MRP) can be used as a raw material in industry, replacing materials derived from fossil fuels. In 2017, Lehigh was acquired by tire giant Michelin to meet its sustainability goals by 2048. Today, Lehigh serves a wide range of products in the global market, supplying a total of more than $10 billion, including asphalt, construction materials, rubber, plastics and polyurethanes, and tires.

Thus, **the circular economy** is a model of economic development aimed at supporting sustainable growth without harming the environment, which increases overall efficiency rather than reducing inefficiency; at the same time, it is restorative, regenerative and holistic. A holistic circular economy in terms of achieving the goals of sustainable development is inclusive and ensures everyone's access to the benefits of such development. Sustainability, environmental and social opportunities are incentives for the implementation of Industry 4.0 results (Fig. 1.4).

The transformational path to a global inclusive circular economy is through "decoupling", which provides employment and growth without negative impact on soil fertility and biodiversity, without depleting natural resources, without polluting water and air [13].

Separating economic development from the growing use of resources, on the one hand, and the use of resources from the negative impact on the environment is not the only super-task that humanity has faced. This is a condition of our survival on Earth [13] . Therefore, decoupling is a necessary condition for directing society and the country, in particular, to a global inclusive circular economy.

So, Viikman A., Skonberg K. identify a critical need for decoupling, that is, for the transition to an inclusive and circular economy. Decoupling is the ability of the economy to grow without a corresponding increase in the use of energy and resources (source limits) and environmental burden (absorption

limits) [13]. An economy without dependencies should not have a harmful effect on soil fertility and biological diversity, lead to a decrease in resource reserves or an increase in the toxicity of land, water and air. Relative decoupling will allow for timing, i.e. giving the economy additional time before resource constraints and/or excessive pollution occur. When the economy approaches the limit, absolute decoupling is demanded to ensure sustainable economic development [13] .

The concept of eliminating the dependence of economic activity on the use of resources has been the main issue of discussions on rational nature management since the publication of the report "The Limits of Growth" [13]. Although relative decoupling has continued and continues, the gains made are quickly offset by a combination of economic growth and the so-called spillover effect, that is, resources freed up through increased efficiency are used for increased consumption. The demand for goods and the production of materials on a global scale, as shown in the graphs, are constantly growing [13; 102] .

In order to achieve the "absolute decoupling" of energy and materials, which is needed by the world, where the environmental consequences of its functioning are growing rapidly and the impact of industrialized countries is many times higher compared to low-income countries, it is necessary to take urgent political measures [13].

The resource dependence of the industrial economy and the "new" infrastructure require a conceptual re-awareness of the ways to achieve the goals of sustainable development and delicate "walking on the planet".

Until recently, the industrial growth of the economy assumed a linear character - **"take-make-use-dispose".** The digital revolution defines the latest vector of development – a circular alternative that enables efficient movement of materials, energy, labor and information in order to restore natural and

social capital [29]. This applies not only to recycling, but also to a system that minimizes risk by managing limited stocks and renewable streams. At the heart of this model's success are the Internet of Things (IoT) and smart assets – digital technologies and devices that have the ability to perceive, store and transmit information about themselves and their environment. Experts describe it as the "fourth industrial revolution" - a fusion of technologies that blurs the boundaries between the physical, digital and biological spheres [1].

DHL and Cisco forecast that the number of connected devices and objects will reach 50 billion in 2020, compared to 15 billion today. These devices are the foundation of intellectual property tools that enable companies to dramatically increase productivity, from optimizing data to capturing new value throughout the asset lifecycle, while reducing carbon emissions.

One of the factors of the transition to a circular economy is the instability of resource costs. Mostly, this leads to higher prices, which reduces risk, reducing quality and reliability of supply, which can ultimately affect the bottom line. This is one of the reasons why, for example, the Danon company prefers plastic materials for the production of dairy product packaging and biodiesel fuel. Supply risk factors also play an important role in Apple's drive to reduce its dependence on mining by using recycled materials such as aluminum, copper, tin and tungsten. Value recovery is the main factor.

However, circular business models are developed not only to conserve resources, reduce costs or prevent value losses, but also to restore value. For example, the scrap value of a smartphone's precious metals is only a few dollars [177]. However, the refurbishing approach means that when a new smartphone is refurbished (with a new touch screen, battery and updated software), it costs several hundred dollars again [2, 152].

This reflects the essence of the potential of the circular economy not only for raw materials and nature, but is also a significant impact factor for

obtaining profit while minimizing costs with a certain philosophical reorientation. Such a philosophical circular metamorphosis is a modern integration vector of business development. The creation of secondary raw materials is the basis of the circular economy. This is a way to overcome the increasing shortage and increasing cost of natural resources and raw materials [146] .

Globally, the world economy will need to transform over the next decade to meet the needs of some 9 billion people. Every year, 8 million tons of plastic material are dumped into the oceans. The cumulative amount of waste dumped into the world's oceans, as well as the impact on marine and ultimately food supplies, is still unknown. In the UK, only 25% or 50 million tonnes of waste is disposed of annually in landfills, with the associated risks of releasing toxins into the ground and greenhouse gases. The level of waste produced by the UK economy is currently forecast to double in the next 25 years, and with landfills and export routes to reduce waste water, the country is under political pressure to come up with new solutions. And this will provide new opportunities for the business sector. These impacts lead to the emergence of a circular economy, which is an alternative to the traditional linear economy (production, use, disposal), in which we conserve resources as much as possible, get the most value for them during use, and then restore products and materials.

The concept of a circular economy is, on the one hand, the ecological and economic state today, and on the other hand, a reflection of their interrelationship regarding the use of energy, materials and processing. In all directions, economic activity is interconnected with cyclical ecological (natural) and socio-cultural processes. Thus, in the traditional linear value chain, environmental problems are primarily related to the use of resources (inputs). They are often separated from the economic problems associated with

environmental pollution from waste management (mining). An important aspect of the circular economy is that efficient use of resources involves a holistic and contextual approach to managing these resources and waste. This approach is applied to both natural and socio-cultural resources. M. Porter and K. van der Linde [239] argued that "... it is important to use resources productively, regardless of whether these resources are natural, physical or human."

Note that A. Dali [239] describes the "linear economy", which involves the growth of production and consumption due to increased exploitation of natural resources, as the "cowboy economy" [136; 137]. The metaphor is the American economy, which requires going west to take possession of new lands and resources when they are fully utilized at home. Such positions are utopian for the global economy today.

Strategic decisions in the field of circular economy are based on operational determination of the complete process of procurement of raw materials, production, utilization and processing as a whole [29] (Ingebrigtsen, Jakobsen (Ingebrigtsen and Jakobsen), 2007) [239]. This means that input and output problems are interdependent. Resource efficiency is based on the diversity of species that have developed certain qualities, which ensures the maximum use of limited amounts of available matter and energy. For example, water circulation systems use a limited resource in an efficient way that gives life to many living things. It is generally known that there is a fixed amount of water on the planet that constantly circulates from the atmosphere to the surface of the earth and back [239].

In 2019 alone, global CO2 emissions embodied in the manufacturing and transporting of construction materials accounted for up to 11% - 23% of global CO2 emissions.

Ecosystems function as examples of integrated cooperation between organisms with different properties and functions. An important characteristic of such ecosystems is that the main elements of substances (input) and waste (output) depend on the choice regarding the further functioning of this ecosystem.

Thus, CO_2 is a vivid example of animal waste as a necessary nutrient for plants. Thus, depending on the perspective, CO_2 can be both a spent element and a nutrient. A similar example is animal excrement as fertilizer for plants and microorganisms in the soil. Microorganisms live off the wastes of plants and animals, while ensuring that the soil has the nutrients that provide a base for these plants and animals to live.

Thanks to the complex interaction of various types of ecosystems, they ensure the maximum use of available resources. Thus, it can be assumed that all species in the ecosystem are absolutely interdependent. In addition to the circulation of energy and matter, there is also an exchange between different systems in individual ecosystems, which interconnected in integrated networks.

The increase in the amount of waste is an example of the use of resources in the modern economy, which is very inefficient compared to the level of exploitation. According to the Norwegian White Paper Waste Report (NOU 2002), the amount of household waste has increased by more than 90% over the past 20 years. However, GDP increased by only 60%. Similar to the description of cycles in nature, it is worth emphasizing a sustainable economy based on the maximum use of available resources.

In the microperspective (short-term), the task of companies is to facilitate the use of available resources in such a way as to satisfy the vital needs of people. There is now an inherent demand to accomplish this task with minimal adverse effects on the environment and society in both the short and long term.

To emphasize the need for innovative thinking in practical economics, V. Hofenbeck argued that the only way to reduce the burden on the environment while simultaneously increasing the total volume of output is to make a radical step from retro-ecological technologies to preventively integrated, clean technologies and rethinking some human consumer habits. However, it is important to point out that recycling should not be done at all costs. Disposal can be inefficient both economically and environmentally. From an environmentally sound perspective, it is not worth using more energy or matter just to maintain the recycling process than is necessary to provide what can potentially be gained from it.

The best way to solve environmental problems related to waste management is to reduce its volume. Therefore, it can be argued that waste processing contributes to reducing the pressure on ecosystems both at the input and output stages [149; 150]. An alternative to recycling is incineration, which releases energy. However, this process is one-time. When the material is burned, it is lost forever. By recycling, you can design several methods of operation. The real value of recycling is determined within the framework of an integrated material, energy and waste management system.

At the same time, other important technologies, such as the Internet of Things (IoT), artificial intelligence, are the basic factors for the development of the circular economy. The scale of risks, threats and, accordingly, challenges in reducing waste volume and managing the need for this process confirms the presence of significant opportunities for business. The basis of digitization is the "new infrastructure" needed to connect all internet things. This involves deploying a network of sensors that collect data and provide analysis of the flow of materials, products and information. This data is analyzed to justify decisions about resource consumption and the need to develop certain systems.

So, the basic idea of an inclusive circular economy is the frugal use of both material and human resources. In the conditions of an all-encompassing circular economy, growth should take place on the basis of human capital, and not instead of the extraction of natural resources [192; 198; 356].

In its simplest definition, such an economy is "low-carbon", efficient and "clean" in production, and is based on consumption and results obtained through exchange, circularity, cooperation, solidarity, sustainability, the use of opportunities, etc. It provides for the expansion of options for national economies, using targeted and appropriate fiscal and social policies, supporting institutions whose activities are aimed at protecting social and ecological foundations, which diversifies the ways of sustainable ecological development in the context of the concept of an inclusive circular economy.

For the stability of the world, we see the need for the transition from a linear to a circular economy as its necessary condition. The circular economy distinguishes between economic growth and the use of natural resources and ecosystems, emphasizing the effective use of these resources [42]. By definition, this is a driving force for innovation in the direction of resource, component and reuse of waste, which is considered equivalent to new business models, in particular in the provision of services [42]. The idea of a circular economy is a concept: the efficient use of a resource makes it possible to create a greater value of a new product through cost savings, the development of new markets or the growth of existing ones.

Construction materials and the building sector account for more than one-third of global resource consumption.

Construction and demolition waste contribute up to 40% of urban solid waste.

Therefore, the circular economy is a relatively new system of operation that aims to "close the loop" and design waste out of the system, which means

moving from the outdated linear operating model of "take, make, dispose", which is very costly and harmful to the environment, to a more responsible comprehensive system of resource management. This operating system extracts resources, uses them in the production of a product, and then disposes of these valuable materials at the end of their use, usually in landfills or incineration, meaning that a large amount of the resource is wasted. On the other hand, the circular economy closes this resource loop, ensuring a functioning that projects waste outside the system, avoiding landfills and incineration altogether and keeping resources in use as long as possible by reusing and regenerating new products.

While inclusive economics is based on the idea of pro-poor growth, it also extends to other fields, such as feminist and environmental politics, social welfare and economic development theories, which identify aspects of economies that are not sufficiently captured in traditional indicators of economic progress.

In this way, the global inclusive circular economy is aimed at creating positive social external consequences at each stage of the implementation of the circular economy, where the social component is rather a driving force, and not just a philosophical reason, giving the opportunity to receive the greatest life benefits for the weakest sections of the population and the least developed countries, due to participation in circular chains of creation of added value, tax shifts and smart business models.

1.3. Landmarks of building a global inclusive circular society

Circular economy is a new economic model in which the emphasis is placed on the reuse of materials, as well as on the creation of added value with the help of services and smart solutions. A circular economy means that the

value chain is organized so that the output of one chain is an input for another, reducing dependence on new types of raw materials [107].

In the global dimension **circular economy** is a mega-topical issue, because according to the assessment of international organizations, the global value of the circular economy market is determined to be worth more than trillion. dollars Currently, the private and public sectors synergistically cooperate at the international level in the direction of promoting the implementation of smart initiatives to remove obstacles and offer new solutions that will accelerate the transition to a circular economy [107]. The current state of the circular economy at the level of the OECD, the UN and the EU is gradually being considered as a means of accelerating the transition of society to a more resource-saving system, increasing competitiveness and responding to global environmental challenges and threats. China and the US, as the world's largest emitters of greenhouse gases and consumers of resources, have also recently recognized the opportunities of the circular economy. At the same time, the EU, known for strict environmental regulations, in 2015 [107] presented a circular economy documentary package, the tools of which are aimed at increasing cost efficiency, current account balance, self-sufficiency, increasing the number of new jobs and achieving goals in the fight against climate change. Thus, the EU's main idea for a circular economy is global eco-design, not just setting recycling targets. The EU defined a holistic, system-level approach to the circular economy [50; 103; 279; 298].

Practitioners, in particular, top managers, point out that the circular economy begins with ideas. We are rethinking the concept of our mechanical parts to simplify their disassembly and recycle parts to maximize reusability. Representatives of the National Agency for the Environment and Resource Management (ADEME, the Netherlands) believe that when a company embarks on the path of a circular economy, its profitability increases. And this

is for at least two reasons. First, the company will save on the cost of raw materials, as well as on the cost of waste management at the end of the production cycle. Profitability will increase and due to the fact that ecologically clean goods are better sold, this will become a strong argument for marketing and sales. E. Zakkai draws attention to the importance of the elements of circular economy implementation [50].

F. Dekker, G. Krotova, J. Kramer, J. Dajain and L. Artemenko worked out the problems of the circular economy of different countries. The influence of resource efficiency on economic development in the leading countries of "green" modernization was studied by the following scientists: K. Geiser, B. Danylyshyn, L. Musina, T. Kvasha, D. Pujari, S. Morch, K. Summers [50]. Along with actions at the EU level, some European countries have developed their own vision of the national circular economy (see table 1.4).

Table 1.4

The vision of the circular economy in different countries

No	Country	Vision	Purpose and goals
1	*2*	*3*	*4*
1.	Denmark	*"BECOMING THE STATE OF GREEN" (Become a green state)*	Ecological purpose. The idea is the correct use of resources. Top goal: Denmark has decided to be the first country in the world with an economy that is completely independent of fossil fuels by 2050.
2.	Netherlands	*"A GLOBAL HOTSPOT FOR CIRCULAR ECONOMY IN 2016" (Global hub of the circular economy in 2016)*	A program to promote the circular economy has been launched in the Netherlands, where special attention has been paid to improving the technological requirements for the circular economy, removing barriers and raising the level of knowledge and awareness of waste reduction and eco-planning.
3.	Scotland	*"MAKING THINGS LAST" (Make things last as long as possible)*	Scotland focuses its circular economy strategy on four different areas: 1) food and drinks; 2) processing; 3) construction and environment; 4) energy infrastructure management. Emissions and waste management is one of the main directions that unites these four areas. The goal is for 70% of all waste to be recycled by 2025.

1	2	3	4
4.	Canada	*"A STRONGER, CLEANER ECONOMY THAT BUILDS A BETTER FUTURE FOR ALL CANADIANS" (A stronger, cleaner economy that builds a better future for all Canadians)*	Canada's Circular Economy Strategy – Smart Prosperity (2016). In a broader sense, "smart" well-being" means a developed economy, a "healthy" environment and a high quality of life. For example, in 2020, Canada plans to be a country that combines "green" economic management with economic success.
5.	Luxembourg	*"A KNOWLEDGE CAPITAL AND TESTING GROUND FOR THE CIRCULAR ECONOMY" (Knowledge and learning are the basis for a circular economy*	Luxembourg's circular economy strategy was proposed in 2014. The main focus is on economic competitiveness, employment and improving the environment. However, the need to develop detailed plans and implement actions.
6.	Sweden	*"SWEDEN WILL BE A WORLD LEADER IN THE INNOVATIVE AND SUSTAINABLE INDUSTRIAL PRODUCTION OF GOODS AND SERVICES" (Sweden will be a world leader in innovative and sustainable industrial production of goods and services)*	Sweden currently has no actual plan or formed vision for a circular economy. It seeks to implement the "Smart Industry" strategy in four main areas: 1) industry (engagement of digitalization potential); 2) sustainable production; 3) industrial skills (ensuring industrial competence); 4) creation of attractive Swedish innovations (test bed).
7.	Japan	*NO ACTUAL VISION, BUT JAPAN IS CONSIDERED A RECYCLING PIONEER IN THE WORLD (lack of vision, but the country is a pioneer in recycling)*	Japan currently has no actual circular economy strategy or vision. The country is a pioneer in recycling. Its policy is primarily aimed at regulating waste management (revolutionary legislation has been adopted in this direction). In particular, every resident must pay for its disposal when buying a car.
8.	Australia	*NO ACTUAL VISION, BUT STRATEGIC STEPS HAVE BEEN TAKEN TOWARDS THE CIRCULAR ECONOMY IN THE STATE OF SOUTH AUSTRALIA. (development of circular economy in southern Australia)*	The new waste strategy 2015-2020 focuses on the disposal of organic waste. The newly created state government organization "Green Industries SA" monitors the implementation of the waste management strategy. The state can achieve the defined goal of "clean emissions" - by 2050.

Source: constructed by the author based on works [50; 117; 15 1; 154; 267].

This is an important step, as long-standing state and local measures and regulations in the US are typically scaled up for national legislation. For example, in 2013 New York City passed a law banning the use of single-use Styrofoam packaging for food and beverages in restaurants and grocery stores. In the state of Colorado, the "Green Building and Green Points" Program has been developed, according to which at least 50% of construction waste should be recycled [50].

China passed a circular economy promotion law in 2009, which defined the need to reduce the use of resources, the importance of their reuse and recycling. According to experts, the circular economy in China is implemented in practice more broadly than its purpose and actions imply [50] . However, the Ellen MacArthur Foundation [4]predicts that China will become a major player among circular economy countries in the future [50] .

South Australia has taken the first strategic step towards a circular economy [50] . In particular, 75–80% of the volume of waste in landfills is currently being processed. Greenhouse gas emissions have decreased significantly compared to 1990 levels, even though economic output has increased by more than 60% over the same period. Almost 40% of the country's energy is provided by wind and solar energy [50]. South Australia has recently taken the following important steps towards the development of a circular economy:

- ✓ the New Waste Strategy for 2015-2020 focused on organic waste disposal was developed;
- ✓ achieving the main goal of " *clean*" *emissions by 2050.*

[4] In 2014, in Davos, the Ellen MacArthur Foundation (the main initiator of the idea of a circular economy) presented the second report on the "circular economy", where it was calculated that the average citizen of the OECD buys 800 kg of food and drinks, 120 kg of packaging and 20 kg of new clothes and shoes for consumption every year. And 80% of these products are not reused.

According to the assessment of the Australian Academy of Sciences, research and consulting companies, compared to the linear scenario of the development of the circular economy, it is possible to create 25,700 more jobs by 2030, as well as reduce the amount of greenhouse gas emissions by 7,700 tons (equivalent to carbon dioxide), which is 27% less emissions compared to the linear economy model [50].

The construction industry is an important sector of the economy. The global construction market was worth about $1 trillion in 2020 and is estimated to reach $1.5 trillion by 2027. The industry helps to meet fundamental housing and infrastructure needs as well as provide jobs. It is one of the key tools nations use to manage growing populations in urban areas.

Although *the circular economy* is a hot topic for discussion at the international level, current commitments are being made at the regional level. At the same time, the goals and action plans for the development of the circular economy lack integrity, system, etc. Countries promote the circular economy through high-level targets or several focus areas [2; 19; 50; 67].

An exception may be Finland, where the world's first Strategy "Circular Economy Roadmap for 2016-2025" has been developed, which defines the steps to the sustainable success of the country. Finland has a real opportunity to create "sustainable well-being" and "a successful decarbonized circular economy within the next 5-10 years. The world needs innovative solutions to ensure economic growth without irrational use of natural resources. The circular economy maximizes the use of materials and preserves its value in the cycle as long as possible [50]. In a circular economy, materials and value remain in circulation for as long as possible, while services and "smart" solutions increase the value of products. Businesses and industry will play a critical role in the global transition to a "carbon-neutral circular economy."

If Finnish enterprises act quickly, they have a chance to be among the leading world-renowned suppliers of "sustainable solutions" for economic development [50; 117].

The construction of a new ecologically sustainable society and the transition to *circular thinking have begun in* Finland [50]. In the most recent period, the FISU network of Finnish communities was founded under the Sitra [5]project, which contributed to the creation of sustainable business ecosystems among companies (industrial symbiosis) in the mining sector, the Finnish Renewable Energy Association and the Climate Council (CLC) [50], whose task is to help the business and industrial sectors identify and maximize opportunities related to climate change.

According to an analytical assessment, the circular economy can provide the national economy of Finland from 2 to 3 billion euros of added value by 2030 in the fields of machinery and equipment, forest industry, and reduction of food waste. For the European economy, the net benefit of the circular economy is estimated to be 1,800 billion euros by 2030. The circular economy also offers significant environmental and social benefits, including significant job opportunities in Finland [50]. It is about evolution, the transition not only to a circular economy, but to a global inclusive circular economy. According to a study conducted by the Club of Rome, the full adoption of the circular economy will provide more than 75,000 new jobs by 2030 [50]. Thus, for a country seeking growth, this type of economy will provide significant opportunities. The Finnish government has set a goal to make Finland a world leader in the circular economy by 2025. Such thinking emphasizes the role of the state in promoting a progressive growth platform, which is a favorable factor for the domestic market and companies. Finland aims to take a leading role by focusing on the development of five such interrelated priority areas [50]:

[5] Finnish innovative a future fund that collaborates with partners from different research sectors to implement new ideas.

I. sustainable food system;
II. use of forests;
III. machinery;
IV. transport and logistics;
V. joint actions

The starting point should be *the optimization of the circulation of value* , not the prevention of waste. In other words, it is the desire to maximize the volume of waste for reuse as a raw material or energy source.

Finland has gone a long way in applying the advantages of the circular economy to practical activities in many sectors of the country's economy, in particular, it concerns the efficiency of energy use in the pulp and paper industry, bottle recycling [50], and the functioning of the "flea market". However, many tasks are still only in the plans. In particular, only 54% of total waste in Finland is recycled or reused. Similarly, it identifies opportunities for the implementation of several innovative service concepts aimed at providing maintenance, reuse or recycling of equipment.

Thus, to bring about major systemic change, each field must provide some input: information, operating models, removing administrative barriers, business experience, practical trials, piloting, networks, the ability to take responsibility, think innovatively, work with other people and with enthusiasm. The "Sitra" project contributes to the development of the circular economy in Finland through the implementation of the "Road Map" in cooperation with other players for the development of appropriate business models for companies in the transition to the circular economy [50].

Therefore, it is possible to single out the following indicative measures for the transition to the circular economy of the EU [50; 154, 171, 172, 174] :

- disposal of 65% of household waste by 2030;
- disposal of 75% of packaging waste by 2030;

- reduction of landfills to a maximum of 10% of household waste by 2030;
- promotion of economic instruments to counteract the creation of landfills;
- simplified and agreed calculation methods for recycling rates in the EU;
- specific measures to promote reuse and stimulation of industrial symbiosis-transformation of the by-product of one industry into raw materials of another industry [50] .

Along with the long-term benefits of the transition to a circular economy, there are certain obstacles to this development [50] :

- the difficulty of promoting systemic changes;
- economic challenges (circular economy can be unprofitable in the short term);
- imperfect markets (lack of necessary products and infrastructure, competition, knowledge and/or incentives in the market);
- imperfect regulation (imperfect legislation and/or implementation);
- social factors (insufficient knowledge and skills related to the circular economy);
- insufficient sorting of waste;
- difficulties in obtaining appropriate financing;
- lack of agreed procedures in various areas.

These factors have different impacts depending on the industry and value chain. To solve these problems, it is necessary to apply certain actions at the state, regional and local levels of the EU. One of the main directions of the circular economy of the EU package is the identification and elimination of significant "bottlenecks " that affect the functioning of production and sales chains and manufacturers [50].

The circular economy provides new and unprecedented opportunities for the creation of wealth and well-being, and is also the main engine for the implementation of the UN 2030 Agenda "Sustainable Development Goals". The world actually needs

The industry, however, is operating on a linear economy model and records high energy and resource use. It generates waste and greenhouse gas intensively, and for an essential sector of the economy, it is currently unsustainable.

Circularity in the construction industry will reduce the costs of materials and construction. It will also reduce waste and pollution generated by the industry. Innovative technologies that will change how they source, produce, transport, and use construction materials can make all these possible.

"pioneer" countries that develop and implement operational models of economic growth and welfare improvement without excessive consumption of fossil fuels and natural resources [50].

Climate change and depletion of natural resources are two of the most acute global problems [50]. Accordingly, the amount of waste can be reduced during the transition to a circular economy. In such an economic system, waste materials and their formation are minimized [50] . In practice, this may mean that the product must be designed so that its materials are separable and recyclable. The need to solve the problems of climate change and the preservation of natural resources has determined the need for the formation of a global business model with a very fast rate of economic growth. In a circular economy, the most important thing [50] is not material flows or waste, but the development and implementation of much more valuable methods, such as proper maintenance, reuse of materials and recycling of equipment.

The starting point should therefore be to optimize the circulation of value, not to prevent the generation of waste. In other words, this is primarily the realization of the desire to maximize the amount of waste for its reuse as raw materials or energy sources.

The implementation of the circular economy takes place by implementing systemic changes through the following actions in various areas (Fig. 1.5):

- information;
- operating models;
- elimination of administrative obstacles;
- business experience;
- practical tests;
- piloting;
- networks;
- the ability to take responsibility;
- ability to think innovatively;
- cooperation with other people;
- enthusiasm.

Let's single out the main number of push factors affecting progress in the development of the idea of implementing the circular economy. So, **the instability of resource costs → price increase → risk reduction → quality reduction and supply uncertainty → influence on the final result**. Along with the above, such important technologies as the Internet of Things (IoT), artificial intelligence, are also the main factors in the development of the circular economy.

The argument for *a circular economy* has traditionally been primarily an economic one: scarcity of resources will make it impossible to fulfill and produce certain goods and services, so reuse, recovery and reconstruction strategies provide a reliable solution to mitigate dependence on the use of natural capital.

Although all strategies aim to further the transition to a circular economy, each of them addresses slightly different aspects depending on the

territorial context. Accordingly, the so-called paradigm shift towards a global inclusive circular economy is a complex task that must comprehensively cover value chains and different players at relevant levels. Only by combining different ways of promoting the circular economy, including all elements in value chains and all stakeholders, can we strive for a paradigm shift. Circular economy strategies address these two types of inclusiveness to varying degrees.

The integrated approach outlined above provides an opportunity to help states understand how to maximize potential benefits, prioritize and develop different models of human well-being that can be implemented in a healthy environment. As a result, a comprehensive inclusive circular economy should ensure not only the creation of jobs and income, but also contribute to the preservation of human health, the formation of a suitable environment and a sustainable future in general [186].

According to the data of the World Economic Forum in 2018, the most inclusive countries (Fig. 1.6) are Norway, Iceland, Luxembourg, Switzerland, Denmark, Sweden, the Netherlands, Ireland, Australia and Austria. The index is designed to reflect not only the amount of economic growth in the city, but also its quality and distribution among the population . Elements taken into account when measuring a city's overall prosperity included GDP per capita, personal safety, access to education, Internet access, housing affordability, environmental quality and access to health care.

In the process of economic development, **Luxembourg** proposed the " *Fit 4 Circularity* " Program, designed to facilitate and accelerate the transition of companies to a full level based on the principles of the circular economy. Innovative ideas, as a rule, are the basis of long-term profitability , because the manager of a business that uses demand does not always have enough strength to solve this issue [172].

Norway is the best developed economy in 2018, with consistently strong performance: it ranks second in one of the three components of the index, Australia (9) is the only non-European economy in the top 10. Among the G7 countries, Germany (12) ranks highest, followed by Canada (17), France (18), Great Britain (21), the United States (23), Japan (24) and Italy (27). In many countries, there is a stark difference between the individual components: for example, the US ranks 10th out of 29, but 26th in intergenerational equity and stability. Meanwhile, France ranks 12th for inclusion, 21st for growth and development, and 24th for equity and sustainability. In the rating of developing countries, six European countries are in the top 10: Lithuania (1), Hungary (2), Latvia (4), Poland (5), Croatia (7) and Romania (10) [133, 145] . These economies are performing particularly well in terms of growth and development, benefiting from EU membership and inclusion with average living standards and reducing inequality. Latin America has three top 10 economies: Panama (6), Uruguay (8) and Chile (9). Activity is uneven among the BRICS economies, with Russia (19) ahead of China (26), Brazil (37), India (62), and South Africa (69). Although China ranks first among emerging economies in GDP per capita (6.8%) and labor productivity growth (6.7%) since 2012, its overall performance is weighed down by poor performance on inclusiveness. Turkey (16), Mexico (24), Indonesia (36) and the Philippines (38) are among the countries showing potential for growth. European emerging economies occupy six out of 10 places in the ranking of developing countries. It has been proven that the index of inclusive development gives a much clearer indicator of the

As of 2020, innovations like modular construction for flexible design, fuel, and material substitutes, and digital construction were already in development. According to the world bank, long and complex value chains are a major obstacle in creating a circular construction economy.

success of the country's economy. Growth is enhanced by sharing wealth across the board and generating it in a way that is sustainable and does not burden future generations with debt [364, 365, 366].

The reality is that too many governments face difficulties in assessing informality. Due to poor official statistics, policy makers depend on unofficial estimates. That is why IMF staff participated in providing more reliable estimates. Thus, the IMF estimated that informality accounts for 38% of GDP in sub-Saharan Africa during 2010-2014, and in some countries accounts for up to 90% of jobs [361].

Understanding informality allows for a better assessment of growth. Therefore, the informal economy is directly related to inclusive growth. Let's say digitization has created more opportunities for people engaged in informal employment to supplement their income. The informal economy can provide income or a social safety net. [361, 367] But this is a difficult question. The poverty rate among informal workers is on average twice as high as among persons in formal employment. Because of low labour productivity, low incomes and limited access to government benefits.

Informality leads to lower tax revenues, which hinders the government's ability to spend on social programs and investments. This means that those most in need of social programs and public infrastructure may not receive them.

A recent IMF analysis found that persistently high inequality is associated with lower, less durable economic growth and greater financial instability. That's why understanding informality is part of how the Fund fulfils its commitment to help countries achieve the 2030 Sustainable Development Goals. More accurate estimates of the informal economy can help make policies more effective and targeted. For example, in Uganda, a large part of the economy is tax-free, changes in tax policy have not

significantly affected the distribution of income. The informal economy is also an important source of employment for women. According to ILO estimates, 92% of women in developing countries work informally. This is the opposite of what we see in advanced and emerging economies where it is more of a source of employment for men. For women, this task is complicated by the fact that, in addition to being paid less than men in formal work, they are also paid less than men in informal work. Statistics on the informal economy, employment, labour productivity and even the regions where these activities predominate are critical to designing targeted policies to support them. In fig. 1.7. the main guiding directions in the global inclusive circular economy paradigm are presented: employment is growing; GDP increases; the negative impact on the environment decreases; resource exhaustion (resource consumption = 0 or unchanged) is at best decreasing; water and air pollution decreases; consumption volumes are increasing; the competitiveness of the economy is growing; the number of jobs is increasing.

Thus, *the global circular economy* should be based on the implementation of four main stages aimed at overcoming the gap (gap) of circularity (Fig. 1.8):

- creation of a global circular coalition with a common philosophy;
- development of a global goal and order of action;
- global goals - local actions;
- circular systems.

The main prerequisites that form the circular economy as a necessary business model are the following:

❖ resources and their pricing. The world is at the stage of ending the use of cheap oil and raw materials. The shortage of fossil fuels and the limitation of all types of natural resources, combined with the increase in consumer demand, are reflected in the problem of waste management. It is not relevant to use a smaller volume of any today. Accordingly, the increased volatility of

resource prices restrains economic growth, preventing the business sector from using those resources that are associated with risks;

❖ growth in the number of consumers among representatives of the middle class. In the world history of 1800, we have two stages of growth in the number of representatives of the middle class, and now the third is defined. In Asia, 525 million people can call themselves representatives of the middle class, which is more than the total population of the European Union [6]. Over the next two decades, the middle class is expected to expand to three billion people, mostly from emerging countries;

❖ ”big data” (Big data). The emergence of the concept of "big data" has transformed the order and scale at which problems can be solved, provided in-depth knowledge of the market and optimization of consumer-oriented solutions. According to this concept, a solution to the problem of determining what and where happens in the economy, what is made of, and in what condition is proposed, which increases the efficiency of circular production compared to subtractive production[7];

❖ change in legislation and globalization of management. An increasing number of companies are responding to various challenges, in particular, new models of legislation are being formed and globalization of management is taking place by introducing new innovative projects for their products, mostly in those cases that were previously considered as problems: for example, increasing the toxicity of various materials or landfills, increasing the volume and amount of waste, which are then transposed into globalized circular chains of added value creation;

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[6] As of January 1, *2015*, *the population* of the countries of the European Union was 508 million 200 thousand people.

[7]Subtractive production (Subtractive manufacturing) is the process by which 3D objects are built by sequentially cutting a solid block of material by hand, but more often this is done by CNC Machine.

❖moving from "agreement" to "relationship". Today's multi-network world reflects new levels of interaction and communication with consumers and brands that go beyond traditional transactions. Online interaction through Facebook, Twitter, YouTube and other websites is a growing global phenomenon that is creating new relationships between customers and companies, particularly within circular chains.

In recent decades, the production of most goods has shifted towards Asian countries due to the affordability of resources, the emergence of a significant segment of middle-class representatives in this region with an increase in their purchasing power, which provided a decisive impetus for the implementation of global trade in goods, in particular in China. The circular economy should be considered in general as a process, from the point of view of receiving waste generated as a result of the production of a certain product and ultimately transformed into secondary raw materials, replacing primary resources and providing equivalent functionality. Such circular initiatives for globalized waste management are often implemented in China or India. Global trade in waste for secondary processing is a necessary condition and a reality for most recyclable goods: metals, paper and plastic.

World population is projected to grow to 8.5 billion people in 2030, and to 9.7 billion in 2050. Global GDP is expected to double almost every two decades, with significant increases in per capita incomes – linked to rising global demand and consumption, also doubling material use, leading to unsustainable environmental pressures (climate change, pollution, land use change). Without a change, by 2050, the world's consumption level would necessitate the resources of 3 planet Earths.

According to 2014 data from the International Solid Waste Association (ISWA), almost half of plastic exports are made from household waste, which

is a recycled raw material. Most of these products (87%) were exported to China. The same situation is typical for the USA and Japan. Thus, the circular economy of plastic products in Europe and the USA materializes through international transportation, recycling, secondary production of plastics and manufacturing of products in China. In view of this, certain questions arise regarding the ecological efficiency of such circularity. The question lies in the environmental friendliness of the conditions, the professionalism of product processing. Accordingly, the Chinese government is trying to reduce dependence on unregulated, small-scale, low-tech recycling operations and operate without harming the environment, which is a prerequisite for large-scale research by scientists in the field of circular economy.

A significant number of practical implementations and scientific research during the last two decades makes it possible to describe the theoretical, methodological and empirical aspects of the circular economy and the directions of its implementation. China is intensively and extensively pursuing this idea to develop long-term effective solutions to overcome the acute shortage of resources and prevent environmental degradation. Practical activities are carried out at the micro, meso and macro levels. They cover production, consumption, waste management and are based on various government support programs in order to promote, regulate, monitor and evaluate existing practices for the successful implementation of the circular economy.

The results confirm that research institutes in China offer two indicator systems for evaluating the performance of the circular economy. Their focus is on implementing the 3R principles. In addition, one of the indicator systems considers the impact of eco-industrial parks on the economy and the environment. Note that the indicator systems are different and non-standardized, and also require coordination of activities for their

harmonization due to the heterogeneity of the population and the specifics of the regions. This will make it possible to compare resource use and environmental performance across firms, industries, regions and countries.

The very transition to *a circular economy* means changes in human thoughts and actions [42] . This requires a systemic approach and affects how business models, governance, law, logistics, housing, agriculture and other areas will be organized and structured. In addition, the circular economy is a system in which raw material flows are effectively directed, rationally processed, implemented entirely on the basis of renewable energy sources [42]. However, any actions do not create a negative impact on human life and the functioning of ecosystems within the framework of the formation and effectiveness of global circular chains of creation of added value [42].

In accordance with the researched paradigm of the global inclusive circular economy, we suggest considering the new circular product life cycle as a necessary prerequisite for the effective implementation of the paradigm policy [192].

In *a global inclusive circular economy* [270], people are at the center of the model, where value begins with the realization of a balanced society for everyone, from all walks of life and for different countries - from the most developed to the least developed. In addition to waste, the global inclusive circular economy considers poverty, which forms two main external effects, which even more socializes this problem or, as it is relevant to say, includes it.

In this way, it is possible to single out 3 basic fundamental pillars of the global inclusive circular economy:

1) **inclusiveness of the population:**

the ability to satisfy all your needs without owning these goods, but simply having access to them. That is, an inclusive circular economy allows for inclusion in the system of those who are currently excluded from our

economies, thus positively affecting inequality and/or injustice. In this case, we are talking about a business strategy for implementation - equality. People will be included in a circular business model [270], that is, the product is offered in a modular and adaptable way to meet the needs of any range of customers - in terms of purchasing power.

2) **formation of human value:**

the opportunity to get more, because even with a low income, a decent life is still possible. Accessing the economy for prosperity (contrary to the accusation of not being able to pay for products thinking) will result in less reliance on financial credit and therefore less debt. Here, the business strategy is access. Customers and New Prospects will focus on helping current customers expand further within the economy or integrate new prospects into it. Every person is a potential customer with different growth potential.

3) **well-being of people:**

the opportunity to gain access to a secured income, taking into account the fact that in the "circular economy" the role of the workforce is redefined. This can lead to the creation of new jobs, micro-jobs and micro-tasks that do not yet exist, i.e. creative employment growth. Labor can become this infinite renewable resource and lasting (WR Stahel). Here, business strategy is a skill. People and labor are valued in the economy where they are used, that is, the main focus is on the use of people as a critical entity in the new economy, where they are considered the driving force of support for both the biosphere (the human-as-resource model) and the technosphere (the people-as-service model). With the help of these three additional grounds, we reinforce the basic circular principles.

Global inclusive circular economy aimed at creating positive social external consequences at each stage of circular economy implementation. That

is, the inclusive and social component is rather a driving force, and not just a philosophical reason. That is, we are talking about the possibility of receiving the greatest benefits of life for the weakest sections of the population and the least developed countries.

Based on the above-mentioned approach, the following inclusive circular models can be distinguished:

- circular startups (low-income solutions (access and capability);
- feedback loops (access, equity and opportunity);
- joint actions based on ecosystems (sharing platforms);
- c service shared platforms (access, equity and capabilities).

Other business models can be created using 'circular thinking' to solve societal challenges using the concepts of Cradle to Cradle, the 'Irish Package'. Therefore, the inclusiveness of the population, the creation of human value and their well-being together give profitable inclusive business models. That is, the basis of the tax shift is a smart strategy , which will allow the formation of a high-quality inclusive circular society.

Therefore, such an evolutionary path involves certain metamorphic changes or peculiar so-called "shifts" during the transition from the philosophy of recycling to the philosophy of circularity of the economy. And this forms the so-called simulation models in the form of global chains of creation of added value, the purpose of which is reducing the coefficient of energy and material use, as well as applying additional investments for the transition to circular models (for example, 3% of GDP per year (Poland, Czech Republic)).

In the process of the 4.0 revolution, the circular economy is both its consequence and its result (it is robotic, which, accordingly, led to a decrease in the number of jobs, and this determines the need for their increase). Thus, we consider specific "circular examples": how an "ordinary" city was

transformed into a "circular" city or what internal changes took place (that is, we are talking about circular evolution).

Therefore, the ambitious goal of the global inclusive circular economy is the implementation of appropriate eco-measures to preserve climate conditions, which will make it possible to create more than 65 million new jobs in 2030, which is equivalent to the combined workforce of Great Britain and Egypt today, as well as avoid more than 700 thousand premature deaths from air pollution compared to conducting ordinary business [361].

Annual waste generation is projected to grow by 70% by 2050. Plastics, with no action, would account for 15% of the global carbon budget and 20% of oil consumption by 2050 (up from 1 and 6% in 2014). The need to transcend linear economic models and shift to a climate neutral circular economy, is a key priority of the European Green Deal.

Reforming subsidies and pricing for carbon emissions in 2030 alone will make it possible to generate approximately 2.8 trillion. dollars state revenues per year. In 2030, this is more than the total GDP of India today. These are necessary funds that can be used to invest in public priorities [175].

The impact of *climate change*, such as **sea level rise** or **the intensity of natural weather events**, is now evident and is often referred to as the "*new normal" around the world*. Having the opportunity to overcome certain points of transition, it is worth considering that beyond their limits the consequences become unstoppable and irreversible. Many of them are referred to as feedback loops, which increase the risk of ruptures and lead to climate change. The predictions of environmental scientists are now increasingly confirmed, for example, the acceleration of the rise of the water level of the world's oceans, the melting of the Arctic glaciers, the disruption of the ocean circulation and the increase in the number of natural weather events such as floods and heat waves.

Studying *the practical needs* for the implementation of the circular economy paradigm, the eradication of child labour is identified as an indicator of a global inclusive circular economy. Today, more than 350 companies from ten different industries participate in the Responsible Minerals Initiative to ensure transparency in the extractive industries, using a wide range of tools and resources to obtain the minerals they need and preserve the sources of their extraction. Mining will provide an opportunity to apply human potential and catalyze economic activity, which is a long-term process after the exhaustion of a certain mineral resource. Since such resources are limited, countries work to stimulate their own economic development. Yes, the active operation of the mine will continue even after its closure, if a global inclusive circular economy is ensured in the process. To promote inclusive economic development in local communities and diversify national economies, members of the *Responsible Minerals Initiative* are committed to working with others to ensure sustainable economic opportunities. Many products that we use every day are produced using child labour. Here are just a few examples from their list:

Total waste generation in the EU-27 has been around 2.2 billion tonnes per year since 2004, growing over 2.3 billion tonnes in 2018. This means around 5.2 tonnes per capita a year (except a few post- 2008 years), in which hazardous waste is increasing – from 186 kg/capita in 2004 to 227 kg/capita in 2018. Construction produced 36% of the total waste, mining/quarrying 26.2%, manufacturing 10.6%, waste /water 9.9%, households 8.2%, services 4.2%, energy 3.5%, agriculture/forestry/fishing 0.9%, waste/scrap 0.5% in 2018.

- ***coffee and sugar.*** There is evidence of child or forced labour in sugar cane and coffee harvesting in 25 countries worldwide;

- ***gold.*** Children mine for gold underwater or on the banks of a river, using oxygen tubes for breathing. They process the gold with mercury, which is a poisonous substance that causes irreversible changes in their health. 22 countries are known to use child labor;
- ***shoes.*** Child labor is used for the production of shoes, primarily in Asia. Children are mostly recruited to perform subcontracted work at factories with their informal employment, which makes it difficult to identify and prevent the development of such a phenomenon;
- ***toys.*** Both child labor and forced labor are used in toy production in China. Toys for our children can be made by another child, for whom work is a kind of play;
- ***leather products.*** Children may work in dangerous conditions typical of the leather industry in Bangladesh, India, Pakistan and Vietnam, where bags and other leather products are made;
- ***mobile phones.*** Children in the Democratic Republic of Congo work in dangerous conditions to mine cobalt ore, a mineral needed for lithium-ion batteries used in mobile phones, laptops and electric cars;
- ***chocolate desserts.*** Adults and children harvest the fruit of the oil palm, which is used to make palm oil, an ingredient found in almost 50% of the products in any supermarket. According to a 2013-2014 report by scientists at Tulane University, they estimate that 2 million children work on industrial plantations in West Africa;
- ***clothes.*** Child labour abuse in the garment industry is widespread in many countries of the world, from South America to Southeast Asia. Anything from plain t-shirts to fancy evening wear can be made or decorated by such an exploited worker.

In the table 1.5 contains data on child employment, that is, in which countries and to what extent child labour is used. One example is also the production of car paint and eye shadow. Micas are a group of minerals of industrial importance. They are used in the production of many products that consumers buy, including in the manufacture of cosmetics, cars and electronics. According to data, 25% of the world's mica production is provided by the Indian states of Bihar and Jharkhand, where child labour and dangerous working conditions are common. In particular, child labour is used in informal mining and gathering operations not authorized by the government.

In 2017, more than 40 companies created *the Responsible Mica Initiative (RMI)* , committing their members to be responsible for their mica supply over the next five years. The initiative aims to work with producers to implement sustainable collection, processing and sourcing practices, as well as to improve the traceability of supply chains. Through the implementation of this initiative, companies invest in the activities of territorial communities to solve the main issues of labor relations violations.

A World Bank report estimates that 10 % of all workplace injuries are amputations and fractures. 2.78 million work-related deaths and 374 million injuries and illnesses annually. Two-thirds get a permanent cough, while 87% of injuries, particularly severe consequences are for girls.

Thus, as of 2018, according to Worldatlas [405], the worst countries with the most difficult conditions for children are the following:

1) **Bangladesh** (garment factories, agriculture, manufacturing);
2) **Chad** (agriculture, military);
3) **Democratic Republic of the Congo** (mining, agriculture, industry, military);
4) **Ethiopia** (mining industry, shoe shine);
5) **India** (mining industry, agriculture, garment factories);

6) **Liberia** (dangerous farming conditions);

7) **Myanmar** (agriculture, construction, small industry);

8) **Nigeria** (agriculture, street begging, mining, construction);

9) **Pakistan** (agriculture, garbage collection, carpet weaving, coal mining, brick kilns);

10) **Somalia** (fishing, construction, begging).

member *L'Oréal* works with a limited number of suppliers who commit to sourcing mica from human rights-friendly, child-free mines that can be monitored by independent auditors. Stakeholders hope that legalization and regulation of the industry will increase wages and productivity, and significantly reduce the use of child labour.

Certain questions arise during the research. Tasks are defined accordingly. One of these issues is how to properly "launch" an inclusive circular economy and what accents to highlight.

In contrast to the linear economy, the circular economy is a system in which resources are used as sustainably as possible by repairing, restoring or recycling products or materials without throwing them away. Modern academic discourses are based primarily on business models, approaches to "clean" production, optimization of productivity and efficiency, but at the same time we have insufficient research on certain social and institutional consequences [319].

Accordingly, the inclusive circular economy makes it possible to expand such a discussion, since the transition to an inclusive circular economy is discussed, which is ensured by the implementation of political interventions, international cooperation in the direction of economic development, the formation of certain business models and changes in consumer behavior [120].

Application **of circular economy methods** as a "tool" for achieving the Sustainable Development Goals [124]. The circular economy, which makes it

possible to improve the working conditions of waste collectors and ensure the provision of appropriate services for their disposal, can significantly contribute to ensuring the health and improving the quality of life of people involved in this activity. In addition to waste disposal, there are practical circular economy programs for various sectors defined by the Sustainable Development Goals, including water and sanitation, clean energy production, food, urban development, etc.

2. **Using education and training to reduce impacts** on global supply chains. While the circular economy offers real opportunities for developing countries, there is also a real risk that the circular economy and closed-loop supply chains could have the effect of reducing poorer countries' participation in global supply chains. An example can be the use of 3D printing. Special attention should be paid to the education of young people in developing countries, who could potentially refuse the opportunities that the circular economy will offer.

3. **Ensuring the "right to repair".** Repair is an important element of the circular economy to prevent the consumption of resources and re-acquire the economic value of products. However, repair is becoming increasingly complex and exclusive - monopolized by powerful companies - due to design standards and lack of maintainability. Ensuring the "right to repair" of products, especially electronics (cell phones, computers, etc.), requires companies of all industries to provide consumers and independent repair shops with the necessary service documentation, tools and spare parts. Ensuring the "right to repair" is an important building block for the development of an inclusive circular economy.

4. **Active involvement of people as proactive citizens**, not only as consumers . As the circular economy involves a shift to new business models, such as sustainable product systems, and consumers become users, issues of

ownership, consumer rights, data privacy and intellectual property become relevant. The reuse of products and secondary materials requires new standards and regulations in the area of health, hygiene and product safety to ensure consumer protection. In addition, an inclusive circular economy implies a change in social practice and behaviour and the active involvement of citizens, as it is about changing **products.**

5. **Data transparency and consumer protection.** As digital technologies, big data, artificial intelligence and blockchain will play an important role in the circular economy, it is important to ensure transparency and protection of such data. New digital technologies can provide relevant data on resources such as water, land, forests, waste, and accurate tracking of their stocks and flows. To make the circular economy inclusive and to ensure equal opportunities for all, it is necessary to have open access to such data. Furthermore, industrial symbiosis approaches can only work when stakeholders trust each other and are willing to share data. However, the growing amount of information and data collected by companies about consumers implies the need for new approaches to ensure corporate accountability and public scrutiny of the extent to which "big data" is being used.

We will find out how circular inclusive economies can function effectively [275; 278].

1. **Inclusiveness in the informal sector**, i.e. the profit-oriented sector of the economy, where the main regulation takes place with the help of dominant informal norms. It can be defined as economic activity in general, which for various reasons (non-monetary turnover, high taxes, legal prohibitions, etc.) is not taken into account by official statistics and is not included in GNP [57].

2. **Decisions regarding the role of women in society and the economy.** Women make up a large part of the informal sector. They work as domestic workers, in the field of street trade, perform agricultural types, construction

work, may be collectors or waste collectors, etc. However, they receive significantly lower wages, and sometimes their work is unpaid. Thus, according to the attached 2018 ILO report, 58% of workers in the waste sector are women, and 92% of women work in the informal sector. Global unemployment is more than 190 million. persons In 2017, about 42% of workers (or 1.4 billion people) in the world are estimated to be vulnerable categories based on the form of employment. This share is especially high in developing countries. It is at a level above 76%. In general, progress on in-work poverty is too slow. In developing countries, the number of people at the poverty line exceeded 114 million in 2018, or 40% of the employed population. It was expected that unemployment in developing countries would increase by half million per year in 2018 and 2019. At the same time, the unemployment rate was at the level of 5.3%. 82% of women in developing countries belong to the vulnerable categories of persons in terms of employment (in 2017), compared to 72% of men. Globally, the average age of workers is expected to increase from 40 in 2017 to 41 in 2030, mainly in Europe and East Asia, especially China [124]. Women financially support their families, raise children, take care of other family members and take care of their own homes. Any solution developed through the prism of circularity and inclusiveness must first of all be based on gender awareness and take into account gender issues.

3. **Active position of citizens.** Participation and activation of citizens' activities complement this sector. In many countries of the world, governments act only when citizens actively defend their positions, their status quo. Bangalore in southern India is an example of how citizens collectively challenged the actions of urban local authorities, both during court hearings and during public discussion, and achieved the result - changes in the areas of waste disposal and water use.

4. **Authorized ecosystem players.** Local authorities often try to solve these problems. It is wrong to assume that most local administrators are corrupt or have vested interests. They work under pressure, their decisions can be lobbied, which affects their activities, they have low salaries, they are not always sufficiently motivated and sometimes they are incompetent. Ecosystem players such as capacity-building bodies, non-profit organizations and educational institutions must break down their own strategy. Thus, in 1995, Surat, a large port city in Gujarat in western India, was devastated by floods and plague. After heading the municipality, Commissioner Rao cleaned up the city, turning it into one of the most prosperous in India.

5. **Political interventions.** Geographical "transfer of ideas" can be an important tool for transferring knowledge and achievements. What can Bangalore get in Medellin or Barranquilla in Colombia; whether there are lessons learned from Kochi, Kerala or Panaji, Goa that can be applied to other regions of India; what can be learned from the example of Malang in Indonesia and designed for Kampala in Uganda.

So, taking into account the above, we come to the conclusion that in **the global inclusive circular economy, the main goal is** to solve two global problems: *waste disposal and poverty reduction*. Both are consequences of human activity. These questions can be solved using circular thinking. There is global recognition that the system we live in was designed with a narrow economic approach. Expanding it by incorporating other dimensions will encourage innovation.

The implementation of the human component between the biosphere and the technosphere in the so-called "butterfly model" from the Ellen MacArthur Foundation will make it possible to rethink the role of man in these two cycles [269]. According to this "adapted butterfly diagram" it is possible to trace the role of man as an integral part of the flow of resources and energy,

since it is man who is this resource and energy [271]. Figure 1.10. reflects the main components of the mechanism of formation of an inclusive circular economy:

Components of the mechanism of formation of an inclusive circular economy	circular economy methods (toolkit of sustainable development goals)
	education and training to reduce pressure on global supply chains (3D printing)
	right to repair
	proactive population
	data transparency and consumer protection
	inclusiveness in the informal sector
	the role of women in society and in the economy
	responsibility of ecosystem players
	transfer of ideas by " political interventions "
	" butterfly model " – adaptation to an inclusive economy
	projecting positive social externalities
	overcoming poverty
	circular human flows
	technologies as drivers

Fig. 1.10. **Components of the mechanism of formation of an inclusive circular economy**

Source: constructed by the author.

1. Projecting positive social external effects. An inclusive circular economy focuses on creating positive social externalities at every stage.

2. Overcoming poverty is an important point in the implementation of global inclusiveness. Poverty, like waste, is a human construct that needs to be

eliminated. Meeting physiological and safety needs is an important first step towards empowerment, as poverty and inequality often go hand in hand.

3. Circular human flows. Man is at the center of the biological and technical spheres of the circular economy. Under such conditions, people profit equally from access to vital resources and from the application of developed skills, acquired knowledge and education.

4. Growth indicators of the inclusive circular economy. An inclusive circular economy makes it possible to revise the meaning of the concept of "growth" and develop new ways of evaluating it.

5. Technology as a driving force. Technology itself is not deterministic. So, blockchain technology, for example, can be fundamental in the implementation of inclusivity, as it provides increased transparency, decentralization of power and is actively used to fulfill supply chains.

Conclusions to chapter 1

The generalization and systematic analysis of the theoretical and conceptual basis of the formation of the global inclusive circular economy gives grounds for such conclusions.

1. **It has been studied that the main risks are for us** in 2020 will be risks associated with *the surrounding environment*. To mitigate climate change, it is necessary to: extend the life of the product and increase the intensity of use; increase recycling to use waste as a resource; use circular designs to reduce the use of materials; implement circular models with priority to low-carbon materials. In addition to the achievement of 17 UN sustainable development goals, in particular, some of them have an active practice in the application of circular practices: [100] 1) ensuring the availability and sustainable management of water resources and sanitation [21]; 2) ensuring access to

inexpensive, reliable, sustainable and modern sources of energy for all; 3) promotion of progressive, comprehensive and sustainable economic growth, full and productive employment and decent work for all [21]; 4) ensuring the transition to rational models of consumption and production; 5) protection and restoration of terrestrial ecosystems and promotion of their rational use, rational forest use, combating desertification, stopping and reversing (reversal) the process of land degradation and stopping the process of biodiversity loss [21]. The potential consequences of the transition to a circular economy on greenhouse gas emissions are significant, achieved mainly through increased resource efficiency, increased useful life of buildings and assets, increased recycling and reuse, and absolute reduction in the use of primary raw materials. Thus, the circular economy can be considered as an effective strategy to help mitigate climate change.

2. It has been investigated that the process of formation and development of a global inclusive circular economy originates from the new pragmatism of Grzegorz V. Kolodko, who brought "to the fore" the role of values in the economic activity of people and society and asserted that "there is no economy without values", that "the economy is society, always". V. Nordhaus and P. Romer continued to save. whose interests focused on climate change and its impact on the economy. They were the first to draw attention to global warming and climate change and their impact on the economy. The logical continuation was the research of M. Kremer, E. Duflo, A. Banerjee in a new approach to finding recipes for fighting poverty. The history of the beginning of the circular economy goes back to the concept of regenerative design. It has been studied that the conceptual basis of the circular economy originates from the concept of regeneration (regenerative design), is based on the idea of Cradle-to-Cradle, according to the Hanoverian principles, through biomimicry and the goals of Sustainable Development. So, the circular

economy is a relatively new system of operation that aims to "close the loop" and project waste out of the system. This means moving from an outdated linear operating model of 'take, make, dispose', which is very costly and damaging to the environment, to a more responsible comprehensive resource management system.

3. The current state of the circular economy at the OECD, UN, and EU level is gradually being considered as a means of accelerating society's transition to a more resource-saving system, increasing competitiveness and responding to global environmental challenges and threats [107]. China and the US, as the world's largest emitters of greenhouse gases and consumers of resources, have also recently recognized the opportunities of the circular economy. At the same time, the EU is known for strict environmental regulations [107] .

4. The implementation of major systemic changes will occur with changes in each area with a separate contribution: information, operating models, removing administrative obstacles, business experience, practical trials, piloting, networks, the ability to take responsibility, think innovatively, work with other people and with enthusiasm [50]. With the influence of the main number of push factors affecting the progress in the development of the idea of implementing the circular economy: instability of resource costs → price increase → risk reduction → quality reduction and supply uncertainty → influence on the final result.

5. Along with the above, such important technologies as *the Internet of Things (IoT)* , artificial intelligence, are also the main factors in the development of the circular economy. In the study of this process, global supply chains of secondary raw materials, based on three main drivers for the successful creation of such initiatives, certainly play an important role: 1)

circular efficiency; 2) finding the right partners; 3) the scale of the circular initiative.

6. The most inclusive countries are Norway, Iceland, Luxembourg, Switzerland, Denmark, Sweden, the Netherlands, Ireland, Australia and Austria. The index is designed to reflect not only the amount of economic growth in a city, but also its quality and distribution among the population. The main guiding directions in the global inclusive circular economy paradigm**:** employment is growing; GDP increases; the negative impact on the environment decreases; resource exhaustion (resource consumption = 0 or unchanged) is at best decreasing; water and air pollution decreases; consumption volumes are increasing; the competitiveness of the economy is growing; the number of jobs is increasing.

7. 3 basic fundamental pillars of the global inclusive circular economy are singled out: inclusiveness of the population; formation of human value; human well-being: the main focus is on the use of people as a critical actor in the new economy, where they are seen as the driving force supporting the biosphere (the human-as-resource model) and the technosphere (the human-as-service model).

8. **The global inclusive circular economy** is aimed at creating positive social externalities at each stage of circular economy implementation. That is, the inclusive and social component is rather a driving force, and not just a philosophical reason. That is, we are talking about the possibility of receiving the greatest benefits of life for the weakest sections of the population and the least developed countries. Therefore, such an evolutionary path involves certain metamorphic changes or peculiar so-called "shifts" during the transition from the philosophy of recycling to the philosophy of circularity of the economy. And this forms the so-called simulation models in the form of global chains of creation of added value, the purpose of which is reducing the

coefficient of energy and material use, as well as applying additional investments for the transition to circular models (for example, 3% of GDP per year (Poland, Czech Republic)). In the process of the 4.0 revolution, the circular economy is both its consequence and its conclusion.

9. **The main goal of the global inclusive circular economy is** to solve two global problems: waste disposal and poverty alleviation. Both are consequences of human activity. These questions can be solved using circular thinking. There is global recognition that the system we live in was designed with a narrow economic approach. Expanding it by incorporating other dimensions will encourage innovation.

The main results of the study were published in: [23; 24; 25; 26; 27; 28; 32; 38; 40; 41; 44; 47; 49; 49; 50; 375;].

CHAPTER 2

METHODOLOGY OF SYSTEM ANALYSIS OF THE GLOBAL INCLUSIVE CIRCULAR ECONOMY

2.1. Directions of implementation of the EU action plan in the field of global inclusive circular economy.

Politicians around the world advocate the introduction of circular business practices. The Dutch government's ***Green Deal*** offers help to companies that realize the opportunities of the circular economy. Some governments have created working groups to remove regulatory barriers, such as the Resource Efficiency Working Group in Denmark, which aims to identify risks to the implementation of circular economy practices in existing regulations and propose options to overcome them. Until recently, UK law made it illegal for city dwellers to rent out their homes on a short-term basis using websites such as Airbnb. Legislation was changed in 2015 to legalize this practice. The Scottish Government, in setting up the Material Brokerage Service, aimed to aggregate contracts for the 3 million tonnes of recycled materials collected annually across 200 government agencies, forming an efficient supply chain. China decided to stimulate the use of secondary materials in production processes by reducing by 50–100% VAT on goods produced from them [126; 128; 151; 174].

There are two complementary directions for accelerating the formation of a circular economy. **The first** is to focus on market and regulatory failures. **The second** is the activation of market activity by using the following tools:

- setting goals;
- change in public procurement policy;
- creation of platforms for cooperation and provision of financial or technical support to enterprises.

Table 2.1

Formation of circular economy policy (based on scientific research)

Literature	Offers
European Commission study "Scoping study to identify potential circular economy actions, priority sectors, material flows and value chains" (2014)	13 barriers to the transition to a circular economy have been identified; 3 types of political intervention
EREP research is a European resource efficiency platform,	manifesto and recommendations for circular economy policy
Research by the Environmental Audit Committee of the UK House of Commons Environmental Audit Committee "Growing a circular economy: Ending the throwaway society" (2014)	The first priority is to implement the circular philosophy
University College London study "Policy Options for a Resource Efficient Economy" (POLFREE)	Effective use of resources (both secondary and primary)
Research by the European Environment Agency "Resource efficiency in Europe"	The basic ideas of building such a society with clear guidelines are laid out
Resource Efficiency Program (ProgRess) (2012). Federal Ministry of the Environment, Nature Conservation, Construction and Nuclear Safety of Germany (BMUB)	Reducing environmental damage and increasing jobs due to the introduction of a circular economy

Source: constructed by the author based on [182]

The study of the European Commission identified 13 barriers to the transition to the circular economy, starting from the insufficient level of qualification of employees and the amount of investment in the development of secondary products and ending with the incoherence of policies in this area.

Three types of political intervention are proposed, which should be carried out to overcome the barriers [126; 128; 151; 174]:

I. regulatory instruments:
   – implementation of current legislation;
   - revision of relevant legislation;
   – new measures or rules;

II. other tools and approaches:
   - voluntary agreements;
   – fiscal incentives, including taxes, fees, information and advisory services, awareness campaigns;

III. public investment, for example in R&D, skills development and training and infrastructure, industrial symbiosis and clusters, and green public procurement.

Research EREP is a European resource efficiency platform, a manifesto and recommendations for circular economy policy (2012) [174] (Table 2.1). Measures for the introduction **of a circular, resource-efficient and sustainable economy in the EU** include:

- ❖ encouraging innovation and accelerating public and private investments in resource-efficient technologies and systems;
- ❖ implementation and use of "smart" regulation, standards and codes of conduct;
- ❖ cancellation of subsidies and tax benefits;
- ❖ creating better market conditions for goods and services that have a shorter life cycle and that are durable, repairable and recyclable;
- ❖ prevents a shortage of resources in the field of politics at the national, European and global levels;

- ❖ determination of policy goals for all economic entities with the aim of increasing the efficiency of the economy and the development of society by 2020;
- ❖ measuring progress related to land use, materials, water and greenhouse gas emissions, as well as biodiversity.

Committee ***of the UK House of Commons Committee*** in the context of the growth of the circular economy (2014) developed the following recommendations for the country's government:

- reform taxation and producer responsibility rules to reward companies that develop more secondary products;
- provide information about the location of materials;
- to provide local authorities with the right to directly manage the processes of collecting and processing materials, including food waste;
- establish longer warranty periods for consumer goods;
- set new standards for eco-design;
- cease operations of enterprises that use non-recyclable materials in the presence of better alternatives;
- use public procurement standards to promote the development of the circular economy;
- to encourage the Green Investment Bank to finance innovative circular economy technologies.

University College London (UCL) researchers in the study **"Policy Options for a Resource-Efficient Economy" (POLFREE)** supported the initiatives of the European Commission regarding the efficient use of resources. A new combination of policy, business models, and global governance mechanisms is proposed, with the help of which it is possible to increase the efficiency of resource use [176; 199; 207].

Main working tools:

* **find out the reasons for inefficient use of resources;**
* **develop new concepts and paradigms for resource efficiency improvement policies;**
* **develop scenarios and simulate directions for the implementation of the policy of effective use of resources;**
* **provide support in resource efficiency policy management.**

The following institutes are involved in cooperation: *University of Wuppertal, TNO, Maastricht University, research institute in Osnabrück, Institute for Sustainable Development of Europe (Vienna), Potsdam Institute for Climate Change Research and others*.

The European Environment Agency highlighted the issue of resource efficiency in Europe, outlining policy directions and main approaches in the 31 EEA member countries and partner countries (2011).

Based on the results of the review of policies and tools for the efficiency of resource use in 31 European countries with the aim of analyzing national experience in the development and implementation of policies for the effective use of resources, the following **conclusions were made**:

- ✓ **there is no clear definition** or common understanding of the term "resource efficiency" between countries;
- ✓ **only Austria and Germany** (as well as the Flanders region in Belgium) have a special strategic document for the efficient use of resources;
- ✓ **the priority resources** most often reported by countries are energy carriers (22 mentions), waste (18), minerals and raw materials (16), water (14);
- ✓ **strategic goals for increasing the efficiency of resource use** are quite general in nature; most often it is about ensuring a more

efficient use of resources, increasing the volume of waste processing, increasing the share of renewable energy sources and preventing the occurrence, etc.

The German Federal Ministry for the Environment, Nature Conservation, Construction and Nuclear Safety (BMUB) developed *the Resource Efficiency Program (ProgRess) (2012)*.

The development of the Resource Efficiency Program (ProgRess) is aimed at increasing the efficiency of resource use, which will make it possible to reduce environmental damage, increase the competitiveness of the German economy, create new jobs and ensure long-term employment.

In 2002, the German government set a goal of doubling the productivity of raw materials by 2020 compared to 1994. The *ProgRess program* contributes to its achievement. Strategic approaches and established measures have been identified, such as strengthening efficiency consultations for SMEs, supporting environmental management systems, taking into account resource aspects in standardization processes, using resource-efficient products and services in the field of public procurement, applying product labeling and certification schemes, and improving closed-loop management. Examples of material flows and technologies important for strategic approaches are bulk metals, rare and strategic metals, photovoltaics and electric mobility, sustainable construction and closed-loop management of plastic waste. The country's government will report every four years on progress in this direction.

Thus, it is proposed to take into account the possibility of forming an integrated circular policy circle with a combination of the necessary directions: sharing economy (sharing economy), circular, socially inclusive.

Along with that, it is worth outlining the basic ideas of the sharing economy *(sharing economy)* [406], which is an economic model often defined as a peer-to-peer (P2P) activity of acquiring, providing, or sharing access to goods and services facilitated by a community-based online platform. Communities of people have shared the use of assets for thousands of years, but the advent of the Internet - and its use of big data - has made it easier for asset owners and those seeking to use those assets to find each other. This dynamic can also be called the share economy, shared consumption, collaborative economy, or peer economy. Sharing economies allow individuals and groups to make money from idle assets. Thus, physical assets are classified as services. Take, for example, car-sharing services like *Lyft and Uber*. According to the Brookings Institution, private vehicles are unused for 95% of their lives. The same report detailed Airbnb's cost advantage over hotel space, as homeowners use spare bedrooms. Airbnb rates are reported to be 30 to 60% cheaper than hotel rates around the world. **The sharing economy** has evolved over the past few years, where it now serves as an umbrella term for a range of online economic transactions that may even include business-to-business interactions.

Freight leads to 20% of urban traffic and causes 50% of urban road transport carbon emissions. It is responsible for 60% of air pollution caused by urban road transport.

Other platforms that have joined the sharing economy include [291]:

cooperation platforms - companies that provide shared workspaces for freelancers, entrepreneurs and home workers in major cities.

lending platforms - companies that allow individuals to provide loans to other individuals at rates that are cheaper than those offered through traditional lending institutions. Fashion platforms are sites that allow individuals to sell or rent their clothing.

freelance platforms - sites that offer cooperation with freelancers in a wide range, from traditional freelance work to services traditionally reserved for handymen. Accelerated primarily by the growth of Uber and Airbnb, the sharing economy will grow from $14 billion in 2014 to a projected $335 billion by 2025.

Modern critics of the sharing economy often draw attention to *regulatory uncertainty*. Businesses that offer rental services are often regulated by federal, state, or local governments. Unlicensed providers of rental services may not comply with these rules or pay associated costs, giving them an "unfair" advantage to offer lower prices. There is also concern that the greater amount of information posted on an online platform may create racial and/or gender bias among users [297].

Airbnb has faced complaints of racial discrimination from African-American and Latino tenants. In what is called collaborative consumption, the sharing economy, or the peer-to-peer economy, owners rent out something they don't use, such as a car, house, or bicycle, to a stranger through these peer-to-peer services. The company usually has an ***eBay rating*** or review system so that people on both sides of the transaction can trust the other. Due to the popularity of these services, many people do not have to buy when others can rent: *Airbnb, DogVacay, RelayRides, TaskRabbit, Getaround* [291].

The explosive growth of the sharing economy has surprised even optimistic market experts. On the one hand, there are currently many thousands of platform economies operating in virtually every sector and activity around the world. Yes, in 2009, there were several of them: ***Zipcar, BlaBlacar and Couchsurfing. Airbnb*** was launched in the fall of 2008, Uber in the spring of 2009 [291].

But this is no longer an advantage of the millennium, but a part of modern society. At the same time, the sharing economy has lost some of its

original appeal. In the early days, there was rarely a conversation about how the sharing economy could responsibly mitigate hyper-consumption and truly build shared connections. These benefits have not disappeared, but it is increasingly difficult to find sharing economy platforms that practice these principles in reality. The focus shifted to **usability, price, and transactional efficiency**: "community" as a commodity.

In this process of "in-progress" growth, we cannot forget that building a thriving, stable sharing economy platform depends largely on changes in mindset and trust. Platforms that seek to grow too quickly (or spend money too quickly, or assume that demand will be exponential) or compromise customer trust (which is hard to build and very easy to lose) may find themselves facing tough decisions.

In a world with a fast-growing economy, ever-shrinking resources, overpopulated cities and unexpected prices, the sharing economy in combination with the circular economy looks like a clear path and vector of development for many countries.

Clear **advantages of the sharing economy** are:

- ***Flexibility:***

In this market, you don't need to "own" what is used - because the schedule is always flexible. For example, with the development of the sharing economy, the ability to work as a digital nomad from anywhere in the world is 1000 times easier. With shared transportation platforms such as Spanish Ecooltra and Yego, e-scooter, Bicing; long-distance ride-sharing platforms Amovens and Blablacar; or German car2go and drivenow, which offer car sharing companies in major European cities.

- ***Independence:***

For those who don't care about a traditional job, the community economy doesn't require a professional work environment, so there's no need to stay in

an atmosphere that matches your personality. The best example of this is the large number of co-working spaces that are piling up. Even more professions that allow you to neutralize the atmosphere choose to work remotely, rather than in one physical space.

- ***Sustainable use of resources in the direction of circular economy:***

The sharing economy helps consumers earn money by renting out unused goods or resources, enabling the development of a variety of circular smart startups. For example, renting out a house using Airbnb, expensive tools from the garage, cars, or even sharing leftovers in the fridge before going on holiday. All of this helps to reduce waste, and provides a way for items to be resold and reused.

- ***Building trust in the community:***

The sharing economy, like the circular economy, is based on trust and cooperation between users and suppliers. Ratings and ratings are an expected part of every platform, promoting the honesty and transparency that are key components of a successful sharing economy. Barcelona's Badi platform, which aims to make city life accessible to everyone, everywhere by connecting people to shared spaces, is a great example of how the sharing economy is largely driven by the people in it.

- ***Economic benefits:***

An obvious benefit of the sharing economy is the financial benefits it allows consumers. According to Deloitte's report on the economic impact of Airbnb, consumers save an average of $88. for the night, staying in the proposed Airbnb space, as opposed to traditional accommodation. These economic benefits not only help users and service providers, but also the workers who work on these platforms around the world.

But along with the obvious benefits, it is worth highlighting **the potential disadvantages of the sharing economy**:

- ***Security:***

most sharing economy platforms are based on trust and guest and host ratings.

- ***Absence of regulatory acts:***

Another disadvantage is that in many cases there is a lack of regulation and control over the products and services exchanged in these transactions. For example, hotels are inspected for quality assurance, while Airbnb apartments are not. The digital approach of the "sharing economy" model is not consistent with current laws and regulations, and the provision of economic services does not have to meet certain regulatory requirements, which, on the other hand, helps to preserve the services provided.

- ***Uncertain future:***

The sharing economy, like the circular economy, undoubtedly has its fans and those who consider it a "cosmic" concept. Many are not ready to move to this model, where others already use more than four platforms in their daily lives.

- ***Volatility of income and benefits:***

While the sharing economy offers many opportunities in terms of working hours, travel and freedom, jobs can be more unstable and unable to provide a living wage. Employees must pay for the costs associated with running a business (maintenance, insurance, etc.), which take the lion's share of their income. The bottom line is that consumers and businesses continue to evolve, and the sharing economy will evolve with them. If someone is "just looking to make some extra money" to pay off debt or save up for a big purchase, this can be a great way to make some extra cash. If consumers see it as their only source of income, it can be much more difficult.

As an aid in reusing resources and reducing waste, **the sharing economy** is one of the most important models at the moment. With the ever-increasing

popularity of "sharing" and the rise of the sharing economy (concern economy, shared consumption, etc.), companies around the world are making it fast, easy, and cheap to get goods and services, meaning the process is inclusive.

The EU has approved the implementation of an ambitious **"Economic Package" cycle,** which contains measures that help stimulate Europe's transition to *a circular economy*, strengthen global competitiveness, promote sustainable economic growth and create new jobs. Accordingly, the "Circular package" of economic measures in the EU action plan is based on circular goals for waste processing. On the basis of such goals, legislative proposals on waste disposal were adopted in order to implement EU actions in the field of circular economy. Since plastic is an important and widely used material in our economy and everyday life, there is an emphasis on the need to implement global measures for its recycling. The opportunities and problems associated with the disposal of plastics are becoming more and more global, and solving these issues will greatly contribute to the achievement of the sustainable development goals by 2030. The main goals and mission of the circular economy, the vision of the new economy of plastics production in Europe are outlined, and measures to introduce the industry into the circular process are proposed.

> Freight leads to 20% of urban traffic and causes 50% of urban road transport carbon emissions. It is responsible for 60% of air pollution caused by urban road transport.

In December 2015, *the European Commission* adopted the EU Action Plan for the circular economy, which defines the circulation of plastics as the main priority, undertaking to solve the issue of plastic waste disposal ("*prepare a strategy addressing the challenges posed by plastics throughout the value chain and taking into account their entire life-cycle*" [118]). In 2017, the European Commission confirmed that manufacturing activities will focus on the

production and use of recycled plastics in order to fully recycle plastic packaging by 2030.

The European Commission adopted an ambitious cycle of measures **"Economic Package".** Accordingly, the "Circular Package" of the economy covers the EU Action Plan for the development of the circular economy. In general, it defines an action program with measures covering the entire cycle of operation from production and consumption to waste management and the market for secondary raw materials. The annex to the action plan defines the time limits when the actions will be carried out.

The proposed measures will contribute to the "closing" of the product's life cycle by increasing the volume of recycling and reuse, which will ensure benefits for both the environment and the economy.

The revised legislative proposals on waste set goals for reducing their volume and define long-term measures for handling and recycling. Therefore, the EU action plan proposes the following circular goals for waste processing:

* the common goal of the EU is to recycle 65% of the volume of municipal waste by 2030;
* the common goal of the EU is to recycle 75% of packaging waste by 2030;
* obligatory weighing of waste, arrangement of the landfill with the aim of destroying up to 10% of the volume of municipal waste in general by 2030;
* ban on landfills of separately collected waste;
* promotion of economic instruments that prevent waste disposal;
* simplifying and improving the definition and harmonized methods of calculating disposal rates in the EU;

* specific measures to promote reuse and stimulation of industrial symbiosis – transformation of one branch by-product into another raw material of industry;
* economic incentives for manufacturers to market environmentally friendly products and support recovery and recycling schemes (eg for packaging, batteries, electrical and electronic equipment, vehicles).

Within the defined goals, the following legislative proposals regarding waste were adopted with the aim of implementing **EU actions** in the field of *circular economy* [118]:

- ✓ the proposed Waste Directive;
- ✓ an addendum to the proposed Waste Directive was developed;
- ✓ proposed Directive on packaging waste;
- ✓ an addendum to the proposed Directive on packaging waste was developed;
- ✓ the proposed Landfill Directive;
- ✓ the proposed Directive on electrical and electronic waste, end-of-life vehicles, batteries and accumulators and spent batteries and accumulators;
- ✓ provided analytical information on the goals of waste management;
- ✓ a staff working document was created - an implementation plan.

Plastic is a widely used material in everyday life. It performs certain important functions. The use of products made of this material makes it possible to solve certain problems in society. Innovative materials used in automobile and aircraft construction make it possible to save fuel and reduce CO_2 emissions. Highly efficient insulating materials help conserve electricity. Plastic packaging ensures the safety of food products and contributes to the reduction of food waste. In combination with 3D printing, biocompatible

plastic materials, using medical innovations, make it possible to save people's lives.

There is an urgent need to solve the environmental problems created by the production, use and consumption of plastics today. Plastic waste entering the oceans is one of the signs of environmental problems causing public concern.

To rethink and improve the functioning of such a complex value chain, it is necessary to ensure the cooperation of all the main market players: from plastic manufacturers to processors, retailers and consumers. It also requires innovation and a shared vision to drive investment in the right direction. Plastic production is a very important area for the European economy. Increasing its sustainability will provide new opportunities for innovation, competitiveness and job creation in accordance with the goals achieved by the renewed EU Industrial Policy Strategy [151; 152] .

The EU can ensure the transition to **circular plastic production**. This strategy is based on the new plastic economy, where the development and production of plastic products fully take into account the needs of its reuse, repair and recycling. This will make it possible to reduce the volume of environmental pollution with plastic waste and its adverse impact on our lives and the environment. Implementation of the strategy's objectives will also enable the achievement of the priorities, the Energy Union with modern economies with low carbon emissions, resources and energy efficiency, contributing to the achievement of the 2030 goals of sustainable development and the Paris Agreement.

The strategy offers basic commitments for action at the EU level. At the same time, the private sector, together with national and regional bodies, authorities and citizens must also mobilize. International cooperation is necessary primarily for changing the external borders of Europe. By acting

together, Europe can turn challenges into opportunities and be a driver of change at an alterglobal level.

Under these conditions, alternative types of raw materials (such as bioplastics or plastics made from carbon dioxide or methane) are being developed that offer the same functions of traditional plastics with a potentially lower environmental impact, but currently represent a small market share. Increasing production alternatives will also reduce dependence on fossil fuels.

A very large amount of plastic waste is thrown away, which leads to environmental pollution (both land and seas) and significant economic and ecological losses. In the world, from 5 to 13 million tons of plastic (1.5% - 4% of the volume of global plastic production) falls into the oceans every year. According to estimates, plastic makes up more than 80% of marine litter. Plastic waste is transported by ocean currents over very long distances. Damage to the marine environment in general amounts to 8 billion dollars. per year worldwide [118].

In the European Union, from 150 to 500 thousand t of plastic waste enters the oceans every year. This is a small fraction of the volume of global marine litter. However, plastic waste from European countries ends up in particularly vulnerable marine areas, such as *the Mediterranean Sea* and *parts of the Arctic Ocean*. Studies confirm that plastics are accumulating in the Mediterranean Sea at a density comparable to that found in areas of the highest plastic pollution in the oceans. Plastic pollution also affects areas of the European Economic Area, the outermost regions along the Caribbean, Indian, Pacific and Atlantic oceans. In addition to environmental damage, marine litter causes economic damage,

In China, implementing circular economy opportunities would decrease the consumption of non-renewable resources, including fossil fuels, by 49% in 2030 and 71% in 2040.

particularly in activities such as tourism, fishing and shipping. For example, the share of economic damage from garbage in fishing in the EU was estimated at approximately 1% of the total amount of fishing income of the EU countries [152].

This phenomenon is exacerbated by the growing volume of plastic waste generated each year due to the increased consumption of "single-use" plastics, i.e. packaging and other consumer goods that are thrown away after one short-term use, rarely recycled and litter the environment. These include small packages, bags, disposable cups, lids, cutlery, for the manufacture of which plastic is widely used due to its lightness, low cost and practical functions.

New plastic production is also increasing, creating additional potential threats to both the environment and human health. Microplastics (tiny fragments of plastic smaller than that 5 mm) accumulate in the sea and can also get into food production. Conducted research made it possible to detect microplastics in the air, drinking water and food products, such as salt, honey, with a still unknown impact on human health.

In general, every year in the EU, according to the assessment, about 75,000 to 300,000 tons of microplastics are thrown away. Although a large amount of microplastics is formed by the fragmentation of larger pieces of plastic waste, a significant amount also ends up in the environment, making it difficult to track and prevent the formation of its microparticles. In addition, the increase in the market share of plastics with biological properties provides both new opportunities and creates certain risks. In the absence of clear labeling for consumers and without proper collection and treatment of waste, this can negatively affect the production of plastics and create problems for its mechanical recycling. However, bioavailable plastics can be used in some areas, which will contribute to the development of innovative activities in general.

As circular plastic value chains become cross-border, the challenges and opportunities associated with plastics production need to be seen in the light of international developments. For example, China recently decided to limit the import of certain types of plastic waste. Today, there is a growing awareness of the global nature of societal challenges. This is evidenced by international initiatives on marine litter disposal, for example, the UN Global Partnership Agreement on Marine Waste Disposal and action plans put forward by the G7 and G20. The resolution on disposal of marine debris and microplastics was adopted at the UN session in December 2017.

The mission of the circular economy is to strengthen cooperation between the EU and developing countries in the field of environmental protection through the conclusion of political agreements aimed at stimulating the circular economy, "green" public procurement and innovative, sustainable and inclusive growth.

Green solutions are encouraged through overseas partnerships to address the environmental challenges facing developing countries. In particular, meetings of European and local entrepreneurs are organized and opinions, experiences, etc. are exchanged.

In particular, the missions are outlined by topics related to eco-innovations, the production of chemical and plastic products, waste disposal, water resources, environmental pollution and the experience of the urban population, etc. These issues require multilateral discussion, as they involve the adoption of innovative business decisions. For example, the use of modern technologies can help reduce the destructive impact of waste on the environment.

In order to obtain **advantages** in the implementation *of the circular economy*, European countries should develop a strategic vision, defining the main tasks of the circular economy of plastics for the coming decades. This

vision should encourage investment in innovative solutions and turn today's challenges into opportunities.

While the EU will propose **specific measures** to implement its vision, all players involved in the plastic value chain need to work together to achieve this goal: from plastics manufacturers and designers to brands and retailers to recyclers. Similarly, civil society, academia, business and local authorities will play a critical role in reaching agreements, working with regional and national governments to bring about positive change.

An innovative and sustainable plastics industry, where design and production fully meet the needs of reuse, repair and recycling, contributes to the growth of jobs in Europe, as well as the reduction of greenhouse gas emissions and dependence on imported fossil fuels.

Plastics and products containing plastics are intended to ensure greater durability of products, their repeated use with high-quality processing. By 2030, plastic packaging on the EU market can be reused or recycled in an economically efficient way (Fig. 2.5) [172; 169; 296].

Changes in production and design make it possible to increase the level of recycling of plastics in all directions. By 2030, more than half of the plastic waste produced in Europe is planned to be recycled. The volumes of waste disposal of plastic packaging reach high rates compared to other packaging materials.

As this circular economy fact shows in highly industrialized countries like China, access to key consumer products is essential to maintaining a productive workforce. But the current linear economy will lead to scarcity of natural resources and dangerous levels of emissions.

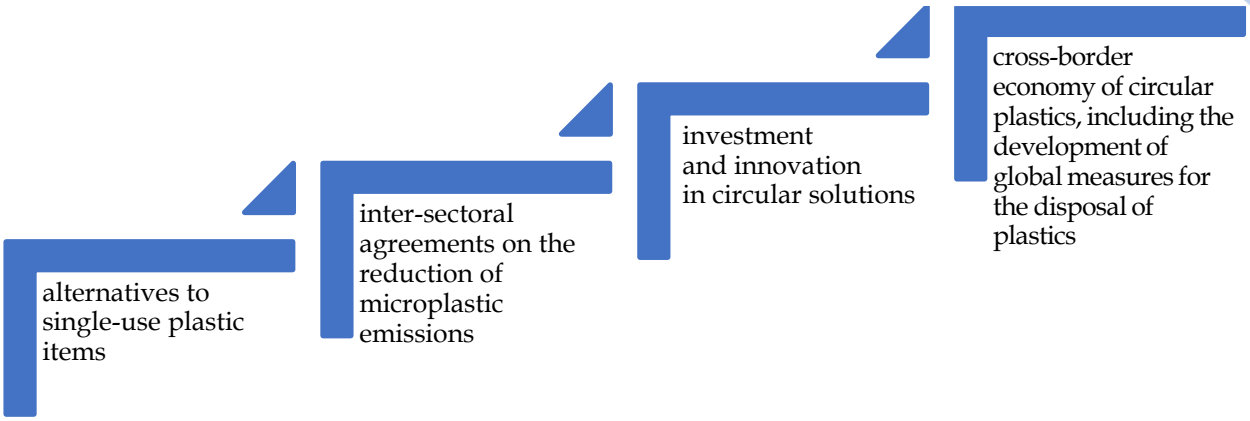

Fig. 2.5. **Measures to introduce industry into the circular process**

Source: constructed by the author

The activities *of the EU countries* in the direction of plastic processing are being significantly expanded and modernized. Thanks to the improvement of individual collection and investment in innovation, increasing the qualifications of employees and the capacity of business entities, the export of unsorted plastic waste has been abolished. Recycled plastics are a more valuable raw material for industry both domestically and abroad.

value chain is more integrated. In particular, plastic waste recycling technologies are actively used in the chemical industry. Accordingly, substances that prevent processing have been replaced or gradually removed.

The market for the creation of recycled and innovative plastics is growing successfully, as the number of **recycled products increases**. Demand for recycled plastics in Europe has quadrupled, providing a steady flow of material to the recycling sector.

The increase in the amount of plastic recycling contributes to reducing Europe's dependence on imported fossil fuels and reducing $CO_{2\ \text{emissions}}$ in accordance with the obligations of the Paris Agreement. Innovative materials and alternative raw materials for the production of plastics are used under the condition of their advantage compared to non-renewable resources. This, in

turn, contributes to the reduction of carbon emissions and creates additional opportunities for economic growth. Europe confirms its leadership in waste sorting and processing with advanced equipment and progressive technologies. The governments of European countries pursue a policy of consumer rights protection, which accordingly affects the methods of production of plastics. This creates favourable conditions for social innovation and entrepreneurship, as well as many opportunities for Europeans.

Consumers as the main players are informed about the main benefits and can therefore actively contribute to the transition to a circular philosophy. Improved design, new business models and innovative products are emerging, offering more sustainable consumption patterns.

Many entrepreneurs identify the need to take decisive action to prevent the creation of plastic waste as a business opportunity. The activities of companies that develop and provide circular solutions (for example, reverse logistics for packaging or alternatives to single-use plastics) are considered promising.

The leakage of plastic into the environment is drastically reduced every time, as effective waste collection systems, together with a reduction in the volume of this waste generation and an increase in consumer awareness, make it possible to prevent the accumulation of waste and ensure that it is properly processed. New solutions have also been developed to prevent the release of microplastics into the sea.

The EU occupies a leading position in the global dynamics of production. Countries cooperating in circular production stop the flow of plastic emissions into *the ocean* and take appropriate measures to prevent the accumulation of their waste. To move to an alternative or circular vision, the transition strategy proposes an appropriate set of measures in the EU based on the implementation of the principles of effective regulation. In particular, any

measure that may have a significant socio-economic impact will be accompanied by an assessment of this impact. Recognizing the importance and necessity of joint efforts, the strategy also identifies key measures for national and regional authorities and industry.

Increasing plastics recycling **can provide** significant environmental and economic benefits. A higher efficiency of plastic processing compared to other materials can be achieved only by improving the way of manufacturing and designing plastic products. It will also require increased cooperation through a targeted circular network: from industry as plastics producers and recyclers to public and private waste management companies. Basically, **the main players** must cooperate to:

- improving the design of production products and supporting innovation, which facilitates the processing of plastics and plastic products;
- expansion and improvement of separate collection of plastic waste to ensure high-quality recycling;
- expansion and modernization of sorting and recycling in the EU;
- creating viable markets for recycled and renewable plastics.

Over the last period, *the European Commission* has facilitated the cross-sectoral dialogue and is now calling on its participants to make concrete commitments to support the 2030 circular economy strategy.

New waste management rules have been proposed to implement the goals of the strategy. They set out the obligations of national authorities to strengthen measures for the separate collection of waste, the objectives aimed at encouraging investment in recycling and avoiding the overproduction of infrastructure facilities for the processing of mixed waste (e.g. incineration) and the need to develop agreed rules on extended producer responsibility. The European Commission called on the co-legislators to agree on the adoption of

new rules. In general, the introduction of new European legislation will make it possible to improve the current situation, stimulating public and private investments in the appropriate direction. However, additional and targeted measures are needed to supplement waste legislation and remove barriers specific to plastics production.

The opportunities and challenges associated with the production of plastics are becoming increasingly global. Solving these problems will largely ensure the achievement of the 2030 goals of sustainable development. Outside of Europe, per capita consumption of plastics is growing rapidly, particularly in Asia. Global circular networks and plastic production chains are being developed across the continent, and plastic waste is traded internationally. In the EU, about half of the collected plastic waste is sent abroad, where the methods of its treatment remain uncertain. More than 85% of exported plastic waste is now transported to China. However, the situation is changing after China banned the import of some types of plastic waste, which creates opportunities for processors in the EU.

In many countries of the world, appropriate systems for the prevention, collection and processing of plastic waste are needed. Marine debris from one country can end up on the territory of another, and fragments of plastic from all over the world accumulate over time in oceans and seas, being carried by currents. International cooperation is crucial to solving this problem. The world's oceans and seas are global heritage. And if the current trend does not change, it could have a legacy effect for future generations through the degradation of marine ecosystems and threats to human health. Establishing reliable waste prevention and

The world generates 49 Mt of e-waste worth USD 63 billion, per year, only 20% is collected and recycled under appropriate conditions.

management systems, especially in developing economies, is essential for the preservation of marine products [294].

The EU will continue to support international action to promote best practices and use its own external funding instruments to support the improvement of waste prevention and management worldwide. In particular, the European Commission will conduct political dialogues on issues of environmental protection and industrial development within the framework of free trade agreements and actively cooperate in accordance with the agreements of regional maritime conventions. The EU will also actively participate in the working group established by *the United Nations* Environment Assembly in December 2017 to develop international measures to combat plastic marine litter and microplastics. In 2018, the European Commission launched a specialized project to reduce plastic waste and marine litter in East and Southeast Asia, where this problem is becoming more and more acute. Possible ways to reduce pollution in the Mediterranean Sea supported by the Barcelona Convention and in the world's river basins are also considered, as a large proportion of waste plastics are carried by rivers before they enter the sea. The European Commission will also promote the cooperation of the most important regions of the EU with the neighboring countries of the Caribbean, Indian, Pacific and Atlantic oceans in various areas, including waste management and disposal.

The EU has achieved the highest level of plastic recycling in the world. With targets to improve packaging recycling, European countries have ample opportunity to introduce new developments, supporting in particular investments in modern recycling technologies, new improved recycling materials and solutions to limit marine litter emissions. It is also important to ensure that plastic waste sent abroad for recycling is treated under conditions similar to those applied in the European Union in accordance with the rules

for the shipment of such waste, supporting waste management actions under the provisions of the Basel Convention and developing an EU certification scheme for recycling plants. Global efforts are also needed to promote the widespread use of secondary and recycled plastics.

Therefore, the challenges related to the production, consumption and service life of plastics can be one of the opportunities for the economic development of the EU and the growth of the competitiveness of the European industry. Addressing these issues while forming an ambitious strategic vision for them, covering the entire value chain, will stimulate economic growth in general, more jobs and innovation. European leadership in global decision-making will enable the transition to a circular economy, providing citizens with a cleaner and safer environment.

The starting point for the implementation of the idea of a paradigm shift in Europe was the Roadmap to a Resource-Efficient Europe in 2011, which was the first step towards developing holistic actions, covering different policy areas and industries. The document sets out the steps towards the integration of circular economy logic throughout the EU and emphasizes the key success factor – the involvement of a wide range of stakeholders in prioritization, implementation and management. Subsequently, the European Commission supported a fully circular economy in the Manifesto for a Resource-efficient Europe (European Commission, 2012), which calls for a circular, resource-efficient and flexible economy. The latest EU-level planning for the circular economy was the EU Action Plan for the Circular Economy (European Commission, 2015), part of the circular economy package. The action plan offers an overview of economic planning policy topics that are mega important at the EU level: production; consumption; waste management; market of secondary raw materials; industry actions on plastics, food waste, critical raw

materials, construction and demolition, biomass and bio-based materials; innovation and investment; monitoring.

In addition, the European Commission has started defining strategic documents continentally, sectorally in terms of the circular economy, a defining example of which is the published European Strategy for Plastics in a Circular Economy (European Strategy for Plastics in a Circular Economy (European Commission, 2018)).

2.2. An index approach to assessing the circularity and inclusiveness of the economy

Improvements in the implementation of legislation and the application of management systems, transparent monitoring and other actions are necessary to achieve the environmental goals of the circular economy. Increasing the awareness of the business sphere about the state of the environment, the awareness of employees and consumers is equally important, as are the components of production, consumption and waste disposal. Specialists of environmental and other governmental institutions, and scientists from different countries have developed and implemented a single set of indicators in evaluating the circular economy [127; 343].

At the lowest level - *micro levels* – depending on the characteristics and conditions, different sets of indicators are developed to implement the principles of circular economy at different enterprises. The set of indicators should contain general indicators for evaluating the enterprise (for example, in industry) and specific indicators in accordance with the specifics of the activity of a particular business entity. Thus, a set of indicators was developed in 2009 by the Chinese scientist A. Cheng (A. Cheng) for an *iron and steel production enterprise*. Thus, 4 indicators were proposed for consideration at the initial

level, 12 at the second level, and 66 at the higher (third) level. Other scientists (Du, Cheng (2009)) focused on indicator systems, displaying them at the meso- or sectoral level. Scientists used the DEA efficiency analysis method with nine indicators and the Malmquist index [8]to evaluate the production of enterprises in the metallurgical industry. In 2014, Wu and other economists analyzed the effectiveness of circular economy policies using DEA.

Other researchers (in particular, Shi (2008) used 22 indicators to evaluate production barriers, including political, financial and economic, technical and informational, managerial and organizational, etc. X. Geng in 2010 developed a system of indicators to evaluate the overall environmental performance of an industrial park, and based on energy, Y. Wang and other scholars in 2008 considered the possibility of interaction between barriers to save energy [162; 188; 342].

Two Chinese government agencies **NDRC and MEP**[9] developed at *the meso-level,* two systems of indicators aimed at researching the activity of eco-industrial parks. The NDRC indicator system has 13 indicators grouped into four groups: production resource ratio, resource consumption level; the level of comprehensive use of resources; the level of the rate of reduction of waste water discharge (table 2.2). They are based on the principles of *3R* - reuse, reduction and disposal of industrial waste. The MEP indicator system has 21 indicators. They are grouped in the same way as in the NDRC system. However, the MER system differs in structure, as it covers economic development, reduction and disposal, environmental pollution control,

[8] And index, Malmquist (Malmquist productivity index, MPI) are used in the field of regulation of natural monopolies. The index characterizes changes in the company's productivity over time. This index has components characterizing changes in efficiency and technology over the period under study. The Malmquist index is calculated in practice using the efficiency coefficients determined by the ASF method.
And the analysis of the operating environment (ASF) is one of the most popular methods of analyzing the effectiveness of activities and evaluating the operating environment *(Data Envelopment Analysis).* It is widely used to analyze the performance of industrial and agricultural enterprises, banks and medical institutions, universities and schools.

[9] NDRC: National Development and Reform Commission. Ministry of Environmental Protection.

administration and management. Economists-scientists (Geng (2009)) grouped industrial parks according to the MEP system by three sectors of integrated groups and developed three main groups of indicators.

Table 2.2.

A system of indicators on the meso-, macro-, and micro-levels of implementation of the circular economy

A group of indicators	Indicators
Production of resources	Production of the main types of mineral resources, energy output
	Level of use of land resources
	The level of energy production
	The level of production (receiving) of water
Resource consumption	Energy consumption per unit of output
	Energy consumption per unit of output in the main industries (iron, copper, aluminum, cement, fertilizers, paper)
	Water consumption per unit of output
	Water consumption per unit of output in the main industries
Integrated use of resources	Coefficient of use of industrial solid waste
	Reuse of industrial wastewater
	Speed of recirculation of industrial wastewater
Reducing the volume of waste generation	The rate of reduction of industrial solid household waste
	The rate of reduction of the rate of industrial water waste
Economic development	Value added per capita
	Growth rates of added value in industry
Reduction and disposal of materials	Energy consumption per unit of created industrial added value
	Fresh water consumption per unit of created industrial added value
	Generation of industrial wastewater per unit of created industrial added value
	Generation of solid waste per unit of created industrial added value
	Reuse of industrial wastewater
	The level of utilization of solid industrial waste
	The level of reuse of processed treated wastewater
Fighting environmental pollution	Required oxygen per unit of added value created
	SO_2 per unit of created industrial added value
	Level of removal of hazardous solid waste
	Level of speed of treatment of domestic wastewater
	The level of household waste processing
	Waste collection system
	Environmental management system
Administration and management	The degree of installation of information platforms
	Environmental report
	The degree of satisfaction of the local population with the quality of the environment
	The degree of awareness of the population about eco-industrial development

Source: built by the author on the basis of work [127; 343].

The NDRC meso-level system is also used at *the macro-level* , but one such indicator is added: the importance of recycling materials at the regional level . This is in line with the principles of the circular economy and indicates the government's commitment to promoting resource efficiency and maintaining a circular mindset. However, we note that scientists assume a deepening of the system of indicators, which is due to the limitation of the 3R principles and the coverage of only environmental aspects. A more systematic assessment is offered in add. 1, which contains an analysis of the circular economy implementation process in China [127; 342].

In general, China is making significant efforts to implement the principles of a circular economy in order to **ensure the implementation of long-term and sustainable solutions to combat** the problems of acute resource scarcity and environmental degradation [369]. Policy implementation is carried out at the micro-, meso- and macrolevels covering production, consumption and waste management. The concept of a circular economy is based on the assessment of such resources as energy, water, various by-products of production and knowledge. Industrial symbiosis is an expanded concept in which benefits derive from integrated economic and environmental aspects. These aspects jointly promote competitiveness by implementing an efficient allocation of resources and increasing productivity. The repurposing of industrial structures helps to reduce the impact of negative external factors, and also helps to improve the general well-being in society.

As this circular economy fact shows in highly industrialized countries like China, access to key consumer products is essential to maintaining a productive workforce. But the current linear economy will lead to scarcity of natural resources and dangerous levels of emissions.

The concept of the circular economy has been analyzed *by the European Commission, the European Resource Efficiency Platform* (EREP), the Ellen MacArthur Foundation (EMF) and other institutions (EASAC, 2015). The current economic model is based on a linear process that begins with the extraction of raw materials for production purposes and ends with the disposal of waste industrial goods that are no longer used by consumers (take-make-consumedispose). The vision of the European Commission (EC, 2015) is defined in such a way as to support "…the transition to a circular economy, where the value of products, materials and resources is preserved in the economy as long as possible, and the production of waste is minimized. And this is its main aspect (EMF, 2012; Club of Rome, 2015) - it is a general reduction of wasted resources and a general increase of resources that are reused or restored" [13].

As noted in *EASAC* (2015), the main objective of society in a circular economy is to reduce the negative interactions between the economy, the environment and its natural resources to ensure the well-being of future generations, which will contribute to sustainable development.

Among the factors that support the transition from a linear to a circular economy, we will single out the following main ones. Long-term sustainability of existing models of production and consumption. During the 20th century production of building materials increased 34 times, ores and minerals - 27 times, fossil fuels - 12 times. For economic growth, a significant reduction in resources to support sustainable development and a growing world population are necessary (UNEP, 2011, 2016). Business as usual is predicted to lead to scarcity of non-renewable materials such as metals and radical changes in the use of natural resources to produce goods and services and to provide welfare (Angrick et al., 2014). Production (resource decoupling) and reducing

the environmental impact of any resources used (decoupling) are important components of sustainable development.

The above considerations are important for a region like the EU, which has only scarce non-renewable resources and is dependent on imports. The structure of production and consumption must be sustainable in the long-term perspective also with regard to greenhouse gas emissions, the volumes of which must be reduced to zero by 2050 in order to comply with the global warming threshold of 2° C (UNFCCC, 2015). Current global consumption patterns are 50% of sustainable levels (Global Footprint Network, 2015). Since in developed countries 55–65% of greenhouse gas emissions are related to the extraction, transport and processing of raw materials (OECD, 2012), circularity, by reducing the energy required to extract, transport and process these materials, contributes to the reduction of greenhouse gas emissions.

Environmental damage associated with the extraction of resources can be significant. Since the main goal of the circular economy is to reduce the consumption of natural resources, the associated impact on the extraction of these resources and the disposal of waste will also be reduced. The European Commission defines environmental impacts as business risks through regulation aimed at limiting or pricing essential resources (e.g. carbon, water, ecosystem payments, taxes), which can also be reduced in a circular economy.

An additional emphasis in the European Commission's latest action plan is to identify the role of the circular economy in green growth, innovation and job creation that do not depend on an unsustainable linear growth model. Such trends can also contribute to industry competitiveness (EASAC, 2015) [327; 328; 329] .

The indicators used reflect **the level of the circular economy**. There are a large number of indicators that make it possible to determine the state of the environment and the amount of natural resources. They were developed and

proposed to be used by various organizations. The analysis of these issues goes beyond the scope of the study, but we will define some specific sets of indicators that make it possible to measure the level of the circular economy.

The United Nations Environment Program (UNEP, 2013) provides a set of core environmental indicators that can serve as a basis for developing sustainable development goals and indicators for tracking progress in environmental sustainability. They reflect the state of affairs regarding the following global environmental issues:

- **climate change;**
- **destruction of the ozone layer;**
- **production of chemicals and waste;**
- **use of natural resources (air, land, water, biodiversity);**
- **environmental management.**

Recently, UNEP (2016) proposed a new measure of material consumption – the amount of materials needed for final demand (consumption and capital investment) in a country or region (expressed in tonnes per capita).

A comprehensive set of indicators characterizing corporate stability is defined by the Global Reporting Initiative (GRI, 2016). This set of indicators covers three "pillars" of sustainability (economic, environmental and social) . They contain indicators that make it possible to estimate the volumes of materials, energy, water, as well as waste and their disposal. These are data on the activities of companies and other organizations that should be available, as they report on the sustainability of their activities.

Another set of indicators was developed within a joint project of Yale and Columbia universities and the World Economic Forum. An Environmental Sustainability Index (ESI) was developed based on the compilation of 21 indicators in 5 baselines obtained from 76 baseline data (Yale University, 2005). Since 2005, it has been adapted to create the Environmental Indicators Index

(EPI), which makes it possible to compare the level of effectiveness of countries in the field of human health protection from environmental damage and ecosystem protection (Hsu et al., 2014).

The World Bank proposed 50 indicators, which can be used to measure progress towards sustainable development and identify important trends in the environment.

The OECD presented indicators of "green" growth, which consist of 25–30 indicators under four main headings, in particular (OECD, 2014) the following indicators: (Table 2.3) [280; 289].

Table 2.3.

OECD "green" growth indicators

A group of indicators	Indexes
1. Environmental and resource productivity	Carbon and energy productivity
	Productivity of carbon dioxide; energy productivity
	Productivity of resources
	Productivity of water
	Multifactor performance reflecting environmental services
2. Base of natural resources	Stocks of natural resources (index of natural resources) Renewable stocks (fresh water resources, forest resources, fish resources)
	Non-renewable reserves; Mineral resources
3. Ecological aspect of the quality of life	Environmental health risks Environmental services
4. Economic opportunities and responses to political measures	Technologies and innovations Ecological goods and services International financial flows Prices and transfers (environmental taxation, energy pricing, water pricing and reimbursement) Management rules and approaches Training and skill development

Source: constructed by the author based on [280; 289].

The indicators listed above are used as a basis for national indicators of "green" growth in some countries (for example, in Switzerland). Although they contain indicators that characterize the level of the circular economy, more

specific information (which is currently used in several countries) is obtained from economic calculations of material flows (EW-MFA6). They are widely used to determine trends in the efficiency of resource use, but at the same time, data on investments in the development of the national economy, changes in the material stock in the economic system, as well as the conditions for exiting the crisis for other economies or the environment are available.

Advanced indicators of GDP reflect data on GDP (or other indicators of the system of national accounts), but contain some information about some shortcomings in the management of the national economy to provide a more complete assessment of the wealth or well-being of a country.

Social indicators make it possible to analyze a wide range of social issues, problems and trends, such as life expectancy, poverty rate, unemployment rate, disposable income, education level, etc.

Environmental indicators indicate the state and development of the environment and related issues, such as human health. These indicators can also contain information about specific issues, such as water pollution in a certain area or solid waste generation. At the same time, they can be used to assess more general environmental phenomena at the global level, such as climate change and human impact on ecology, etc.

Indicators of well-being are used to illustrate the general satisfaction of people with life or to characterize its quality in more detail by activity and place of work, family, state, health and standard of living [340; 341].

Estimating the inclusiveness of economic growth according to **the methods of international economic institutes** is generally a mathematical tool used to calculate a composite index. Its calculation uses groups of indicators that characterize the dynamics of various processes that affect the resulting inclusive growth, as well as regression equations aimed at quantifying the relevant factors.

We describe the methods of assessing the inclusiveness of growth and provide a list of the main indicators by various methods, in particular, the **UN** method **uses indicators related to income**:

- the share of the population that consumes less than $2. per day (for PCS in US dollars) [231; 2374 347];
- the ratio of income and consumption of the richest 20% of the population to the poorest 20%.

Indicators not related to income:

- average number of years of education (for young and adult population);
- infant mortality rate.

Indicators of growth and expansion of economic opportunities:

- GDP growth rates per capita by PPP (in constant prices);
- employment rate;
- elasticity of the total number of employed to GDP (elasticity of employment).

The main indicators of the infrastructure:

- electricity consumption per capita;
- the share of asphalted roads in the total length of the road network.

Indicators of social equality to ensure equal access to economic opportunities, education and health care services:

- the number of doctors, nurses and midwifery personnel per 10,000 people;
- the share of public spending on education and health care from the volume of total spending;
- the ratio of students to teachers in primary school.

Indicators of access to social infrastructure services:

- the share of the population with access to electricity in the total population;
- the share of the population using high-quality sanitation facilities.

Indicators of gender equality and opportunities:

- gender segregation in primary, secondary and higher education.

Indicators of the system of social guarantees:

- share of spending on social security from the volume of state spending on health care and social security.

Indicators of the effectiveness of the state administration and the activity of public institutions:

- quality of public administration;
- level of corruption.

The assessment of the inclusiveness of growth **according to the IMF methodology** is based on a concept that makes it possible to determine social mobility and analyze the distribution of income among the population and uses the following groups of indicators that reflect inclusive growth:

- macroeconomic:

GDP per capita; debt to GDP; investment volume; inflation rate; state expenses; GDP volatility;

– structural: openness of the economy; educational level; financial openness; volume of direct foreign investment; development of information and communication technologies; infrastructure quality; export of services and goods.

The OECD methodology focuses on different types of resources that can be measured at a given moment and determine the well-being of future generations: economic, natural, human and social capital. This technique is based on three main indicators. The first indicator - multidimensionality - is based on determining the well-being of the population and contains 11

indicators in monetary and non-monetary dimensions. The second - the impact on the distribution - is related to the method of comparing multidimensional assessments of the population's well-being. The third - strategic expediency - allows you to determine the income of households and the state of health care of their members. Europe is at the forefront of the global transition to a low-carbon and circular economy. This is an opportunity to transform the economy and make it more sustainable, create jobs and create competitive advantages for Europe (Figure 2.6).

Therefore, Eurostat offers its methodology and detailed indicators for the EU as a whole and separately for each country, divided into sub-indexes [178] :

Production and consumption:

* Self-sufficiency of the EU in terms of raw resources;
* Production of household waste per capita.

The reduction of municipal waste generation is evidence of the effectiveness of waste prevention measures and changes in the structure of consumption by citizens. Focusing on municipal waste rather than industrial waste has the advantage that it reflects the consumption side and does not affect the presence or absence of strong manufacturing industries in the country. This indicator is focused on municipal waste. Even though household waste represents only about 10% of the total volume of generated waste or about 30% of the total amount of waste, excluding the main mineral waste, the further process of its development can give a good indication of the change in the structure of consumption and the prevention of waste in the member states of efficiency and where the actions and participation of citizens are most relevant. As for the amount of municipal waste generated, the data refers to the delivery of waste to a garbage collector or to a storage facility.

* Production of waste, except for basic mineral waste per unit of GDP [178] .

The indicator is defined as all waste generated in the country (in mass unit), excluding basic mineral waste, per unit of GDP (in euros). The coefficient is expressed in kg per thousand euros. Data on waste generation, excluding primary mineral waste, cover hazardous and safe waste from all sectors of the economy and households, including waste from waste processing (secondary waste), but excluding most mineral waste. Major mineral waste is excluded, as the weight of total waste generation and processing is mainly determined by mineral waste from construction/demolition and mining, and the latter varies considerably between Member States. The exclusion of major mineral waste reflects general trends more accurately than total waste and improves comparability between countries. A high difference in the indicator can also be due to a number of factors:

- Differences in the classification of waste by Member States may lead to partial incomparability, for example the high value for Estonia is the result of the inclusion of waste from energy production.
- Differences in purchasing power are not fully reflected in exchange rates, thereby understating real income in some Member States.
- Different economic structures and the specialization of certain Member States in high-value services (e.g. finance or IT sectors).

* Production of waste, with the exception of basic mineral waste for internal material consumption.

The indicator is defined as all waste generated in the country (in a mass unit), excluding major mineral waste, divided by the country's internal material consumption. The coefficient is expressed as a percentage (%), since

both terms are measured in the same unit, namely tones. The indicator is an indicator of the efficiency of material use, comparing the amount of waste generated with internal. The smaller the value of the ratio, the better the indicators. The ratio is strongly influenced by the non-metallic mineral component. This indicator may require additional contextual indicators for interpretation. Data on waste generation, excluding primary mineral waste, cover hazardous and safe waste from all sectors of the economy and households, including waste from waste processing (secondary waste), but excluding most mineral waste.

Waste management [178]:

- The level of household waste processing.

This indicator measures the share of recycled municipal waste in the total generation of municipal waste. Recycling includes material recycling, composting and anaerobic digestion. The coefficient is expressed as a percentage (%), since both terms are measured in the same unit, namely tons.

- The level of processing of all waste, not taking into account the main mineral waste.

The indicator is calculated as recycled waste (RCV_R) divided by the total amount of processed waste excluding primary mineral waste (TRT) multiplied by 100. It is expressed as a percentage (%) because both terms are measured in the same unit, namely tonnes. Recycled waste is waste that is directed to recovery operations other than energy recovery and landfill (referred to as recycling for simplicity). Waste data are adjusted for waste collected in one country and processed in another country. The amount of processed waste is regulated as follows: waste processed at domestic enterprises plus waste sent outside the country for processing minus waste imported and processed at domestic processing enterprises. Waste treatment is based on waste statistics regulations, and waste imports and exports are

based on foreign trade statistics and reported according to the combined nomenclature (CN codes). Major mineral wastes are excluded to avoid situations where trends in the production of conventional wastes may be masked by large fluctuations in waste generation in the mining and mineral processing sector. It also allows for a more meaningful comparison between countries, as mineral waste is a very significant amount in countries characterized by the largest mining and construction industries.

The indicator reflects the treatment of national waste, regardless of its location, and it excludes waste imported from non-EU countries.

- The level of recycling of packaging waste by type of packaging.

The indicator is defined as the share of recycled waste in all recycled packaging waste. Packaging waste covers spent material used to store, protect, handle, deliver and present goods, from raw materials to processed goods, from producer to consumer or consumer, excluding production residues. Packaging waste is divided into plastic packaging waste and wooden packaging waste. The coefficient is expressed as a percentage (%), since both terms are measured in the same unit, namely tons. This indicator covers only the packaging fraction of plastic and wood waste.

- Level of e-waste processing.

The indicator is calculated by multiplying the "collection factor" set in the WEEE Directive by the "reuse and recycling factor" defined in the WEEE Directive; where: "Collection factor" equals the volumes collected in the reporting year divided by the average amount of electrical and electronic equipment (EEE) placed on the market over the previous three years (both expressed in mass units).

- The level of construction and demolition waste processing.

The indicator is part of a set of circular economy indicators. It is used to monitor progress towards a circular economy in the thematic area of waste

management. Construction and demolition is one of the biggest sources of waste in Europe. Many materials can be recycled or reused, but the level of reuse and recycling currently varies widely across the EU.

***Secondary raw materials*:**

- The importance of secondary materials in meeting the demand for raw materials.

The indicator measures for which raw materials a given part of its investment in the production system falls on the processing of "old scrap", that is, scrap from finished products. EOL-RIR does not take into account scrap that originates from manufacturing processes ("new scrap"). Figure 2.7 illustrates the system boundaries and flows for EOL-RIR calculation using System Analysis data [10].

EOL-RIR is determined by several factors. The first is the demand for raw materials, which is growing for almost all materials. The second is the amount of materials that are available for processing. Because some materials are built into durable goods, they will be available for recycling in the future. Due to the lack of data for certain steps of the value chain, the indicator is partly based on estimates.

The EOL-RIR should be calculated using the following formula:

$$EOL\text{-}RIR = (G.1.1 + G.1.2) / (B.1.1 + B.1.2 + C.1.3 + D.1.3 + C.1.4 + G .1.1 + G.1.2).$$

[10]The first part of the figure represents the raw material life cycle stages in other countries, while the raw material life cycle stages in Europe are represented by brown boxes. The boundary of the system is represented by pink strokes. Streams used to calculate EOL-RIR are shown in green (primary material), yellow (processed material) and purple (secondary material).

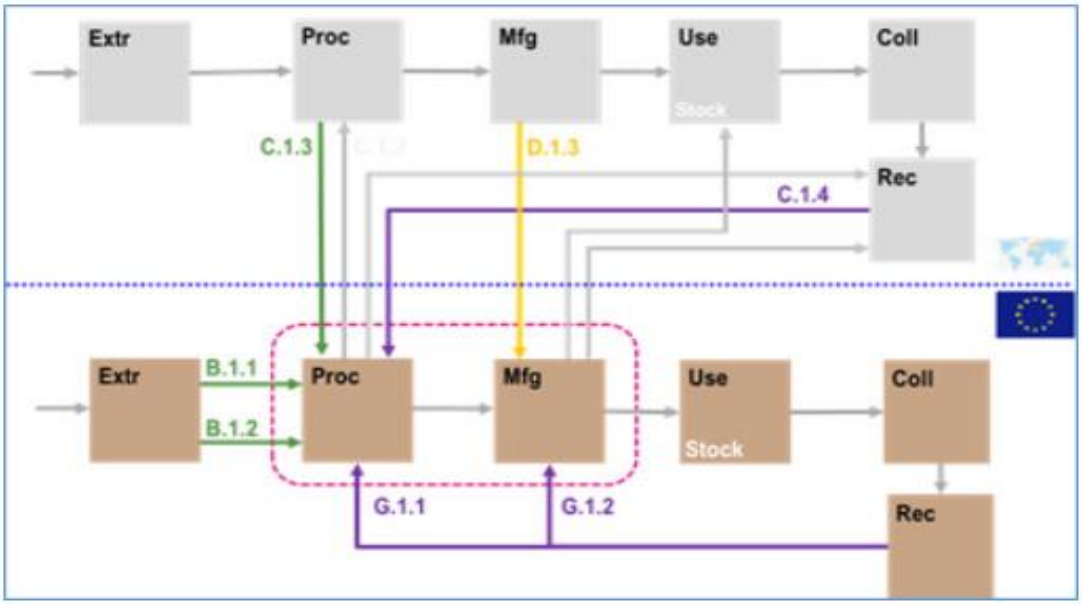

Fig. 2.7. **System limits and flows for calculating EOL-RIR when using data**

Source: [178]

- The level of use of processing materials as secondary raw materials.

Conclusions to chapter 2

The indicator measures the share of reclaimed and returned material in the economy - thus saving the extraction of primary raw materials - in the total use of materials. The ratio of circular material use is defined as the ratio of circular material use to total material use. Total material use is measured by summing total domestic material consumption (DMC) and circular material use. Circular use of materials is based on the amount of waste processed in domestic recovery facilities, minus imported waste destined for recovery, plus exported waste destined for recovery abroad. Waste processed in domestic recovery plants includes recovery operations from R2 to R11 - as defined by

the Waste Framework Directive 75/442 / EEC. Imports and exports of waste intended for recycling - that is, the amount of imported and exported waste intended for recovery - are estimated from European statistics on international trade in goods. A high score means that more secondary materials are replacing primary raw materials, thereby reducing the environmental impact of primary material extraction.

- Trade in secondary raw materials.

The indicator measures the amount of selected categories of waste and by-products transported between EU member states (within the EU) and across EU borders (outside the EU). According to the classification of the Joint Research Center (JRC), five classes were chosen: plastic; paper and cardboard; precious metal; iron and steel; copper, aluminum and nickel. The indicator includes the following variables:

- Internal EU trade in secondary raw materials (measured as imports from EU countries).
- Import from non-EU countries and export of secondary raw materials (regarding non-EU) to non-EU countries.

***Competitiveness and innovation*:**

- investments, jobs and gross value added related to circular economy sectors.

The indicator includes "Gross investment in tangible goods", "Number of persons employed" and "Value added at factor costs" in the following two sectors: the recycling sector and the repair and reuse sector. The processing and repair and reuse sectors are defined and approximated to the economic activities of the NACE Rev. classification. 2.

Value added at factor costs is gross operating income after adjusting for operating subsidies and indirect taxes. It can be calculated as the sum of turnover, capitalized production, other operating income, increase minus

decrease in inventories and deduction of the following items: purchase of goods and services, other taxes on products that are related to turnover but not subject to deduction, duties and taxes related to production. Cost adjustments (such as depreciation) are not deducted.

- Patents related to processing and secondary raw materials.

The indicator measures the number of patents related to processing and secondary raw materials. Assignment to processing and secondary raw materials was carried out using the corresponding codes in the Cooperative Patent Classification (CPC).

The term **"patents"** refers to patent families that include all documents related to a single invention (eg, applications to different authorities), thereby preventing multiple counting. The family's share is divided between each applicant and the respective technology. While the indicator provides an understanding of the most relevant innovative recycling technologies, it does not cover all technologies related to waste management, as well as other services and business models of the circular economy. It should also be noted that not all relevant innovations are or can be patented [178].

CHAPTER 3

ANALYSIS OF THE GLOBAL INCLUSIVE CIRCULAR ECONOMY

3.1. Assessment of the circular economy of the European Union

In January 2018, the European Commission adopted a set of the following measures within the framework of the implementation of the main areas of activity to ensure the sustainable economic development of European countries and the Circular Economy Action Plan:

- **The EU-wide strategy** for plastics in the circular economy and the annex, aimed at transforming the ways of development, production, use and processing of plastics and products made from them. By 2030, all plastic packaging must be recycled. The strategy also emphasizes the need to take specific measures, for example, the use of legislative instruments to reduce the accumulation of plastic waste, for single-use products made of this material (this has the greatest impact on the pollution of seas and oceans). In order to reduce the amount of plastic waste accumulating in the environment, the European Commission adopted a proposal on the need to create reception facilities in seaports to solve the issue of ship exits and published a report on the impact of the use of plastic on the environment [171-175];
- **the need to develop legislation on the chemical industry,** production products and waste. The circular economy monitoring framework is provided

at the EU level and the relevant national level. Monitoring is based on 10 main indicators covering each stage, i.e. production, consumption, management of waste and secondary raw materials, as well as economic aspects (indicative assessment);

- **published a report on strategic (critical) raw materials and the circular economy**, which highlighted the potential of using 27 basic materials in the economy.

So, **initial the indicator** proposed by the European Commission is **EU** self-sufficiency for raw materials (%) (Fig. 3.1).

This indicator measures how independent the EU is from the rest of the world in providing certain raw materials. Raw materials are necessary for the functioning of the EU economy. The functioning and diversity of industries depends on the supply of raw materials, that is, their extraction, processing and import. The EU action plan for the circular economy provides for specific measures in the field of critical raw materials. Critical raw materials are products of great economic importance for the EU. In some cases, their extraction causes dangerous environmental consequences. However, such products are of critical economic importance with significant environmental consequences. Recovery of critical raw materials is one of the main problems that must be solved during the transition to a circular economy [155; 156] .

So, the critical situation is characteristic of dysprosium, europium, natural graphite, molybdenum, phosphorus and platinum - the supply of these materials in the EU is close to zero. Several critical raw materials (CRM), in particular vanadium, tungsten, cobalt, and antimony, have high recycling, others are characterized by rapid recycling after the end of their service life (for example, recycling reaches 95% for industrial catalysts and 50–60% for automotive ones) [155; 156].

The next indicator is generation of municipal waste per capita (Figure 3.2). It is this indicator that proves the effectiveness of measures to prevent waste generation and change the consumption pattern of citizens. The advantage of focusing on domestic rather than industrial waste is that it reflects consumption and is unaffected by the presence or absence of strong manufacturing sectors in a country. Even if household waste is only about 10% of its total amount or about 30% of the generated volume of waste, in addition to the main mineral waste, the further evolution leads to a change in the consumption model and makes it possible to prevent the generation of waste in the EU member states through the effective activities of their citizens.

In fig. 3.2 shows the production of household waste by country, the volume of which is expressed in kilograms per capita. At the end of 2016, the volume of household waste production varied significantly: from 777 kg per capita in Denmark to 261 kg in Romania. The variations reflect differences in consumption patterns and economic wealth, but also depend on the conditions of municipal waste collection and management. There are differences between countries in how commercial and administrative waste, together with household waste, is collected and managed. So, in 19 out of 31 countries (EU and EFTA member states), the volume of household waste generated per capita increased during 2000 - 2016. The highest average growth rates were recorded for Malta (2.5%), Greece (2.4%), and Latvia.

The largest decrease occurred in Bulgaria (with an average annual decrease of -2.5%), followed by Romania (-1.3%) and Slovenia (-1.2%).

The most important indicators characterizing the circular economy in general and the European Union in particular are the following: recycling rate of municipal waste; the level of recycling of waste in general, except for major mineral waste (Recycling rate of all waste excluding major mineral waste); the level of recycling of packaging waste (Recycling rate of packaging waste by

type of packaging); recycling rate of e-waste; the level of processing of biological waste (Recycling of biowaste); Recovery rate of construction and demolition mineral waste.

Let us describe some of these indicators. The first indicator (Recycling rate of municipal waste) measures the share of recycled household waste in the total amount of household waste. Disposal includes material disposal, composting and anaerobic processing [11].

Thus, the highest level of household waste recycling is determined in Germany, followed by Belgium, Denmark, France, Italy, Slovenia, Sweden and Montenegro. In 2016, the biggest gap in increasing the level of recycling is characteristic of Lithuania, Bulgaria, the Czech Republic, Luxembourg, and Poland.

Germany has the highest recycling rate in the world. Austria is in second place, followed by South Korea and Wales. These four countries managed to recycle from 52% to 56% of municipal waste. Switzerland ranks fifth (recycling almost half of its own municipal waste).

According to Eunomia [12], these countries have such a general state policy that stimulates the development of the processing sector, simplifying this process for households, providing its financing and motivating the implementation of this type of activity. For this purpose, clear political goals are established for local self-government bodies.

So, Wales [13], as one of the four administrative and political parts that make up the United Kingdom of Great Britain, has quite ambitious disposal goals. It strives to achieve zero waste by 2050, the EU contributes to the

[11] With the method of biomass conversion without access to air with the help of bacteria .

[12]Eunomia is an independent consulting company that helps clients achieve better environmental and commercial results.

[13] a territory in Western Europe that is part of the United Kingdom of Great Britain and Northern Ireland. It is located in the southwest of the island of Great Britain. The capital is the city of Cardiff. The people of Wales are called the Welsh.

realization of this goal by determining by 2030, from the guidelines of ensuring the recycling of at least 65% of waste. According to a forecast by Eunomia, Wales could be the world leader in recycling, reaching the results of Germany in 2018.

The next indicator is the recycling rate of all waste excluding major mineral waste (%) (Recycling rate of all waste excluding major mineral waste). This indicator involves the processing of data on waste collected in one country and processed in another. Volumes of processed waste are determined and regulated as follows: waste processed at domestic enterprises, plus waste exported from the country for processing, minus waste imported and processed by domestic economic entities. This indicator covers harmful and hazardous waste from all sectors of the economy and households, including secondary, with the exception of most mineral waste. This makes it possible to make comparisons by country, since very large amounts of mineral waste fall on states with developed mining and construction industries. This indicator may also contain data on waste imported from EU countries.

The European Commission (EC) estimates that the circular economy directly created jobs that employed 3.9 million people.

So, in general, the EU (28) is characterized by an average level of waste recycling (50-60%). The highest value is determined for Luxembourg (90%), Belgium (80%), Slovenia (60–70%), the Netherlands (70%), Italy (60–70%).

The lowest indicators are typical for Greece (10–20%), Bulgaria (15–20%), Estonia (20–22%). It is also important to single out the countries with the highest positive dynamics: Croatia (25→40%), Latvia (40→61%) and Slovenia (50→75%).

The level of packaging waste recycling by type (%) . (Recycling rate of packaging waste by type of packaging) is one of the main indicators of the

circular economy. It makes it possible to determine the volumes of incoming secondary material, which helps to avoid the formation of waste that accumulates in landfills or is incinerated, thus fixing the cost of materials as much as possible and reducing losses. This indicator is used to monitor progress in achieving the target level of packaging recycling: 55% as of 2008; 65% and 70% by 2025 and 2030, respectively.

The EU action plan for the promotion of the circular economy is aimed at the development of priority areas, in particular the processing of plastic and biological materials. The European Commission proposed to ensure that EU countries recycle 55% of plastic packaging waste (by 2025). Such an indicator will reflect progress in achieving this goal. For biological materials such as wood, the European Commission has proposed a target of 75% in 2030 (preparation of volumes of secondary resources for reuse and recycling).

So, in terms of *the level of recycling of plastic packaging* as of 2015, according to Eurostat data (Fig. 3.5), Bulgaria (60.8%), the Czech Republic (61.7%), Slovenia (63.4%), Slovakia (54.4%) and the Netherlands (50.7%) exceeded the average planned indicator for the EU, while the EU-28 indicator was 40.3%.

It is also worth highlighting the countries that have introduced the basic principles and implemented certain actions in the direction of the development of the circular economy. In general, according to indicators of recycling of plastic waste, the most positive dynamics are characteristic of Bulgaria, Croatia, Slovenia and Slovakia.

According to data, the average rate of wood recycling for the EU-28 in 2015 was 39.8% (expected forecast for 2030 – 75%). According to (Eurostat data for 2015), this level was reached by Belgium (74.9%), which was surpassed by Portugal (86.5%) and Ireland (85.4%). The rate of wood waste recycling has decreased in Denmark, Greece, Cyprus and Latvia.

Table 3.1

Recycling rate of e-waste

	2008	2009	2010	2011	2012	2013	2014	2015
EU (28 countries)	:	:	:	28.7	28.8	29.6	32.2	:
Belgium	28.3	30.8	30.4	31.9	32	31.7	28.4	30.9
Bulgaria	:	:	40.8	49.4	62.4	60.2	68.3	96.5
Czech Republic	:	:	22.7	26	27.1	28.5	29.3	37.9
Denmark	:	39	41	50.1	46.5	37.6	42.3	43
Germany	:	38.1	37.8	34.4	34.8	35.6	36.9	:
Estonia	:	22.4	30.3	36.9	35.9	27.8	30.4	33.3
Ireland	:	:	30.9	32.5	36.1	38.6	43.1	46.1
Greece	21.6	29	19.4	19	18.6	22.1	29	32.7
Spain	:	12.6	14.7	16.7	19	26.1	26.2	:
France	:	19.2	21.8	22.6	22.6	23.6	26.3	32.2
Croatia	:	:	:	:	:	:	35.7	58.3
Italy	:	:	27.8	29.8	27.7	26.3	27.3	:
Cyprus	:	10.9	11.5	11.5	12.2	12.1	17	:
Latvia	:	:	14.5	19.9	26.5	27.8	26.4	23.1
Lithuania	15.2	10.5	16.6	28.2	41.1	43.8	64.6	45.9
Luxembourg	36.6	38	33	30.6	27.6	29.3	35.4	42.5
Hungary	28.3	29.5	26	25.3	30.8	40	47.7	50.7
Malta	:	12.1	13.1	9.7	9.9	11	11.5	:
Netherlands	22.5	22	27.8	33	33.2	31.3	38.1	39.4
Austria	46	36.1	35.7	37.1	38.2	37.6	39.1	40.7
Poland	:	13.9	17.7	23.9	30.4	28.1	27.4	33.1
Portugal	21.8	24	22.8	30.5	24.9	32.3	38.2	42.7
Romania	:	17	12	10.3	14.5	21	21.3	:
Slovenia	:	17.6	22	26.4	26.9	16.7	27.5	47.7
Slovakia	31.8	34.2	34.9	39.6	42.6	41.7	44.1	40.3
Finland	37.9	29.9	28.7	31	32.8	36.3	42.4	43.2
Sweden	62.4	52.2	55.3	64.9	62.6	64.9	52.7	51.6
Great Britain	:	:	26.9	23.9	22.5	22.8	29.6	36.6
Iceland	:	:	:	:	:	:	:	:
Liechtenstein	:	:	:	:	:	:	117.8	127.1
Norway	35.4	46.9	45.3	48.4	46.4	46.5	47.5	50.4

Source: distributed by the author based on [178]

Circular material use rate is an indicator that measures the volume of circular (secondary) materials in the economy in relation to the total use of resources. The increase in the volume of secondary materials replacing primary raw materials makes it possible to avoid extraction of primary material. The coefficient indicates the amount of waste collected in the country (intended for recovery) and returned as secondary materials to the economy, which makes it possible to save the extraction of primary raw materials.

So, the absolute leader with the same indicator in different periods of the study is the Netherlands (28%), and the same stability is characterized by Belgium (16–17%) and France (16–17%); Sweden recycles almost all of its waste, Singapore – more than 60% [6].

In general, this is a rather low level of recycling (the Netherlands has the highest rate (28%)), but there are countries with a nascent state of the secondary economy and the level of use of circular material - Bulgaria (3%), Ireland (3%), Greece (2.5%), Latvia, Romania, Portugal (3%). It is worth noting that the global level of circularity is 9.1%, which demonstrates the global circular gap.

Patents related to recycling and secondary raw materials (Patents related to recycling and secondary raw materials) is an indicator that makes it possible to determine the number of patents under which recycling of secondary resources is carried out. Given that this indicator reflects the state of application of innovative recycling technologies, it does not cover all data on the most relevant innovations related to waste management, as well as on other services and business models of the circular economy. It should be noted that not all-important innovations can be patented.

So, according to the latest studies, the Netherlands is inferior to the positions of Luxembourg, which will develop according to the circular economy model from 2018. Applying the Circle Economy model, Luxembourg

is the first country to take further measures in this direction and demonstrate the progress achieved over the past two years to be a circular hotspot.

In the short term, primary raw materials are predicted to continue to be the main way of developing to meet the demand for material resources, especially given their importance for circular and clean technologies, digital, space and EU defense applications. The Raw Materials Initiative envisages a diversification strategy to ensure supply and access to raw materials from different sources, such as global markets, the EU and through recycling. This will ensure sustainability throughout the life cycle, starting with extraction, while minimizing social and environmental impacts.

The circular use of raw materials in the EU economy is relatively insignificant in terms of volume. A large share of secondary resources in the EU is made up of construction materials that have a long service life. These stocks often provide value to the EU economy for decades and may be available for recycling at the end of their useful lives.

As long as the demand for raw materials for the production of long-term products and the construction of infrastructure exceeds the volumes of materials that can be supplied from recycled resources, primary mining will remain necessary. In general, the use of raw materials in the EU economy can be improved by extending the useful life of products (for example, through repair and reuse) or increasing the amount of material recycling.

In China, activity in the field of inventions has increased significantly from less than 50 new patent developments related to processing and secondary raw materials in the annual period before 2005 to almost 250 such inventions in 2013. At the same time, Japan's activity in this area has decreased from more than 350 inventions patented in 2000 to China's level over the past year. The activity of other countries (for example, the USA and Germany) in this direction is characterized by relatively low levels. However, South Korea's

e-waste patent activity is growing. It is these countries that currently form the global circular landscape, taking into account the leading countries and the outsider countries in ensuring the circular activity of the European Union.

So, based on the previous analysis, the following characteristics can be identified for individual countries with a national, regional or local orientation.

Table 3.2

Indicators of the EU Circular Economy, 2017

Indexes	Leader countries	Countries with a reduced rate
Generation of household waste per capita	Malta (2.5%) Greece (2.4%) Latvia (2.1%) Denmark (1.9%)	Bulgaria (– 2.5%) Romania (– 1.3%) Slovenia (–1.2%)
(Recycling rate of municipal waste) measures the share of recycled household waste	Germany, Belgium, Denmark, France, Italy, Slovenia, Sweden and Montenegro Lithuania, Bulgaria, the Czech Republic, Luxembourg, Poland	Romania Estonia Greece Croatia, Malta, Slovakia, Montenegro, Albania
Recycling rate of all waste excluding major mineral waste (%)	Luxembourg (90%), Belgium (80%), Slovenia (60–70%), Netherlands (70%), Italy (60–70%). *the highest positive dynamic* a: Croatia (25→40%) Latvia (40→61%) Slovenia (50→75%).	Greece (10–20%), Bulgaria (15–20%), Estonia (20–22%).
The level of packaging waste recycling by its type (%). (Recycling rate of packaging waste by type of packaging)	to monitor progress in achieving the target level of packaging recycling: 55% as of 2008; 65% by 2025 70% by 2030	
	55% of plastic packaging waste by 2025. 75% - 2030	
The level of recycling of plastic packaging	Bulgaria (60.8%), Czech Republic (61.7%), Slovenia (63.4%), Slovakia (54.4%), the Netherlands (50.7%), *EU-28 - 40.3%.* Norway - 97%	Estonia 26.5% France 26.5% Hungary 32% Austria 33% Finland 26.5% Iceland 29.7% Liechtenstein 18.3%
Wood recycling index	EU-28 in 2015 was 39.8% (expected forecast for 2030 – 75%). Belgium (74.9%), Portugal (86.5%) Ireland (85.4%).	Poland 33.1% Netherlands 39.4% Datvia 23.1% France 32.2% Greece 32.7% Belgium 30.9%
Circular material use rate	**The Netherlands (28%) Belgium (16-17%) France (16–17%) Sweden recycles almost all of its waste, Singapore - more than 60%**	**Bulgaria (3%), Ireland (3%), Greece (2.5%), Latvia, Romania, Portugal (3%).**

The circularity rate is 9.1%, showing a global circularity gap of 90%

Patents related to recycling and secondary raw materials	China South Korea USA Germany France Poland Italy Great Britain Netherlands	Latvia Hungary Romania Japan Canada
Patents related to processing and secondary raw materials per million inhabitants	Luxembourg Germany Netherlands Austria Finland	Romania Bulgaria Italy Cyprus Greece

Source: constructed by the author based on [178]

- **Belgium** → Regional program for circular economy 2016-2020 → Local-regional (Brussels); (*is a pioneer of the circular economy at the national level*);
- **Denmark** → Circular economy strategy → *national level*;
- **Finland** → Circular economy road map for Päijät - Häm → *regional level*; Finnish Circular Economy Roadmap 2016-2025→ *national level*;
- **France** → Circular Economy Plan for Paris → *local level*;
- **Germany** → Program for sustainable development and use of natural resources → *national level*;
- **Greece** → Transition to a circular economy model of sustainable production and consumption structure → *regional level*;
- **Italy** → Model for Italy – Towards a circular economy;
- **Luxembourg** → National waste and resource management plan → *national level;*
- **Norway** → Sustainable and circular consumption strategy in Oslo → *local level*;
- **Poland** → Road map – transformation in the direction of the circular economy → *national level*;
- **Portugal** → Oslo 2030 Circular City Roadmap → *local;*

- **Slovenia** → Strategy for the transition to a circular economy in Maribor → *local;*
- **Spain** → Extremadura 2030. Strategy for a green and circular economy. Extremadura Government Action Plan; promotion of circular economies in Catalonia→ *local and regional level;*
- **Netherlands** → Circular Hague – transition to a stable economy; Rotterdam and the circular economy; Circular Economy Roadmap Northern Netherlands *local and regional level;*
- **United Kingdom** → Road map of London; Scotland's circular strategy; circular Glasgow; circular Peterborough→ *local level*.

3.2. International trade in waste and unused products in the sectoral and spatial dimension.

In the formation of circular trade in waste and scrap, green public procurement is increasingly being used to promote environmental policy. State authorities actively use their purchasing power, encourage the production and use of environmentally friendly goods and services. Public procurement accounts for a significant share of economic activity, about 15-20% of GDP in both developed and developing countries. Procurement policies can make an important contribution to sustainable consumption and production. The main rules of the WTO governing public procurement are enshrined in the WTO Agreement. In addition, according to the OECD data, it is possible to analyze the trade in waste, scrap and unused products by industry, thereby distinguishing the leaders of exporters and importers.

Hence, HS code: a code in the Harmonized System (HS) that identifies a commodity. Codes for the years 2002-2008 are reported in the H2 version of the HS, codes for the years 2009-2011 are reported in the H3 version of the HS,

and codes for the years 2012-2016 are reported in the H4 version of the HS. The types of waste to which this indicator applies are distinguished: chemicals, metals, minerals, paper, textile plastic, etc. At the same time, they can be analyzed **according to the following indicators**:

- export value: the value of the country's exports in current US dollars;
- export weight: the weight of exports from an individual country in kilograms;
- import value: the value of imports in the country in question in current US dollars;
- import weight: weight of imports in the country in question in kilograms.

In this way, it is possible to analyze the amount of export and import of waste and scrap in US dollars and in kilograms for all countries between 2003 and 2016 (latest official data).

Table 3.3

HS code: code in the Harmonized System (HS): chemistry

300680	Pharmaceutical products; Gel preparations for use in human or veterinary medicine as a lubricant for parts of the body for surgical operations or physical examinations or as a bonding agent between the body and medical instruments
300692	Pharmaceutical products; **pharmaceutical waste**
382510	Residual products of chemical or related industries, not specified elsewhere and not included therein; **municipal waste**
382530	Residual products of chemical or related industries, not specified elsewhere and not included therein; **clinical waste**
382541	Residual products of chemical or related industries, not specified elsewhere and not included therein; **halogenated waste organic solvents**
382549	Residual products of chemical or related industries, not specified elsewhere and not included therein; **waste organic solvents, except for halogenated ones**
382550	Residual products of chemical or related industries, not specified or included elsewhere; **waste metal thinners, hydraulic fluids, brake fluids and antifreeze fluids**
382561	Residual products of chemical or related industries, not specified elsewhere and not included therein; (except sewage sludge, household waste or waste covered by 27.10); other waste nec in 3825; **those containing mainly organic components**
382569	Residual products of chemical or related industries, not specified elsewhere and not included therein; (except sewage sludge, household waste or waste covered by 27.10); other waste nec in 3825; except those containing mainly organic components
382590	Residual products of chemical or related industries, not specified elsewhere and not included therein; not. at 3825 or 27.10

Source: built by the author based on [289]

So, Table 3.16 shows the structure of waste and scrap by codes in the Harmonized System (HS) in the field of chemical waste. In table 3.4. the indicated countries-leaders and countries-outsiders in the export of pharmaceutical waste, as of 2016 (the latest available official data according to OECD statistics).

Table 3.4

Export of pharmaceutical waste, 2016

Cranes with maximum export	thousands of US dollars	Countries with minimal export	thousands of US dollars
USA	3,007.84	Senegal	10.75
Great Britain	2,221.76	Finland	9.75
Canada	2,007.25	Turkey	8.57
France	1,534.70	Hong Kong, China	4.13
Italy	1,488.68	Iceland	3.78
Singapore	1,405.71	Indonesia	3.26
Belgium	1,223.91	Czech Republic	3.00
Georgia	1,199.32	Portugal	2.90
Japan	1,029.50	Malta	2.55
Ireland	1,005.07	Mexico	2.32

Source: built by the author based on [289]

So, as of 2016, *the absolute leader in the export of pharmaceutical waste is the USA, Great Britain and Canada.* Along with these and other leaders in exports, it is also worth highlighting the countries with the lowest volume of exports: Mexico, Malta, Portugal, the Czech Republic, Indonesia and others.

With the growing awareness of the importance of managing waste as a resource and as a major trade commodity, waste trade has great opportunities for countries with a comparative advantage in sorting and processing activities, while expanding the global level of recycling. In this process, the awareness of the safety of waste and the possibility of trading it for further processing and recovery under proper control is growing. In 2014, India accounted for 13% of the world's secondary steel production, and despite the limited supply of domestic steel scrap production, which involves the trade of

waste and scrap to recover the material, India is one of the top exporters of secondary steel production.

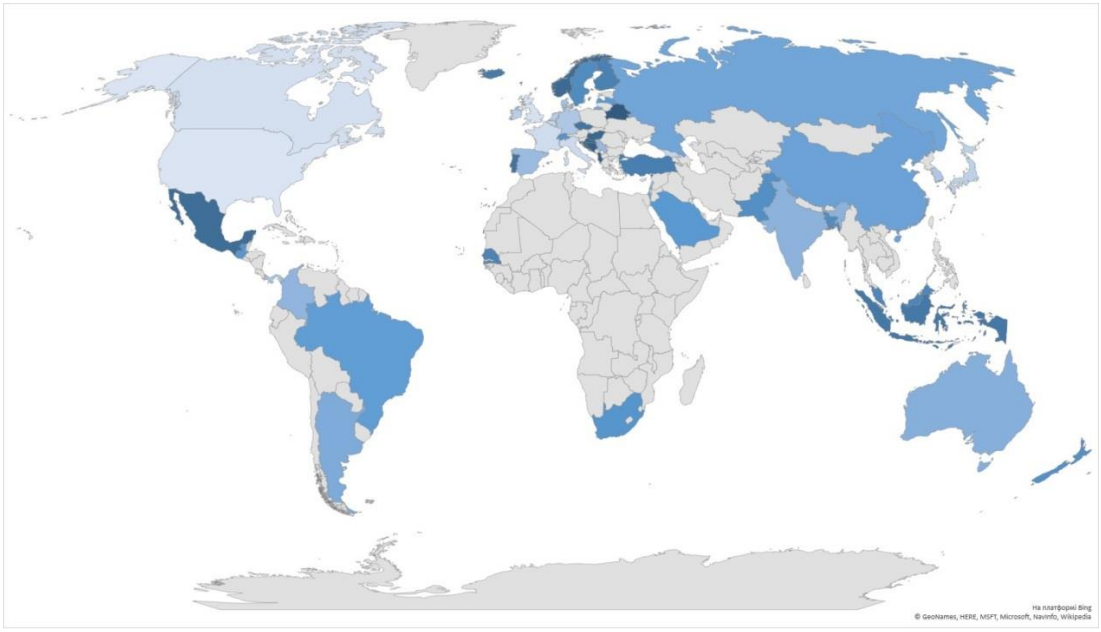

Fig. 3.1. **Export of pharmaceutical waste, 2016**
Source: built by the author based on [289]

The imposition of trade restrictions on waste and scrap can potentially undermine the efficiency of production in developing economies by restricting the supply of raw materials at low prices. However, the global volume of trade in waste and scrap is increasing rapidly, along with potential challenges in some export destinations around environmentally sound waste management. In particular, bilateral trade in wastes increases when there is a divergence of strong environmental policies between trading partners. That is, waste goes to countries with lower environmental standards. In addition, there is particular concern about the increase in two-way waste flows between developing countries with underdeveloped waste management capabilities.

Another equally important issue is the illegal trade in waste. Illegal and informal recycling activities, especially in developing countries with informal e-waste recycling practices in the developing country, often involve toxic emissions and dumping of spent acid without proper treatment or control. This

leads to serious environmental and health problems, which automatically allows us to talk about an inclusive and social component in the proposed methodology for defining a global inclusive circular economy. Claiming that waste imports are polluting the environment, China announced restrictions on waste imports and scrap exports in several stages starting in January 2018.

Thus, Figure 3.1 and Table 3.4 show the importers of waste pharmaceuticals as of 2016. Considering the data, the undisputed leader by a significant margin is the USA, followed by Switzerland, Myanmar, Jamaica, Great Britain and France.

Table 3.4

Import, waste pharmaceuticals, 2016

Cranes with maximum export	thousands of US dollars
the United States	9,734.08
Switzerland	2,834.33
Myanmar	1,458.83
Jamaica	1,182.50
Great Britain	997.72
France	797.48
Norway	661.67
Iran	569.81
Saudi Arabia	369.96
Singapore	366.20
Malaysia	343.54

Source: built by the author based on [289]

Figure 3.2 shows a map of clinical waste exports (by chemistry code) as of 2016 (latest official OECD data). Canada is the absolute leader in the export of clinical waste. Singapore, China, Great Britain and the Netherlands are among the leaders by a certain margin. At the same time, we will highlight the countries with minimal exports, which differ significantly in terms of volume from the leaders. Therefore, Japan, Myanmar, the Czech Republic, Hungary, Indonesia, Israel, Slovakia, Italy, Slovenia, Switzerland, and Poland export minimally (table 3.5).

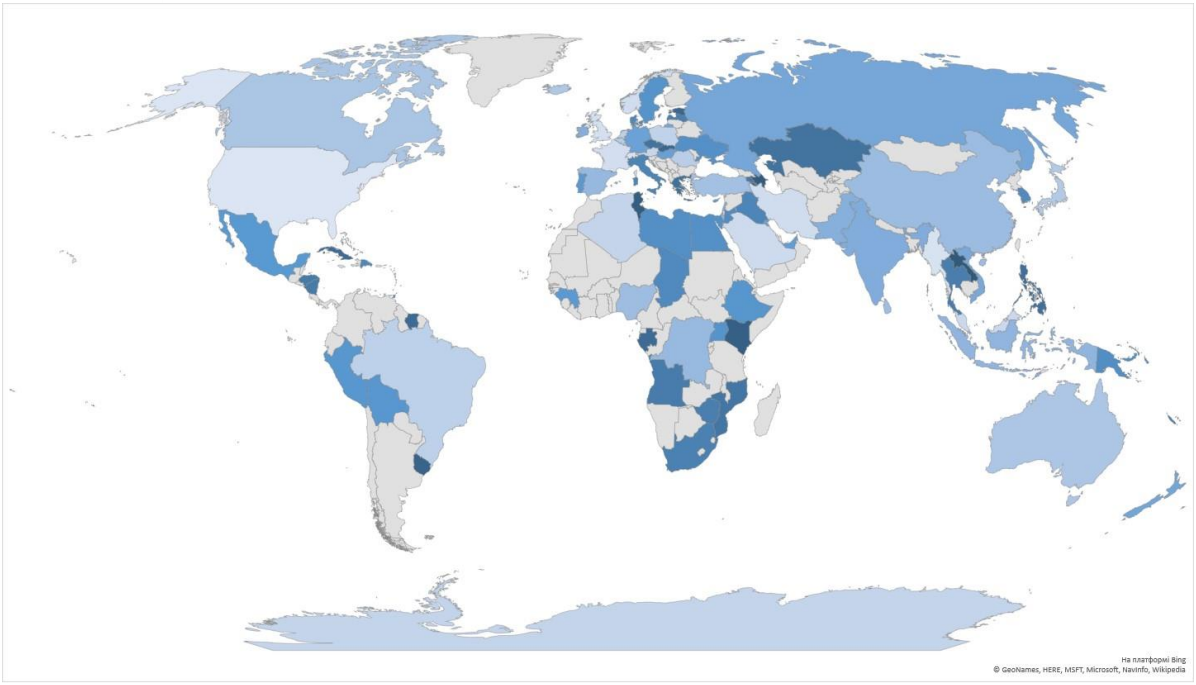

Fig. 3.2. **Import of pharmaceutical waste, 2016**

Source: built by the author based on [289]

Table 3.5.

Export of clinical waste, 2016

Cranes with maximum export	thousands of US dollars	Countries with minimal export	thousands of US dollars
Canada	1,410.57	Poland	5.18
Singapore	466.02	Switzerland	4.32
China	337.93	Slovenia	4.20
Great Britain	267.03	Italy	3.54
Netherlands	156.47	Slovakia	3.21
Germany	99.51	Israel	2.75
Belgium	87.55	Indonesia	2.63
France	84.23	Hungary	2.48
Thailand	53.43	Czech Republic	2.40
Malaysia	53.43	Myanmar	1.30
New Zealand	40.53	Japan	1.26

Source: built by the author based on [289]

Trade flows of waste and scrap do not in themselves indicate an increase or decrease in pressure on the environment. The point is whether such trade in waste and scrap is treated and recovered in an ecological environment

and is in line with circular economy goals. It would be important to understand the extent to which trade in waste and scrap potentially contributes to recycling in general.

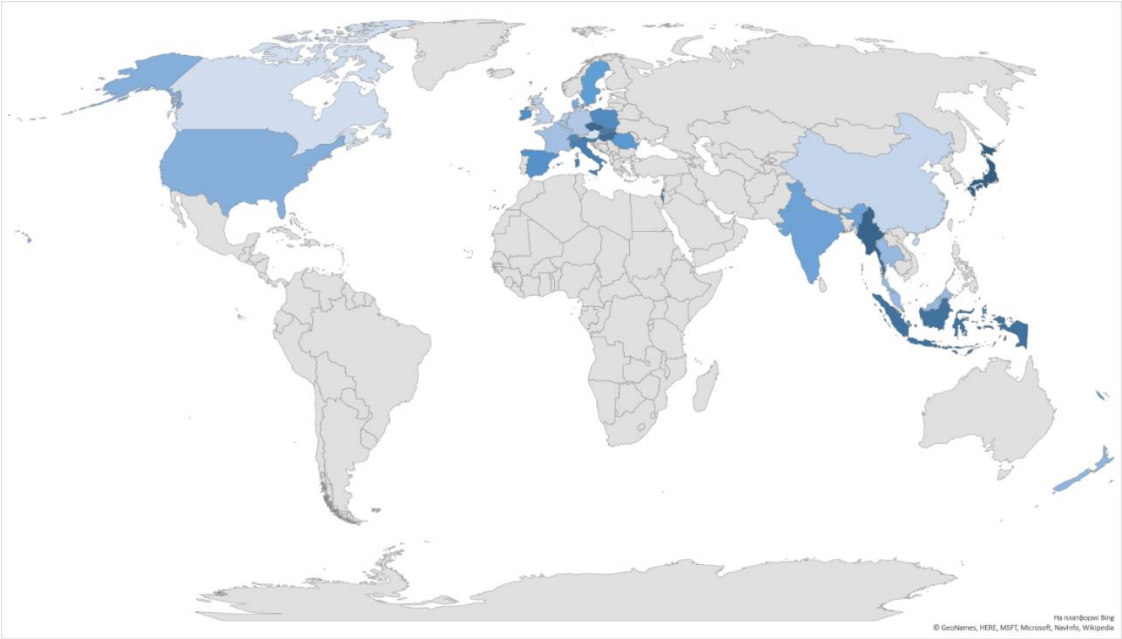

Fig. 3.3. **Export of clinical waste, 2016**
Source: built by the author based on [289]

Diversification of the trade of waste for recycling materials and the trade of waste as residues intended for energy, nevertheless, such recovery is an important and potentially difficult task. Another equally important and potential issue is the definition and classification of waste, scrap and secondary raw materials, which may vary depending on the country. The distinction between end-of-life products, hazardous waste and recycled materials as materials may not be the same and will require diversified follow-up.

Therefore, Table 3.6 and Figure 3.18 show imports by chemical code of clinical waste as of 2016. Regarding the leading exporter countries, the absolute leader is again the USA.

Table 3.6

Import of clinical waste

faucets with maximum import	thousand US dollars	countries from minimal import	thousand US dollars
USA	1,523.94	Singapore	6.29
China	500.53	Poland	5.47
Great Britain	329.93	Morocco	2.88
Netherlands	315.12	Canada	2.82
Belgium	103.54	Timor-Leste	2.63
Sweden	62.22	Bosnia and Herzegovina	2.48
Australia	52,11	UAE	2.23
Denmark	35.99	Austria	1.52
Ireland	34.87	Thailand	1.30
Myanmar	34,14	Tunisia	1.22
Malaysia	34.08	Chile	1.05

Source: built by the author based on [289]

China, Great Britain, the Netherlands, and Belgium have imports that are almost three times smaller, but still very important. Chile, Tunisia, Thailand, Austria, and the UAE have the categorical opposite, that is, the minimum volumes of imports. But despite such meager imports, it is still present. After all, there are many countries that do not import and export waste and scrap in general and separately by industry.

Substitution of primary raw materials for secondary raw materials would contribute to decoupling by reducing the demand for primary materials and maintaining levels of economic growth. Because natural resources are geographically unevenly concentrated, the effects of such trade are "visible" globally according to the distribution of primary raw materials. For example, in 2013, 43% of the world's iron ore production was exported outside the country of origin. There are also exporters of secondary raw materials concentrated in other parts of the world. For example, the European Union, Japan and the USA are identified as the largest exporters of scrap metal. However, to date, the definition of secondary raw materials and tracking as such has not been accepted at the international level. That is why trade flows

are so problematic to describe. In addition to the fact that the use of secondary raw materials and materials will only increase, barriers in circular trade will be removed. Export restrictions are often applied to secondary raw materials. The OECD Export Restrictions Database indicates that approximately one-third of waste and scrap exports by 2009 were subject to restrictions.

In the conditions of the European Union, the lack of adequate tools and standards for ensuring the quality of secondary raw materials and increasing their use and trade are identified as potential barriers that need to be eliminated. Regarding the adoption of recycling standards, an important aspect is to ensure that the product is designed in such a way that it is easier to recycle and refrain from using hazardous content. Similarly, information and provision about the chemical and material composition of products is of particular importance to ensure the secondary nature of disposal and the useful life of products. With the emergence of global value chains and the activation of the formation of global circular value-added chains, eco-design and eco-labeling play an important role, which is one of the important steps in promoting the transition to a global circular economy and removing barriers.

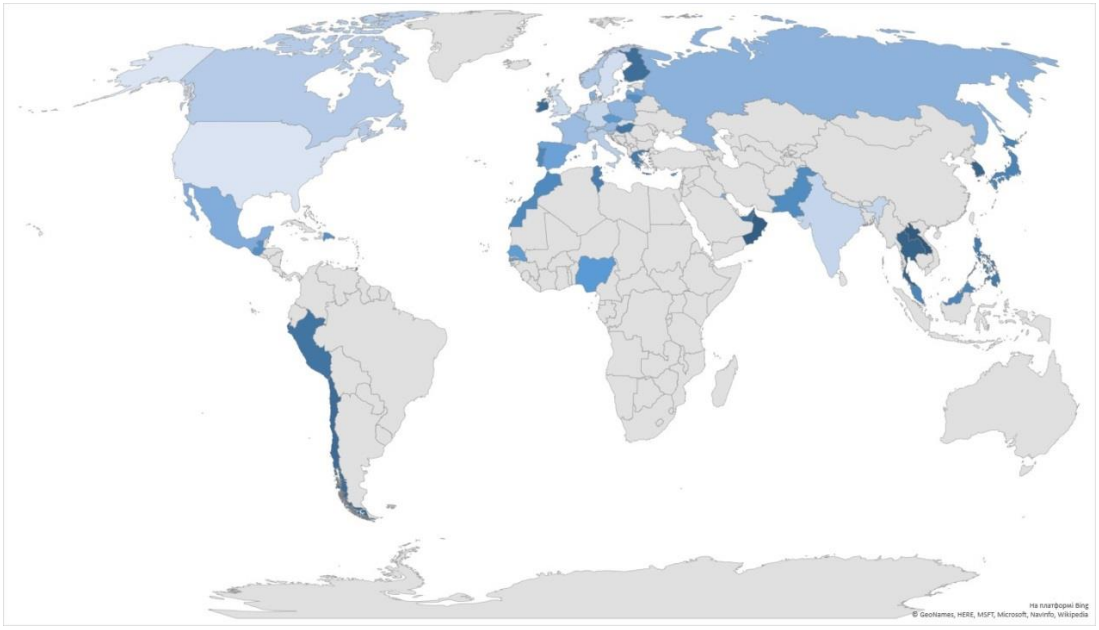

Fig. 3.4. **Import of chemical household waste, 2016**

Source: built by the author based on [289]

The largest importers of municipal chemical waste in 2016 were the USA, Hong Kong, Sweden, Slovakia and Germany (Table 3.7). Laos, Oman, Thailand, Korea, Ireland, Chile and others were minimally represented.

Table 3.7

Import of chemical household waste, 2016

faucets with maximum import	thousands of US dollars	countries from minimal import	thousands of US dollars
USA	6,812.49	Philippines	14.51
Hong Kong	6,082.43	Hungary	13.04
Sweden	3,920.66	Peru	12.31
Slovakia	2,197.56	UAE	11.00
Great Britain	1,857.76	Finland	8.07
Germany	1,235.66	Chile	8.03
India	1,178.54	Ireland	5.81
Netherlands	768.27	Korea	3.24
Switzerland	735.57	Thailand	3.16
Italy	679.98	Oman	3.00
Canada	586.93	Laos	1.92

Source: built by the author based on [289]

As of 2016, Japan was the leader in the export of chemical household waste. Canada, Austria, Norway, and the USA are also leaders. Poland, Lebanon, Turkey, Indonesia, Kuwait and Oman have minimal but present exports of such waste (table 3.8).

Table 3.8

Export of chemical household waste, 2016

Cranes with maximum export	thousands of US dollars	Countries with minimal export	thousands of US dollars
Japan	8,839.46	Spain	23.52
Canada	6,673.67	Denmark	20,10
Austria	4,198.28	Italy	11.09
Norway	4,021.23	Hungary	10.57
USA	3,488.90	Finland	9.64
Great Britain	2,556.14	Oman	4.99
Germany	2,079.27	Kuwait	4.65
Australia	1,585.44	Indonesia	3.90
Greece	632.92	Turkey	2.15
Romania	504.01	Lebanon	1.57
Estonia	440.16	Poland	1.01

Source: built by the author based on [289]

The next group in terms of waste and scrap **is plastic.** Table 3.9 shows the corresponding codes and their meanings according to the classification. The UN Merchandise Trade Database records only legal transactions. The real value of the global waste market is the opportunity to create circular startups that become components in global circular chains of added value. In 2012, the European Environment Agency reported that around 250,000 tons of illegal e-waste were shipped from the European Union to West Africa and Asia each year, and this waste trend is on the rise in smuggling. It is now clear that the waste recycling industry, regardless of its "dirty" outlook, is actually a very profitable business for Indonesia, Malaysia, Thailand, Vietnam and the Philippines. This attracts legal and illegal players.

Table 3.9

HS code: Harmonized System (HS) code: plastic

391510	Ethylene polymers; waste, splitting and scrap
391520	Styrene polymers; waste, splitting and scrap
391530	Vinyl chloride polymers; waste, splitting and scrap
391590	Plastic nec in heading No. 3915; waste, splitting and scrap
400400	Rubber; rubber waste, splits and scrap (except solid rubber) and powders and granules obtained therefrom

Source: built by the author based on [289]

At the end of May 2019, the Philippines sent 69 containers of garbage back to Canada. The containers were shipped from Canada to the Philippines in 2013 and 2014 as part of a global waste trade. However, smuggling has been at the center of a dispute between the Philippines and Canada as non-recyclable materials have been found mixed up inside containers. Knowing that these non-recyclable materials have no economic value and will only end up in landfills, the Philippines demanded that the containers be returned to Canada [358]. It took years to solve the problem. In 2009, a similar situation occurred between Brazil and Great Britain. Unlike the Philippines case, where

the smuggled items were non-recyclable materials, the illegal items found in the 89 containers being transported to Brazil fall under the toxic category.

Transboundary movements of hazardous waste and their disposal (Basel Convention), which is the main international agreement that regulates the transfer of waste between countries, in particular, prohibits toxic materials. However, the Convention did not regulate the transportation of plastic waste. Thus, while Brazil's experience was clearly illegal, the Philippines' case was less obvious [282]. While the garbage dispute between the Philippines and Canada was still ongoing, another parallel issue came into focus. It was China and the ban on the import of plastic waste. In 2017, the Chinese government approved the National Policy to Regulate the Import of Industrial Waste, Electronic Scrap and Plastic Waste for economic and environmental reasons. Elimination of smuggling is one of the main goals of the policy. In mid-2017, after China announced at the World Trade Organization that it would no longer accept certain types of solid waste, it took effect in 2018. Since China was a major importer of waste, the ban has thrown the global waste trade industry into chaos all these years. [282]

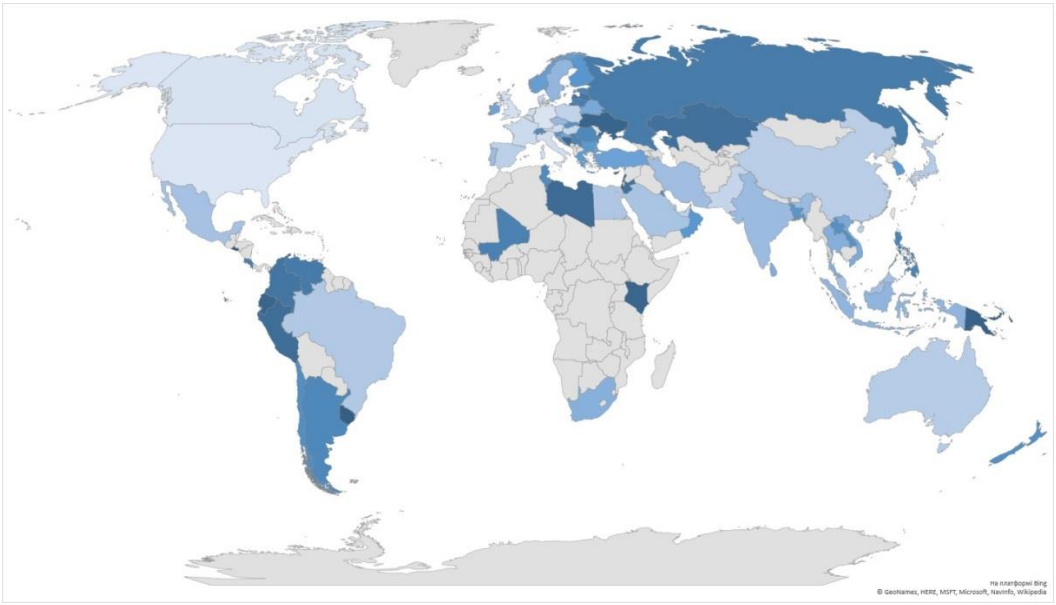

Fig. 3.5. **Export of rubber waste, 2016**

Source: built by the author based on [289]

A significant share of plastic waste is subject to export-import both within the EU and between the EU and other parts of the world. The export of plastic waste to non-EU countries amounted to about 150,000 tons per month at the beginning of 2019. The main redistribution and reduction of plastic waste exports from the EU-28 countries to countries outside the EU took place between January 2017 and April 2019. As a result of this restriction on imports into China, the amount of plastic waste exported to China and Hong Kong has become very limited, and exports have shifted to other directions [358].

Awareness of the problem of plastic waste management has only increased relatively recently, compared to the management of materials such as paper, glass and metals. This is one of the reasons why the EU still does not have the capacity to reuse, recycle and recover all its plastic waste and is looking for export opportunities. Waste is exported because of lack of capacity and because of the demand for imports and the profit that could potentially be made.

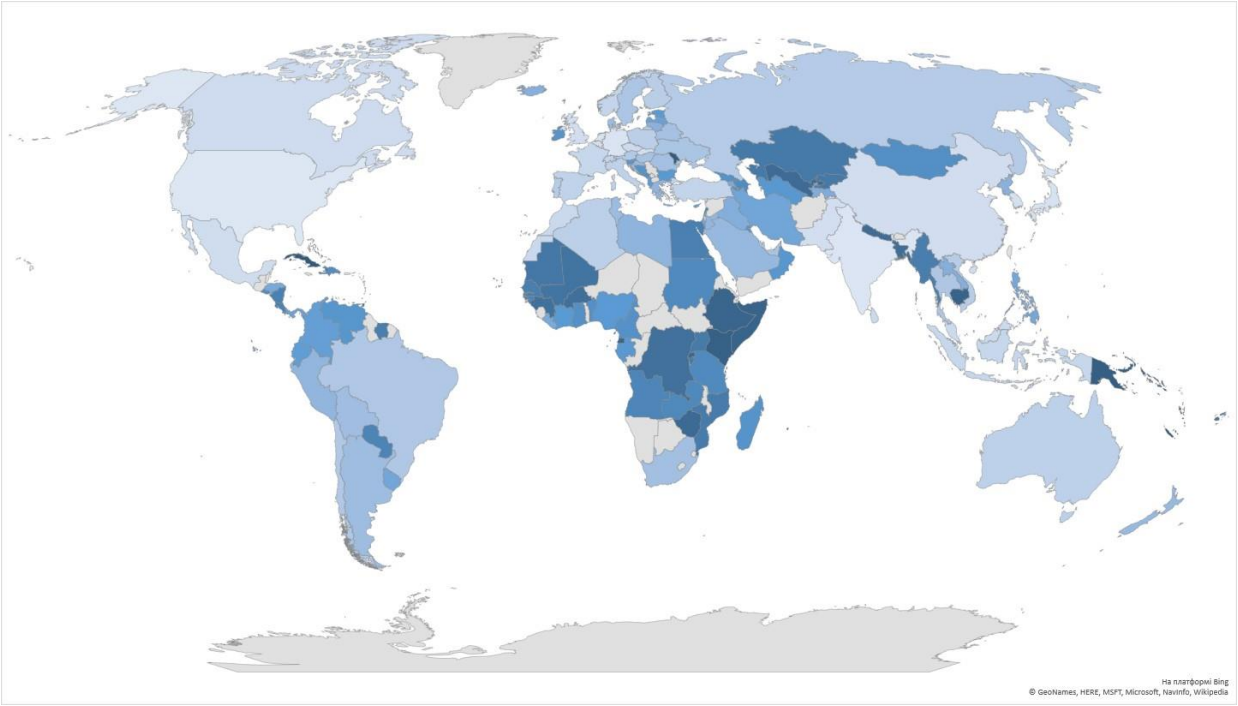

Fig. 3.6. **Import of rubber waste, 2016**

Source: built by the author based on [289]

China was the main destination where exporting countries (mainly G7 countries) sent their plastic waste for recycling. Since 1988, about half of the planet's plastic waste has been sent to this country to be melted down and turned into pellets. This changed significantly when China announced that it would accept plastic waste bales with less than 0.5% unrecycled contamination, up from the previous level of 1.5% [358].

Table 3.10

Export of rubber waste, 2016

Cranes with maximum export	thousand US dollars	Countries with minimal export	thousand US dollars
USA	25,732.70	Libya	27.44
Germany	17,813.36	Bosnia and Herzegovina	26.05
Canada	17,295.37	Lebanon	24.46
Great Britain	16,653.76	Kenya	24,24
Italy	11,575.71	Ecuador	22.66
Netherlands	9,361.15	Ukraine	22.66
Austria	7,426.52	Papua New Guinea	21.91
Belgium	7,035.08	Israel	15.57
France	6,774.03	Uruguay	4.50
Hungary	6,076.09	Norfolk Island	3.61
Pakistan	5,506.53	Salvador	2.68

Source: built by the author based on [289]

The new standard is nearly impossible to meet, given that plastic materials entering US recycling facilities can contain 15-25% contamination. The new rule effectively banned the vast majority of plastic scrap imports and created a moment to consider international recycling markets.

In 2016, the monthly export of plastic waste to China exceeded 600,000 tons per month. By 2018, they were reduced to less than 30,000 tons. China had many reasons to close its doors to foreign waste. Recycling plants in the developed world sift through plastic waste, sort out the valuable stuff (such as PET and PVD) for local recycling and send the remaining low-quality products to China. Such waste contains various materials, chemical additives and dyes

that make it impossible to recycle [358]. Non-recyclable plastic is disposed of in incinerators, landfills or landfills, polluting the air, land and sea. These environmental and social problems have forced China to close its borders, dramatically shifting the flow of plastic waste around the world.

Table 3.11

Import of rubber waste, 2016

faucets with maximum import	thousands of US dollars	countries from minimal import	thousands of US dollars
USA	26,544.85	Palau	9.85
India	22,360.41	Rwanda	7.40
Germany	18,934.58	Andorra	7.39
Netherlands	10,641.78	Equatorial Guinea	6.37
Japan	9,057.70	Ethiopia	5.51
Belgium	8,829.33	Somalia	5.35
Korea	7,793.90	Aruba	5.07
Slovakia	5,795.13	Cambodia	4.75
Pakistan	5,603.76	Kenya	4.68
Great Britain	5,551.73	Mauritius	3.95
China	4,965.04	Papua New Guinea	3.32
Mexico	4,960.08	Vanuatu	3.00
Canada	4,959.80	Solomon Islands	2.86
Czech Republic	4,409.86	Moldova	2.80
Sri Lanka	4,233.26	Cuba	2.60
Malaysia	3,928.82	New Caledonia	1.82

Source: built by the author based on [289]

For Asian countries, imports are an option, as large amounts of plastic waste have economic value. In addition, these countries do not have the same rules and regulations for waste management that apply in the EU, and therefore may deal with plastic waste in a less controlled manner. Factors determining and controlling the export of plastic waste from the EU to other countries (i.e. how much and where) include: tariff and non-tariff barriers and differences in processing fees for services related to transportation, environmental taxes and strict policy of production capacity legislation and classification. Plastic has become a serious challenge for the planet as a whole.

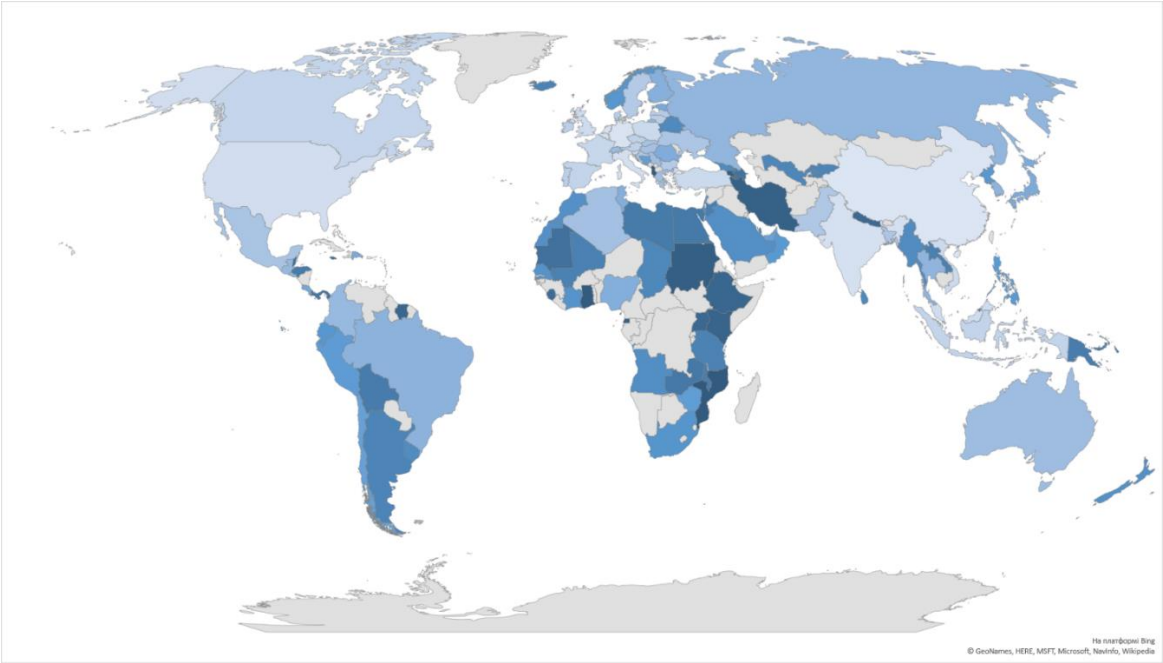

Fig. 3.7. **And import waste of ethylene polymers, 2016**
Source: built by the author based on [289]

At the same time, the production of plastics is largely dependent on fossil fuels. The amounts can be equated to the amount of the aviation sector. Combustion and energy recovery from plastic waste as a result of direct emission of greenhouse gas emissions. While plastic is deposited in landfills, carbon can be released into the atmosphere during this time. This is all a result of a lack of knowledge about the impact on the environment and climate, as well as about the social consequences of exporting plastic waste to countries outside the EU. Mismanaged plastic waste pollutes terrestrial ecosystems, and 80% of ocean plastic is estimated to come from terrestrial resources. Greenhouse gas emissions from plastic production and processing, as well as from plastic waste management - that is, from incineration and landfills - are increasing rapidly. Globally, less than 10% of the nearly 6,300 million tons of plastic waste generated between 1950 and 2015 was recycled. More than 60% of produced plastic (since 1950) is landfilled in nature, including in the world ocean. The rest were burned or ignored. Table 3.12 shows the import of ethylene polymers, waste, splitting and scrap as of 2016 [289].

Table 3.12

Import of waste ethylene polymers, 2016

faucets with maximum import	thousands of US dollars	countries from minimal import	thousands of US dollars
China	1,054,000.00	Surinam	7.02
Hong Kong, China	150,800.00	Ethiopia	6.86
Germany	85,776.24	Macau, China	4.66
Netherlands	74 181.29	Kenya	4.06
Belgium	69,299.41	Iran	4.05
India	51,255.78	Equatorial Guinea	3.54
Italy	49,975.50	Sudan	3.25
the United States	47,918.81	Armenia	2.33
Malaysia	40,189.60	Ghana	2.27
UK	39,353.10	Mozambique	1.80
Vietnam	34,898.90	Albania	1.77

Source: built by the author based on [289]

This method gets rid of various types of waste that are difficult to recycle. The most toxic of them include radioactive waste, electronic waste and incineration ash. The Italian environmental association Legambiente reported in 2001 that there were already 600,000 tons of radioactive waste on the seabed near the coast of the Western Sahara (Fig. 3.8). The immediate problems caused by this waste disposal are health and safety issues for the third world workers who process it. These workers often lack the necessary equipment needed to handle hazardous materials, and they often put their health and lives on the line to process the waste.

Lead from electronic waste is another direct threat to human life. In landfills used to dispose of e-waste, leads to leaching of lead into the ground and ultimately into the local water supply. In Lagos, Nigeria, reports from the World Health Organization and The Lancet link several health hazards, such as increased rates of thyroid dysfunction in women and permanent damage to the central nervous system in children, to electronic waste dumped there from the first world. Despite the existence of several international conventions that prohibit the dumping of WW1 waste, such as the Bamako Convention and the Basel Convention, it has not only continued, but has also formed a global

billion-dollar industry that research has shown is linked to arms trafficking and money laundering [193].

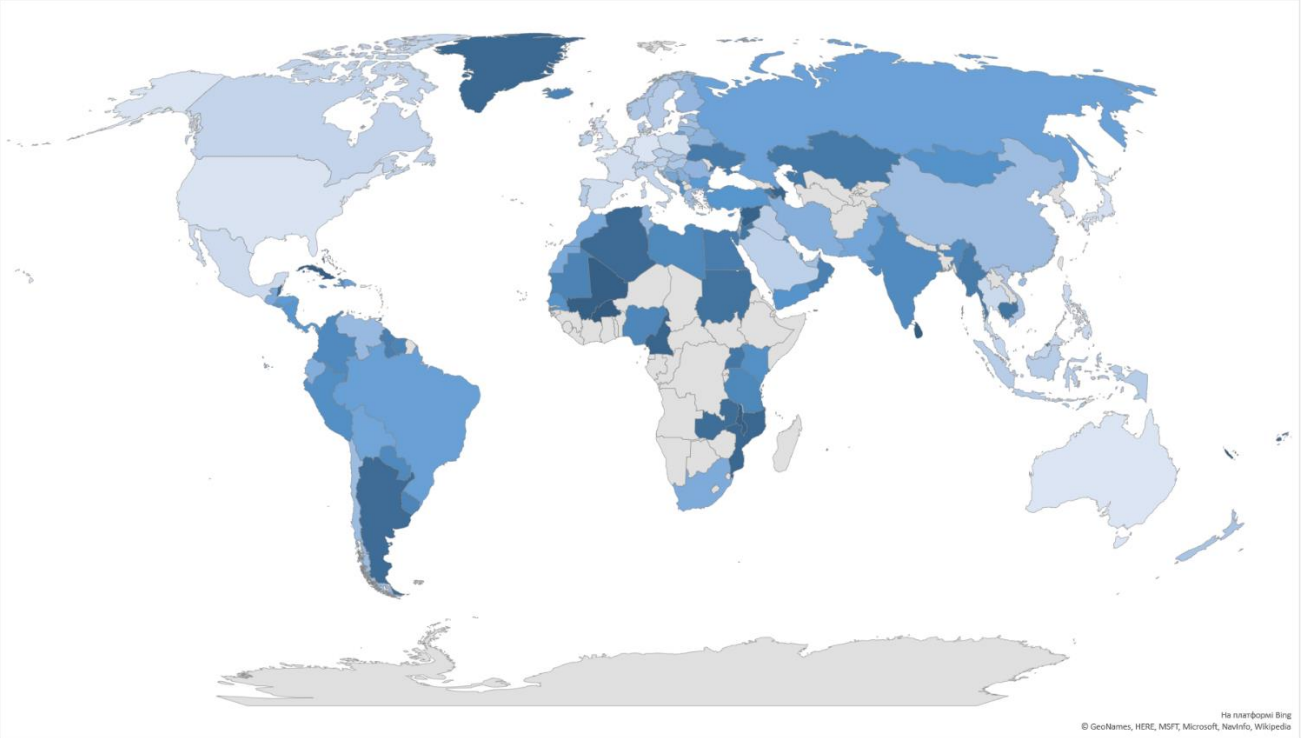

Fig. 3.8. **Export of polyethylene polymers, 2016**

Source: built by the author based on [289]

The top exporters of ethylene polymers, waste, splitting and scrap as of 2016 (Table 3.13) are Germany, USA, Hong Kong, Great Britain and Japan.

Table 3.13

Export of ethylene polymers, 2016

Cranes with maximum export	**thousands of US dollars**	**Countries with minimal export**	**thousands of US dollars**
Germany	316,500.00	Belize	9.21
USA	252,900.00	Cameroon	8.58
Hong Kong, China	167,000.00	Azerbaijan	6.22
Great Britain	139,600.00	I am raw	5.20
Japan	132,600.00	Malawi	3.95
Belgium	126,800.00	Small	3.37
Netherlands	117,500.00	Cuba	3.12
France	73,376.71	Sri Lanka	3.04
Spain	49,630.77	Burkina Faso	2.27
Slovenia	43,018.50	Aruba	2.19
Mexico	41,170.03	New Caledonia	1.22

Source: constructed by the author based on [289].

The next group in terms of waste and scrap is textiles. Table 3.14 shows the corresponding codes and their meanings according to the classification.

Table 3.14

HS code: code in the Harmonized System (HS): textile

500300	Silk waste (including cocoons not suitable for winding, yarn waste and garnet)
510320	Wool and hair; waste of wool or fine animal hair, including yarn waste, excluding garnet composition and wool of wool or fine animal hair
510330	Wool and hair; coarse animal wool waste, including yarn waste, with the exception of garnet composition
520210	Cotton; yarn waste (including thread waste)
520299	Cotton; waste, except garnet waste and yarn waste (including thread)
550510	Fibers; waste (including burrs, yarn waste and garnets), of synthetic fibers
550520	Fibers; waste (including burrs, yarn waste and garnets), of synthetic fibers

Source: built by the author based on [289]

Silk waste is the 1183rd most traded product and the 999th most complex product according to the Product Complexity Index (PCI). The main exporters of silk waste are China ($39.7 million), India ($11.8 million), Germany ($7.81 million), Italy ($4.37 million) and Vietnam ($2.44 million). The main importers are Italy (23.4 million US dollars), China (12.4 million US dollars), Germany (8.47 million US dollars), South Korea (6.35 million US dollars) and Japan (3.46 million US dollars) (Table 3.15)

Table 3.15

Export of silk waste (including cocoons not suitable for reeling, yarn waste and garnet), 2016

Cranes with maximum export	thousands of US dollars	Countries with minimal export	thousands of US dollars
China	40,029.9	Switzerland	7.74
India	14,422.6	Romania	6.48
Germany	8,299.71	Portugal	5.64
Italy	3,779.24	Netherlands	4.83
Vietnam	2,430.77	Russia	3.77
Uzbekistan	1,463.76	South Africa	3.72
Brazil	1,065.81	Latvia	3.00
Great Britain	844.23	Singapore	2.67
Korea	788.98	Indonesia	2.51
Kyrgyzstan	230.39	Norway	1.19
Poland	204.83	Bangladesh	1.15

Source: constructed by the author based on [289].

Trade in silk had a positive balance only in case China, which is the main producer of silk and an exporter that dominates the international market market. Its trade balance was USD 1,000,862 thousand. Almost all other "players" in the silk market of international trade registered a negative trade balance for almost all years during the studied period from 2012 to 2016 AD. The exceptions were France, which showed a positive trade balance in 2014, 2015 and 2016, Vietnam with a positive trade balance in 2015, and Germany with a positive balance in 2013. Compared to 2012, in 2016 the trade balance for silk recorded a lower positive value in the case of China (68.33%) [193].

Table 3.16

Imports of silk waste (including cocoons not suitable for reeling, yarn waste and garnet), 2016

faucets with maximum import	thousands of US dollars	countries from minimal import	thousands of US dollars
Italy	24,444.12	Russia	4.47
China	14,180.84	Finland	4.06
Germany	9,511.10	Ghana	3.69
India	4,554.22	Israel	3.00
Japan	3,665.96	Sweden	2.44
Korea	3,291.55	UAE	2.43
Thailand	2,294.83	Mongolia	2.08
Bulgaria	1,552.81	Cameroon	2.06
Great Britain	1,498.39	Sri Lanka	1.86
Vietnam	1,409.05	Latvia	1.49
Peru	1,389.92	Iceland	1.44
Austria	1,041.60	Paraguay	1.13

Source: constructed by the author based on [289].

Table 3.16 shows the import of silk waste (including cocoons unsuitable for winding, yarn waste and garnet) as of 2016. Accordingly, the undisputed leaders are Italy and China. This is explained by the available capacities and the developed industry. Wool or hair waste wool is the 1160th most traded product and the 949th most complex product according to the Product Complexity Index (PCI). The top exporters of wool or animal hair waste are

the Czech Republic ($17.8 million), China ($14.7 million), India ($13.3 million), Argentina ($9.3 million), and the United Kingdom ($8.32 million).

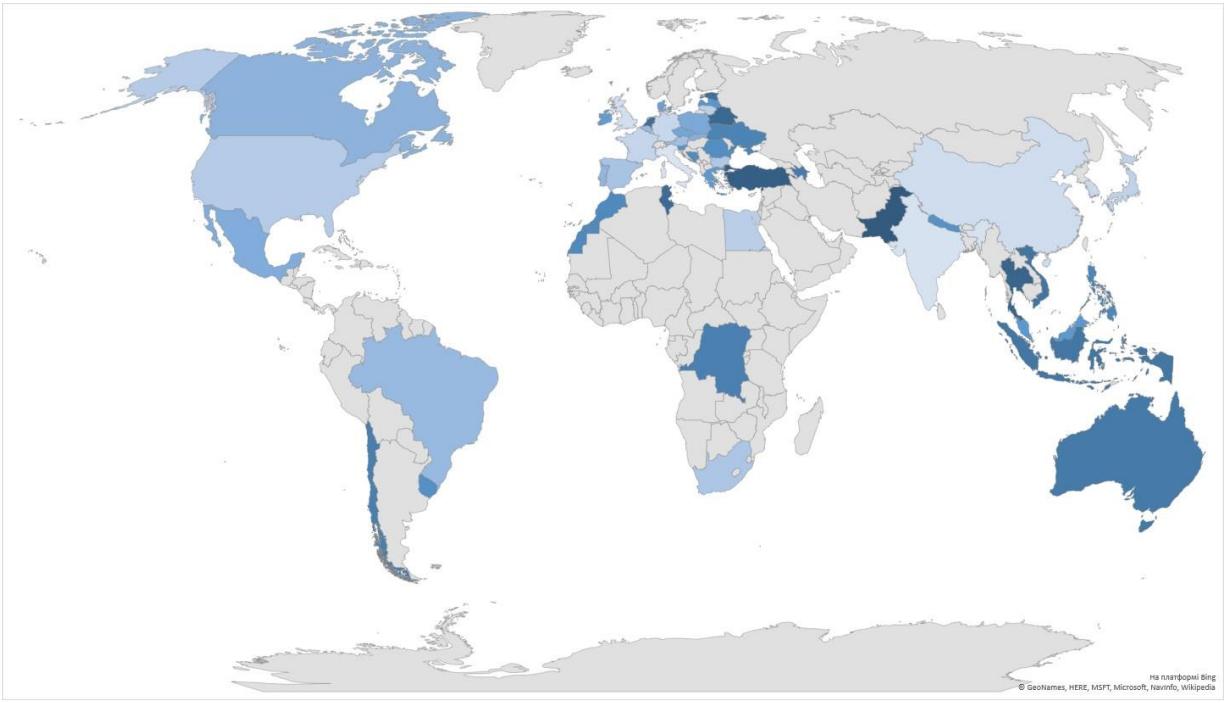

Fig. 3.9. **Import of wool and hair; waste wool or fine animal hair, including yarn waste, 2016**

Source: constructed by the author based on [289].

The main importers are Italy (US$ 54 million), China (US$ 15 million), Belgium-Luxembourg (US$ 4.73 million), Japan (US$ 4.71 million) and Great Britain (US$ 4.34 million) (table 3.17) [193].

Table 3.17

Import of wool and hair; of wool or fine animal hair waste, including yarn waste, 2016

faucets with maximum import	thousands of US dollars	countries from minimal import	thousands of US dollars
Italy	13,480.98	Azerbaijan	8,17
India	4,268.90	Australia	7.75
Great Britain	3,337.62	Indonesia	6.95
China	2,166.46	Vietnam	6.80
Korea	1,686.80	Estonia	5.38
Germany	1,368.30	Netherlands	4.63
France	1,300.52	Tunisia	4.11
Japan	915.53	Belarus	3.47
Lithuania	854.48	Thailand	2.83
Egypt	531.22	Singapore	2.70
USA	343.29	Turkey	1.28

Source: constructed by the author based on [289].

Wool waste produced by sheep shearing is currently considered waste and thus farmers are responsible for disposal costs. Therefore, a solution had to be found to improve the quality of this waste, and turning the so-called greasy wool into fertilizer became a viable option. In this case, we are talking about wool obtained from the Sardinian breed, the characteristic feature of which is very coarse, stiff and rarely used in the textile industry, which is quite different from the finest merino wool, known for its softness.

Table 3.18

Export 2016 Wool and hair; waste of wool or fine animal hair, including yarn waste, excluding garnet composition and wool of wool or fine animal hair

Cranes with maximum export	thousands of US dollars	Countries with minimal export	thousands of US dollars
Great Britain	4,491.93	Moldova	13,14
Pakistan	3,867.89	Estonia	12.48
Belgium	2,733.37	Libya	10.72
India	2,578.78	Denmark	10.54
Italy	2,369.03	Russia	10.38
Czech Republic	2,056.39	Brazil	9.26
Poland	2,052.18	Belarus	6.83
Germany	1,794.95	Guatemala	2.88
Spain	1,390.92	Philippines	2.83
China	1,365.78	Bahrain	1.25

Source: constructed by the author based on [289].

The need for a circular economy is gaining widespread recognition across Europe, and this applies to business, society and the corporate policy of manufacturers. Waste reduction combined with resource wise use has the potential to address the gap due to scarcity of natural resources and a growing global population or consumption. Hundreds of textile companies have successfully innovated and adapted their business models to better compete and combat them. However, the potential is much greater. The textile and clothing industry is in a privileged position where the circular economy thrives and is close to consumers and important to other sectors of the economy. In

Europe, there are already active circular textile value chains capable of recycling fabrics, recovering braces and maximizing resources in production. This asset must be consolidated and improved to release the opportunities of the circular economy and for which there are practically no limits to growth. Prosperity in the circular economy will truly be achieved by combining existing private and public initiatives, removing barriers, investing to promote technological innovation and stimulating demand.

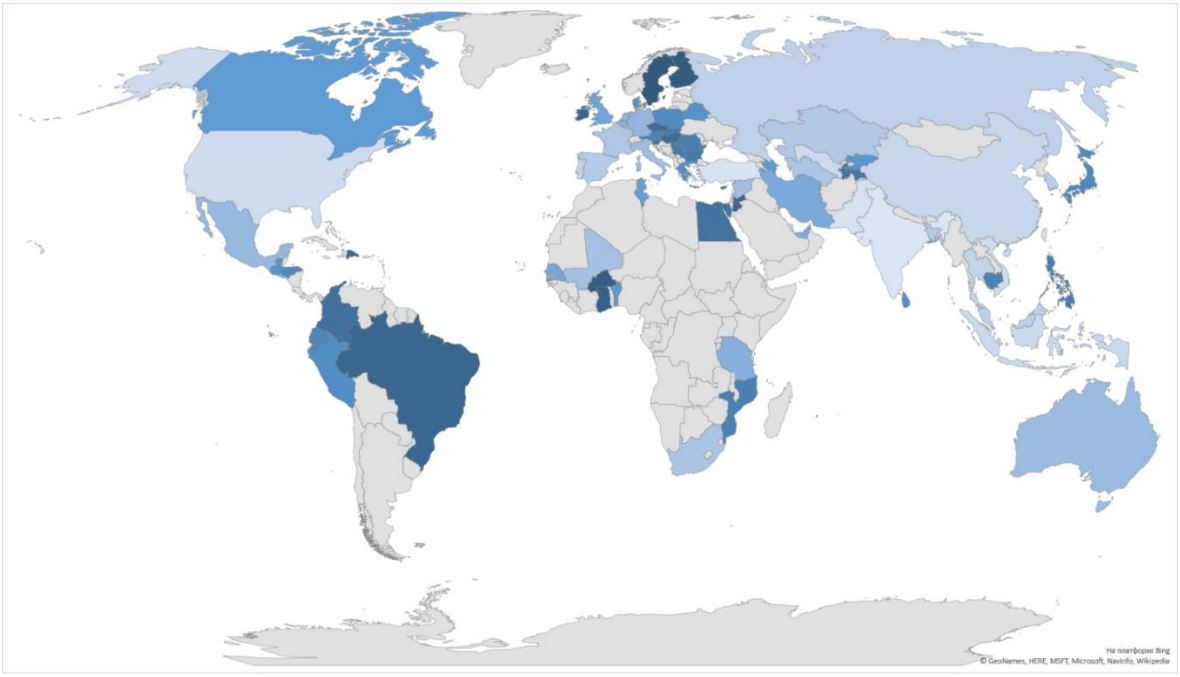

Fig. 3.10. **Export of cotton waste and yarn (including thread waste) 2016**
Source: constructed by the author based on [289].

Cotton waste is the 974th most traded product and the 1191st most complex product according to the Product Complexity Index (PCI). The main exporters of cotton waste are India ($147 million), Turkey ($ 75.5 million), Pakistan ($63.3 million), Germany ($ 45.8 million) and Vietnam ($43.1 million). The main importers are China (US $105 million), Germany (US $80.3 million), France (US$37.1 million), Italy (US$34.3 million), and Malaysia (US$34.2 million) (Fig. 3.25, Table 3.33) [289].

Table 3.18

Export of cotton waste and yarn (including thread waste), 2016

Cranes with maximum export	thousands of US dollars	Countries with minimal export	thousands of US dollars
India	12,173.14	Hungary	9.81
Turkey	10,792.20	Dominican and	8.93
Pakistan	9,099.22	Brazil	6.59
Hong Kong, China	7,829.34	Jordan	5.45
Vietnam	5,415.75	Ireland	4.38
USA	3,869.56	Ghana	3.09
Uzbekistan	3,843.17	Burkina Faso	2.24
Indonesia	3,202.06	Finland	2.17
China	2,900.10	Sweden	1.22

Source: built by the author based on [289]

The textile market is highly globalized, with millions of producers and billions of consumers worldwide involved in so-called linear value chains. These chains - from extraction of raw materials to production, transportation, consumption and waste - involve almost no reuse or recycling. Since 1975, the global production of textile fibers has almost tripled. Today, 60% of textile fibers are synthetic. Polyester is the most commonly used fiber produced from carbon-dioxide processes that require more than 70 million barrels of oil each year. The rest of the fibers are mostly cotton, which uses land and water. In 2014, the number of products produced in the world was almost 14 new items of clothing per person. There are around 171,000 companies in the textile (including clothing) industry in the EU, employing 1.7 million people. In 2017, the EU produced 7.4 kg of textiles per person, consuming almost 26 kg. Therefore, the EU is a net importer of textiles (mainly finished products from Asia) [176]. Exports from the EU mainly include intermediate textile products, such as technical fibers and high-quality fabrics, in which the European industry specializes.

Table 3.19

Imports of cotton in 2016 ; yarn waste (including thread waste)

faucets with maximum import	thousands of US dollars	countries from minimal import	thousands of US dollars
China	35,478.88	Kenya	5.18
Hong Kong, China	6,825.79	Egypt	4.05
Russia	4,976.17	Bosnia and Herzegovina	3.87
Spain	3,361.00	Cape Verde	3.28
France	3,072.36	Burkina Faso	3.09
Germany	2,891.55	Slovakia	2.59
Mexico	1,961.12	Ghana	2.24
Vietnam	1,826.75	Grenada	1.91
South Africa	1,685.82	Mozambique	1.79
Portugal	1,553.89	Uganda	1.39
Belgium	1,471.29	Timor-Leste	1.36
Nigeria	1,267.21	Montenegro	1.22
Malaysia	1,166.42	Armenia	1.17

Source: constructed by the author based on [289].

Private companies and public authorities are increasingly seeing the potential economic, social, environmental and climate benefits of circular trade in textile waste, particularly cotton. Circular business models focusing on textile design, sharing, recycling and reuse of textiles have recently emerged. Such business models cannot be scaled up in isolation - they require system-wide changes supported by regulation and other policies.

Deep refurbishment can cut building-related energy consumption in Europe up to 80%, saving the EU over 30% of its total energy consumption.

In 2019, the European Commission identified textiles (clothing and fabrics) as a priority product category for the circular economy in the area Sustainable products in the context of the circular economy in the direction of policy formation on the EU product policy that promotes the circular economy. In addition, the European Commission has proposed a new circular economy

action plan focused on the sustainable use of resources, especially in resource-intensive and resource-intensive industries such as textiles and construction.

Education and behavior change is an important part of the transition to circular trade in textiles to lead to behavior change throughout the system - from production and processing to transport, consumption and waste [176].

Numerous examples of companies and governments moving towards a circular economy prove that voluntary initiatives can create a market and circular supply chains for textile recycling. Legal incentives and scaling tools to encourage demand should be considered. For example, support for green public procurement. This has huge potential to boost innovation for the circular economy, help reduce costs through economies of scale and create a wider value chain in Europe. Example: successful cases have been recorded in at least the Nordic countries, Great Britain, Belgium, France and the Netherlands. Obviously, not all goods or public procurement can be satisfied with recycled materials, due to the specificity of the functions of workwear, examples in the Netherlands and Great Britain propose to expand existing voluntary initiatives.

A mandatory extended producer responsibility scheme at EU level without this programme. The absorption infrastructure will face important challenges, including: stability of operation, increased market pressure to absorb second-hand items. Lack of a modern market for processed varieties and technologies. Voluntary collection partnerships at EU level would better define roles, responsibilities and benefits for each member of the supply chain. Different utilization potential and material processing costs should be taken into account ("one size does not fit all") [358].

The report of the European Commission notes that the most expensive EPR scheme is not necessarily the most effective. Establishing clear criteria for

the recycling of textile products, which allow turning textile waste into secondary raw materials:

- ✓ stimulate collection and demand for recycled textile materials through partnerships;
- ✓ economically beneficial "green public procurement";
- ✓ investing in textile waste management to overcome technological challenges;
- ✓ reducing the costs of handling textile waste for land maintenance/burning;
- ✓ stimulation of sustainable consumer behavior.

The transition to a global circular economy and trade, in particular, is gradually gaining political attention. By promoting a circular economy not only in a given jurisdiction, but also by exploring synergies in developing countries and collaborating with other countries to achieve material circularity and ultimately decoupling resource use from economic growth at the macro level.

Such initiatives may consider joint efforts to:

• better understanding of the quality and quantity of materials available in the region;

• determination of priority materials for trade and the required level of processing capacity;

• possible coordination of material quality standards

• promotion of demand for used goods and secondary raw materials

• elimination of unnecessary regulatory barriers

• avoidance of environmentally harmful activities such as non-compliance, poorly regulated and informal remediation.

These concepts can be encouraged through multilateral frameworks and international trade negotiations, particularly between leading exporters and importers of waste and scrap.

Jobs in the circular economy produce goods and services in ways that efficiently use natural resources and cause no damage to the environment. These jobs are essential and the workers who do them should be treated with respect and dignity.

These jobs must fit into the framework of the Decent Work Agenda, which is a movement geared towards poverty reduction and inclusive development. Workers in the circular economy should earn a fair income, enjoy job security and have a safe work environment. They deserve social protection and opportunities to express concerns and opinions without fear.

The reality in Europe, however, is that many jobs linked to waste management are low-paying jobs. Also, there are issues of worker safety that need to be addressed. Gender inequality also presents a challenge. Women may not enjoy equal pay or representation in certain industries.

Global circular trade involves countries specializing in exporting goods in which they have a comparative advantage and importing other goods from their trading partners. This process of international exchange requires the transportation of goods from the country of production to the country of consumption. So, the expansion of international trade is likely to lead to an increase in the use of transport. Oil supplies 95% of all energy used in global transportation, making it a significant source of greenhouse gas emissions. The International Energy Agency (IEA) estimated that in 2004, transport was responsible for 23% of global energy-related greenhouse gas emissions. But there are important differences in the contribution of different modes of transport. About 74% of energy-related CO2 in the transport sector comes from road transport, and another 12% from air transport [175].

As *the International Maritime Organization* estimates that about 90% of world trade in goods is carried by sea, and the bulk of CO2 emissions in the transport sector come from road transport, international trade does not seem to play a major role in the generation of emissions from the transport sector. A 2007 IEA study on CO2 emissions from fuel combustion indicates that international maritime transport generates about 8.6% of transport sector emissions [175].

In terms of the carbon footprint of international transport, "food miles" is a new concept that involves calculating the CO2 emissions associated with transporting food over long distances to reach the end consumer. Therefore, some advocate that products should be sourced locally as much as possible, and that food labels should contain information about the origin of the product.

However, the true **"carbon footprint"** of domestically produced versus imported food products is very complex. Mode of transport (air, road, sea or rail) and distance are not the only significant contributors to CO2 emissions. The life cycle of products, including production methods (e.g. greenhouses vs. open-air production; modern energy-intensive technologies vs. manual labor), also plays a large role. Therefore, food miles can be a problem that requires case-by-case analysis and empirical testing.

Conclusions to chapter 3

The analysis of the global inclusive circular economy made it possible to draw the following conclusions.

1. It was found that the highest average growth rates were recorded for Malta (2.5%), Greece (2.4%), Latvia (2.1%) and Denmark (1.9%). The largest decrease occurred in Bulgaria (with an average annual decrease of -2.5%),

followed by Romania (-1.3%) and Slovenia (-1.2%). Thus, the highest level of household waste recycling is determined in Germany, followed by Belgium, Denmark, France, Italy, Slovenia, Sweden and Montenegro. In 2016, the largest gap in the increase in the level of recycling is characteristic of Lithuania, Bulgaria, the Czech Republic, Luxembourg, and Poland. Germany has the highest recycling rate in the world. Austria is in second place, followed by South Korea. These four countries managed to recycle from 52% to 56% of municipal waste. So, in general, the EU (28) is characterized by an average level of waste recycling (50-60%). The highest value is determined for Luxembourg (90%), Belgium (80%), Slovenia (60–70%), the Netherlands (70%), Italy (60–70%). The lowest indicators are typical for Greece (10–20%), Bulgaria (15–20%), Estonia (20–22%). It is also important to single out the countries with the highest positive dynamics: Croatia (25→40%), Latvia (40→61%) and Slovenia (50→75%).

2. According to Eurostat, Bulgaria (60.8%), the Czech Republic (61.7%), Slovenia (63.4%), Slovakia (54.4%) and the Netherlands (50.7%) exceeded the EU average target for plastic packaging recycling in 2015, while the EU-28 figure was 40.3%. The absolute leader with the same indicator in different periods of the study is the Netherlands (28%), and the same stability is characterized by Belgium (16–17%) and France (16–17%); Sweden recycles almost all of its waste, Singapore - more than 60%. In general, this is a rather low level of recycling (the Netherlands has the highest rate (28%)), but there are countries with a nascent state of the secondary economy and the level of use of circular material - Bulgaria (3%), Ireland (3%), Greece (2.5%), Latvia, Romania, Portugal (3%).

3. According to the results of the ranking of the countries of the world according to the social component of the global inclusive circular economy, the high level of this component in the integrated indicator was confirmed, which

confirms the hypothesis that the inclusive component is necessary when considering the global circular economy. Thus, Belgium is the absolute leader, followed by the Czech Republic, the USA, China, France, Greece, Austria and Australia with a high score. Closes the list of South African countries with 0 on social indicators. The fact that Ukraine is in 25th place among the 28 studied countries is noteworthy. The rating of the countries of the world by the environmental component of the global inclusive circular economy with the derived normative index shows the highest rating in Japan and Denmark. The group of countries with an indicator from 0 to 0.2 includes Ukraine and Estonia. South Africa, Hungary, Latvia, France, Poland. Unlike the social component, the ecological component is not represented by countries with high data, which would allow the indicator to be brought to a higher level. According to the ranking of the countries of the world according to the circular component of the global inclusive circular economy, the leaders are Canada, Denmark, Germany and the Czech Republic. The group of countries with a normalized index (0-0.2) consists of China, Pd. Korea, Australia, Mexico, Latvia, Turkey and Ukraine.

4. Thus, in the potential formation of global circular chains of added value, these countries will play the role of circular cores. In addition, the cluster analysis conducted based on the component indicators of the index of the global inclusive circular economy revealed a huge "circular gap" between this core and other countries.

The second group with the GICE index 0.62-0.67 consists of the following countries: Japan, Austria, USA, China. This group is special in that it includes the leading countries in international trade and the international economy in general - these are the USA and China. Accordingly, the most important component of the index is social and economic. In addition, based on the conducted sectoral analysis of international trade in waste and scrap for 2016,

the USA, China, Germany and Canada are the leaders in export and import, which confirms their place in the first groups according to the index. The third group is the most numerous (9 out of 28 studied countries) with the GICE index within 0.5: Luxembourg, Greece, Canada, Lithuania, the Netherlands, Belgium, Great Britain, Hungary, Australia. The most important component is the social one, along with the average level of the circular component. In addition, the social vector is the core that unites all the studied countries. This confirms the socially inclusive vector, which is actively implemented in all countries and reflects the inseparability in the positioning of the global inclusive circular economy, where inclusiveness is at the priority level. The fourth group of countries (0.40-0.49) consists of seven countries with the highest index of the social component, with the exception of Finland, where the maximum is for the circular component. A low level of GICE (0.24-0.36) is noted in Latvia, Estonia and Turkey. The last group consists of Ukraine and South Africa.

5. It has been confirmed that the leading countries in the export-import of waste in various industries are simultaneously components of circular cores around which circular chains of added value are formed.

The main results of the study were published in: [25; 26; 30, 32, 38; 41; 43; 44; 47; 50].

CHAPTER 4

IMPLEMENTATION DIRECTIONS GLOBAL INCLUSIVE CIRCULAR ECONOMY

4.1. Stimulating the implementation of smart business models in circular cities as a priority for overcoming the gap-circularity of national economies

Given the global circulation of the source material (the material used), it is worth evaluating circularity. As of 2015, extracted resources amounted to 84.4 billion tons (these are four groups of resources: minerals, fossil fuels, metal ores, and biomass). In the course of monitoring the implementation of annual material costs, it was found that mining resources are supplemented by resources of the used cycle. According to the latest official data, in 2015, the world economy used 8.4 billion tons of circular resources (waste). This made it possible to use up to 92.8 billion tons of material resources. Most of the materials (56.8 billion tons) that enter the world economy annually are used by society as products that have a short period of operation (perish quickly) and reach their final use, as a rule, within a year. The remaining 36.0 billion tons of materials are transferred to the long-term stock. After meeting the needs of society, the release of resources takes the form of household waste, emissions,

etc. Most of the waste comes from long-term stocks, for example, waste from demolition of infrastructure and housing or scrap metal [148; 336] .

The circularity indicator is used to assess the circularity of the economy. Therefore, the circularity of the economy (global circularity metric) as of 2018 was measured by an indicator of 9.1% [148; 336]:

Circular materials (secondary raw materials) / Extracted resources =
8.4 billion tons / 92.8 billion tons = 9.1%.

The value of 9.1% for the indicator of the circularity of the economy indicates a significant gap - the circular gap is more than 90%. Although our current economy is largely linear, it is useful to outline the context of how this can be used in practice.

So, the global circularity metric (GCM) is a simplified measure for a very complex system. Calculation and interpretation of GCMs have one important aspect - they allow to identify four threats or challenges inherent in the modern global economy.

Tasks of GCM:

1) setting benchmarks (definition of benchmarks). The real value of such an indicator is its ability to establish a zero measurement for the globe and measure progress over time. This implies the need for periodic reporting on acquired values, such as the annual UN Emissions Gap Report;

2) definition of the main characteristics (features). A circular economy is not the same as a system that optimizes the recycling of materials. Rather, it is about preserving value as long as possible. These strategies extend the functional life of products, thereby preventing the generation of waste, reducing its volume and, at the same time, the need for appropriate resources to produce new replacement products;

3) data quality. Various data are used to quantify global material flows and stocks. Data on the receipt and use of materials are relatively reliable, but on the waste of materials, as well as on emissions, as a rule, less true, since the latter are heterogeneous in nature, geographically dispersed and their classification differs according to statistical sources;

4) quality reduction. The proposed method focuses on the end-of-use cycling of materials that are reused in the economic system, but does not take into account the phenomenon of their composition and quality.

Today, most countries with robust recycling programs only achieve 30% recycling (34.6% in the US). The model of the circular economy is aimed at using closed-loop production for the maximum possible conservation of resources based on the adoption of a pragmatic, win-win solution for solving environmental problems.

In addition to facilitating the passage of climate change, minimizing the depletion of resources and waste, supporters of the circular economy promise economic growth and the creation of new jobs. Big business can continue to thrive with "new opportunities" to "expand markets."

However, this vision ignores the fact that endless economic growth is not an option. And a certain solution to the environmental crisis means weakening the power of global corporations, that is, not supporting them.

However, we note that corporate interests are also served by the circular economy. For example, one of the most common functions is the business trend towards providing services rather than selling property. Yes, having DIY tools can save you money and materials. However, the emerging "sharing economy" also increases corporate power and can exacerbate inequality and dependency (for example, the dangerous working conditions of Uber drivers).

It is not up to global corporations to shape the circular economy. It should be "secured" by citizens and educated members of society. It is necessary to understand that complex problems do not have simple solutions.

In order for society to actually flourish, the circular economy must be aimed at increasing economic growth, reducing consumption, and rejecting the use of undemocratic power structures, etc. It must meet the real needs of all people, not the excessive consumption of a few, and be underpinned by shared mechanisms, not controlled by a small number of powerful companies.

Yes, the online platform "Airbnb" belongs to its users, and not to a commercial company with a quasi-monopoly status that gives benefits to participants, not to venture capitalists and private equity funds. Without pressure to grow and maximize profit, such an organization can be a champion for equality and resource intensity [7].

The ecological crisis is interconnected with the crises of inequality, migration and democracy. And the issue of none of these crises can be solved in isolation. Recycling and reuse of materials should be maximized, but this cannot be a panacea in general.

Thus, for the formation of a global circular economy, it is necessary to implement the following four main stages aimed at overcoming the gap (gap) of circularity:

- **creation of a global circular coalition with a common philosophy;**
- **development of a global goal and order of action;**
- **transition "global goals - local actions";**
- **definition of circular system.**

With current global economic trends and available technologies, a fully circular economy is possible only in the long term.

Let's define four main reasons for this phenomenon:

1) society will continue to increase the stock of rare materials, mostly rare earth metals, necessary for the creation of the latest innovative and complex products;

2) the economy of emerging countries and developing countries, as before, accumulates a stock of active resources and environmental infrastructure;

3) technical capabilities are insufficient to completely close the cycle, and in many processing processes there are losses in the quality and quantity of material;

4) some materials, including certain minerals, such as the Feldspar group, may be available in sufficient quantities, especially in certain geographic regions.

Extraction of resources increased from 7 billion tons in 1900 to 84.4 billion tons in 2015. A sharp further increase in the volume of extraction is expected until 2050, which will amount to about 177 billion tons annually [195]. The necessary direction is to limit production and increase the circularity of resources. Uniting them into one aggregate goal to limit production is a difficult task, even undesirable for certain circles of society. Extracted fossil fuels, ores and minerals have very different effects on the development of society, contributing to positive (satisfying basic needs) and negative changes. It also makes it possible to find out how significant barriers can be overcome to achieve goals [159; 191].

Cities play an important role in the transition to a circular economy. IN the world's urban areas are growing quite rapidly. It is predicted that by 2030, 60% of the world's population will be urbanized. Cities contribute to economic growth, producing more than 75% of global GDP in total. It causes 75% of carbon emissions for consuming 75% of the world's resources. Yes, cities have leadership opportunities for leading a "pioneer" lifestyle. This makes it

possible to strengthen ecosystems and contributes to high social and economic well-being. In 2016, according to the UN Sustainable Development Goals, 170 countries agreed to a new urban development program that sets a global standard for sustainable urban development and helps rethink modern planning and management [200].

The systemic approach of the circular economy can increase the role of the city in solving the main social, environmental and economic tasks in general. Circular economy strategies implemented through urban development have a significant impact, although there is also untapped potential. Car sharing, modular construction, sustainable management of organic waste and the study of new consumption patterns will enable cities to take practical measures to reduce emissions, create new jobs, as well as strengthen industrial production, increase competitiveness, and improve the health and well-being of residents.

A significant number of barriers prevent the transition to a circular economy, in particular, these are institutional, cultural, financial, regulatory and technological barriers [138; 159; 191].

The main obstacles to the successful promotion of the circular economy [258; 350]:

- environmental culture
- lack of state support
- administrative barriers
- lack of technical skills
- lack or lack of supply network support
- lack of information
- financial barriers
- lack of corporate culture
- unpreparedness for communication in circular networks

- consumer interests
- linear system
- lack of data (especially on consequences)
- a small number of pilot projects
- high upfront investment costs
- limited funding for circular business models
- standardization
- limitation of circular purchases
- lack of global consensus, lack of internalization of external factors;
- lack of skills and investment in the development and production of a circular product, which can also facilitate reuse, repair, recycling and disposal;
- lack of opportunities to improve cross-circular and cross-sectoral outcomes, particularly due to lack of government support and incentives for transformative change among market agents of circular chains;
- lack of business perception in relation to consumers as users;
- lack of know-how and economic incentives, including for repair and reuse;
- lack of information about the origin and shelf life of products, which does not contribute to raising the level of consumer awareness of the circularity of the economy;
- lack of waste sorting (especially food and packaging);
- lack of stable procurement incentives by state bodies;
- lack of investments and innovations in the field of infrastructure and recycling and recovery technologies;
- lack of coordination of transport flow systems within settlements and between cities and villages, which leads to misunderstandings between shippers and transporters;

- weak policy coherence (for example, policies in the areas of bioenergy and waste);
- problems with obtaining adequate financing for new business models of the ecological economy;
- wide spread of planned obsolescence in the product production chain.

Environmental culture: although there is significant heterogeneity among enterprises and firms in various sectors of the economy, the production of "green" and circular solutions is, as a rule, homogeneous in organizational and managerial aspects [304; 344]. After all, there are always those who respond positively to the challenges of "green" business, and those who do not see the meaning in "green" actions. Such a divergence of views regarding "green" business is due to various reasons depending on the direction of the organization's activity.

Financial barriers: The cost of green innovation and business model development is one of the biggest and most significant costs. Start-up costs and expected returns are very important for small and medium-sized businesses compared to large corporations. Research by scientists and practical experience show that this is exactly the reason that makes it impossible to implement recycling schemes. Separate studies by British scientists also confirm that the implementation of circular economy schemes is a less economically costly measure than reducing the amount of emissions and waste. However, there are also hidden, indirect costs, such as the time spent, human resources required by the business to implement environmental improvements. Sometimes these indirect costs are a critical and defining obstacle to the implementation of "green" circular innovations.

Lack of state support: lack of transparency in the interpretation at the legislative level of such concepts as "responsibility" of the producer, the quality of individual stages of recycling, reusing and recovering, etc.

Lack of information: Limited knowledge about the potential benefits and benefits of recycling is another barrier to implementing a circular economy. Not only do firms overlook the potential financial benefits, but they also find this practice very costly to their business.

Administrative barriers: the transition of small and medium-sized firms to "green" business is usually hindered by administrative barriers caused by the absence of environmental legislation.

Lack of technical skills: Many small and medium-sized businesses lack the technical capacity and ability to identify, adopt and implement technological innovations that would reduce environmental pressures and provide cost savings. In addition, companies take into account the level of technical skills and knowledge of personnel before making new "green" decisions.

Sufficient or lack of supply chain support: small businesses have little impact on engaging their suppliers in implementing sustainable development practices [159].

We do not consider this list to be exhaustive, but it contains the main obstacles to the transition to a circular economy. The transition to a new model begins with the recognition of the systemic nature of changes. Accordingly, examples can be singled out that best describe the smart models of the implemented inclusive circular economy [167; 221]:

Eileen Fisher: **The** equivalent of one garbage truckload of textiles is thrown away or incinerated every second and only 1% of clothing is recycled. It is also worth considering the excessive consumption of water and the amount of pollution from the production and dyeing of textiles, which generally characterizes the fashion industry as one of the least sustainable. However, companies like women's brand Eileen Fisher are tackling this pressing issue in their industry with take-back programs. Since 2009, E. Fisher

has run a program under which customers and employees can return old clothes produced by the company to its stores. In 2018, the company launched Eileen Fisher Renew and opened the Tiny Factory, a 21,000-square-meter warehouse north of New York. Nike Flyknit and Everlane: Production generates 60% less waste. The company's ReNew Reverable Huffed Puffer is made from recycled plastic bottles.

***Gerrard Street*:** The U.S. generated 6.4 metric tons of e-waste in 2016. And that number continues to grow, as e-waste is one of the fastest-growing segments of the country's waste stream. A popular business model for the circular economy is offering a product as a service, and Dutch company Gerrard Street is applying this model to one source of e-waste: headphones. The volume of e-waste is growing rapidly due to the increasing demand for electronics due to the constant updating of technologies and the impossibility of restoring many of its products. This also applies to headphones. Gerrard Street company founders Dorus Galama and Tom Leenders admitted that headphones often fail after a year of use. To solve this problem, modular headphones have been developed, the parts of which can be replaced and modernized.

Similar to a Spotify or Apple Music subscription, users pay a monthly fee for their headphones. Some headphones, starting at $300, are a cheaper and more reliable option. Headphone manufacturing is a niche market. However, the 'Gerrard Street' headphone circular design confirms that the modular electronics design and product model subscription is effective.

***Lehigh Technologies*:** More than 1 billion tires are disposed of each year. At the same time, 50% of these tires are either sent to landfills or disposed of in incinerators, which makes it possible to obtain a valuable resource. Since 2007, the company "Lehigh Technologies" has been recovering the resources of used tires using a cryogenic turbocharger. This process makes it possible to

freeze raw rubber (used tires) and turn it into powder. The resulting micronized rubber powder (MRP) can be used as a raw material for industrial and consumer applications, replacing fossil fuel-based materials. In 2017, Lehigh teamed up with tire giant Michelin to achieve sustainability goals by using 80% of its own tire materials and ensuring 100% recycling by 2048. Today, Lehigh serves a global market with total revenue of over $10 billion. The range of its products is quite wide: asphalt, building materials, rubber, plastics and polyurethanes, tires, etc.

However, many believe that we should not owe the invention of single-use plastic. This year, inspired by a coalition of activist groups, Starbucks pledged to phase out single-use plastic by 2020. The company "McDonald's" and "Starbucks" are also joining forces to develop a "compost" cup of coffee. Thanks to the Ellen MacArthur Foundation, 250 organizations, including brands such as H&M, PepsiCo and Unilever, as well as the World Economic Forum and 40 academic institutions, will collaborate to develop a circular economy for plastics. The aim of the activity is to abandon the widespread use of plastic and to ensure that all plastic products used are recycled. By 2025, the following task has been defined: all plastic packaging must be reusable, recyclable or compostable in order not to pollute the environment.

> Many countries have not identified the skills required to transition towards a circular economy, as they lack the capacity to collect this data

***Zazubean Chocolate*:** Making chocolate bars is a complex process. The practice of their production is different in different companies. It is about social responsibility for harmful or undesirable ingredients used in the production of chocolate, pesticides used in the cultivation of cocoa beans, and also about working conditions. It is worth supporting companies that make environmentally friendly products. “Zazubean” is a Canadian company that

makes the most delicious organic and environmentally friendly chocolate.

It supports its workers and those who grow cocoa beans. The company uses organic cocoa beans in production. This is the basis of production. Although cocoa beans are one of the crops that are most intensively treated with pesticides.

Abeego Foodwraps: The company "Abeego Foodwraps" manufactures natural, reusable food wrap. Recently, this Canadian company offered the world community reusable food packaging made of beeswax. First, it's a reusable product (a big win), and second, it's made from natural beeswax, which is much better for us (and our planet) than single-use plastic. Until now, various types of wrappers have been used to pack cheese, other products, various leftovers and even snacks on the go, etc. This type of wrapping allows food to retain its natural appearance and taste, and always seem to remain fresh.

***Lunapads*:** An environmentally friendly alternative to the feminine hygiene products used in the past, Lunapads is an example of female social entrepreneurship.

Cities are a kind of reflection of the degree of development of the country's economy. Most of the country's population lives in cities and more than 85% of the world's GDP is produced. If we want to move to a circular economy of development, we must first of all focus on the functioning of cities. Cities can be a base for testing and amplifying the impact of the circular economy. Due to a large part of the population, a large amount of materials and data in a small area, the city opens up opportunities for the implementation of new business models, such as reverse logistics, collection of materials, their reuse, rental and sharing. Cities have access to a wealth of materials that, if used, can create new opportunities. In the presence of a significant number of people, local markets are also formed and new business

models of production and processing are implemented. Cities are more receptive to the circular economy also because local politicians tend to be more flexible compared to national government, which often has a bureaucratic structure. In addition, cities will grow over the next 30-40 years. This makes it possible to avoid some linear blocking. Mostly, the population is an open object for the introduction of new technologies, and the concentration of people and things makes it possible to simplify this process. Since innovations make it possible to provide real needs, such as the need to distribute the transport network in cities, because there is not so much space in them, and transport is expensive, then the know-how is approved.

Circular city is a way to create livelihoods that uses systemic thinking to ensure economic, social, and environmental benefits in cities with an economic justification of their feasibility. "Green" or "eco" cities have a strong environmental case, but lack an economic vision of how to make it happen. Thus, the circular city offers a more systematic approach that allows solving problems while generating income and improving the quality of life in cities.

New technologies make it possible to solve the main problems of life support of cities. There are limited resources, the need for which will only grow with the increase in population. By removing some budget constraints on the use of existing assets, governments will be able to allocate more budget funds to areas such as education, medicine, the environment, and more. The circular economy will also provide an opportunity to increase income, which is currently a topical issue. And this will contribute to the creation of new business opportunities in cities that are interested in the development of business and innovation. In general, we

> A circular city is one that promotes the transition from a linear to a circular economy in an integrated way across all its functions in collaboration with citizens, businesses and the research community.

outline the opportunities created by the activities of many people in the field of digital technology and information communication, which makes it possible to implement a significant number of local business models, apply innovations that ensure innovative use of assets and storage of products and materials at the highest level, which is valuable in any period. At the same time, it can also inspire the creativity of business leaders and innovators.

Climate change issues are central to the functioning of production in large cities such as New York, London or Paris. If they want to reach zero or even half their carbon emissions by 2050, they will have to rethink the mobility system in cities, as well as the food system, the water supply system, and so on. Implementation of the circular economy means a systematic approach with economic justification [187].

There are many cities that implement innovative development models. For example, London is a pioneering environmental conservation project. At the same time, in such a small town as Peterborough [14], they are working on creating a circular economy with the involvement of the local business community. In total, an online platform called "Share Peterborough" has been developed with more than 100 sharing resources for sharing via the Internet. Autonomy in cities is mandatory, but it is necessary to create an economic and infrastructural basis for conducting policies that will contribute to their prosperity. Otherwise, the consequences can be catastrophic.

The "Copenhagen model" of development combines environmental initiatives, economic growth and improving the quality of life of the population in real time based on innovative planning. The opportunities of the circular economy are job creation, economic growth and efficient management of resources.

[14]Peterborough is a city in Great Britain, county Cambridgeshire, located 118.6 km north of London, a sister city of Ukraine Vinnytsia. The population is about 159.1 thousand.

The 2025 vision "Copenhagen Cooperation" envisages the cooperation of the city administration in technical and environmental directions with three defined goals: "living city", "city with an edge" and "responsible city". The goal of "living city" implies the need to improve the quality of life of the population and the ecology of the urban space of the best city in the world for cyclists, taking care of its environment. The goal of the "responsible city" is to achieve a zero level of carbon emissions, ensure sustainable economic development, not waste natural resources, increase resilience to climate change in the future [275].

Within the framework of the 2025 vision "Copenhagen development" according to the "responsible city" goal, the majority of Copenhageners use sharing, transfer and reuse schemes. Transfer locations have been created in 11 recycling centers in the city. Cooperation is also underway to identify transfer locations in other cities.

As part of the recently adopted Action Plan on the UN's Sustainable Development Goals, Copenhagen will develop guiding principles so that citizens, institutions and businesses can realize the goals. The action plan contains a list of goals and measures to involve citizens in making important decisions.

In the city, citizens are also involved in collecting and separating their waste, which makes it possible to avoid clogging the territory, for example, public garbage containers are placed in a visible place and the conditional steps on the sidewalk to the garbage cans are painted green. Currently, city-wide schemes for the distribution of biological waste collection have been implemented in the city. The decision to implement them was made in September 2016, and it was implemented in the fall of 2017.

In Copenhagen, plastic waste is separated. Such waste is not burned. Since 2011, a number of pilot programs have been conducted to obtain

information about effective ways to recycle plastic and to dispel myths about how difficult it is to recycle plastic products. This implies the need to cooperate with enterprises, research institutions and associations to find innovative solutions.

When seeking to engage with stakeholders in the value chain, it is worth considering that stakeholder knowledge is often limited to certain parts of the value chain. And this can hinder the search for a solution that meets the requirements of the circular economy. Without the necessary knowledge of the waste management process, it is impossible to build a phased waste collection or design a secondary product for reuse, disassembly or recycling. In addition, if waste management does not know the requirements for production processes, then they will not be able to produce raw materials that will replace primary materials.

To achieve a "real" circular economy, it is important to scale up. This means involving large (multinational) companies in the circular economy, so that they have an incentive to create products and services according to circular principles. Although cities have a significant impact through public procurement, it is not always enough to change the business models of large companies to make more advanced products, recover them, reuse them, etc. [281].

There are examples of such innovative circular activities that confirm the achievement of the goals of sustainable development in the direction of implementing

Jobs in the circular economy will benefit the earth and sustain an ethical economy. However, not all sectors of the economy will enjoy job growth with a circular economy. Experts predict job decline in the mining, coal electricity, and petroleum refinery sectors. The good news however is that with help from the government and employers, workers can make transitions into related circular industries with ease.

the ideas of the fourth industrial revolution. Particular attention should be paid to the Slovenian capital Ljubljana, where various models of circular economic relations are actively being implemented (Circular economy examples in the City of Ljubljana) [184]. The first of the projects is the Slovenian "electronic library" of clothing and design items "Kabiné Šerinjon", (first Slovenian clothing e-library). " Kabiné Šerinjon" is the name of a mobile platform that allows users to rent clothes and fashion accessories by Slovenian designers and a collection of clothes from the Reuse Center without any payment.

The project promotes the development of critical thinking. This year, the ownership of new things, which is taken for granted, is being questioned. This right is based on shared consumption, i.e. shared use, which is the result of cooperation between three faculties in Ljubljana (Faculty of Health Sciences, Faculty of Natural and Technical Sciences and Faculty of Computer and Information Science) and the public waste management company "Snaga Ljubljana". It encourages consumers to think about fairness, shared responsibility, sustainability, ethics and the need to make decisions (exchange, share, reuse clothes).

Another circular project, which is actively being implemented in Slovenia, is the use of the Japanese mountain ash plant for processing it into paper. As in other cities, plants that belong to the list of the most invasive species in the world are also used in production in Ljubljana. In order to prevent excessive use of this plant and to re-use it for cultural purposes, the Re-generation racija collective, the University Botanical Garden of Ljubljana, the Institute of Pulp and Paper Industry and the public transport waste storage company "Snaga Ljubljana" joined together [184; 344]. Ljubljana is one of the first cities in the world to produce paper from Japanese mountain ash at a semi-industrial level. Thanks to this, the problem of invasive species was solved in

an innovative way that corresponds to the principle of circular economy. The paper was used to make paper bags and notebooks.

Another project is the production of paper after processing packaging for milk and juice. In 2015, the state holding "Public Holding Ljubljana" and the public companies "Snaga Ljubljana", "Ljubljanski Polynesian Projects", "Energetika Ljubljana", "Ljubljanska Parking in Tržnica", "Zale" and "Vodogin-Kanaliza" started using the most sustainable sanitary paper on the market (paper towels and toilet paper) made from recycled milk and juice packaging. Separately collected packaging goes to a waste storage company, where it is properly treated and then transported to the paper manufacturer, creating a closed production cycle. Such a closed scheme of the flow of materials contributes to the formation of financial savings and the preservation of ecology.

So, for example, *the Finnish company "Enevo"* installs sensors on garbage cans that provide data collection and analysis. These sensors provide information on the filling of waste bins, enabling Enevo systems to optimize collection routes for trucks. As a result, Enevo customers report savings of 20 to 40% due to reduced fuel consumption and maintenance costs.

A similar situation is observed in *San Francisco and London*, where automatic solar-powered garbage collectors are also installed, which alert local authorities when they are full. Accordingly, optimal routes for garbage collection are created and operating costs are reduced by 70%.

When such an infrastructure is built and large volumes of data are collected, with the help of technological advances, applying artificial intelligence algorithms, it is possible to analyze them more thoroughly. These technologies make it possible to process large amounts of information to create models and identify problems that are difficult to detect or without investment of time and resources.

Another example is the Dutch city of Zaanstad. The city is built on drained lands. Accordingly, repairing the foundations of buildings is an expensive problem. To solve this problem, housing and communal authority "Parteon" collaborated with scientists from "Berenschot Intellerts" to develop an algorithm to predict which foundations need urgent repair. The project used more than 135 million records of data on housing from the municipality and housing and communal services "Parteon", on infrastructure from "Kaaster", on weather from the Royal Meteorological Institute (Netherlands) and satellite data from "SkyGeo". Thus, the "Parteon" service was able to identify more than 11,000 houses that are in a state of emergency, saving time and resources for their repair.

The development of artificial intelligence has contributed to such achievements as self-driving cars, which will make it possible to significantly change not only the ways of movement, but also to increase the volume of production and increase the number of scientific developments, in general to improve the way of life of a person. Thus, cars are mostly not only considered property, but are distributed among different owners according to their status. The world is currently piloting autonomous transport programs in partnership with various technology companies. One such example is nuTonomy [15], which has been piloting an autonomous vehicle in Singapore since 2016. Their initial pilot program had six autonomous vehicles modified as Renault Zoes and Mitsubishi i-MiEVs. Since then, NuTonomy has partnered with local ride-sharing company Grab, [16]with plans for further activity in 2018.

[15] "NuTonomy" (stylized as "nuTonomy") develops software for creating self-driving cars and autonomous mobile robots. Founded in 2013.

[16] "Grab" is the main rival of "Uber" in Southeast Asia, a bicycle sharing company and "oBike" company, registered in Singapore.

An example of innovative promotion of circular economy ideas and their successful implementation is also the activity of the company "VEON" [17]- a digital application for exchanging messages, making calls, watching and sharing videos, which allows you to communicate with friends for free . The app also enables users to explore the world's information space through the "VEON" network, supported by premium brands as well as partners, providing users with relevant content. VEON company, aware of the scale of its activities and opportunities, believes that people should be grateful and responsible for their own actions. As part of the #ourplanet campaign, VEON publishes DIY and Upcycling stories. As of February 2018, the VEON company invited authors from Ukraine to send their interesting stories from the field of DIY and Upcycling. The goal of this project is to provide opportunities for the majority of people to give things a "second life" by joining the "#ourplanet" movement.

Another **example of the successful implementation of the circular economy** is the activity of the **"High 5" plant**[18] – a company in Belgium that created a method of sorting different colored glass using automation technology. It is the first plant in the world to sort incoming streams of empty glasses, pots and cans, separating the four colors needed to make bottles and other packaging materials. The purpose of the company's activity is to increase the share of recycled glass for the production of double-glazed windows [4].

The idea of "0% waste – 100% new life" - this is the priority of Fater SpA. It is the first industrial complex in the world capable of recycling used absorbent hygiene products (baby diapers, feminine hygiene pads) and

[17] The company "Veon" (until 2017 "VimpelCom Ltd") is a global provider of telecommunications services based in Amsterdam. As of April 2012 p. it is the sixth largest mobile network operator in the world (by number of customers).

[18] "High 5" plant known for its ultra-modern equipment for glass processing in Europe. This is a waste sorting center for the production of secondary raw materials, which is one of the main principles of the circular economy.

converting them into secondary raw materials such as plastic, cellulose. The plant is a unique production, the first of its kind in the world, and demonstrates technological efficiency in the industry, processing 10 thousand tons of used absorbent hygiene products per year and serving about one million consumers. The technology, patented by Fater SpA, is a joint venture between P&G and Gruppo Angelini. This company is a model of industrial development that ensures environmental stability. In view of this, the company "Fater SpA" received an award from the European Commission in the nomination "Circular Economy Champion" [5].

Examples of the discovery and implementation of the main ideas of the circular economy are the following startup companies [75; 101]:

- "Thread" [19]: processing of used bottles for shoe production;
- "Looptworks": making clothes from recycled raw materials, balls and purses from airplane seats;
- "LanzaTech": conversion of used carbon into fuel and chemicals;
- "Method" [20]: production of new bottles from plastic collected in the sea;
- "Energizer": disposal of dry batteries and production of new ones;
- "Dell": cleaning from computer garbage;
- "Levi Strauss": updating clothes of any brand;
- "H&M": production of a collection of jeans made from recycled cotton in 2015;
- "Unilever": recycling of waste for new packaging; the company saves more than 140,000 tons of waste sent to the landfill; buys more than 2 million tons of waste every year;
- "Alaska Airlines": making bags and wallets from airplane seats.

[19] The company "Thread" cooperated with the company "Timberland", supplying raw materials processed from waste for the manufacture of shoes.

[20]"Method" is one of the largest and fastest-growing "green" organizations in its field. The company uses the principles of the circular economy, processing plastic collected from marine waste into new containers.

The concept of the circular economy is an integrative, peculiar alternative vector of the development of the global economy. However, along with potential benefits, advantages, and positive implemented experience, there are certain potential obstacles that prevent the recycling process from developing to the maximum.

Many barriers can stop the implementation of circular and "green" economy practices [304; 344]. Taking into account the testimony of existing enterprises that implement the basic idea of the circular economy, we note that it is much easier to create a "green" company than to reformat the activities of a large company in the "greener" direction [201].

The circular economy is transformative, systemic and functional. First, it means behavioral and cultural changes towards different production and consumption, ways, new business models and governance within the shared responsibility of levels of government and stakeholders (People). Second, it allows for complementarity between resources (water, waste, energy, transport, housing and land use) (Policy). Third, the required materials, resources and products are a reflection of the appropriate scale in which the circular economy is applied and reflect the functional links between urban and rural areas (Towns).

Industry is an important part of any modern economy. As countries develop and their economies grow, an ever-increasing supply of basic industrial goods and materials such as steel, cement, aluminum, and plastics is created to support infrastructure, transportation systems, buildings, and factories, as well as to manufacture and package consumer goods . In addition, a developed industrial sector is considered basic for economic competitiveness.

At the same time, industry is the main source of greenhouse gas emissions: 40% of the total emissions were made in 2014, with their constant

growth. To achieve the Paris Agreement's long-term goal of a global economy with zero net greenhouse gas emissions, industrial emissions must be reduced. The policy task for the industrial sector in particular is to reduce emissions while continuing to meet the material needs of economies [51]. Analysis data confirm that circular approaches will make it possible to reduce CO_2 emissions from the production of materials in the EU by 56% by 2050 [51]. For the EU, this is an opportunity both to reduce emissions and to confirm the status of a pioneer and world leader in the circular economy [51].

The issue of e-mobility in the process of developing the circular economy is being studied by specialized companies Sitra (Finnish Innovation Fund), the European Climate Fund, the Clean Energy Transition Commission, the Ellen MacArthur Foundation, and the Climate Works Fund [51].

Discussing the interpretation of the term "e-mobility", we note that the dominant opinion is the need to switch from fossil fuels to alternative fuels in this case, but this is only one small part of the big problem. Even "clean energy" cars have an impact on the environment and human health. Thus, the Ministry of Industry of China, the companies "General Motors" and "Goodyear" take into account these consequences, focusing on methods of waste recovery and prevention of their formation, which are aimed at creating closed-loop systems - acting in accordance with the principles of the circular economy [51].

E-mobility (Electric-mobility) in the Netherlands is gaining more and more popularity. In 2016, almost 25,000 additional electric vehicles (EVs) were registered, resulting in a total of about 120,000 electric vehicles [52; 49; 276; 293] . This direction of development was accelerated by the "Green" agreement on electric transport for 2016-2020, an agreement between the Ministry of Economy and Climate Policy of the Netherlands, the Ministry of Infrastructure and Water Management and 18 private organizations. The "green" agreement is aimed at supporting Dutch e-mobility and increasing the number of electric

vehicles. The Dutch government sees innovation as a basis for solving environmental problems. And in this case, electronic mobility is extremely important. E-mobility and mobility in many economic models is the first step towards the development of a circular economy [51].

In Switzerland, e-mobility is not as developed as in the Netherlands. Despite the fact that the number of electric cars in Switzerland, as in the Netherlands [51], is the same, it is worth considering that the population of this country is half as small. Accordingly, the electricity charging infrastructure in Switzerland is relatively weak. It is organized separately in each canton, but the cantonal charging systems are not connected. Accordingly, the Swiss federal government prepared a public tender for the installation of a universal accessible platform for charging on Swiss highways [51; 249; 276; 293].

The Swiss federal government sees e-mobility as one of the ways to improve "green" policy. The Swiss Parliamentary Group Electro Mobility and the Forum Swiss Emobility are important players in the Swiss market for the promotion and improvement of Emobility. The Swiss Parliament published the General Plan of e- mobility in 2015, which defines the main measures for the development of e-mobility [249; 276; 293].

According to The Club of Rome, full adoption of a circular economy would create more than 75,000 jobs in Finland, 100,000 in Sweden, 200,000 in the Netherlands, 400,000 in Spain, and 500,000 in France by 2030.

Sometimes there are doubts about their prospects due to the excessive amount of energy required for charging. However, the academic consensus confirmed the sustainability of the effects: approximately 95% of EV studies show lower CO_2 emissions from electric vehicles compared to gasoline vehicles.

So, in March 2018, at the exhibition of new models at the Geneva International Motor Show, the *Goodyear company*[21] presented a unique concept tire "Oxygene", which is a transition in the direction of providing sustainable urban mobility. This tire is lined with living moss, which acts as an effective air filter [51].

The tire's open construction and tread design absorb and circulate moisture and water from the road surface, allowing photosynthesis to take place, thereby releasing oxygen into the air [51]. The tire makes it possible to significantly reduce air pollution. In a city with approximately 2.5 million cars, according to Goodyear company estimates, Oxygene tires make it possible to produce about 3,000 tons of oxygen and absorb more than 4,000 tons of CO_2 per year [51].

The concept of such a tire is developed taking into account the principles of the circular economy with an emphasis on reducing material costs, emissions and energy losses. Oxygene tires are made from rubber powder from recycled tires. They have a light, shock-absorbing structure, are strong and resistant to punctures, which extends the shelf life and minimizes the occurrence of problems regarding their service.

The Oxygene tire's energy expenditure during photosynthesis is used to power the tire's onboard electronics, including on-board sensors, an artificial intelligence processing unit and a customized light strip in its sidewall that switches colors, alerting both road users and pedestrians of upcoming maneuvers such as changing lanes or braking.

The concept bus also uses the visible light (LiFi) system for high-performance mobile connections. LiFi equips the bus with Internet of Things

[21] "Goodyear Tire & Rubber Company" is an American company that is the largest manufacturer of tires. The company is ranked 472 in Fortune Global 500 (2009). The company is headquartered in Akron, Ohio.

capabilities, which enables data exchange between vehicles, which is an important component of the intelligent mobility management system [51].

In this way, the company aims to steer the discussions in the direction of ensuring "smart", safe and sustainable mobility in the future.

For example, in China, extended producer responsibility is the official standard in the automotive industry. Thus, manufacturers of **electric vehicles (EVs)** are tasked with creating facilities for the collection and recycling of used batteries [51].

About a decade ago, the Chinese government started promoting electric vehicles in order to reduce vehicle emissions and take advantage of the available economic opportunities. As a result, the production of lithium batteries increased dramatically in line with the growing demand [370].

The concept, named Oxygene, has a unique structure that features living moss growing within the sidewall. This open structure and the tire's smart tread design absorb and circulate moisture and water from the road surface, allowing photosynthesis to occur and therefore releasing oxygen into the air.

Under a new government decision, automakers will have to rebuild batteries in new vehicles to generate energy. The government also controls companies responsible for repairing or exchanging old batteries, promoting the development of this service [51]. It is recommended that such companies facilitate consumers by providing subsidies and appropriate recharge buyback packages.

The government's actions are also aimed at ensuring transparency in this sector with the aim of creating a tracking system for the owners of discarded batteries. Although the impact of the new rules is not fully determined, they are an important step in addressing some of the key issues that arise in the transition to electric vehicles.

General Motors (GM) is continuing to move toward zero-waste production and consumption by expanding the lean industry program at all of its manufacturing facilities in Canada, Mexico and South America. According to this program, at 27 new certified enterprises, all waste generated from daily operations is recycled, i.e. reused [51].

As an example, to reduce costs at GM companies, they use old concrete to create walkways, wash oils from fabric used in painting, and install separate containers for different wastes for recycling in high-traffic sectors.

In production operations, companies that produce products without waste [51], that is, by recycling, recycling or composting, on average realize about 96% of waste from daily operations and convert 4% into energy. By 2020, GM aims to use 150 container-free sites (landfill-free sites) in production in the world in general. Yes, the company's productions in Canada, Mexico and South America are "container-free", i.e. waste-free. In total, 79 of its production facilities (plants) function according to the principle of "reuse, recycle, compost", disposing of almost 96% of waste from daily operations and converting 4% into energy [321].

In the process of developing a strategy of large-scale impact through cooperation and sharing of best practices for the implementation of global operations, General Motors has collaborated with the American Business Council on Materials Markets for Sustainable Development, using online databases of organizations that are responsible for using traditional and non-traditional industrial waste streams as new products and revenue opportunities [51].

The common need for sustainable development produces new scenarios, activating large corporations to take decisive action. Thus, the multinational

energy company "Enel" [22]implements the "Futur-e" model – a full-scale economic project for the reconstruction of 23 thermal power plants, which involves cooperation with local communities to identify new ways of using information [51].

The Futur-e model is based on system sustainability to jointly identify possible circular and long-term solutions [51]. To build this model, the principles of the circular economy were applied through the creation of a large-scale integrated project, which is based on an approach in which all objects are managed as a single "portfolio" and best practices for applying individual solutions at each individual plant.

This is not only a technological revolution, but a large-scale cultural shift. With the continuous introduction of new e-mobility solutions, people's habits are also changing [51]. Today, driving an electric car is not only an alternative choice to fossil fuel cars, it is primarily the future of transportation.

For Italy, the priority is to create an infrastructure network to eliminate the so-called "range anxiety" - the fear that an electric car will stop during a journey. The real turning point in the period of the so-called e-mobility revolution was November 2017, when the National Plan for the charging infrastructure of electric vehicles was approved in Rome. According to the tasks of this plan, the Enel company should install 7,000 charging points in the country by 2020 and 14,000 by 2022 [51; 378]. The increase in the number of charging points will enable the Enel company to attract investments in Italy in the amount of 100 to 300 million euros for the implementation of a public-private partnership. This will simultaneously ensure the implementation of the "EVA+" project as the first integrated system for rapid charging of the

[22] "Enel" company multinational energy company and one of the world's leading integrated electricity and gas operators. It operates in 35 countries on 5 continents, generating power with a controlled capacity of more than 89 GW, selling gas and distributing electricity through a network spanning approximately 2.2 million km.

infrastructure of electric vehicles. This initiative is financed by the European Union and created for long-distance e-trips on the main highways between Italy and Austria [51; 378].

Nowadays, trips in electric vehicles make it possible to overcome borders using technological solutions that increase their autonomy. The 22 kW Fast Charge model, located mainly in urban areas, is now supported by the Fast (50 kW) and UltraFast (up to 350 kW) models outside the city. An electric stop to charge a vehicle in a matter of minutes is not a dream, since 30 fast charging columns have already been installed in Italy since October 1, 2017.

" [23]technology introduced by Enel in Denmark and later in the UK, France, Germany and Italy, electric cars can also be used as mobile batteries that will help balance the energy system by using energy from the system as needed. This project of the "Enel" company received the "sustainable development" award at the "Ecomondo" exhibition in Rimini (Italy). At the 43rd Ambrosetti Forum, held in Cernobbio (Italy) on the shores of Lake Como in September 2017, a detailed study on the electric mobility chain in Italy was presented for the first time. This made it possible to emphasize the main role of the e-sector for the Italian economy, which is 160 thousand companies and 823 thousand jobs and 303 billion dollars. income until 2030 [51; 378].

This example of circular economy makes it possible to distinguish **two main directions of e-mobility** [51]:

[23] "Vehicle-to-grid (V2G)" technology – this is the concept of two-way use of electric cars and hybrids, which involves connecting the car to the general electrical network for recharging with the possibility of issuing electricity back to this network to participate in the management of electricity demand. For car owners and with V2G technology, it is possible to sell electricity to the power system during periods when the car is not in use, and to charge when electricity is cheaper. In many countries, the price of electricity depends on the time of day. It is also possible to drive a car with this technology to your own home and use it as an uninterrupted power supply for this home or office. V2G technology is now widely developed by the US government and the company "Google".

- electric cars as "sustainable materials" that contribute to the reduction of energy consumption and, as a result, harmful emissions;
- cars as mobile batteries, based on the application of the "product as a service" concept, in which the company or service provider does not sell the car to the customer, but directly only the mobility service, reducing the number of vehicles in circulation, and therefore offering obvious benefits for cities, that is, the transition to the implementation of a new vector of the circular economy - the inclusiveness of the service.

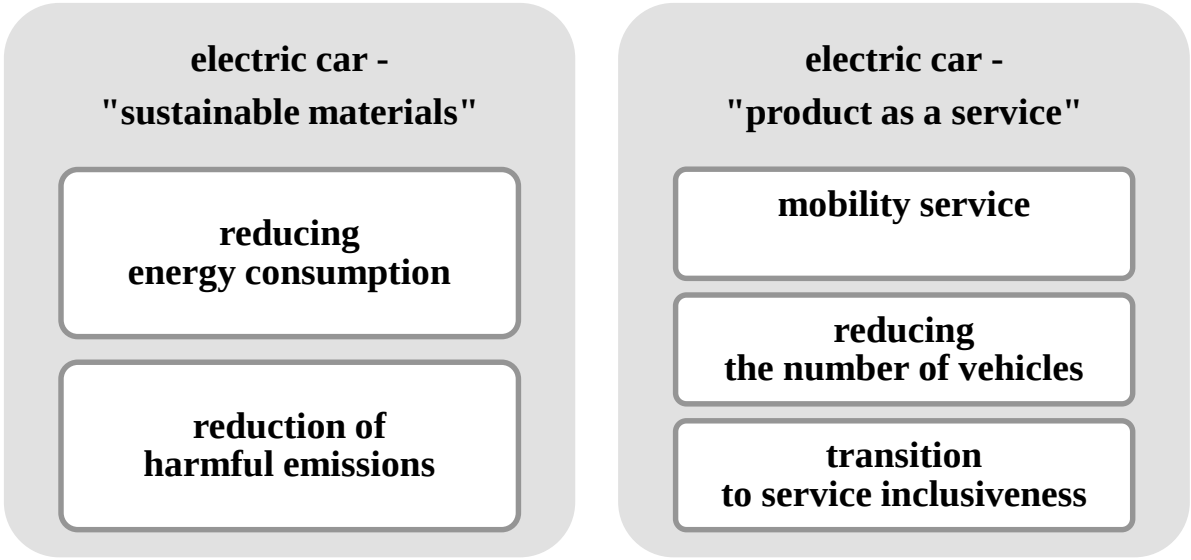

Fig. 4.1. **E-mobility in the circular economy**

Source: compiled by the author based on [51].

Reducing emissions in the fight against climate change, the coming of age of electric energy conservation technologies, and increasing the use of renewable energy sources and "smart" networks are three factors that have enabled the electric car to become a new circular model of mobility [51].

In general, the number of electronic vehicle registrations in Italy alone gives an idea of the speed of the transition - in the first eight months of 2018, this indicator increased by 110%. This accordingly reflects the global trend of

a global increase in the number of new e-vehicles on the road, reaching a total of 4 million.

Table 4.1.

Stimulating the means of implementing smart business models in overcoming the gap-circularity of national economies

Global initiatives	UN (Sustainable Development Goals) Club of Rome Decision of TNK Ellen MacArthur Foundation, Rockefeller Foundation World Economic Forum Global responsibility initiative (more than 200 corporations) EU action plan for the circular economy.	reverse logistics; collection of materials and their reuse; rental and sharing platforms; "electronic libraries of things"; innovative models of urban development; innovative planning; pilot projects; cooperation to find innovative solutions; infrastructure for collecting large volumes of data; tracking systems for owners of discarded batteries; containerless objects; Circular economy road maps; "People-politics-places" model.	**Local initiatives**
Regional initiatives	sustainable business ecosystems (industrial symbiosis); intersectoral cooperation; rationalization of national and European fiscal systems; creation of an economic and infrastructural basis for conducting a circular policy; national plans.	rejection of the widespread use of plastic; the awareness "you use everything - everything is recycled"; social responsibility for harmful or undesirable ingredients; social responsibility for working conditions; awareness of short-term losses and long-term gains; refusal of child labor; women's social entrepreneurship.	**"Behavioral initiatives"**

Source: constructed by the author

The number of e-vehicles in general on the roads is still insignificant, but the trend points to its further growth. In particular, the second revolution of e-

mobility took place at the Vallelunga Autodrome [24], where the Enel X company presented a new range of products developed on the basis of customer requirements and the use of innovative technologies for the e-motor racing world. Enel X will be the official supplier of the MotoE charging infrastructure for the 2019 Formula E World Championship.

At the current stage, more than 150,000 electric cars of "Groupe Renault" are used in different countries of the world. Their goal is the large-scale deployment of 100% electric mobility. The electric vehicle is part of today's true ecosystem at the intersection of mobility and energy, where digital technologies play a major role.

Source: compiled by the author.

Ways to overcome the circularity gap based on smart business models and circular cities are highlighted:

- increasing the scale of circular activity;
- creation of an economic and infrastructural basis for conducting a circular policy;
- environmental initiatives, economic growth and improving the quality of life of the population in real time based on innovative planning;
- cooperation of local administrations in technical and environmental directions in three directions: "living city", "city with outskirts" and "responsible city";
- involvement of citizens in making important circular decisions;
- avoiding clogging of territories (public garbage containers in a prominent place and coloring of conditional steps on the sidewalk to garbage cans);

[24] Autodromo Vallelunga (Italian " Autodromo di Vallelunga ") is a circular race track 32 kilometers north of Rome. It is used to hold Italian and international car and motorcycle racing championships.

- involvement of large (multinational) companies in the circular economy, to stimulate the creation of products and services in accordance with circular principles;
- "electronic libraries" of clothing and design items;
- mobile platforms for renting clothes and fashion accessories from the Center of reuse without any payment.
- cooperation between three educational institutions and public waste management companies;
- use of plants for processing into paper;
- production of sustainable toilet paper (paper towels and toilet paper) from recycled milk and juice packaging;
- garbage can sensors that collect and analyze data on savings of 20 to 40% due to reduced fuel consumption and maintenance costs;
- automatic solar-powered garbage collectors that alert local authorities when they are full. Accordingly, optimal routes for garbage collection are created and operating costs are reduced by 70%;
- infrastructure for collecting large volumes of data, with the help of technological advances, applying artificial intelligence algorithms;
- development of artificial intelligence - self-driving cars,
- digital applications for exchanging messages, making calls, watching and sharing videos that allow you to communicate with friends for free about renting and borrowing essentials;
- sorting of different colored glass, using automation technology to increase the share of recycled glass for the production of double-glazed windows;
- processing of hygienic means for absorption and turning them into secondary raw materials, such as plastic, cellulose;

- government actions aimed at ensuring transparency in this sector in order to create a tracking system for the owners of discarded batteries;
- loss-making industry programs;
- containerless objects;
- full-scale economic projects for the reconstruction of thermal power plants;
- national plans in infrastructure for charging electric vehicles for long-distance e-trips are the main ones.

4.2. Circular chains of added value creation in the formation of the global inclusive circular economy paradigm.

An important point in the circular economy is that promising activity should be raised to the mesolevel. This means that decisions are not related to individual individuals, but to the interaction between entities in defined (integrated) value chains – global circular chains of added value creation (including global supply chains of secondary raw materials). Thus, decisions that allow for a positive effect for the cycle can be effective even if they do not provide a sufficient degree of profitability for the individual actor.

The main goal of a smart city is to optimize city functions and promote economic growth while also improving the quality of life for citizens by using smart technologies and data analysis. The value lies in how this technology is used rather than simply how much technology is available.

Changes are needed to maximize the use of resources at the structural level. It is important that the involved entities coordinate planning in order to achieve high results. It is necessary to determine the principles of economic decision-making, which is characterized by cooperative interaction. The new

system reflects rational interaction between independent subjects at the meso level.

However, this does not mean that communication actions should replace strategic actions in all areas. Accordingly, it is important to find out in which areas activities should be coordinated, and in which to compete, in order to realize economic potential and ensure environmental results. Thus, an important structural implementation in the cyclical value chain is the creation of a kind of communicative platform where participants exchange information necessary for the effective implementation of decisions in certain areas.

Value-added collaboration often drives successful businesses primarily to benefit from its implementation, for example by reducing costs or risks, increasing revenues, or increasing the value of intangible assets such as brand reputation or trust. However, this cannot be achieved in isolation from society. Global supply chains of secondary raw materials can be considered as one of the solutions in the field of ecology, which affects various sectors of the economy [401]. The concept of such a chain can help identify potential opportunities for managing emissions and waste in general, as well as ensuring their supply at all stages of the life cycle of a recycled product.

Thus, in fig. 4. 5 presents a diagram of the formation of global circular chains of creation of added value in accordance with the above approaches. We note that the implementation of global circular chains of added value creation [42], taking into account global supply chains of secondary raw materials, should be based on three main *drivers* for the successful creation **of such initiatives**:

1) **circular *efficiency***. Mastering all elements of the added value chain from start to finish to create an effective management system for reducing carbon emissions and other waste. Initiatives that cannot be achieved only with

the help of a single company can be very attractive when supplied within the circular chain;

2) **from *finding the right partners.*** *When* engaging in a global circular value chain initiative, one looks beyond one's circle of well-known companies. The point is to identify the ideas that will most effectively solve a specific value chain challenge, and to build a chain with a better ability to implement those ideas. Building effective chains requires understanding the sources of value (value) – social, economic and environmental – for all stakeholders and ensuring that they are distributed fairly and proportionally;

3) **the *scale of the circular initiative*.** This requires time and resources from all partners, as well as careful monitoring of performance to achieve maximum effect. For example, in order to determine the possibilities of mitigating the consequences of climate change, it is necessary to take into account all stages of production, starting from the early stages of design and ending with operation. Often the stage at which the impact of carbon or other emissions is greatest is the defining stage of the circular chain with potential opportunities for joint action to reduce CO_2 emissions.

Scientific studies make it possible to assert that **sustainable development** is a non-reversible process and entrepreneurs have the necessary potential to create a sustainable economy. This requires studying the conditions under which entrepreneurial activity will make it possible to transform the economy into a sustainable system. At the same time, entrepreneurs will contribute to economic growth, achieving social and environmental goals in the process of waste management. Accordingly, the circular economy should be considered at the micro, meso, and macro levels, which cover production, consumption, and proper use of waste (Table 4.2) [121]. At the same time, we suggest considering the circular economy also at the mega-level, which involves globalized waste management within the framework of the creation of global

circular chains of the formation of added value, which is not identified with global supply chains of secondary raw materials [385]

Table 4.2

Levels of circular economy

levels	Micro-	Macro-	Meso-	Mega-	*GOAL*
Production	Environmentally friendly production Ecodesign	Eco-industrial park Ecosystem of agriculture	Regional eco-industrial network	Regional	Global circular value chains
Consumption	"Green" purchases and consumption	Ecologically clean park	Rent, service		
Waste management	Product recycling system	Trade in waste, industrial parks	Symbiosis of urbanization		
Development support	Policy and laws, information platform, capacity building; application at all levels				

Source: constructed by the author

A positive aspect of the circular economy policy is the absence of unpredictable restrictions on the development and implementation of technologies. Legislation is aimed at introducing "green" technologies, but sometimes long after these technologies have been developed and applied to the market. Effective enforcement of legislation is a necessary condition for the successful implementation of valuable technological solutions for the use of the environment. The main focus of governments in developing and emerging countries is on investments for infrastructure development. Expensive environmental implementations are not a priority area. International practice confirms that state economic incentives are an effective means of stimulating the behavior of producers and consumers to bring them in line with the 3R principles.

While ecological cycles are the result of long evolutionary development, economic cycles are based on preconceived and integrated plans through

dialogue between the agents involved. To develop convenient cycles in economic sectors, it is necessary to create communication networks (global circular networks), where different subjects can coordinate their own actions based on common interests, which is the basic idea of network relations. In addition, it is important that communication networks ensure the protection of values related to nature and culture.

According to J. Sternberg, the chief executive officer of the Swedish company "Box of Energy AB", which cooperates with the companies "Porsche" and "Volvo Cars", car manufacturers face the problem of recycling a huge amount of batteries, which in the near future will form a new market for "second life applications" for energy storage, that is, the so-called circular market for batteries of e-vehicles with an inclusive orientation [45].

The company "Bloomberg NEF" released data that by 2040, more than half of the volume of sales of new cars and a third of their total number, equal to 559 million cars, will be electric. By 2050, companies will invest approximately $550 billion. in household, industrial and network batteries. The basis of this process is the circular economy, since the battery coming from the electric car becomes part of the new energy world [45].

Although the issue of climate change seems to warrant a rapid transition to electric mobility, it may turn out to be just a transitional technology. Electric cars will do little for urban mobility and livability in the coming years. Established automakers like Porsche are working on new modes of transportation, especially for congested and growing markets like China. Instead of fewer cars, as transportation experts have called for, automakers continue to promote personalized transportation, albeit a greener version.

With the growth of the population, a paradigm shift in transport, aimed at solving transport problems, may be necessary. In Copenhagen, for example, bicycles now outnumber cars in a city center that will be car-free within the

next ten years. Many other cities, including Oslo in Norway and Chengdu in China, are also on the car-free path [45].

Experts are already developing new ways of developing cities. They combine efficient public transport, as can be found in Curitiba, Brazil, with the principles of walkability, as can be seen in Woben, Germany. They are characterized by mixed use, mixed income and transit orientation, as seen in places such as Fruitvale Village in Oakland, California [45].

These events are not only about environmental problems related to transport. They increase liveability by returning urban space to green developments. They reduce the cost of living by reducing travel costs and time. They provide health benefits through reduced pollution and a more active lifestyle. They improve social cohesion by promoting interaction with people on city streets and help reduce crime. And, of course, they improve economic performance by reducing productivity losses due to congestion. That is, all this works in the direction of the development of an inclusive transport paradigm [45].

Electric cars are a rapidly expanding technology that is helping to address climate change and improve air quality -- at least for a while. But the endgame of evolution must eliminate many daily needs for movement [45; 167] .

Converting minerals into batteries takes a supply chain, and each stage can be a bottleneck and a bottleneck. The likes of electric vehicle manufacturers should be concerned that the supply of one of the key mineral components, or recycling infrastructure, could become too centralized in one country. Without

In a **circular economy**, smart phones would be designed so they could be **repaired** more easily. And when they stopped working they would be simple to take apart so that the **precious metals** and materials inside them could be **reused** in another product, or **returned safely to nature**.

a variety of sourcing options, the possibility of supply constraints becomes more likely.

Currently, graphite is quite centralized because fewer countries produce it, but reserves are more diversified. With almost half of the world's cobalt ore reserves concentrated in the Democratic Republic of Congo for the foreseeable future, and with a large share of processing capacity in China, the supply chain could be more vulnerable.

Ultimately, governments may restrict supply again. In this scenario, the Democratic Republic of the Congo is not among the top suppliers. It poorly assesses most of the indicators of the World Bank caused. unstable political situation, and China is better. But as China has shown in the case of rare earth elements, there is uncertainty about the reliability of the supplier.

The supply of basic materials for lithium batteries is not threatened anytime soon, but demand is likely to open up new areas for mining, leading to new risks. The political situation of countries with large reserve stocks and large shares in the processing of these metals can quickly become uncertain. Will countries such as Bolivia allow lithium to be freely exported and will the Democratic Republic of the Congo and China restrict the supply of cobalt [45; 147; 160; 161; 165] .

Environmentally, **the future of the lithium-ion battery** is also worrisome. Ultimately, lithium recycling should play a role in mitigating political, environmental, and economic risks in the future, but high rates of lithium battery recycling are yet to emerge [45].

From a marketing perspective, most potential buyers want an EV because it is more environmentally friendly than a regular car. These customers will therefore be more interested in other stable characteristics of the car. Manufacturers hope that using recycled materials can help buyers

choose one brand over another. In particular, it is possible to single out companies that are leaders in the use of recycled material [45] :

- ***Nissan Leaf***. Nissan's Green Program aims to eliminate all waste throughout the life of a vehicle, from design to disposal. Almost 25% of the Nissan Leaf is made from recycled materials. Old PET soda bottles are recycled to make the seats, recycled fabrics are used in the soundproofing under the hood, and parts from old electrical appliances are used in the center section. Resin from recycled plastics is even used to make larger plastic sheet components such as accessories and door parts [45; 147; 160; 161; 165].
- ***BMW i3.*** Some of the most environmentally friendly features of the BMW i3 do not use recycled materials, but instead consider the impact of production on the environment. Instead of using formaldehyde or other chemicals to ignite the leather seats, BMW uses olive leaves. The door panels are made from renewable natural fibers such as open-pored eucalyptus, which has been FSC certified [45; 147; 160; 161; 165].
- ***Toyota Prius*.** The Prius uses bio-plastics in their seat cushion design, and in several other parts. Electric car manufacturers have one main goal when developing new models - making them more energy efficient so they can expand their range. One of the key factors to consider is therefore the weight of the vehicle. The lighter, the less energy needed to move forward. As a result, EV manufacturers are looking for lighter, non-structural materials. In some cases, recycled materials are able to provide their solution while having a lower manufacturing carbon footprint. Some recently developed secondary materials are lighter than their alternatives, helping to reduce the overall weight of the vehicle. British manufacturers Luxus have developed a new material, Hycolene, used to make interior parts that are 10-15% lighter compared to their primary plastic equivalents [45].

Another company, **Benecke-Kaliko**, uses TEPEO, an inner foil that is 50% lighter than PVC [25]. This material can reduce the weight of the car by 2 kg and produces 48% less CO_2 during the entire life cycle compared to ordinary PVC foil [45; 147; 160; 161; 165].

The problem with the disposal of car parts, especially metals, at the end of their life is the pollution of scrap metal; due to contamination by other materials, the metals are not considered pure enough to be recycled to make new structural parts of the car. However, during the manufacturing process, there is the potential for vehicle structural materials to enter the recycling supply chain. In a controlled production environment, the quality of the secondary material can be preserved and scrap contamination can be much less of a problem [45].

For example, only about half of the sheet metal used to make car doors can be used to enter the recycling supply chain, and the rest is recycled. As a result of the circular value chain partnership between Jaguar Land Rover (JLR) and aluminum manufacturer Novelis, 30,000 tonnes of press shop aluminum bar were reclaimed from JLR factories and reprocessed by Novelis to be used in the production of new body panels.

The time is approaching when the first batches of batteries from electric and hybrid cars will reach the "retirement age", but their use may continue, for example, for cooling beer in the chain of stores "7-Elevens" in Japan, providing energy for gas stations in California (USA) or saving energy in the process of heating houses in Europe [345]. Lithium-ion batteries can produce electricity for another 7-10 years after their end-of-life use (for example, removed from

[25] Polyvinyl chloride (PVC, English PVC) or polyvinyl chloride, polyvinyl chloride resin is a colorless, transparent plastic, a thermoplastic polymer, a product of the polymerization of vinyl chloride CH 2 = CHCl. To obtain a soft material from polyvinyl chloride, it is mixed with a plasticizer. In the presence of organic peroxide compounds at 40 °C and a pressure of 5 atm, vinyl chloride easily polymerizes into an elastic mass, which is also called polyvinyl chloride resin.

electric car service points on highways), forming a so-called circular value chain.

According to the forecasts of the company "Bloomberg New Energy Finance" ("BNEF") [26], by 2025 the global stock of electric vehicle batteries will exceed 3.4 million compared to 55 thousand in (2018). Accordingly, the search for ways to reuse such technology is an increasingly urgent issue [45] . China, home to roughly half of the world's power plants, introduced rules in August 2018 that will make automakers responsible for battery health and manage their mobility. A product's "second life" generates a second revenue stream for the same manufacturer. It is about creating a secondary market of the automotive industry (aftermarket) and, accordingly, additional profit and value in the circular chain [45].

Table 4.3

The main reference e-points in the formation of circular chains of creation of added value

Company	H location	Role in the chain
1	**2**	**3**
Chevrolet	Michigan (USA)	Data center / *data center*
EVgo	California (USA)	EV charging / *e-charger*
Florida Power&Light	Florida (USA)	grid management / *network management*
Nissan / Eaton / Mobility House	Amsterdam (Netherlands)	energy storage / *energy accumulation*
BMW	Leipzig (Germany)	energy storage farm / energy storage "farms".
Renault / Connected Energy	Belgium	EV charging / *EV charging*
Renault / Renewable storage	Porto Santo (Portugal)	Renewable storage / *renewable storage*
Renault	Paris (France)	Backup power for elevators / *backup power for elevators*
Ecar ACCU	Cameroon (Africa)	Solar energy storage / *solar energy storage*

[26] The company "Bloomberg New Energy Finance" (" BNEF ") is an industry research firm focused on helping energy companies create broad economic opportunities. With a team of experts, BNEF provides independent analysis that enables decision-making bodies to navigate changes in the developing economy.

Eaton	South Africa	Energy storage / *energy storage*
Nissan / Sumitomo	Namie (Japan)	Street lighting / *street lighting*
Nissan / Sumitomo	Japan	Large-scale power storage / large-scale *energy storage*
BYD	Shenzhen (China)	Energy storage / *energy storage*

Source: built by the author based on [45; 147; 196; 249; 360]

However, with the development of this type of economy, where a large number of companies are increasingly applying the idea of reuse, the largest manufacturer of electric cars in the United States, Tesla Inc. may be uncompetitive. The Palo Alto, Calif.-based company said the batteries it produces may not be usable after 10 to 15 years of use, and it is focusing its efforts specifically on recovering raw materials.

However, the amount of reuse of these products may decrease if it becomes more profitable to mine materials such as cobalt and make new batteries.

Components will typically be replaced after about a decade in family cars and after four years in heavier buses and taxis. Although the replaced batteries will not be able to be used in passenger cars, they will be used for less complex tasks, such

Status of transformation: around 10% of companies are substantially engaged in the Circular Economy

The Swiss private sector is still at the *beginning of the transformation process*: between 8% and 12% of companies are substantially engaged in the transformation towards a Circular Economy. 12% of the companies have substantially integrated circular business activities into their business model. 9% of companies invest more than 10% of their total investments in implementing circular business **activities**. 8% of the companies have implemented more than 10 activities in the field of Circular Economy. 12 % of companies generate more than 10% of their **sales** with circular products/services.

as storing electricity from solar panels and wind turbines, and for storing energy from regular grid connections, provided that prices are low.

According to G.-E. Melin, founder of the London-based company Circular Energy Storage Research & Consulting, the lithium-ion battery "virtually never dies" [45]. It's like taking an alkaline battery from a flashlight and putting it in the remote control, and that's enough. By 2025, approximately three-fourths of the volume of used EV batteries will be reused and then disposed of to collect raw materials [45; 147; 196; 249; 360].

For example, in western Sweden, the so-called "Box of Energy" is being installed, the size of a large refrigerator, which uses 20 battery modules obtained from Volvo hybrid cars. They store energy from solar panels on the roof of a residential complex [45; 147; 196; 249; 360].

Large-scale systems can also reduce costs for business representatives. Nissan Leaf batteries will soon help light the streets in the Japanese coastal city of Namie, which is recovering after the 2011 disaster at the Fukushima-1 NPP [45; 147; 196; 249; 360].

Toyota, maker of the Prius hybrid, installs used batteries at 7-Eleven convenience stores in Japan. The hybrid batteries will store energy from the solar panels and then be used to cool drinks, heat or cook food on grills, etc. A typical "ev" battery retains approximately 50%–70% of its capacity after its use in electric vehicles [45; 147; 196; 249; 360].

The circular chain of creation of the added value of the lithium-ion battery can be divided into six main segments, starting with the extraction and processing of raw materials and ending with the disposal of the final product, taking into account the production of storage batteries and electric vehicles (Fig. 4.6) [45; 147; 196; 249; 360].

The extraction of minerals and other raw materials used in lithium-ion batteries, along with the processing of these materials, takes place outside the

EU. China is a leader in the production of fuel cells. In 2014, China itself had 41% of the world production capacity of automotive cells, while the EU had 5% [45; 147; 196; 249; 360].

The next step in the process is the production of the storage battery, which accounts for approximately 40% of the cost of the "ev" battery. Overall, in electric vehicle production, led by the US and Japan, the EU's global market share is 22% of the 20 manufacturers of hybrid electric vehicles ("PHEV") and battery electric vehicles ("BEV"), and China's 33%. Although the EU is in a strong position (mainly due to legislative requirements on the ground), it is not ready to ensure the collection of a large number of batteries that have exhausted their resource, that is, before their proper disposal [45; 147; 196; 249; 360].

Regarding the first and last stages of the battery value chain, we note that when manufacturing lithium-ion batteries, materials are used that are either considered critical [45] or are among the list of those classified as critical raw materials (CRM), as determined according to the assessment of the European Commission. CRMs are defined as raw materials of significant economic importance to the EU and as materials vulnerable to supply disruptions. Economically important raw materials play a significant role for EU industries, creating added value for the EU economy [45] as well as influencing the creation of new jobs, and materials that are vulnerable to supply disruptions are those that have a high supply risk to adequately meet the demand of EU industry [251; 300; 302; 335].

Recently, the European Commission revised the methodology for evaluating critical raw materials. According to the assessment of raw materials conducted by the European Commission in 2017, 27 of the 61 elements of classified materials are considered critical. With economic importance and

moderate supply risk, cobalt is considered one of the 27 CRMs, while lithium, nickel and aluminum belong to the list of classified raw materials.

It is assumed that at each stage of the disposal process, that is, collection, disassembly and recycling, jobs will be created in different numbers. Collecting EV batteries is considered a labor-intensive process, while disposal is, as a rule, more capital-intensive [45].

Since the processing industry of lithium batteries is not yet developed on a large scale, accurate data on employment rates have not yet been published in the scientific literature. In the study, employment rates were calculated based on data obtained through interviews with lithium-ion battery processors. Analyzing the received information, it was found that for every thousand tons of lithium-ion battery waste, 15 jobs were created for the collection, disassembly and disposal of these batteries. Of these 15 jobs, approximately 80% of their number are designated for the collection and dismantling of lithium-ion batteries, while the remaining 20% are for battery disposal. Note that these indicators do not take into account the process of technological development. It is likely that after 2030, the number of jobs per thousand tons of lithium-ion batteries will depend on the technologies used [45; 251; 300; 302; 335; 351].

The WEEE Forum (2017) released data from various sources on employment rates. Thus, for the processing of each additional thousand tons of electronic waste, 7 to 8 new jobs are created. This is in line with the assumption made in this study, as lithium-ion battery recycling is expected to be more labor-intensive than e-waste disposal due to the more complex procedure [45; 407].

Instead of recycling batteries removed from vehicles, the battery can be recovered and the segments given a "second life" through a storage program. Electric vehicles generally require high performance batteries. Therefore, the

battery is removed from the vehicle as soon as the power drops below a certain point of no recovery. It is estimated that this mostly occurs when the batteries are used at 70% - 80% of their original capacity level. At this point, batteries also provide charge and discharge for other applications, such as electricity storage [45; 408].

Secondary electricity batteries available for storage applications may still provide a useful life in the future electricity system due to the further increase in intermittent renewable energy sources connected to the European electricity grid. Flexible capacity in the future power system will be critical to complement renewable electricity technologies. Saving electricity must ensure that it is consumed and produced at times when it is needed, and battery manufacturing technologies can contribute to solving this issue. This technology is very flexible, providing instant power when needed.

Reuse of "ev" batteries in "second life" systems extends their useful life. Different scientific sources have different views and predictions about the share of batteries that will support "second life", stressing that the market is currently very uncertain. Some scientists predict that a small number of batteries will have a second life, given the decline in lithium-ion battery prices in the future market, while others expect that most batteries will receive a "second life" before being recycled. Despite the controversy on this issue, Bloomberg New Energy Finance (2017) predicts that in 2025, 27% of these batteries will receive a secondary resource in stationary storage, and the remaining 73% will be available for recycling. However, this will depend on a number of factors, including the costs of remanufacturing 'ev' storage batteries, the cost of materials that can be extracted from Li-ion batteries, and the cost of recycling [45; 167; 179; 251].

Cobalt is the main component of lithium-ion batteries in electric cars. Its extraction is associated with the use of child labor. Cobalt is mined in many

countries of the world, including Australia, but most of the world's supply is provided by only one African country - Congo. Undemocratic labor standards are applied in this country, including child labor.

Table 4.3

Leading countries in the supply of basic raw materials for the production of batteries for electric vehicles

No	**Production lithium**	**Reserves lithium**	**Production graphite**	**Production cobalt**	**Processing cobalt**	**Production nickel**	**Processing nickel**
1	Australia	Chile	China	Congo	China	Philippines	China
2	Chile	China	India	New Caledonia	Canada	Russia	Russia
3	Argentina	Argentina	Brazil	China	Australia	Canada	Japan
4	China	Australia	Turkey	Canada	Madagascar	Australia	Canada
5	Zimbabwe	Portugal	Canada	Australia	Congo	New Caledonia	Australia
6	Brazil	Brazil	Austria	Philippines		Indonesia	New Caledonia
7	Portugal	USA		Madagascar		China	Indonesia

Source: constructed by the author based on [45].

And because cobalt is now in such high demand, its global price has doubled over the past year. According to human rights group Amnesty International, this growth has put pressure on miners in the DRC to increase production, leading to tens of thousands of children being lured or forced into grueling and dangerous work. UNICEF estimated in 2014 that 40,000 children work illegally in Congolese mines, a serious underestimate given the growing global demand. Children work 12 hours or more. A significant part of the cobalt mined in the DRC is mined from small mines, sometimes literally ending up in semi-rural yards [45; 222; 236; 266; 283; 299; 315].

An Amnesty report has revealed for the first time that cobalt mined by children is ending up in products from major tech companies including Apple, Microsoft, Tesla and Samsung. From the age of 4, children can choose cobalt from inhaling toxic vapors [45; 222; 236; 266; 283; 299; 315].

The nickel used in the same batteries is toxic to extract from the earth. There are environmental problems and conflicts with land use associated with

lithium mining in countries such as Tibet and Bolivia [45; 222; 236; 266; 283; 299; 315].

The elements used in the production of batteries are limited. This makes it impossible to electrify all the world's transport with the help of modern battery technologies. Meanwhile, there is still no environmentally safe way to dispose of lithium-ion batteries.

Electric cars often come with higher levels of non-exhaust emissions. Electric vehicles further add to the problem of fine dust, as it causes more tire wear and dispersion of dust particles.

Electric cars **share many other issues with conventional cars** as well. Both require roads, parking and other infrastructure, which is particularly problematic in cities. Roads divide communities and make it difficult for those without cars to access basic services. Changing people's dependence from combustion to electric cars also has little effect on sedentary urban lifestyles, as it perpetuates our lack of physical activity [45].

Other problems are related to overloading. Given the trends in population growth and urbanization around the world and in Australia, electric cars - despite their obvious advantages over fossil fuels - are unlikely to solve urban mobility and infrastructure problems. Improvements in recycling, innovation and environmental friendliness of battery plants can significantly improve the impact of battery production. Such certification schemes, such as the one proposed in Sweden, can help ensure low-impact high-capacity battery chains and avoid conflict minerals and human rights violations in the industry [45; 222; 236; 266; 283; 299; 315].

A large number of EU multinationals work with global supply chains in developing countries. They represent a larger share of world trade with added value, over 40% in 2010, compared to only 20% in 1990 and 30% in 2000. Creating an effective connection with micro, small and medium-sized

enterprises (SMEs) operating precisely at the last link of global value chains. It is this supply that is the main challenge of ensuring sustainable development and circularity, both for multinational companies and for small businesses. At the same time, multinational companies, although still facing difficulties in monitoring and influencing the sustainability of micro- and informal sector enterprises that feed their various levels of well-located suppliers, are using their leverage to promote circularity in their supply networks, including among SMEs in developing countries that wish to adjust their processes and practices to continue conquering the global value chains of which they are part.

The EU plays an important role in supporting and encouraging companies in their efforts to conduct their business responsibly. The relevant EU efforts focus on mobilizing investment in selected value chains, but also place a strong emphasis on facilitating the formation of strategic value chain groups that can be used to manage networks and connectivity, i.e. partnerships between asset leaders and producers to facilitate scale-up and replication of circular economy practices. Moreover, the EU may be the world's largest and single market with standards applied across global value chains.

4.3. “Tax offsets” as smart prerequisites for the formation of an inclusive circular economy

The concept of tax shifting or "tax shifting" is known by various names, in particular, Environmental Tax Reform (ETR), Environmental Fiscal Reform (EFR) [288], Green Fiscal Reform (GFR) or Green Tax Swaps (GTS) [176; 180].

The Ex'tax project is an independent organization that strives for a fundamental tax shift from labor to the transfer of the tax burden on the use of natural resources. Ex'tax is based on the legacy of the Dutch entrepreneur Eckart Vincen (1939-2008) [209]. The Foundation provides support and

practical tools to help implement the Ex'tax idea. The ultimate mission is to facilitate the implementation of Ex'tax in national and European fiscal systems [209] .

All scientific studies carried out regarding the concept of circular economy have shown results that describe specific real examples in European countries (cities). In particular, how Europe can get an economic profit of 1.8 trillion. euros by 2030, provided that the principles of the circular economy are followed. And what advantages can this concept offer to emerging and developing countries. These issues will become relevant because the bulk of the world's population is concentrated in these countries, and in the future, global environmental and social consequences will largely depend on how countries such as Brazil, China and India use their natural resources.

Thus, **Brazil** is implementing a new national policy based on the use of solid waste, accordingly initiating a number of innovations in the social, technological, economic, political, legal and environmental spheres. Accordingly, the advantages already offered by the circular economy model compared to the linear economy in the Brazilian context are manifested, for example, in the existing informal circular supply chains. At the same time, a potentially important role can be played by the government, helping existing production networks to adopt a circular production model.

At the same time, it is worth outlining the role of taxes in the circular system. Payroll taxes were the largest source of tax revenue in 2012 in 24 EU Member States, accounting for more than half of total tax revenue in 13 Member States. The highest shares of payroll taxation were observed in Sweden (58.6%), the Netherlands (57.5%), Austria (57.4%) and Germany (56.6%), and lower in Bulgaria (32.9%), Malta (34.6%), Cyprus (37.1%) and Great Britain (38.9%).

High taxes on labour and social contributions create incentives for business, increasing efficiency by hiring fewer workers or moving the production of goods and services to low-income third countries. These high taxes stimulate technological innovation. For companies in the European Union and the European Free Trade Association (which includes the EU + Iceland, Liechtenstein, Switzerland and Norway), payroll taxes and social security contributions make up more than 65% of the total tax rate.

In 2012, 500 million Europeans paid €5.1 trillion. taxes (51%), and consumption taxes (including value added tax, duties and green taxes) accounted for 28%, the remaining 21% - from profits, exports and assets.

As defined by the European Commission, environmental taxes include taxes on energy, transport, pollution and resource extraction. Environmental or "green" taxes are considered favorable to economic growth because they are less of a burden on the economy than payroll taxes or income taxes.

Environmental taxes can be an extremely effective tool for preventing environmental damage. For example, in Sweden, in the early 1990s, a tax on the use of fertilizers reduced the demand for them by 15-20%. In the Netherlands, in 1989, leaded gasoline was taxed, as the result of its use was heavy pollution. Two months later, leaded gasoline was withdrawn from the market. According to the European Commission, governments can and do use environmental taxes to help a country achieve its environmental goals and as a way to generate additional revenue [123].

According to the relevance described above, the company *Ex'tax* (short for withdrawn tax) is a proposal to update tax systems to effectively respond to the challenges of the 21st century by shifting the tax burden from the use and consumption of natural resources [180; 337]. Such a smart approach to the "tax shift" [22] creates incentives for saving natural resources and removing materials in a closed cycle - that is, the development of a circular economy.

Reduction of labor taxes [22] will provide an opportunity to attract a large number of creative start-ups, increasing employment, services and innovation. Such an idea received significant support in 2016-2017. among academics, international institutes and business organizations.

$$TaxFmax = F\{\downarrow Ltax\ ;\ \uparrow Rtax;\ \uparrow Ruse;\ \uparrow EJ\} \qquad (4.1)$$

Function (Ex'tax) tax offset

A reduction in taxes on labor leads to an increase in employment, and business models will focus on the reasonable use of resources, that is, they will become [22] circularly oriented.

For the EU in general, no progress was observed during the period under study (2002-2017). The share in total revenues from labour taxes remained approximately eight times larger than revenues from environmental taxes. Revenues from labour taxes relative to environmental taxes were slightly lower in the first years (2002-2006) compared to the rest of the studied period. Revenues from labour taxes relative to environmental taxes increased during the recession years (2008 and 2009), decreased slightly immediately afterward, and remained fairly stable after 2011 (according to the latest OECD data).

The years since the 2008 recession have offered an opportunity to use environmental fiscal reform to address rising unemployment—that is, to increase environmental taxes by reducing labour taxes and thereby encouraging job creation. The lack of any progress on such a tax change at EU level suggests that this opportunity has not been taken. This lack of progress comes despite renewed interest in environmental fiscal reform, driven by a variety of factors, including the push for fiscal consolidation and growing recognition of the financial burden of some measures, such as fossil fuel

subsidies. The recent sharp drop in global oil prices is seen by some as an opportunity to reform fiscal measures targeting the production and consumption of energy from conventional sources (especially fossil fuels), for example by strengthening carbon pricing mechanisms and revising fossil fuel subsidies.

In addition to energy and carbon taxes, pollution and resource taxes provide opportunities to further reduce pollution. Such taxes are still largely unused in the EU, and constitute only 3.4% of revenues from all environmental taxes in 2017, which corresponds to approximately 0.08% of the gross domestic product (GDP) in the EU (Table 4.4.). In recent years, there have been no signs of an increase in the share of pollution and resource taxes in environmental taxes. This is despite increased attention to material resources in EU policy, represented, for example, by the 2011 Roadmap to a resource-efficient Europe and the 2015 Circular Economy Package. Transportation taxes, such as vehicle sales taxes or annual vehicle taxes, are the second most important revenue-generating category, and their share was fairly stable between 2003 and 2016.

The lack of progress in the field of environmental fiscal reform may be the result of a number of obstacles to the implementation of environmental taxation. In its review of tax reforms in member states in 2015, the European Commission refers to the following three key barriers [175]:

1) **the potentially regressive nature of environmental taxes and possible related equity issues;**
2) **potentially harmful impact on the competitiveness of the relevant sectors; and**
3) **administrative and executive costs for raising these taxes.**

The Commission does, however, suggest successful implementation strategies, namely transparency and early involvement of those affected by the tax, phasing in the tax according to a pre-announced schedule, and making

such tax measures part of a broader policy package aimed at achieving a specific environmental and generally circular objective.

The European Commission's analysis also suggests that higher energy taxes (a form of environmental taxes), offset by lower labour taxes, may actually increase competitiveness. However, the administrative and enforcement costs must be proportionate to the political and environmental goals that the tax aims to achieve. Other studies also suggest that any potentially negative impact of environmental taxes can be reduced or resolved through careful design and implementation of tax adjustments [175].

Another factor limiting changes in relative tax levels is the high level of political attention generated by any changes in a country's tax system. This can make any changes difficult and slow down the pace of change. The political difficulties of modifying the fiscal system are reflected in a recent study by the European Commission, which assessed the EU's potential for fiscal reform in different scenarios of political adoption in different member states [178].

The lack of policies that would facilitate the shift of the tax base from labour to environmentally harmful goods and practices in recent years, as well as the lack of plans by the vast majority of member states to implement these changes, makes it unlikely that the 2020 target will be met.

The Ex'tax project reviewed the reports of approximately 140 major corporations in 12 industries and concluded that in every industry, companies are already rethinking their business models and reorienting their production [180].

The use of natural resources (such as water, fuel, metals and minerals) is now virtually untaxed and therefore unrestricted. On the other hand, labor is taxed at high tax rates. Yes, Fig. 4.12 and 4.13 show that the lowest taxes are observed in Ireland, Romania, Cyprus, Poland, and the highest as of 2016 – in Austria, Belgium, Sweden [22]. Instead, data on environmental taxes are

respectively the lowest in Luxembourg, Ireland, Germany and the Czech Republic, and the highest in Denmark and Greece.

That is, such results are typical for a linear economy. But in the conditions of a modern comprehensive, circular economy, the architecture of the fiscal system is being adapted to the principles of circularity. At the moment, green taxes provide only 6% of tax revenues in the entire European Union. These taxes mainly relate to energy use and transportation. A paltry 0.3% of revenue comes from pollution and the use of natural resources, such as fish.

The "tax shift" from labor resources to pollution will reorient the creative power of entrepreneurs, focusing attention on reducing the number of employees while using resources wisely, that is, using the mechanisms of the circular economy to form an inclusive society. According to the calculations of the Dutch organization "The Ex'tax Project" in cooperation with tax firms Deloitte, EY, KPMG Meijburg and PwC, Ex'tax tax change for the Netherlands will amount to more than 30 billion euros.

According to the conducted analysis, it is possible to single out such countries in which this "tax shift" is already taking place in Lithuania, Romania, Slovenia, Great Britain. That is, starting from 2006 to 2016, these countries offer inclusive and circular business models, which are becoming the rule for their economy. After all, it is appropriate the tax shift is a key element in unlocking the social power of the circular economy [22; 210].

In 2018, total environmental tax revenue in the EU was €324.6 billion, representing 2.4% of EU GDP and 6.0% of total EU government revenue from taxes and social contributions.

Energy taxes in the EU accounted for more than three quarters of total revenues from environmental taxes (77.7% of the total) in 2018, significantly ahead of taxes on transport (19.1%) and pollution and resources (3.3%).

The Netherlands is diversifying its range of products towards services. In addition, the manufacturer is incentivized to prioritize the product life cycle by expanding the optimization of return on assets, for example, by building devices that will last well and are easy to maintain. In Sweden, for example, there is a reduced tax on the repair, maintenance and reconstruction of private homes, which aims to increase employment while reducing the amount of undeclared work. In general, by lowering labor taxes and raising environmental taxes, the government thereby creates a so-called "attractive neutral budget" [175] by encouraging manufacturers to adopt circular design and accompanying repairs, while avoiding recycling and consumption of single-use products (plastics or fossil fuels). Studies show that this alignment of the tax regime with the ambitions of sustainable development pays off, according to economic models developed Exxtax [180].

Table 4.4.

Leading countries in tax revenues from environmental and pollution taxes, 2018.

"tax shift	Profit from environmental taxes	Environmental taxes, % of total tax revenues	Environmental taxes, % of GDP	Profit from pollution taxes	% of total income from taxes and social contributions	Pollution taxes as a % of GDP
Lithuanian a	Germany	Latvia	Greece (3.7%)	Netherlands	The Netherlands (1.08%)	The Netherlands (0.42%)
Romania	Italy	Bulgaria	Denmark (3.6%)	France	Estonia (0.84%)	Estonia (0.28%)
Slovenia	Great Britain	Croatia	Croatia (3.6%),	Great Britain	Malta (0.73%)	Hungary (0.25%)
Great Britain	France	Slovenia	Slovenia (3.5%)	Spain	Hungary (0.66%)	Malta (0.24%)
	Netherlands	Greece	Latvia (3.4%)	Italy		Denmark (0.17%)
	Spain	Netherlands	The Netherlands (3.3%)	Belgium		

Source: built by the author based on [289]

Revenues from taxes related to the environment (environmental taxes): Germany, Italy, Great Britain, France, Netherlands, Spain. The least are Iceland, Malta, Cyprus, Estonia, Lithuania, Latvia, Luxembourg (Table 4.4) [178].

Environmental taxes (environmental taxes) as a percentage of total revenues from taxes and social contributions (including attributed social contributions): maximum values Latvia, Bulgaria, Croatia, Slovenia, Greece, Netherlands, Estonia, Cyprus.

Environmental taxes (environmental taxes) as % of GDP: Greece (3.7%), Denmark (3.6%), Croatia (3.6%), Slovenia (3.5%), Latvia (3.4%), Netherlands (3.3%). The smallest values are typical for Iceland (1.3%), Ireland (1.6%), Luxembourg (1.7%), Switzerland (1.74%), Germany (1.8%) [178; 289].

Profits from pollution taxes: the Netherlands, France, Great Britain, Spain, Italy, Belgium, Poland, Denmark have the highest values. The lowest profit for 2018 was recorded in Cyprus, Luxembourg, Romania, Croatia, Greece, the Czech Republic, Ireland, Slovakia, Malta, Latvia, and Bulgaria.

Pollution taxes as a percentage of total revenue from taxes and social contributions (including attributed social contributions): maximum values: Netherlands (1.08%), Estonia (0.84%), Malta (0.73%), Hungary (0.66%). The smallest values (0.02%) are characteristic of Romania, Cyprus, Greece, 0.3% - Switzerland, the Czech Republic, 0.04% - Luxembourg, Ireland [178; 289].

Pollution taxes as a % of GDP: the Netherlands (0.42%), Estonia (0.28%), Hungary (0.25%), Malta (0.24%), Denmark (0.17%) are the highest. Very low values of 0.01% - Switzerland, Cyprus, Greece, Ireland, Czech Republic [178; 289].

In 2016, only in two EU member states (Latvia and Slovenia) the share of total revenues from taxes and social contributions consisting of environmental taxes exceeds 10%.

Nine EU Member States moved labor and environmental taxes between 2003 and 2016 (Bulgaria, Estonia, Greece, Hungary, Italy, Latvia, Poland, Romania and Slovenia). Six Member States moved in the opposite direction (Cyprus, Ireland, Luxembourg, Portugal, Slovakia and Spain), as well as Norway; however, some of these changes were quite small [178].

The 2015 review of tax reform in Member States by the European Commission identified a group consisting of around a third of EU Member States where there are particular opportunities to improve the design of environmental taxes. Proposed ways forward include restructuring vehicle taxation, indexing environmental taxes to inflation and adjusting fuel excise duties to reflect the carbon and energy content of different fuels.

A recent report *from the European Commission* analyzed the extent to which environmental taxes are increasing based on good practice. This report found that environmental taxes could rise in the EU from an average level of 2.5% in 2013 to 3.6% of GDP by 2030. Countries reported that politically feasible increases in environmental taxes, especially energy taxes, are lower than projected optimal rates. However, this gap narrows when looking further into the future. The report concluded that, although in the short term the best practice scenario is considered difficult, in the long term almost all proposed changes to national tax systems can be considered politically feasible [175; 178].

The fiscal forecast in Europe has increased political interest in the potential of environmental fiscal reforms. Long-term changes, including demographic changes and technological breakthroughs in energy and transport in the transition to a low-carbon, green economy, will contribute to the destruction of existing tax bases in European countries. These expected trends call into question the general basis of modern thinking on tax reform. Much more work needs to be done to develop sustainable, long-term tax systems in Europe in the face of such systemic challenges.

The green tax reform lowers taxes on labour, which encourages job creation, and increases taxes on pollution and other environmentally harmful activities. In Denmark, according to government calculations, the green tax shift has positive effects on employment. When the Ministries of Finance and Economy calculate the short-term (first year) 1 impact of tax increases on GDP and employment, they use standard multipliers developed over time and based on actual experience.

These multipliers predict changes resulting from a shift equivalent to 0.1% of GDP due to increased revenues or government spending. The coefficients can be used to predict tax increases or tax decreases [175; 178].

In Denmark, which has been implementing a green tax change since the 1990s, the green tax change is predicted to have a positive employment effect. Increased employment due to income tax cuts will exceed reduced employment due to higher energy taxes [175].

The greatest attention should be focused on the tax shift in taxes and restrictions on the use of plastic bags. In order to find the best solution for Ukraine in this matter, the Ukrainian non-governmental organization Re Think [27]conducted a study of the policies of the countries of the world regarding the circulation of plastic bags. According to its results [303], it became known that 33 countries have completely banned the use and circulation of some plastic bags. Kenya is known for the strictest regulations, where for using the package, you can be imprisoned for up to 4 years or pay a fine of 40,000 dollars. USA, and Bangladesh became the first country to ban thin plastic bags back in 2002. In the European Union, Italy was the first to ban plastic bags – back in 2011.

[27] ReThink works on rethinking production and consumption, changing the functioning of the linear model of the "take-make-throw" economy, suggests thinking about your impact on the environment, motivates responsible waste management, demonstrates permanent innovative solutions that radically change the rules of the game and give future generations a chance.

In addition, 53 countries have introduced a partial **ban or tax on plastic bags**. For example, Denmark began taxing producers back in 1994. Georgia has limited the circulation of polyethylene bags with a thickness of up to 15 microns. In countries such as the Netherlands and Iceland, in addition to the tax, the free distribution of data packages is also prohibited. After the introduction of a tax of 22 euro cents in Ireland, the demand for plastic bags fell by 90% within the first year.

There are countries where there are voluntary initiatives by supermarket chains or other market operators to minimize the use of plastic bags. There are eight such countries. For example, in Singapore, the chains removed plastic bags from sale on their own initiative, and the leading chains in Austria agreed to do the same this year.

Unfortunately, Ukraine is included in the list of countries where no decisions have been made, and this issue is only being discussed.

Yes, single-use plastic bags have been banned in **France** since July 1, 2016. Other bags are prohibited from January 1, 2017 (except for bags made entirely or partially of biological raw materials suitable for composting). Goal of using 100% recycled plastic by 2025. The total tax on polluting storage works will be gradually doubled - from 40 euros per ton to 80 euros per ton in 2025, and a tax on non-recyclable goods will be introduced in parallel. The association has long called for this tax, and it may now take the form of a General Tax on Polluting Activities (TGAP) [239][28] paid by producers of non-recyclable goods that have so far been exempt from all environmental taxes (excluding extended producer responsibility sectors[29]), as opposed to the "polluter pays" principle [318].

[28] TGAP (General Tax on Polluting Activities), 2018. URL: http://www.douane.gouv.fr/articles/a13102-tgap-general-tax-on-polluting-activities

[29] Enterprise resource planning (ERP system) (English Enterprise Resource planning)

In 2002, **Ireland** introduced a charge of €0.15 on plastic bags at the point of sale, which increased to €0.22 in 2007. The aim was to reduce the consumption and negative effects associated with plastic bags on the landscape. As a result, discarded plastic bags dropped from 5% of total garbage pollution in 2001 to 0.13% in 2015. The award raised 200 million euros over 12 years. The proceeds were used to fund environmental projects across the country. The 'Irish bag' plastic charge is considered to be one of the most successful and well-received environmental measures ever introduced.

Finland has created one of the most successful systems in Europe to reduce container contamination. The government first introduced a beverage packaging deposit refund system in 1950. Now disposable and glass bottles are collected according to this scheme. With deposits ranging from €0.10 to €0.40 per container, return rates for disposable packaging reached 95% in 2015. This was due to close collaboration between government, civil society, retailers and the drinks industry. After the introduction of the tax package in 1994, the government also offered incentives for manufacturers and importers to participate in the deposit refund system.

In 1996, **the UK** introduced a landfill tax that reflects the environmental costs of waste (e.g. greenhouse gas emissions), as well as reducing waste generation and increasing recycling. Thanks to the tax, the amount of waste sent to landfills decreased from 50 million tons in 2001 to 12 million tons in 2015. Currently, inert, hazardous waste (e.g. concrete, sand) is assessed at £2.65 (€2.96) per tonne, and bio-waste (food, paper) is levied at £84.40 (€94.2) [332] .

In 1992, the **Swedish government** introduced a tax on nitrogen (NOx), a potent pollutant associated with acid rain and respiratory problems, which reduced NOx emissions by 30-40%. The tax was applied to energy produced for space heating, power generation and industrial processes to limit soil acidification, which undermines crop and pasture production. Initially, the

initial tax rate was 40 keg/kg NOx for all fuels, and in 2008 it was increased to 50 keg/kg (about 5 euros at the time). This revenue has been used to reimburse those taxed businesses that emit low NOx volumes in order to encourage energy efficiency and reduce any potentially negative impact on competitiveness. This has resulted in many companies implementing a tax system to implement emission reduction measures. Annual revenue was £900 million (€1 billion) in 2016 [332].

Another example of the successful application of eco-taxes is shown in Ireland. The decline in salmon stocks in Ireland led the government to double the prices of existing licenses for the industry and commercial salmon fishing in 2007. The license scheme has helped to ease fish pressure on salmon stocks, and the revenue has been used to fund projects related to habitat conservation and restoration. Funding for such projects has provided some improvements, such as stabilizing salmon stocks. But most importantly, it helped to improve the condition of river banks and restore coastal zones, bringing wider environmental benefits.

Developing economies such as Brazil often face the false dilemma of choosing between social development and environmental protection, as they appear somewhat incompatible. The dilemma becomes even more acute when some degree of environmental destruction seems inevitable if social development is to be achieved. At the global level, the economy currently follows a linear model based on "extraction, production and disposal", and as a result, the planet's ability to support life is rapidly diminishing. First of all, it has the greatest impact on people and the economy of developing countries. Two inevitable consequences caused by today's linear model of production are becoming increasingly apparent – non-renewable resources for the production of goods are rapidly becoming scarce, and environmental damage is compromising ecosystem services such as clean water, clean air, fertile soils

and biodiversity – very often irreversibly. On the other hand, the concept of Cradle to Cradle[30], on which the circular production system is based, can offer a truly viable alternative to the dilemma of "development or conservation", since it is able to contribute to the improvement of the natural ecosystem and at the same time promotes human social justice, that is, it forms an inclusive society in a global dimension [22]. This is because this economic model is based on the same rules that produce the natural production system that sustains life.

Conclusions to chapter 4

The study of directions for the implementation of the global inclusive circular economy model made it possible to draw the following conclusions.

1. Cities play an important role in the transition to a circular economy. It is predicted that by 2030, 60% of the world's population will be urbanized. Cities contribute to economic growth, producing more than 75% of global GDP in total. It causes 75% of carbon emissions for consuming 75% of the world's resources. A circular city is a way to create life, which uses systemic thinking to ensure economic, social and ecological advantages in cities with an economic justification of their feasibility and in contrast to "green" or "eco" cities with a strong ecological "case", with a circular economic component present. Thus, the "circular city" offers a systemic approach that allows solving problems while generating income and improving the quality of life in cities.

[30] The term Cradle to Cradle was proposed by the Swiss architect Walter R. Stachel in 1970. In 2002, it was popularized by the German chemist Michael Braungrad and the American designer William McDonagh in their book Cradle to Cradle: Remaking the Way We Make Things. The book became a kind of instruction for achieving the C2C model, and the term was registered as a trademark of McDonough Braungart Design Chemistry (MBDC). MBDC patented the product certification system based on the C2C principle, but in 2012 the patent was transferred to the Cradle to Cradle Product Innovation Institute to ensure the independence and openness of the certification process. To date, 161 companies participate in the C2C system, 347 certificates have been issued for 2,500 products (mainly in the European Union, the USA and China).

These include New York, London, Paris, Peterborough, Ljubljana, San Francisco, Saanstadt and others.

2. It has been proven that without the necessary knowledge of the waste management process, it is impossible to build a phased collection of waste or to design a secondary product for reuse, disassembly or recycling. In addition, if waste management does not know the requirements for production processes, then they will not be able to produce raw materials that will replace primary materials.

3. Ways to overcome the circularity gap based on smart business models and circular cities are highlighted: increasing the scale of circular activities; creation of an economic and infrastructural basis for conducting a circular policy; environmental initiatives, economic growth and improving the quality of life of the population in real time based on innovative planning; cooperation of local administrations in technical and environmental directions in three directions: "living city", "city with outskirts" and "responsible city"; involving citizens in making important circular decisions; avoiding clogging of territories (public garbage containers in a prominent place and coloring of conditional steps on the sidewalk to garbage cans); the involvement of large (multinational) companies in the circular economy, to stimulate the creation of products and services in accordance with circular principles; "electronic libraries" of clothing and design items; mobile platforms for renting clothes and fashion accessories from the Center of reuse without any payment; automatic solar-powered garbage collectors that alert local authorities when they are full. Accordingly, optimal routes for garbage collection are created and operating costs are reduced by 70%; infrastructure for collecting large volumes of data, with the help of technological advances, applying artificial intelligence algorithms; development of artificial intelligence - self-driving cars; digital applications for messaging, calling, watching and sharing videos

that allow you to communicate with friends for free about renting and borrowing essentials; sorting of different colored glass, using automation technology to increase the share of recycled glass for the production of double-glazed windows; processing of hygienic means for absorption and turning them into secondary raw materials, such as plastic, cellulose; government actions aimed at ensuring transparency in this sector with the aim of establishing a tracking system for the owners of discarded batteries; loss-making industry programs; containerless objects; full-scale economic projects for the reconstruction of thermal power plants; national plans in the charging infrastructure of electric vehicles for long-distance e-trips are the main ones.

4. An important point in the circular economy is the interaction between subjects in defined (integrated) value chains - global circular chains of added value creation. Thus, decisions that allow for a positive effect for the cycle can be effective even if they do not provide a sufficient degree of profitability for the individual actor. Value -added collaboration often drives successful businesses primarily to benefit from its implementation, for example by reducing costs or risks, increasing revenues, or increasing the value of intangible assets such as brand reputation or trust. However, this cannot be achieved in isolation from society.

5. High taxes on labour and social contributions create incentives for business, increasing efficiency by hiring fewer workers or moving the production of goods and services to low-income third countries. These high taxes stimulate technological innovation. For companies in the European Union and the European Free Trade Association (which includes the EU + Iceland, Liechtenstein, Switzerland and Norway), payroll taxes and social security contributions make up more than 65% of the total tax rate. As defined by the European Commission, environmental taxes include taxes on energy, transport, pollution and resource extraction. Environmental or "green" taxes

are considered favorable to economic growth because they are less of a burden on the economy than payroll taxes or income taxes. Environmental taxes can be an extremely effective tool for preventing environmental damage. For example, in Sweden, in the early 1990s, a tax on the use of fertilizers reduced the demand for them by 15-20%.

6. This approach to the "tax shift" creates incentives for the saving of natural resources and the removal of materials in a closed cycle - that is, the development of a circular economy [22]. Lower taxes on labour will attract a large number of creative startups, boosting employment, services and innovation. But in the conditions of a modern comprehensive, circular economy, the architecture of the fiscal system is being adapted to the principles of circularity. At the moment, green taxes provide only 6% of tax revenues in the entire European Union. These taxes mainly relate to energy use and transportation. According to the conducted analysis, it is possible to single out such countries in which this "tax shift" is already taking place in Lithuania, Romania, Slovenia, Great Britain. That is, starting from 2006 to 2016, these countries offer inclusive and circular business models, which are becoming a rule for their economy [22].

The main results of the study were published in: [22; 23; 24; 33; 34; 35; 36; 37; 39; 42; 45; 48; 51; 52; 265; 371; 372; 373; 374].

CHAPTER 5

ADAPTATION OF THE GLOBAL INCLUSIVE CIRCULAR ECONOMY MODEL TO THE REALITIES OF UKRAINE

5.1. Modern trends in the formation and processing of secondary raw materials in Ukraine

Ukraine is the only European country where almost 93% of household waste **ends up in landfills** [4; 63]. While Ukraine is not so developed in this field. However, such a problem is relevant for Romania, Bulgaria, Poland and some other EU countries , where waste still exists and a significant part of it is not reused or properly processed. The experience of leading foreign companies that develop various technical means to meet the needs of humanity, technology providers and managers who make decisions is valuable, as their success stories, proposals and views on current issues make it possible to find out where Ukraine should start [4; 63; 76].

Table 5.1.

The amount of generated waste of all types of economic activity per unit of GDP, kg

The target benchmark set for 2020 is 950.0				
	2015	2016	2017	2018
The amount of generated waste of all types of economic activity per unit of GDP, kg per 1,000 dollars. USA according to the 2011 PCS	977.4	904.2	1089.8	1015.7

Source: based on [72]

It is worth noting that the amount of generated waste of all types of economic activity per unit of GDP in kg per 1,000 dollars. USA according to the PKS of 2011 is shown in table 5.1.

Yes, it is noticeable that according to the available data, from 2015 to 2018, the volume of waste only increased and in 2018 reached 1,015.7 kg per 1,000 dollars produced. USA. And Ukraine sets a benchmark for 2020 – 950 kg. Resource intensity of GDP (the ratio of consumed physical volumes of natural resources, generated waste and emissions of pollutants to the volume of GDP), % to the level of 2015 year is shown in table 5.2.

Table 5.2.

Resource intensity of GDP

The target benchmark set for 2020 is 90.0

	2015	2016	2017	2018	2019[31]
Resource intensity of GDP:					
Energy intensity of GDP	100.0	102.3	94.7	95.3	-
Material capacity of GDP	100.0	100.0	98.2	97.2	-
Carbon capacity of GDP	100.0	105.8	85.1	83.8	-
Water capacity of GDP	100.0	98.2	91.6	95.2	-
GDP waste capacity	100.0	92.5	111.6	104.0	-

Source: based on [72]

To date, the government has approved, with further consideration of technical proposals regarding compliance with EU law, the framework draft law "*On waste management*" *developed by the Ministry of Natural Resources of Ukraine* [76; 79; 85]. There is a consensus among scientists, politicians, economists, businesses, ecologists, and responsible citizens: waste should be created less, collected separately, and again maximally used as raw materials

[31] Source: Ministry of Economic Development , data for 2019 - 31.01.2021.

for processing enterprises in order not to deplete the planet's natural resources and preserve the environment [308].

In general, these principles are supported by the EU and are defined by the legal basis for the practical implementation of the provisions of the National Waste Management Strategy until 2030, adopted in November 2017 [56; 79; 111].

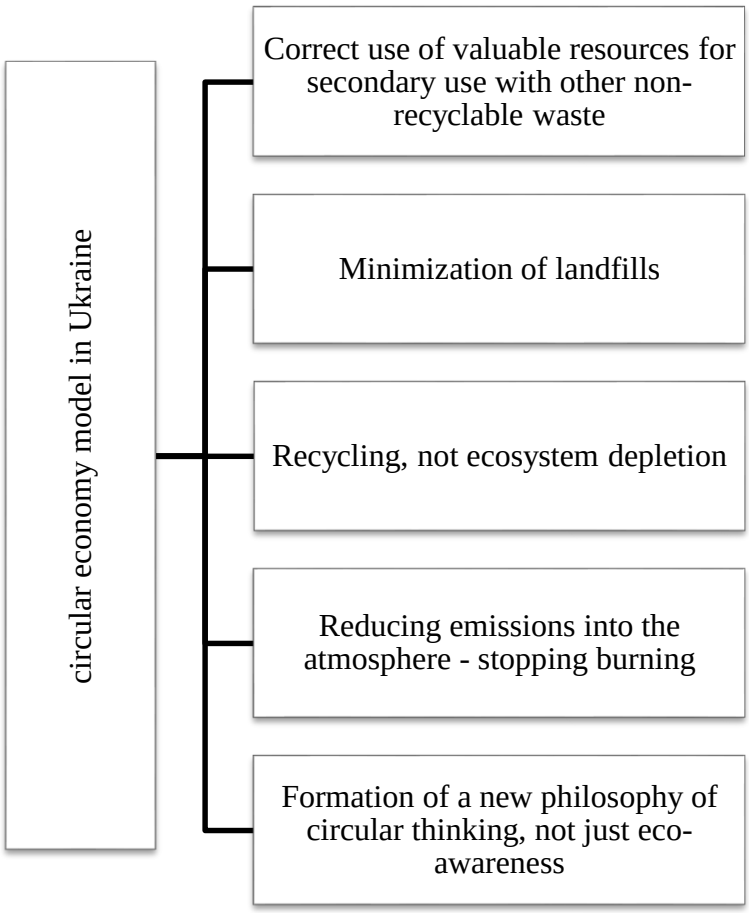

Fig. 5.1. **Conceptual directions of formation of the circular economy model in Ukraine**

Source: constructed by the author

In particular, the draft law foresees the need to introduce a hierarchy of waste management and extended responsibility of the producer, a system of long-term waste management planning at the national, regional and local levels, the introduction of a waste management information system and [79] the National list of waste, as well as promoting the attraction of investments in

this area, the creation of modern infrastructure, and therefore, the reduction of the number of waste management facilities that do not meet the requirements of the law [56 ; 79; 111].

According to various estimates, the volume of solid household waste generation in Ukraine amounts to more than 11 million tons (not including the temporarily occupied territories, the Autonomous Republic of Crimea, and the city of Sevastopol), and the rate of waste generation is on average 250–300 kg per year per person [79; 112].

To solve this problem, in 2016, the government started reforming the field of waste management. At the end of 2017, with the participation of international experts from EU countries, the National Waste Management Strategy and the relevant plan for its implementation were developed and approved. At the beginning of 2019, the Government approved the Plan for the Implementation of the National Waste Management Strategy [79] and in parallel, together with the regional state administrations, the preparation of regional waste management plans - investment plans for each individual region of Ukraine [112] was started.

Reforming the field of waste management also required the adoption of a new legislative framework, which will enable the implementation of the reform in the field of waste in practice[32]. Yes, **the main legal acts** in this area are as follows:

- Constitution of Ukraine;
- Law of Ukraine "On Central Bodies of Executive Power" [55];
- Law of Ukraine "On Waste";
- Appendix 1 to the Resolution of the Cabinet of Ministers of Ukraine dated April 5, 2014;

[32] The government approved the framework bill "On waste management" on May 22, 2019 / Ministry of Ecology and Natural Resources of Ukraine (Ministry of Natural Resources of Ukraine). URL : https://menr.gov.ua/timeline/Novini.html.

- Resolution No. 85 "Some issues of approval of the maximum number of employees of the apparatus and territorial bodies of central executive bodies, other state bodies";
- the scheme of directing and coordinating the activities of central executive bodies by the Cabinet of Ministers of Ukraine through its respective members, approved by Resolution of the Cabinet of Ministers of Ukraine No. 442 [55] "On optimizing the system of central executive bodies" dated September 10, 2014;
- Decree of the Cabinet of Ministers of Ukraine No. 820 "On approval of the National Waste Management Strategy in Ukraine until 2030" [16] dated November 8, 2017;
- Decree of the Cabinet of Ministers of Ukraine No. 117 "On Approval of the National Waste Management Plan" dated February 20, 2019.

Adoption of the project involves bringing into line the current legal acts of the Cabinet of Ministers of Ukraine and central executive authorities.

Accordingly, the Cabinet of Ministers of Ukraine decided to establish *the State Agency of Ukraine on Waste Management* as a central executive body whose activities are directed and coordinated by the Cabinet of Ministers of Ukraine through the Minister of Ecology and Natural Resources [28], who implements state policy in the field of waste management.

Thus, *the European Union in the Plan for the implementation of the national waste management strategy* assigns a significant role to public procurement for the development [60] of the circular economy, which is largely due to their annual volume, which in the EU is 14% of GDP. In the countries of the Organization for Economic Cooperation and Development, on average, the total volume of public procurement reaches about 20% of GDP and 15% in countries that are not members of this organization. According to some

estimates, public procurement accounts for one fifth of the world GDP. In Ukraine, they are also significant - almost 13% of GDP. Given such volumes, purchases can contribute to transformational changes in the market [60; 86; 111].

Government customers are among **the largest consumers in the market** and, thanks to the use of their purchasing power, are able to choose goods that will contribute to the realization of the goals of the circular economy, and therefore to sustainable consumption and environmental protection. They can stimulate a critical mass of demand for greener products that would otherwise struggle to enter the market. Thus, procurement itself is a powerful stimulus for eco-innovation. Compared to other mechanisms for stimulating sustainable development, public procurement is a transparent tool based on the principle of fair competition, thanks to which customers can choose the most favorable offer [60; 95].

For example, in the Netherlands, 32 municipalities and 2 provinces have set a goal of achieving 50% circular procurement by 2025. One of the means of the gradual introduction of circular procurement in Ukraine is the development of standard specifications for certain categories of goods that have a high potential for reuse, extension of their existence or processing in order to ensure the convenience of customers during the organization of such procurement [60].

Circular procurement should play an important role in achieving the global Sustainable Development Goals until 2030, the implementation of which was announced by Ukraine, in particular goal 12 – responsible consumption and production, which among the tasks defines the development of sustainable public procurement [60].

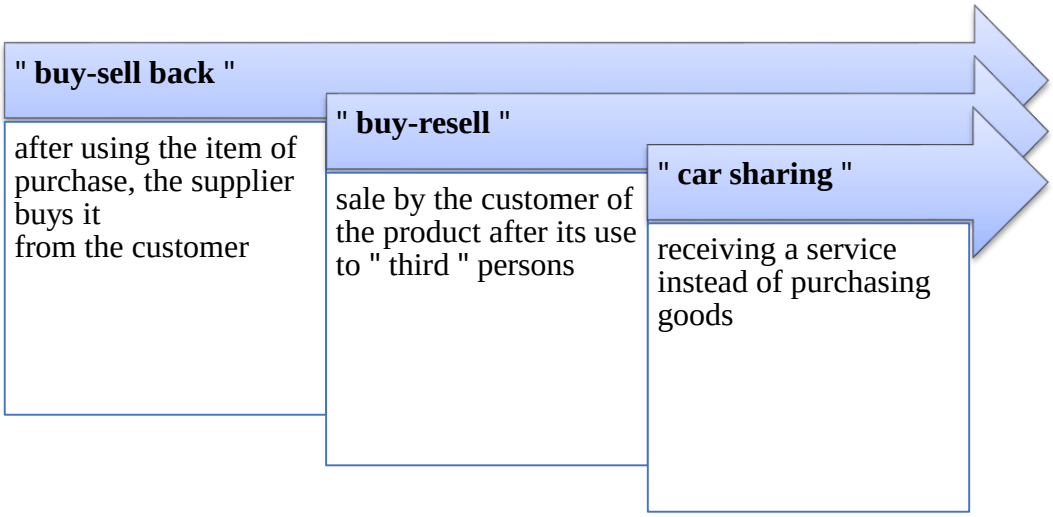

Fig. 5.2. **Organization of circular public procurement**

Source: constructed by the author.

Such processes are often characterized by the concept of "leasing society". The implementation of the criterion of circularity assumes that circular purchases will be made according to it.

In Ukraine, it is expedient to implement the principles **of planning in the field of development of circular procurement**, in particular by establishing a recommended percentage of procurement to which customers should strive, which corresponds to the practice of developing national plans for "green" procurement by EU member states [60].

Following **draft orders of the Ministry of Natural Resources of Ukraine** on:

- approval of Methodological recommendations for sustainable "green" public procurement until 2020 (Ministry of Natural Resources of Ukraine, Ministry of Economic Development of Ukraine, other interested central bodies of executive power);
- the introduction of economic incentives for the introduction of environmentally friendly production technologies and the expansion of processing (recycling) opportunities (in a year after the adoption of the law on

waste management and the formation of the central executive body for waste management).

An Interdepartmental Coordinating Council for Scientific Research on Multiple Use of Natural Resources and Waste Processing (Recycling) was established. In addition, the Ministry of Ecology and Natural Resources of Ukraine has reviewed and proposes a national environmental policy for implementation [64].

According to their definition, the state environmental policy is the activity of state bodies aimed at ensuring the constitutional right of everyone to an environment safe for life and health and to compensate for the damage caused by the violation of this right. Environmental policies can also be developed by individual enterprises or organizations. Environmental policy at the national level is formed by the Ministry of Ecology and Natural Resources of Ukraine. Until recently, the Ministry of Natural Resources of Ukraine simultaneously developed environmental policy and implemented it. Currently, within the framework of the public administration reform, it is planned to focus the efforts of the Ministry of Ecology and Natural Resources of Ukraine precisely on expert, analytical activities, which will consist in the development of political decisions in the direction of environmental protection, and their direct implementation will depend on various state agencies, services or local authorities [94].

At the strategic level, the priorities of the environmental policy are defined in the Draft Law of Ukraine "On the Basic Principles (Strategy) of the State Environmental Policy of Ukraine for the Period Until 2030" [86; 93].

The European Union has chosen the path of development of a circular economy (closed-loop economy), which means obtaining as much raw material for the economy as possible from waste and end-of-life goods, and

using as little as possible non-renewable natural resources, such as minerals or wood.

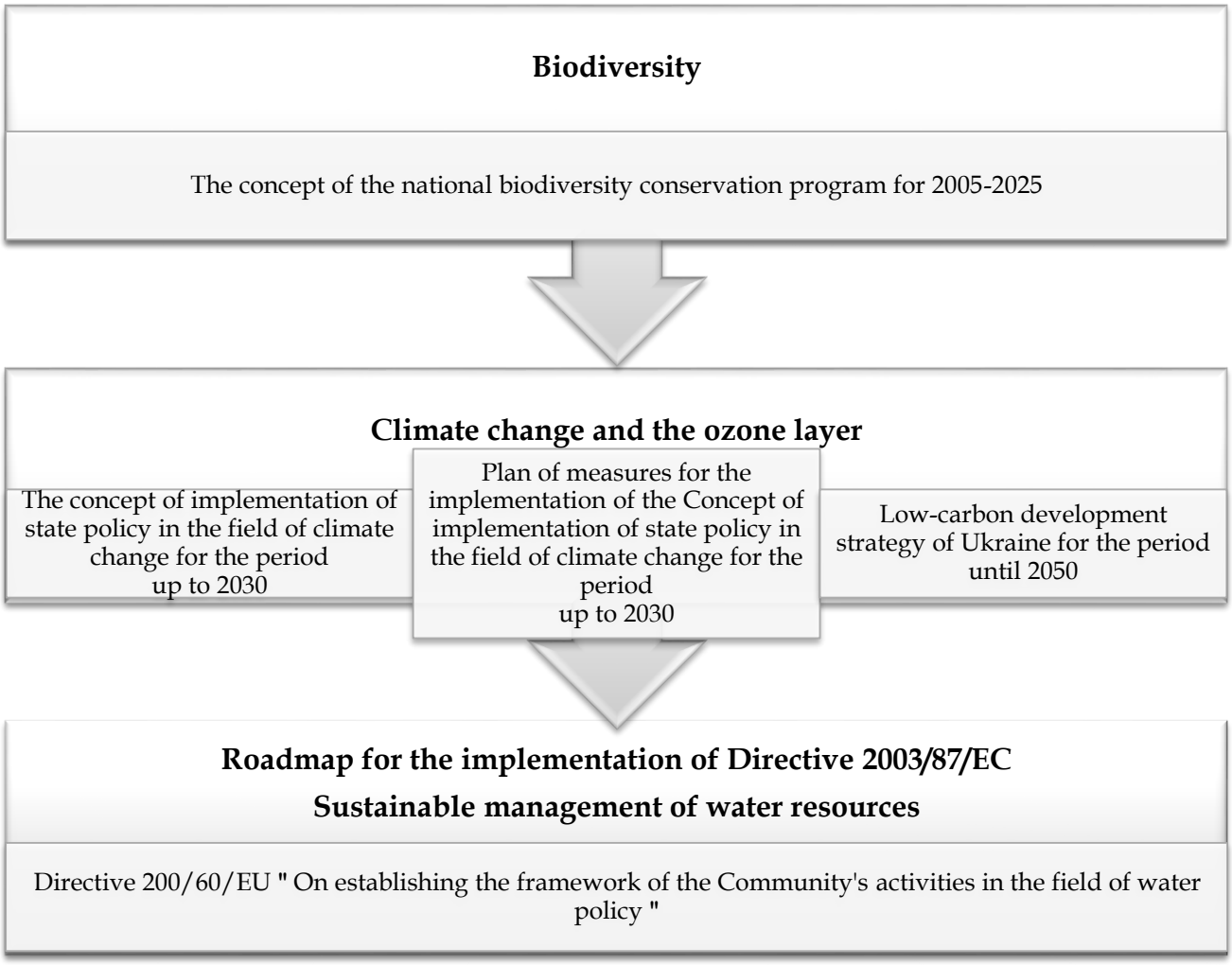

Fig. 5.3. **Environmental policy priorities**

Source: constructed by the author

It is *an Association Agreement* with the EU, according to which it undertook **to increase the amount of waste processing and reuse it in the economy**. The goal of reforms introduced by Ukraine is to get rid of dependence on the export of natural resources and goods with a low degree of processing. At the same time, such structural changes make it possible to overcome the influence of those productive forces that, hindering society and citizens, seek to "freeze" the post-Soviet extensive economic model, which is based on the exploitation of natural resources: fuel, iron ore and other

minerals, forests, fertile soils, water, etc. Responsible business realizes that a successful Ukraine is possible, according to economic laws, only in case of integration with the international economic system and the European economic space.

The Council of the European Union has approved a directive that prohibits the manufacture of certain single-use plastic products in the EU, for which there is an alternative [12] . It is noted that this is the final stage of the procedure for the adoption of the relevant directive, which was previously voted for by the European Parliament. One of the main goals of this directive is to reduce the amount of plastic waste generated by society. According to the new rules, single-use plastic plates, cutlery, drinking straws, balloon holders and cotton buds will be banned by 2021 [12] .

According to the directive, by 2029, 9 out of 10 used plastic bottles should be collected as sorted waste [12] . By 2025, plastic bottles available for sale should also contain at least a quarter of material suitable for recycling, and by 2030 – 30% [12] . There is also the possibility of prosecuting manufacturers of plastic products and involving the tobacco industry in reimbursing funds for the disposal of cigarette butts.

Table 5.3

Packaging waste management in 2030.

Type of waste	***The rate of recycling in Ukraine today***	***Goal by 2030***	
		According to the National Strategy	**According to Directive 94/62/EC**
Waste in general	12-14%	65%	70%
Glass	15–18%	75%	75%
Paper	22–25%	75%	85%
Metals	1%	75%	80%
Aluminum	3-5%	75%	60%
Plastic	10-12%	60%	55%
Tree	3-5%	65%	30%

Source: constructed by the author based on [66]

The implementation of the system of extended producer responsibility (EPR) in Ukraine is an effective way to solve the problem of waste and environmental pollution, an effective step for the implementation of a closed-loop economy [3; 109].

Extended producer responsibility is one of the principles on which the National Waste Management Strategy is based. According to its provisions, product manufacturers are responsible for accepting returned products and waste left after use, as well as for further waste management and financing of such activities [66]. Special measures in the field of household waste envisage the implementation of some economic instruments. In particular, the implementation of the scheme "pay for what you throw away" [93], mechanisms for implementing the principles of "polluter pays" and "extended producer responsibility". An effective and cost-effective system of collection and removal of household waste should be created, which will cover the population as much as possible, and separate collection and responsible handling of individual hazardous components of this waste should be introduced as a link in schemes of extended responsibility of the producer [3; 93; 109]. The strategy envisages that producers and importers will fulfill obligations regarding [93] collection and processing of household waste components independently and/or through the organization of extended producer responsibility, and/or by paying an environmental tax. It is planned to implement RBB for individual

The globalisation and social transformation processes have increased the priority of preservation of the environment and, therefore, Ukraine must take immediate steps. For a long time, the country's economy has been developing with unbalanced use of natural resources and low priority of environmental protection making balanced (sustainable) development impossible.

components of household waste [93]. Provided full implementation of the RBB principle for packaging waste, it is possible to implement a "pledge-return" system [93] for beverage packaging waste, in particular glass bottles. In the field of specific types of waste, it is envisaged to develop a draft law "On packaging and packaging waste" in accordance with Directive 94/62/EC of the European Parliament and the European Council "On packaging and packaging waste" of December 20, 1994 [93] and the best European practices. The issue of handling packaging waste should be regulated exclusively by laws. The development of competition will be ensured in the field of packaging waste management. Any monopolies in this area are prohibited. Requirements for the separate collection and storage of packaging waste are established based on EU best practices and specific local rules and regulations. The strategy envisages the determination of the standards of preparation for the reuse and recycling of packaging waste, which must be fulfilled by manufacturers and importers. By the end of 2030, at least 65% of packaging waste in general should be prepared for reuse and recycled. The minimum target indicators of preparation for reuse and recycling of various types of materials contained in packaging waste are as follows: 60% – for plastic; 65% – for wood, 75% – for ferrous metals, aluminum, glass, paper and cardboard [66]. Therefore, the role of RBB as an organizational and financial tool in achieving such high standards of packaging recycling can be the main or very important [66].

The manufacturer can assume individual responsibility. However, mostly producers act collectively - **by establishing an Extended Producer Responsibility Organization (ERRO)** , which works on behalf of producers of goods and creates incentives, including financial ones, for the separate collection, sorting and processing of packaging waste and other goods that end up in waste.

On December 2, 2015, the European Union published the Action Plan for the transition to a closed-cycle economy – an economy where the generation of waste should be reduced to a minimum, and the reuse of resources, raw materials and materials should be maximized. Separate collection and extended producer responsibility are the basis of a closed-loop economy [74]. Currently, extended liability organizations have been established in 26 EU countries, only 2 countries do not have such organizations yet.

In the countries of the Economic Cooperation Organization, the amount of household waste has stabilized, the amount of recovery of materials from them has increased sharply, landfills have decreased, and the amount of incineration of such waste is not increasing. These positive trends occur during GDP growth in 1990–2014.

In 2018, expenses for environmental protection amounted to UAH 34,392,270.3, including [112]:

- waste management - UAH 10,012,249.3;
- import of waste as secondary raw materials – 97.5 million dollars. USA.

The infrastructure of the solid waste market of Ukraine is completely insufficient for the implementation of a comprehensive approach to the implementation of the inclusive circular economy policy:

- 1 waste incineration plant;
- 3 waste incineration plants;
- 26 garbage sorting lines;
- 6,000 landfills and landfills and more than 35,000 illegal landfills;
- 1,181 cities where separate collection of solid waste has been implemented;
- 33 biogas plants;
- 1,186 number of enterprises in the field of solid waste management;

- about 17,500 employees in the field of solid waste management.

According to the Ministry of Regional Development of Ukraine, on average, Ukrainians annually throw away about 10 million tons of household waste, of which:

- 93.8% are taken to landfills and landfills;
- 4.2% are processed.

In 2018, Ukraine accumulated more than 421 million tons of waste, of which 9 million tons were household waste. Separate collection of solid waste was implemented in 1181 settlements, that is, only 4% of their total amount [33.34]

The following traditional ways of waste management can be singled out. **The first and oldest** is *burial*. This method is an anti-environmental option. Toxic infiltration waters are formed, methane enters the atmosphere, which contributes to the formation of the greenhouse effect. There are a total of 6,000 official landfills and landfills in Ukraine, and more than 35,000 unofficial landfills. In total, only 53% of garbage is sent to legal solid waste landfills in Ukraine, 44% rots in illegal landfills. Legal landfills occupy an area of about 10,000 hectares, spontaneous landfills - about 2,000 hectares. Their total area is 12,000 hectares (one and a half times more than the area of Chernihiv). The area of Ukraine is about 60 million hectares. The number of overloaded landfills is 256 units. (4.2%), and 984 units. (16%) do not meet environmental safety standards. The certification and reclamation of landfills is carried out improperly. Out of 1,991 landfills requiring certification, 157 were actually certified in 2018. (requires certification of 30% of landfills from their total number). Out of 543 landfills that need reclamation, 74 units were actually remediated. (7.7% need reclamation) [93]. The need for the construction of new

[33] 460 cities operate in Ukraine; about 500 districts; 885 urban- type settlements; 28,388 villages.
[34] Ukrainian industrial and ecological association for procurement and use of secondary material resources "Ukrvtorma".

landfills is more than 421 units. Due to an improper system of solid household waste management in settlements, mainly in the private sector, 26,600 unauthorized landfills covering an area of 0.75 thousand hectares are discovered every year [108] .

The second method is *burning.* When burning solid waste, it is possible to reduce their volume and obtain a certain amount of energy. However, factories pollute the atmosphere, and ash involves disposal. Out of 5 waste incineration plants in Ukraine, there is a processing center in Kyiv – the **"Energia" plant,** which can:

- dispose of about 250,000 tons of solid waste per year;
- produce up to 220 thousand gcal of heat.

At the same time, there are about 2.5 thousand waste incineration plants in the world.

Therefore, according to the level of MSW incineration in different countries, Denmark and Switzerland occupy leading positions (Fig. 5.4.) – 80% is incinerated to obtain the necessary energy. It is followed by Japan – 70%, Belgium and Sweden - 50% each, Austria, Italy and France - 40%, Great Britain and the USA - 17%, and Ukraine - 3%. In particular, Table 5.4 shows that the share of incinerated and disposed waste in the total amount of generated waste as of 2018 was 29.7%. The target benchmark set for 2020 is 35%.

Table 5.4

The share of incinerated and utilized waste in the total amount of generated waste, %

The target benchmark set for 2020 is 35.0				
	2015	2016	2017	2018
The share of incinerated and utilized waste in the total amount of generated waste, %	30.0	29.0	27.6	29.7

Source: based on [72]

The third method is sorting and recycling. This is an important method that is the most ecological option. It is profitable to process solid waste into secondary raw materials, paper, glass, plastic, aluminum, non-ferrous metals, etc.

According to the State Statistics Service of Ukraine, in terms of the number of waste management facilities, specially designated places and waste disposal facilities at the end of 2017 [72] (Fig. 5.5), the most problems arose with facilities (the smallest number) for burning waste for the purpose of thermal processing. In second place are installations (the smallest number of them) for burning waste for the purpose of obtaining energy, as well as installations for disposal [72].

It should be noted that today there is no other method of recycling than heat treatment of garbage. The Scandinavian countries at one time established such processing to determine how much energy is needed in general to heat a home in 8-9 months at a low ambient temperature. That is why these countries are currently leading in terms of the effectiveness of circular economy implementation. They only found out how much potential fuel is needed in general to heat, for example, a city.

Such measures make it possible to simultaneously solve the issue of landfills - places where garbage is buried. In Ukraine, the problem of landfills practically remains unchanged from 2011 to 2017. However, it is worth noting that landfills will continue to function, so it is incorrect to claim their absence. In this case, it can only be about correct inert burials.

With this in mind, we note that burning garbage is unprofitable, it needs to be processed to obtain solid waste, i.e. recycled material. Therefore, the circular economy helps to reduce the amount of resource use. In this case, however, there is no single correct solution, as the quality of recycled plastic,

for example, decreases. It is also worth noting that at the human level it is not about sorting garbage, but about separate collection of waste (if any).

Yes, the data in fig. 5.7 it is confirmed that from 2011 to 2017, the volumes of waste incineration for the purpose of obtaining energy increased by one and a half times. Since 2013, only incineration has been practically absent, which is a positive point. The increase in the amount of compostable waste is also very important.

If we determine the potential solutions in this situation for Ukraine, we have several such options:

- cheap burial;
- construction of waste processing plants;
- increase in environmental taxes.

Although experts offer a better option: pay money for processing when buying a certain product, and then receive it from retailers. Therefore, the necessary amount must be included in the price of the product in advance.

As evidenced by the data of the State Statistics Service of Ukraine for 2016, they currently operate with very limited information on such categories as waste generation and disposal. The necessary terminology **is not legally defined** and this problem is still unresolved. Accordingly, under the conditions of the implementation of the circular economy, the question remains open as to why waste processing facilities are not being built in Ukraine. Scientists believe that due to the impossibility of ensuring a constant and uninterrupted supply of recycled materials.

In particular, table 5.6 shows waste management **by region.** So, those that are disposed of are mostly seen in the Dnipropetrovsk, Zaporizhzhia, Poltava and Kirovohrad regions. The least amount was disposed of in *the Transcarpathian region, the city of Kyiv, Odesa, Rivne, and Kherson regions*. At the same time, the least amount of energy was burned in *the Ternopil, Zakarpattia,*

Chernivtsi, Khmelnytskyi, and Chernihiv regions. Most of the waste was burned in *the city of Kyiv, Ivano-Frankivsk, Kharkiv and Rivne regions.*

Table 5.5.

Waste management by region in 2018

	Disposed of	*burned*	*Removed to specially designated places or objects*
Ukraine	**103658.1**	**1028.6**	**169523.8**
Vinnytsia	481.7	58.4	913.6
Volyn'	118.6	21.2	234.3
Dnipropetrovsk	***85056.3***	***26.1***	***104550.5***
Zhytomyr	48.9	44.1	199.5
Zakarpattia	0.4	6.0	179.8
Zaporizhzhia	***3325.8***	***52.4***	***1568.1***
Ivano-Frankivsk	553.0	122.3	1005.5
Kyiv	33.8	21.5	1348.4
Kirovohrad	**1854.6**	**26.5**	**35743.6**
Lviv	354.5	46.0	1188.9
Mykolayiv	61.2	28.6	2005.2
Odesa	9.2	54.6	524.7
Poltava	**2771.7**	**45.5**	**1325.9**
Rivne	23.2	61.6	206.2
Sumy	198.0	21.1	518.4
Ternopil'	240.7	4.4	29.4
Kharkiv	285.0	69.2	861.8
Kherson	33.4	23.9	68.9
Khmelnytskyy	500.9	10.1	264.5
Cherkassy	787.3	16.7	281.8
Chernivtsi	91.1	8.3	216.3
Chernihiv	109.8	14.0	291.4
Kyiv city	2.1	212.1	474.2

Source: based on [72]

So, for example, paper processing requires 100 tons of secondary raw materials per day, which is impossible under the current circumstances, i.e. without ensuring a constant supply, and first, proper separate collection of paper waste. However, it is worth remembering that 20% of the total volume of recycled materials will be residues, so at the same time you need to think about how to deal with them.

Table 5.6

Generation and utilization of waste by categories of materials in 2016.

	Formed	*Disposed of*	*Burned for energy*
That's all	**295870.1**	**84630.3**	**1035.3**
Used solvents	1.1	0.1	–
Waste acids, alkalis or salts	278.6	77.4	–
Used oils	14.0	22.1	0.2
Chemical waste	940.7	4.8	0.0
Sediment of industrial effluents	**3919.8**	**1019.3**	0.0
Sludge and liquid waste of sewage treatment plants	838.3	9.4	–
Medical and biological waste	0.7	0.1	–
Waste of ferrous metals	**3706.0**	**3272.7**	–
Waste of non-ferrous metals	23.5	4.8	–
Mixed waste of ferrous and non-ferrous metals	10.4	1.4	–
Glass waste	25.8	1.8	0.0
Paper and cardboard waste	184.5	47.8	0.0
Rubber waste	20.3	5,6	0.0
Plastic waste	51.9	51.4	0.0
Wood waste	933.8	58.3	381.5
Textile waste	18.8	1.1	0.4
Waste containing polychlorodphenyls	0.1	0.0	–
Unsuitable equipment	10.8	0.9	0.0
Unsuitable vehicles	2.0	0.1	0.0
Accumulators and battery waste	4.0	33.4	–
Animal waste and mixed food waste	990.6	315.1	0.0
Waste of plant origin	8606.0	3158.4	392.3
Animal excrement, urine and manure	4288.7	3146.9	–
Household and similar waste	6946.2	6.5	257.3
Mixed and undifferentiated materials	9429.1	1390.3	0.2
Sorting remnants	81.9	186.0	0.1
Normal sediment	693.6	406.2	–
Mineral waste of construction and demolition of objects, including mixed construction waste	822.5	222.5	0.0
Other mineral waste	225883.5	57016.1	3.3
Combustion waste	13829.9	4150.6	0.0
Soil waste	501.7	87.1	–
Empty rock from dredging works	12500.1	9930.6	–
Solidified, stabilized or vitrified waste; mineral waste generated after processing	311.2	1.5	–

Source: built by the author based on data from the State Statistics Service [72]

The data of fig. 4.8. reflect this problem, since as of 2016 (the latest official data) by categories of waste in all points, their generation exceeds disposal. The most problematic are combustion waste, household and similar waste, and waste of plant origin.

Yes, there is only one old waste processing plant operating in Ukraine today, and there are also those that stopped functioning because they were unprofitable due to a violation of the supply of recycled materials. So, we are talking about certain circular imbalances. It is also not worth comparing Ukraine with individual European countries, which at one time had the following circular imbalances: 1) institutional; 2) infrastructural; 3) expert; 4) economic. However, strict legislation and high environmental taxes have served their function, as has the awareness that safe recycling ensures a safe residue. This is the goal of the circular activity of waste processing plants.

Along with this goal, it is necessary to implement comprehensive measures in the direction of overcoming circular gaps. Ukraine has a sufficient number of capacities for the processing of packaging waste in the event of the adoption of Draft Law No. 4028 "On Packaging and Packaging Waste". As shown in the diagram, the available capacities for processing secondary raw materials are underutilized. These capacities can be quickly increased if needed. In addition, domestic processing enterprises are forced to import hundreds of thousands of tons of waste paper.

So, even with the introduction of packaging waste collection norms provided by the Draft Law "On Packaging and Packaging Waste", there are enough enterprises to process packaging waste. Accordingly, the lack of processing capacity cannot be an argument against the implementation of separate collection and RRV. Production capacity for waste processing at the current stage is as follows: PET bottles (about 20 enterprises), secondary

polymers (about 40), paper (15), glass (15), metal (16). Such processing enterprises are located fairly evenly across the territory of Ukraine.

For example , in order for a consumer to be able to drink 330 ml of a drink, several industries in several countries must work. In general, this process can be paid as follows. In Australia, where there are significant deposits of bauxite, raw materials necessary for the production of aluminum are extracted from the earth's bowels. At the first stage, natural raw materials undergo purification and enrichment, as a result of which **500 kg of bauxite** and **500 kg of waste are obtained from each ton of ore** . Bauxite is loaded into ore trucks and shipped to Sweden, Norway and other countries where it is possible to get cheap electricity. At specialized enterprises, 250 kg of aluminum is obtained from 500 kg of bauxite in the form of massive ingots, which are then heated to 500°C and rolled to a thickness of 3 mm. At the next stage of processing by cold rolling, the thickness of the obtained sheets is reduced to 0.3 mm and cans with lids are stamped from them. They are washed, painted, the necessary information is applied, varnished, a protective coating is sprayed on the inner surface and the edge is bent. At the soft drinks factory, they are once again washed, cleaned, and only then are they filled with products and sealed.

Then the cans are placed in a special cardboard or plastic container and sent to the retail network, where they sell out in an average of 3 days. A few minutes are enough to drink such a can of drink. After that, 84% of cans are thrown into the trash. As a result, the total volume of waste in the production of cans is 88%.

In addition, it is worth adding to them the waste generated during the manufacture of cardboard; beet growing and sugar production; extraction and production of other beverage components; harmful gas emissions and waste

water accompanying the described process at all stages. The same situation is typical for all products without exception (Fig. 5.4).

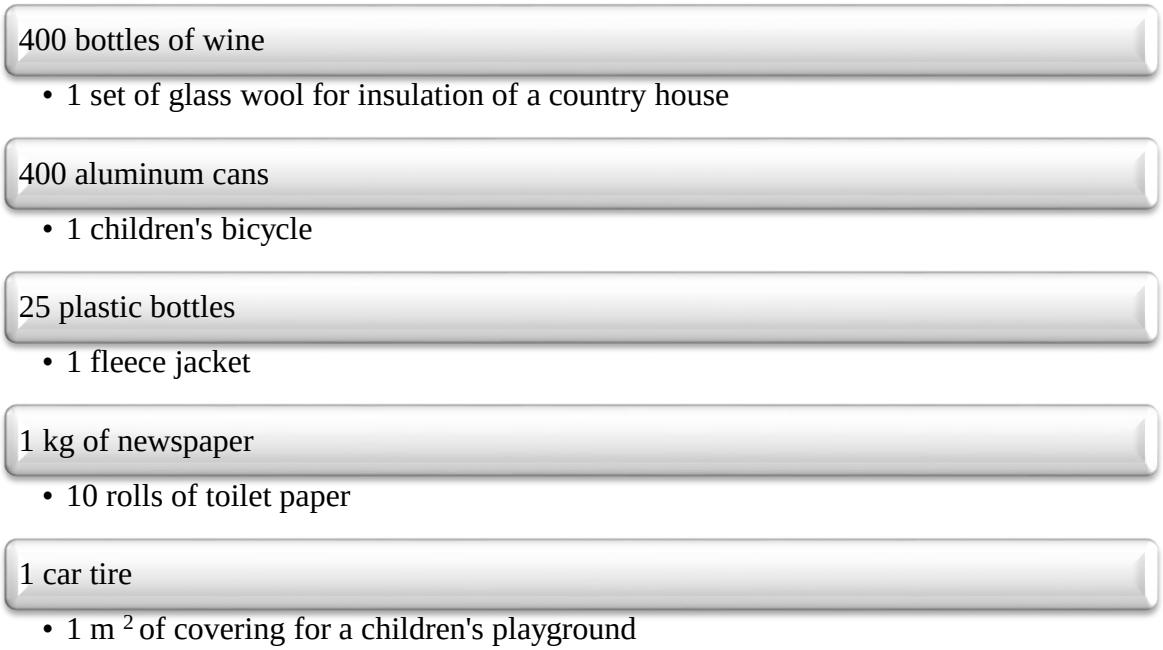

Fig. 5.4. **Practical possibilities of waste processing**[35]

Source: constructed by the author

It is estimated that approximately:

- 600 thousand tons of polymers;
- 770 thousand tons of glass;
- 550 thousand tons of textiles;
- 1.1 million tons of waste paper;
- 550 thousand tons of metal.

At the same time, 20% of aluminum, 33% of iron, 50% of lead, and 44% of copper are extracted from secondary raw materials in the USA, Germany, Japan, and France. Only in the USA, MSW processing annually provides a profit of more than 2 billion dollars. Taking into account that the disposal of 1 million tons of waste paper makes it possible to preserve 60 hectares of forest, and the processing of 120 tons of tin cans - to obtain 1 ton of tin and avoid the

[35] "Ukrvtorma" Ukrainian industrial and ecological association for procurement and use of secondary material resources.

extraction of 400 tons of ore from the depths of the earth, it is obvious that recycling is the safest way of human development in waste management.

Main **types of waste**:

- metal is the simplest raw material for processing. Garbage should be collected, metal parts should be separated, ferrous metals from non-ferrous metals, remelted and they can be further used in production. The metal melts without any damage and can be reused. Only radioactive metals cannot be processed. Their disposal is specialized;
- it is unacceptable to burn car tires. The smoke released during burning is poisonous. Car tires are processed in the following way: they are crushed into crumbs, which are used to create road surfaces, split, obtaining artificial oil, gases or raw materials for metallurgy. This raw material is processed in any form;
- packaging of the company "Tetra Pak". This is a special type of recycled material. Its processing requires much more costs compared to single packaging. There are at least two processing technologies: "wet" and "dry".

Processing of multi-layer packaging in the "wet" way (a process similar to waste paper recycling) is carried out as follows: separation of cellulose fiber from polyaluminum in a hydrodisintegrator (sometimes to disinfect product residues, it is necessary to increase the temperature in the hydrodisintegrator, increase the time for swelling or add chemicals); washing, cleaning of fiber and production of new cardboard; production of granules from the remaining polyaluminum mixture. Processing of multi-layer packaging in the "dry" way takes place as follows: loosening/splitting of the packaging; separation of cellulose fiber from polyethylene/aluminum flakes using a cyclone.

The following packaging processing enterprises of the company **"Tetra pak" operate in Ukraine**:

- "Zmiyiv Paper Factory" LLC, Kharkiv Region. (the capacities make it possible to recycle more than 1,000 tons of waste per month);
- MPP "Rada", Kyiv region. (partially valid)

Alternative fuel RDF (refuse derived fuel) or solid secondary fuel is fuel obtained from waste residues. RDF contains high-calorie components of waste, such as plastic, paper, cardboard, textiles, rubber, leather, wood, etc. Calorific value of RDF is 15±19 MJ/kg.; the size of the RDF grain is ~ 20–25 mm.; the content of dangerous components in the fuel is strictly controlled and does not exceed permissible standards. RDF can be used as the main or additional fuel in the furnaces of cement plants, CHP plants, and metallurgical furnaces.

The feasibility of using RDF/SRF is determined by: logistics, the distance from the fuel producer to the cement plant.

The complexity of using RDF/SRF is determined by:

- lack of appropriate legislation in Ukraine;

- the uncertainty of the terms of transfer (sale) of fuel to cement factories.

Table 5.7.

Capacities for processing separately collected waste as of 2018.

The number of enterprises engaged in the processing of secondary raw materials	Wastepaper	Polymers	pet bottle	glass breaker
	20	39	15	17
Production capacity, thousand tons	1200	260	77	800
Capacity utilization, %	92	65.4	65	60.2
Import, thousand tons	392.3	53.4		32.5
Stock, thousand tons	712.2	116.6		449.5
Load capacity, thousand tons	1104.5	170	50	482

Source: according to the data of the Ukrainian industrial and ecological association for procurement and use of secondary material resources "Ukrvtorma".

Table 5.8

Geographical location of enterprises processing secondary polymers, including PET (number located in the region)

City	Number
Lviv	3
Kyiv	17
Chernihiv	1
Sumy	1
Kharkiv	6
Dnipro	7
Zaporizhzhia	1
Kherson	1
Odesa	3
Kropyvnytskyi	2
Cherkasy	1

Source: based on [72]

Significant **consequences of climate change** are increased risks [106]:

- for human health, related to almost all manifestations of climate change;
- a significant decrease in yields of the main agricultural crops as a result of increased droughts and the penetration of previously uncharacteristic pests and pathogenic diseases of agricultural plants, as well as due to other extreme weather phenomena;
- aggravation of water supply problems in the southern and southeastern regions, which suffer from drought in the summer and where the population is least provided with drinking water of adequate quality;
- increased land degradation and desertification due to the rapid pace of climate change;

- decrease in productivity, viability and stability of forests in conditions of significant water stress, which increases the probability of fires and outbreaks of mass reproduction of dangerous pests;
- accelerated degradation of ecosystems;
- the occurrence of accidents and unstable functioning of electrical networks and centralized heat supply systems, other infrastructure objects [106] .

In the long-term perspective in Ukraine, **adaptation to climate change** will be considered with the same degree of priority as climate change prevention, and will cover aspects of planning and policy improvement for expanding the knowledge base, scientifically based definition of needs and expenditures, implementation of innovative approaches and creation of conditions for attracting foreign investments.

Activity history of Ukraine in international processes of combating climate change [87; 88; 89; 105; 106]:

- a party to Annex I to the UNFCCC since 1997 [106] ;
- a party to Annex B to the Kyoto Protocol since 2004 [106] ;
- first place in the world in terms of the number of joint implementation projects (250 projects); 47 million units were issued. the set amount of GHG emissions under the scheme of targeted "green" investments during 2008-2012 within the framework of the Kyoto Protocol [106];
- an active participant in the negotiation process within the framework of the UNFCCC;
- defined obligations related to climate change, according to the Association Agreement between Ukraine and the EU (2014);
- party to the Paris Agreement (2016).

According to the Low-Carbon Development Strategy of Ukraine until 2050, as of 2017, the **following periods can be distinguished in the general trend of GHG emissions** [106]:

1) a sharp decrease in the volume of GHG emissions in 1990–1999, which is associated with the collapse of the USSR and the adaptation of the Ukrainian economy to new conditions. In addition, there was a significant decrease in GDP in the country [106];

2) stabilization and restoration of economic growth in 1999–2008, characterized by relative stability of economic development and an increase in the GDP indicator. The trend of the dynamics of GHG emissions does not reflect GDP growth, since structural changes in the economy are taking place during this period [106] . This is due to the growth of the role of trade, services, and the financial sector compared to the growth rate of industrial production;

3) the decline and gradual recovery of GHG emissions in 2008–2012, which was significantly influenced by the global financial and economic crisis. In particular, export-oriented industries - metallurgy, chemical industry, mechanical engineering, as well as related industries - electric power and mining industry were most affected;

4) negative dynamics in the industry of Ukraine in 2013–2015, which formed 21–23% of GDP. Almost all industries have reduced production volumes. The only branch of industry that showed positive growth rates was the production of pharmaceutical products [106];

5) gradual growth of the economy of Ukraine, starting from 2016, due to structural reforms.

The heaviest GHG is CO_2. Its share in emissions during 1990–2015 was 65–75%, the share of methane varied between 21–33%, and N_2O – 6–8%.

The fight against climate change is ***a global challenge*** that requires broad international cooperation, the global consensus on which is expressed by the following successively concluded international agreements: the UNFCCC, the Kyoto Protocol, the Paris Agreement. Considering that with the help of the tools provided by the first two agreements, it was not possible to achieve a significant reduction of GHG emissions, 195 countries of the world, including the main powerful economies, concluded the Paris Agreement, which entered into force on November 4, 2016.

The reform is aimed to prevent the adverse impact of climate change, adapt to climate change and preserve the ozone layer by improving public policy for achieving the county's sustainable development, creating legal and institutional prerequisites for the gradual transition to low-carbon development together with economic, energy and environmental security and improving people's welfare.

In accordance with the goal of limiting the increase in the global average air temperature below 2°C from the pre-industrial level, the parties to the Paris Agreement must balance the sources of GHG emissions and absorption in the second half of the 21st century. or actually achieve net zero global GHG emissions by 2100.

The goals of Ukraine's SNVR correspond to the global goals of the Paris Agreement, and joint international actions will be crucial for their achievement. International cooperation will help significantly reduce the costs of decarbonization and create economic opportunities for people and businesses, while reducing the risks and consequences of climate change [87; 88; 89; 105].

In Ukraine, the energy intensity of the GDP on the basis remains extremely high compared to the developed countries of the world. In 2015, the

energy intensity index of GDP in Ukraine (according to purchasing power parity (PPP) and in 2010 prices) was 2.2 times higher than the corresponding global indicator, 2.6 times higher than the indicator of the OECD group of countries, and 3.2 times higher than the indicator of the 28 EU countries [77; 78; 80; 82; 83; 90; 91].

Table 5.9.

Foreign direct investment in the economy of Ukraine in January-June 2019 in waste processing.

	01.01.2019	*07/01/2019*
Great Britain	20,487.2	20,530.5
Germany	17,100.3	16,979.7
Poland	201.5	207.7
USA	691.3	713.1
Virgin and British Islands	160.7	170.0
Turkey	2,092.3	61.9
Cyprus	8,684.0	8,718.8
Hungary	1 148.0	1 144.4
Russia	259.7	261.1

Source: constructed by the author on based on [72]

According to the Federation of Automobile Industry Employers, the Nissan Leaf remained the most popular electric car in Ukraine in 2019, controlling half of the market. The relatively cheap vehicle, which is largely imported from the US, is a favorite of EV seekers on a budget and makes up a quarter of all EVs purchased by Ukrainians. Vehicles up to a year old and less than a year old make up 7 and 6% of the market, respectively.

However, imports of new cars and more expensive segments of the market are growing slowly:

- Nissan Leaf
- Tesla Model S 12.4%
- e-Golf VOLKSWAGEN
- BMW i3 with 6%

- FIAT 500e

The three key conclusions can be drawn regarding electric vehicle registrations [171]:

- More electric cars are registered than hybrids.
- The second and third places in electric car models are now occupied by representatives of TESLA, in general every fifth registered pure electric car of this brand.
- In terms of the total number of registrations of "green" cars in 2019, Lviv Oblast is ahead of Kharkiv Oblast for the second time in a row [171].

5.2. Ways to solve systemic problems of rational use of waste and unused raw materials.

By supporting the global sustainable development goals [11] until 2030 declared *by the United Nations General Assembly resolution* of September 25, 2015 No. 70/1 and the results of their adaptation taking into account the specifics of Ukraine's development, set out in the National report "Sustainable Development Goals: Ukraine", to ensure compliance with the Sustainable Development Goals of Ukraine for the period up to 2030 President of Ukraine V. Zelenskyi **from September** 30 2019:

SDG 1) poverty alleviation;

SDG 2) overcoming hunger, achieving food security, improving nutrition and promoting the sustainable development of agriculture;

SDG 3) ensuring healthy lifestyles and promoting well-being for all at all ages;

SDG 4) ensuring inclusive and equitable quality education and promoting lifelong learning opportunities for all;

SDG 5) ensuring tender equality, empowerment of all women and girls;

SDG 6) ensuring availability and sustainable management of water resources and sanitation;

SDG 7) ensuring access to affordable, reliable, sustainable and modern energy sources for all;

SDG 8) promoting progressive, inclusive and sustainable economic growth, full and productive employment and decent work for all;

SDG 9) creation of sustainable infrastructure, promotion of comprehensive and sustainable industrialization and innovation;

SDG 10) reducing inequality;

SDG 11) ensuring the openness, safety, viability and ecological sustainability of cities and other settlements;

SDG 12) ensuring the transition to rational models of consumption and production;

SDG 13) taking urgent measures to combat climate change and its consequences;

SDG 14) conservation and rational use of oceans, seas and marine resources in the interests of sustainable development;

SDG 15) protection and restoration of terrestrial ecosystems and promotion of their rational use, rational forest use, combating desertification, stopping and reversing (reversal) the process of land degradation and stopping the process of biodiversity loss;

SDG 16) promoting peaceful and open societies in the interest of sustainable development, ensuring access to justice for all and building effective, accountable and participatory institutions at all levels;

SDG 17) strengthening the means of implementation and activation of work within the framework of the Global Partnership in the interests of sustainable development [11].

The domestic consumer knows about the so-called "biopackages". It is impossible to find out which of them are actually biopackages, and which are oxo-degradable. There is no mandatory certification and marking. A total of 99.9% of the bio-bags issued at grocery checkouts and bio-bags for trash are not actually "bio" [303] .

From January 1, 2019, the manufacturer can certify its products for biodegradability and compostability. This is possible thanks to the appeal to *the State Enterprise "Ukrainian Research and Training Center for Standardization, Certification and Quality Problems"* by the authors of the draft law on restricting the circulation of polyethylene bags in Ukraine [303].

According to the order, the National Standardization Authority has put into effect the National Standards and their amendments, according to which products can be certified for suitability for biochemical decomposition, composting and biodegradation. National standards are harmonized with European and international standards. This means that products certified in Ukraine will be evaluated according to the same standards as in the EU. The adoption of such standards will make it possible to regulate the use of the term "biodegradable package" and will force manufacturers to necessarily certify this product.

Standards for application:

- DSTU EN 14995:2018 (EN 14995:2006, IDT) Plastics. Evaluation of the ability to biochemical decomposition. Test procedure and technical conditions;
- DSTU EN 13432:2015 (EN 13432:2000, IDT)/ Amendment No. 1:2018 (EN 13432:2000/AC:2005, IDT). Packaging. Requirements for packaging disposed of by composting and biodegradation.

Ukraine can implement the new reality [13] earlier than neighboring countries and gain advantages. The transition from the old linear model of the economy to a circular one involves the creation of new market niches (industrial design, engineering, remanufacturing, processing, service), as well as business models. Ukraine can be an Eastern European hub in this new reality, having joined its formation in the early phase. However, in order to reach such a qualitatively new level of resource efficiency, technological innovations and changes in behavior patterns, large-scale investments and special packages of state incentives will be needed [13].

Among domestic scientists, this issue was studied by A. Bazilyuk, T. Zatonatska, S. Kozhemiakina, and I. Taranenko. In their works, the ideas of prominent foreign researchers lose their original meaning and are "enriched" with the usual set of "directions and recommendations" from inclusive (previously "sustainable", "balanced", "socially oriented", "innovative", etc.) development. Many such studies contain only justification of the importance of inclusive growth as the basis of the socio-economic development of the country through the inclusion of all members of society.

In Ukraine, there is still no strategy for inclusive growth. However, in 1992, the country joined the UN strategic document "Agenda for the 21st Century", [104] concluded international agreements and treaties that oblige the state's management structures to carry out development on the principles of balance, and in 2015 the "Ukraine - 2020" strategy was approved, which provided for the implementation of 62 reforms [113].

The goal of the reforms is to achieve European living standards in Ukraine and a worthy place for Ukraine in the world [103] . Among them, 8 reforms and 2 programs were identified as priorities [92; 103] . The essence of this program document, which should ensure sustainable economic growth, is defined by the words "good intentions". Accordingly, the adoption at the UN

Sustainable Development Summit of 17 global sustainable development goals by 2030 [104] requires the development of a new sustainable development strategy of Ukraine for this period, the draft of which has been prepared today. However, in the project of the Strategy "Ukraine - 2030" the concept of "inclusion" is not given due attention, although in the introductory part there is a definition of the terms "inclusiveness", "inclusive growth", "inclusive society" and "inclusive institutions". However, the essence of these concepts is not revealed in the text. One gets the impression that these concepts are used in the draft law as their native decor promotional element. They are almost always combined with the term "balanced", which in this context is perceived as a synonym for the concept of "inclusive". At the same time, the draft strategy contains many tools and mechanisms for creating an appropriate legal framework for inclusive growth. To evaluate the effectiveness of state policy in this direction, it is necessary to measure the degree of inclusiveness of growth. At the current stage, international organizations have begun the development of methodological recommendations for the calculation of the index of inclusive development. In the methods proposed in the study, an important role is assigned to the effective activity of the government and public institutions, whose policy should be optimized both to create conditions for comprehensive participation in the production of GDP, and to eliminate inequality in the distribution of the created product [92].

Climate change and the depletion of the ozone layer are among the major challenges of the world development posing potentially serious threats to the global economy and international security due to increased direct and indirect risks related to energy security, provision of food and drinking water, stability of ecosystems, risks to health and people's lives.

Ukraine ranks 47th in the IDI rating, which is a much lower indicator of its level than it was five years ago. Prolonged hostilities in the east of the country nullify the effect of existing progress, as this situation negatively affects the least well-off sections of the population and encourages talented people to leave the country in search of better opportunities. Ukraine also has one of the highest indicators of inequality of well-being among all developing countries (according to the World Bank, our state belongs to the group of developing countries) [99]. However, in general, the indicators of income inequality and poverty in Ukraine, according to the evaluation data, which is a positive factor for its development, are not very high. The analysis confirms that the domestic education system supports inclusive growth with a fairly high level of opportunities for students from different socio-economic strata of the population [99]. Compared to other states of the group of developing countries, the middle class in Ukraine, although less well-off than in developed countries, is quite numerous, and the system of health care and assistance to the unemployed determine its primacy in the group in terms of income and level of social protection [134; 135].

The development priorities should be the improvement of professional training, reduction of the administrative burden when creating a new business, expansion of financing for entrepreneurs, as well as strengthening of the fight against corruption [366]. For rapid economic growth, Ukraine needs to reorient itself and change its philosophy of thinking through the implementation of a global inclusive circular economy (inclusive-circular business models), that is, to overcome a kind of circular gap.

The term **"absolutely imperfect" ("Perfectly imperfect")** Sh. Engelen (Fig. 5.15) reflects the situation with the positioning of food in the circular chain of Ukraine. Yes, only food that looks perfect is sold in the EU, and products that do not pass certification are usually used for socially inclusive purposes.

However, the situation in Ukraine can be resolved in a different way, according to its realities [153].

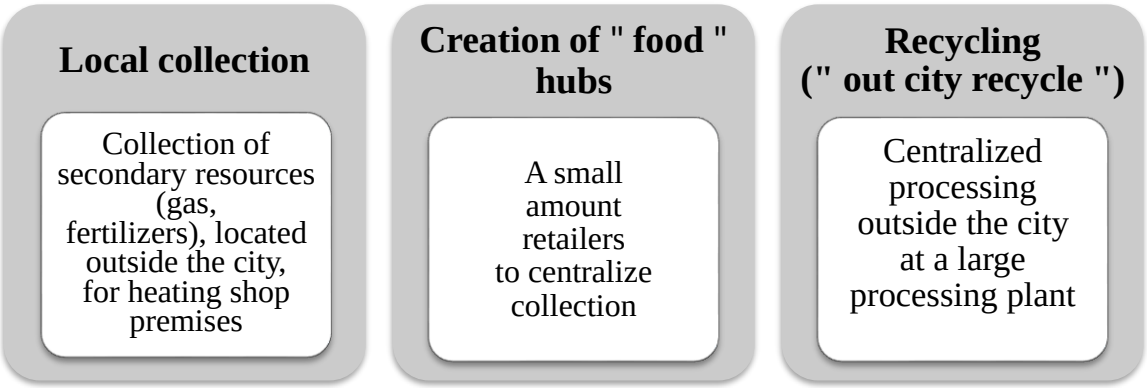

Fig. 5.15. **Directions for solving the issue of consumption in the circular chain**

Source: constructed by the author

Global circular economy is implemented during the following four main stages aimed at overcoming the gap (gap) of circularity:

- creation of a global circular coalition of countries of the world with a common philosophy and mandatory participation of Ukraine;
- development of a global goal and order of action;
- global goals – local actions;
- circular systems.

Scientists singled out **four main reasons** for the slow implementation of the ideas of the full-cycle economy:

1) society is increasing the stock of rare materials, mainly rare earth metals, necessary for the manufacture of the latest innovative and complex products;

2) the economy of developing countries, as before, is aimed at accumulating a stock of active resources and building environmental infrastructure;

3) technical capabilities are insufficient to completely close the cycle, and in many processing processes there are still losses in the quality and quantity of material;

4) some materials, including minerals, may be available only in certain geographic regions.

According to M. Saprykina, head of the Center "Development of Corporate Social Responsibility" and an expert on sustainable development, the EU is discussing the need to develop a long-term food strategy and create a network of public purchases to share experience [59].

In general, more than 20% of Europeans suffer from obesity, and approximately 700 billion euros are spent annually on the treatment of this diet-related disease.

However, man consumes what he grows. In the EU, more than 11% of soils are prone to erosion. The cost of measures aimed at eliminating the consequences of this phenomenon and preventing their occurrence in Europe is 3% of the global GDP. In addition, the food industry and agriculture generate 30% of CO_2 emissions and a lot of food waste.

To overcome these challenges, start-up companies are created. The Swedish KITRO conducts research to obtain information about which food is most often thrown away. Scanning leftover food provides detailed data. Accordingly, restaurant managers stop cooking unpopular dishes.

Procurement plays an important role. The municipality of Copenhagen has developed a food strategy, the goal of which is to use 90% of products of organic origin. In 2016, an indicator of 88% was achieved. The strategy involves the implementation of training for kitchen staff (mentors together with students, for example, study information about the seasonality of fruits) and the restructuring of procurement methods. In 2019, the food strategy and tenders were developed based on the goals of sustainable development.

Tenders, for example, include the following SDGs: measuring results and working with contractors to achieve change. With this in mind, training is based on information about products and SDGs, and the Copenhagen community learns how public procurement contributes to the implementation of sustainable solutions [1; 12; 15].

The 3M company emphasized the importance of a scientific approach in making sustainable decisions. According to its strategy, the goals of sustainable development are integrated at the stage of product development. The company has developed a strategic model of sustainable development, covering three areas of scientific activity: circular economy, climate and community research.

Starting in 2019, every product of the company will have a positive impact on sustainable development. As of March 1, 2019, 3M joined the RE100 group of companies that use only renewable energy and urgently transitioned headquarters in 70 markets to fully renewable energy. Responsible business understands the value of sustainable development goals, but appropriate state measures are needed to address this issue. In Ukraine, a national report with indicators of sustainable development goals has been published, but this document does not have legislative force.

Thus, it is proposed to form an integrated circular policy circle with a combination of its necessary directions.

According to the OECD definition, extended producer responsibility (EPR) is an approach within environmental policy, according to which the producer's responsibility for a product extends to the post-sale stage of its life cycle. Thus, product manufacturers are responsible for accepting returned products and waste [66] remaining after the use of such products, carrying out further waste management and ensuring financial responsibility for such activities [16; 60; 66; 73; 109; 379; 380; 381]. The RBB system operates on a non-

profit basis (profit is not intended for distribution). The manufacturer or importer of packaged products is responsible for the packaging of its products throughout its life cycle, including at the stage of circulation, collection and disposal of packaging waste. State authorities play the main role in ensuring that the manufacturer complies with the principles of RBB. For this purpose, there is an appropriate legal framework that ensures control of the implementation of RBB systems. Financial contributions from manufacturers and importers of packaged goods are the main source of funding for RBB systems.

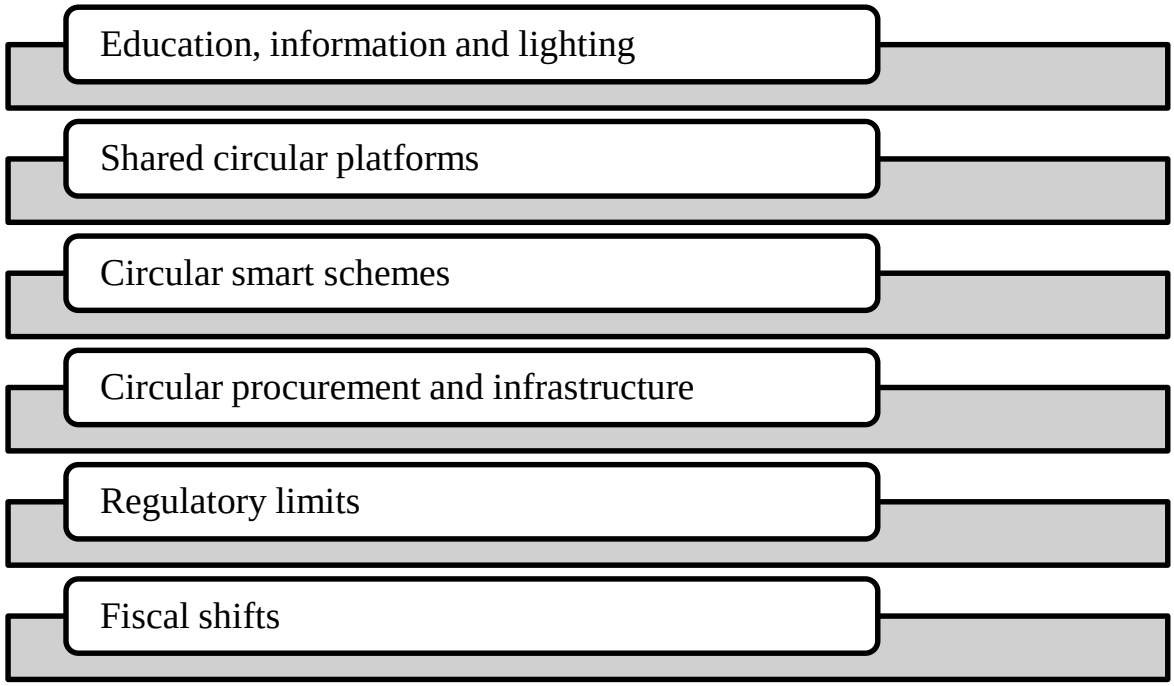

Fig. 5.17. **Directions of state policy for the formation of a circular economic environment**

Source: constructed by the author

In fig. 5.17. directions of state policy for the formation of a circular economic environment are depicted. And one of them is the introduction of so-called fiscal shifts. The procedure for paying the environmental tax in 2020 has not changed and is still regulated by Articles 240 - 250 of Chapter VIII of the

Tax Code of Ukraine (hereinafter - Tax Code) [17] . At the same time, in 2019, there were changes regarding the definition of payers who pay an environmental tax in terms of obligations for emissions of carbon dioxide into the atmosphere by stationary sources of pollution and the size of the rates of this tax, as well as, it is stipulated that payers of the environmental tax must draw up a separate Annex 1 to the Declaration, in terms of obligations for emissions of carbon dioxide under code 19011000 [17].

Table 5.1 0

Tax rates for discharges of certain pollutants into water bodies

The name of the pollutant	*Tax rate, hryvnias for 1 ton*
Ammonium nitrogen	1610.48
Organic substances (according to indicators of biochemical oxygen consumption (BSK 5)	644.6
Suspended substances	46,19
Oil products	9474.05
Nitrates	138.57
Nitrite	7909.77
Sulfates	46,19
Phosphates	1287.18
Chlorides	46,19.

Source: based on [17; 91]

The green tax has been levied on companies that have a negative impact on the environment in Ukraine since 2011. Economic entities that emit polluting substances into the atmosphere, discharge wastewater, dispose of waste (except for enterprises that dispose of waste as secondary raw materials) and generate radioactive waste must pay for it. Enterprises that deal with radioactive waste generated as a result of the Chernobyl disaster are exempt from paying the green tax.

45% of the collected tax goes to local budgets, and 55% goes to the state budget. The total amount of tax revenues will be about UAH 140 million. However, the use of funds in Ukraine is inefficient, and often they are not used for environmental protection activities. Only USD 10.5 million was allocated from the central budget for nature protection measures. USA (from 140 million

from the USA). In particular, USD 6.9 million was allocated to combat the harmful effects of water. The rest of the funds were spent on activities indirectly related to environmental problems. In particular, the situation with the disposal of household waste remains disastrous. According to Ukrtvorma (Ukrainian Industrial and Environmental Association for the Storage and Use of Secondary Material Resources), only 6.6% of household waste was processed and disposed of in Ukraine last year: 2.48% was burned and only 4.18% of household waste was collected by secondary raw material collection points and incinerators. The rest is still being transported to landfills, many of which are in terrible condition. For example, the only Kyiv landfill in the village of Pidhirtsi (Obuhiv district) has been operating for more than 30 years and has long been overloaded.

About 10 million tons of household waste accumulated at the landfill: the height of the garbage bed rose to 90 meters, which is equal to the height of a 27-story building. The leachate lake is also very dangerous because it is a mixture of toxic liquids from the landfill mixed with rainwater. At the moment, about 1 million tons of leachate has accumulated in the lake. In total, Ukraine has 5,500 landfills and landfills with a total area of 8.5 thousand hectares. About 10 million tons of garbage, including hazardous waste, is buried there every year, which is disposed of in landfills, because many areas simply do not have a separate waste collection system. The problem with the disposal of oil waste remains unsolved, a significant part of which is burned in furnaces, polluting the environment with thousands of tons of hazardous substances (nitrogen oxides, sulphur dioxide, methane, formaldehyde, hydrogen chloride, carbon monoxide). According to market participants, up to 40% of oil waste is used for heating in Ukraine. Burning of oil waste is prohibited in Europe.

Table 5.11

Tax rates for pollutant emissions

The name of the pollutant	*Tax rate, hryvnias for 1 ton*
1	**2**
Nitrogen oxides	2451.84
Ammonia	459.85
Sulfuric anhydride	2451.84
Acetone	919.69
Benz(o)pyrene	3121217.74
Butyl acetate	552.23
Vanadium pentoxide	9196.93
Hydrogen chloride	92.37
Carbon monoxide	92.37
Hydrocarbons	138.57
1	**2**
Gaseous fluorine compounds	6070.39
Solid substances	92.37
Cadmium compounds	19405.92
Manganese and its compounds	19405.92
Nickel and its compounds	98872.97
Ozone	2451.84
Mercury and its compounds	103931.28
Lead and its compounds	103931.28
Hydrogen sulfide	7879.65
Carbon disulfide	5120.56
n-butyl alcohol	2451.84
Styrene	17903.89
Phenol	11128.67
Formaldehyde	6070.39
Chromium and its compounds	65822.27.

Source: based on [17; 91]

The benefits of the RBB system for the state and citizens are as follows6 attraction of private investments and new technologies; absence of costs for maintenance and development of separate collection infrastructure for the state; reduction of disposal of household waste; increase in tax revenues due to the legalization of the activities of existing waste collection, sorting and processing operators; development of the field of waste processing and relevant branches of the machine-building complex and the creation of new jobs in these branches of the economy. Separate collection and extended producer responsibility are the basis of a closed-loop economy. According to the terms of the RBB, the manufacturer is responsible for the collection and

disposal of used packaging, as well as goods whose expiration date has passed. In the world, electronics (35%), tires (18%), packaging (17%), vehicles (12%), batteries (12%) and others are under the influence of RBB [16; 60; 73; 109; 379; 380; 381].

In Ukraine, there is actually no system of separate collection of household waste, part of which is packaging waste. Ukraine also lacks a system for handling hazardous waste and waste electrical equipment and batteries. In addition, 94% of household waste is buried in landfills and landfills, there are annual losses of secondary raw materials, and the main reason for this is the lack of relevant legislation. As a result, only 12-14% of packaging waste and 3% of solid household waste are processed in our country, and waste paper imports are 250-350 thousand tons per year. In addition, according to estimates, every Ukrainian produces 300 kg of garbage annually. Due to the lack of a proper garbage and waste processing mechanism in Ukraine, the number of landfills is constantly increasing [63]. In order to improve the situation, it is necessary to improve approaches to waste processing and set prices for these services. In order for Ukrainians to start collecting waste separately, they must have an incentive. For example, if the manufacturer pays for the entire product cycle, the consumer will only pay for their own unsorted waste that cannot be recycled. Therefore, the manufacturer, creating a packaging design and packing commercial products in it, must understand that he ultimately has to pay for the recycling and disposal of this packaging [63].

In order to solve the problems in Ukraine, it is first necessary to introduce extended producer responsibility - a financial and organizational mechanism for ensuring the transition to a closed-loop economy: (a) extended producer responsibility as an effective and economical waste management tool; (b) liability of the manufacturer and importer of goods for the products even after

they have been used; (c) responsibility for introducing separate collection, sorting and preparation of products for further processing or safe disposal [16; 60; 73; 109; 379; 380; 381].

Today, there are several waste strategy centers and different models are considered for different types of waste. However, it is quite difficult to choose the most effective one, since all three models can be used taking into account the experience of their implementation in developed countries, but it is impossible to predict which is more effective - extended liability or a combined model. In order for the extended producer responsibility model to function in Ukraine, it is necessary to spread the practice of separate garbage collection among the country's population; adopt draft laws on waste, which provide for the creation of extended producer responsibility organizations.

So, today in Ukraine, three different models are being discussed, which provide for streamlining the collection and disposal of waste. The first model is based on a combined system of extended producer responsibility for packaging waste, used tires, electrical and electronic equipment waste, used oils (lubricants). The second model provides for the introduction of a tax on the production and import of packaging and goods in packaging and to direct its application to compensation for household waste processing services. The third

The country's poor ability to adapt to the consequences of climate change such as floods, drought, coastal degradation and prolonged periods of abnormal heat, can cause social and economic instability. In the recent decades, climate change and ozone depletion have become some of the world's most pressing economic and political challenges in terms of developing strategies to reduce ozone-depleting and greenhouse gas emissions and gradually move to a low-carbon development path in all economic sectors and aspects of human life.

model proposes to implement the extended responsibility of the producer of containers and packaging through the creation of a non-profit organization of extended responsibility, which will rely on the obligation to fulfill the norms of recycling and disposal of packaging waste.

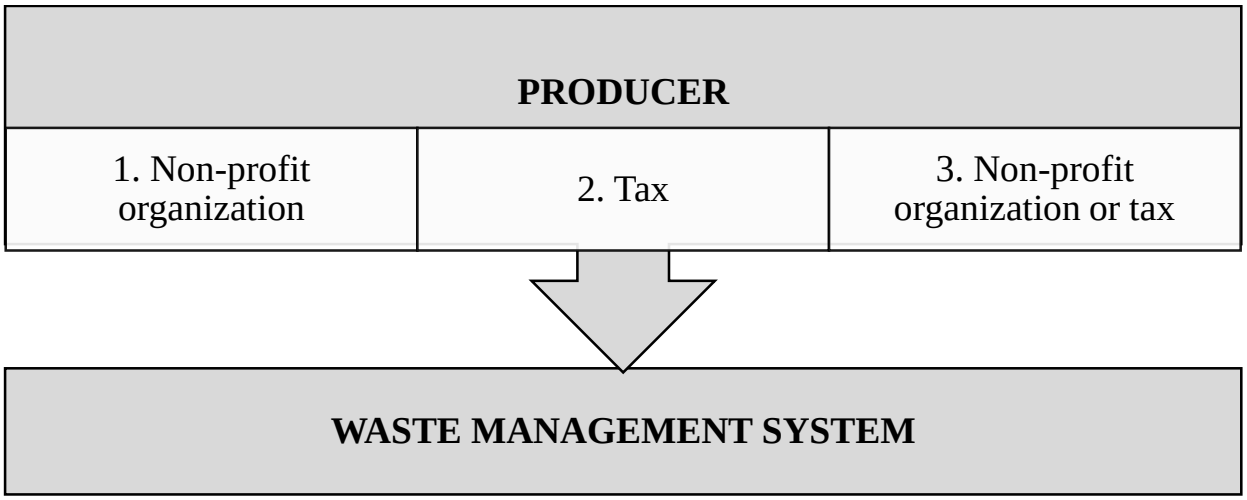

Fig. 5.18. **Models of ordering problems of waste collection and disposal**

Source: compiled by the author based on the materials of the ECOBUSINESS magazine.

Expanding the responsibility of producers and waste sorting is the most optimal option for Ukraine today. However, there is a difference between the concepts of "waste" in general and "packaging waste". Packaging waste, to which the extension of responsibility applies, is 30% of the volume of all waste. Separate collection solves the issue of only secondary raw materials - packaging waste. Solving the problems associated with garbage, i.e. the remaining 70% of the remaining waste, is a matter of recycling, disposal and incineration, for which manufacturers of packaged goods are not responsible. That is why, in addition to the producer's responsibility, a financial incentive for consumers is necessary [16; 60; 73; 109; 379; 380; 381].

There are processing capacities in Ukraine, but they are only partially loaded. Thus, processors of automobile batteries are loaded by 30%, and lamps by 14% . There is a powerful agricultural chemical market in Ukraine. The corporate standards of the main players in this market include taking care of the products they sell and the waste they create. In view of this, responsible

companies for several years conclude contracts with disposal organizations that collect this waste (containers with pesticides and other plant protection products) free of charge and dispose of it. Therefore, the implementation of the extended producer responsibility system in Ukraine is an effective way to solve problems with waste and environmental pollution, an effective measure for the implementation of a closed-loop economy.

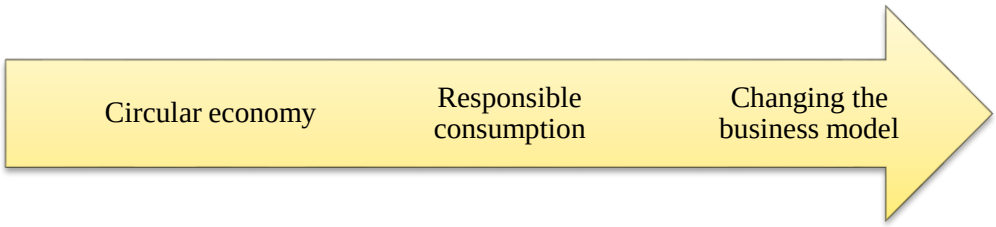

Fig. 5.19. **Necessary steps towards the formation of a circular policy in Ukraine.**

Source: constructed by the author

The framework draft law "On waste management" developed by the Ministry of Natural Resources of Ukraine . It is supported by the EU and is the legal basis for the practical implementation of the provisions of the National Waste Management Strategy until 2030, adopted in 2017 [64; 79; 84; 85; 93] .

In particular, the draft law provides for the introduction of a hierarchy of waste management and extended responsibility of the producer, a system of long-term waste management planning at the national, regional and local levels, the introduction of a waste management information system and the National list of waste, as well as the attraction of investments in this area, the creation of modern infrastructure and the reduction of the number of waste management facilities that do not meet the requirements of the law [79].

According to various estimates, the volume of solid household waste generation in Ukraine amounts to more than 11 million tons (not including the temporarily occupied territories, the Autonomous Republic of Crimea and the city of Sevastopol), [93] and the rate of waste generation in Ukraine on average

reaches 250–300 kg per year per person [72] . To solve this problem, in 2016, the reform of the field of waste management was started. At the end of 2017, with the participation of international experts from EU countries, the National Waste Management Strategy and the Implementation Plan were developed and approved [79]. At the beginning of 2019, the government approved the Plan for the implementation of the National Waste Management Strategy, and in parallel, together with the regional state administrations, the preparation of regional waste management plans - investment plans for each individual region - was started [79].

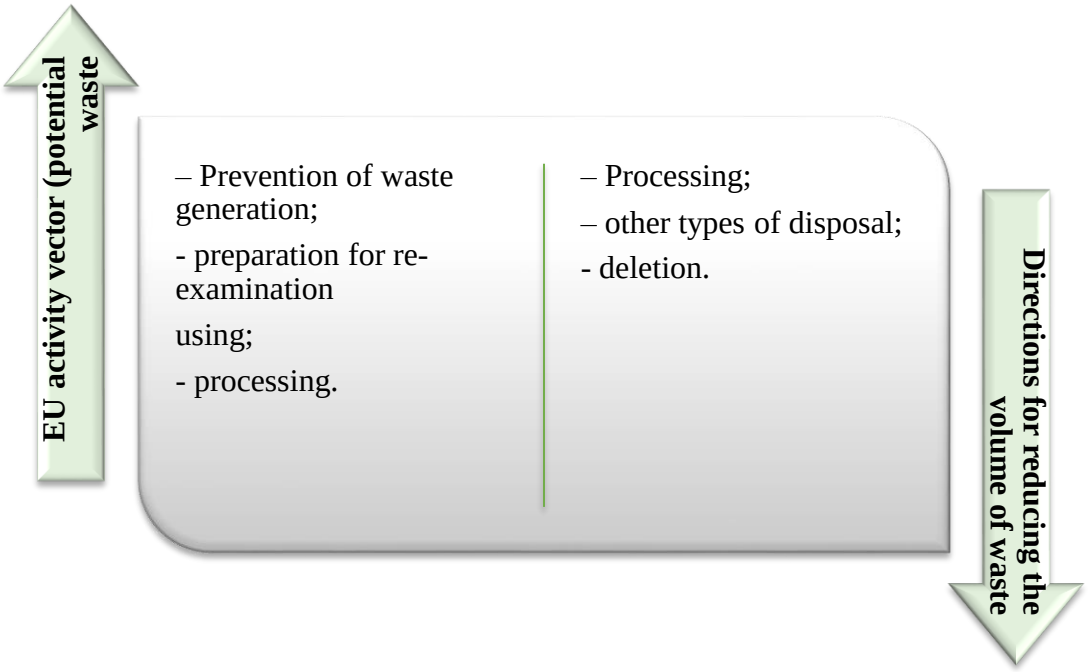

Fig. 5.20. **Vector of the EU's work with potential waste vs directions of waste reduction in Ukraine.**

Source: constructed by the author

Management also required the adoption of a new legislative framework that would enable the implementation of the reform in the field of waste in practice.

In the countries of the Economic Cooperation Organization, the amount of household waste has stabilized, the recovery of materials from them has increased sharply, the volume of landfills has decreased, and incineration is not increasing. Such positive trends occurred during GDP growth in 1990–2014 [5; 61].

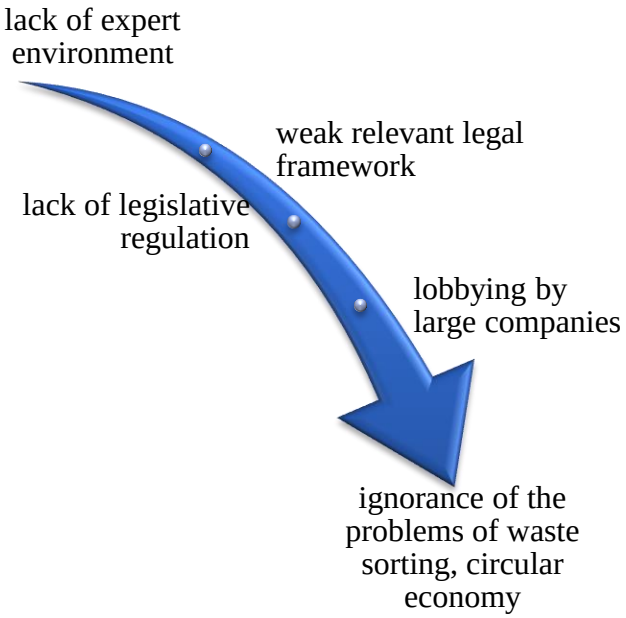

Fig. 5.21. **Key barriers in the adaptation of a circular economic environment in Ukraine**

Source: constructed by the author

When it comes to the circular economy in Ukraine, the focus is mostly on the management of solid household waste (MSW). According to experts, we currently have a "distorted perception by society" of information about solid waste processing. It is possible to single out the main problems characteristic of this industry and project them to solve the issue of implementing the circular economy.

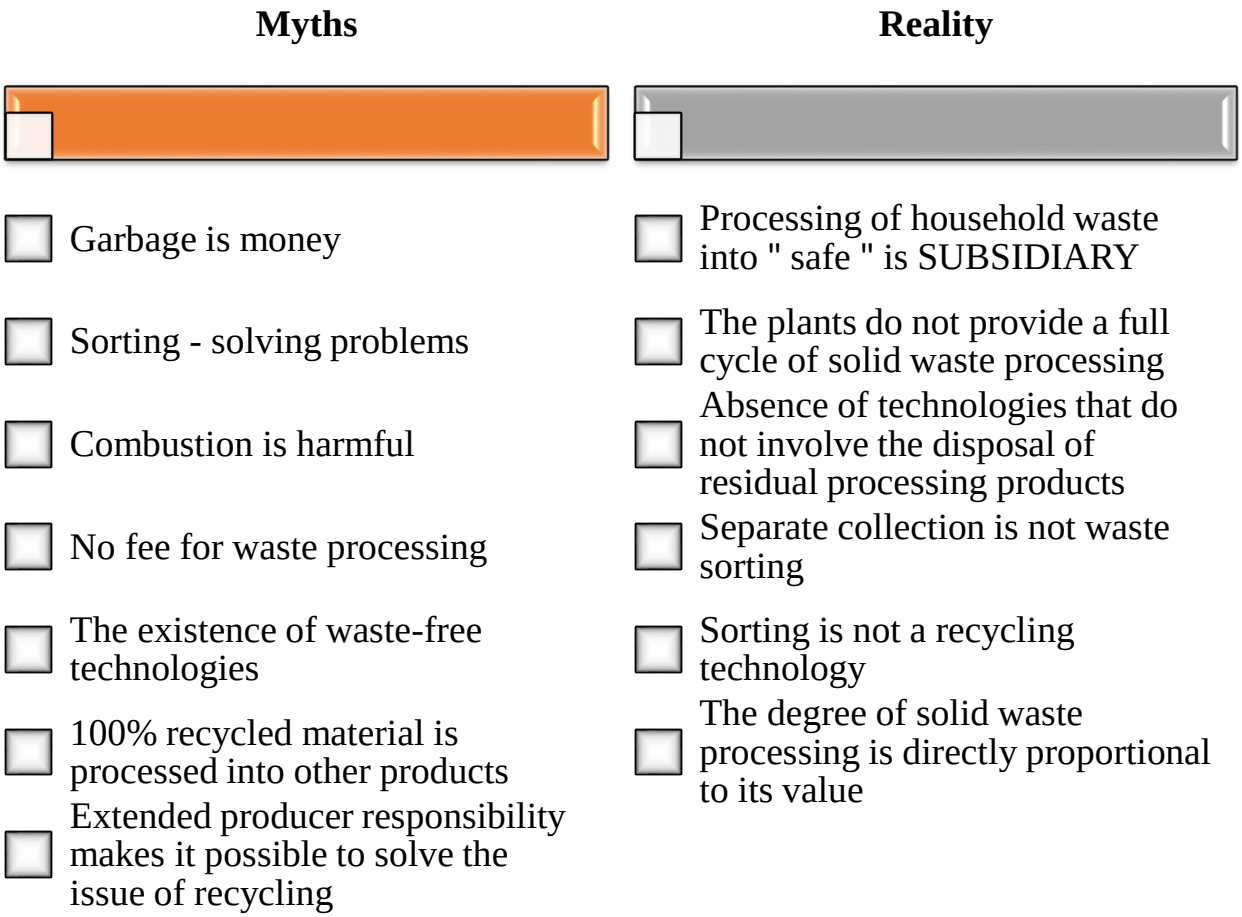

Fig. 5.22. **Myths and Ukrainian realities of the functioning of the recycling market**

Source: constructed by the author

When collecting waste, it is necessary to properly organize the optimal collection and subsequent movement of solid waste. Then mechanically distribute solid waste streams, separate secondary raw materials and prepare the remaining part for further processing. The separated part, which is not a recyclable material, needs to be processed into inert residues. And at the end, the remains should be moved to a place of permanent storage.

An important issue of the introduction of a circular economy in Ukraine is ***the utilization of organic matter***, since 50% of the volume of disposed waste is organic product waste.

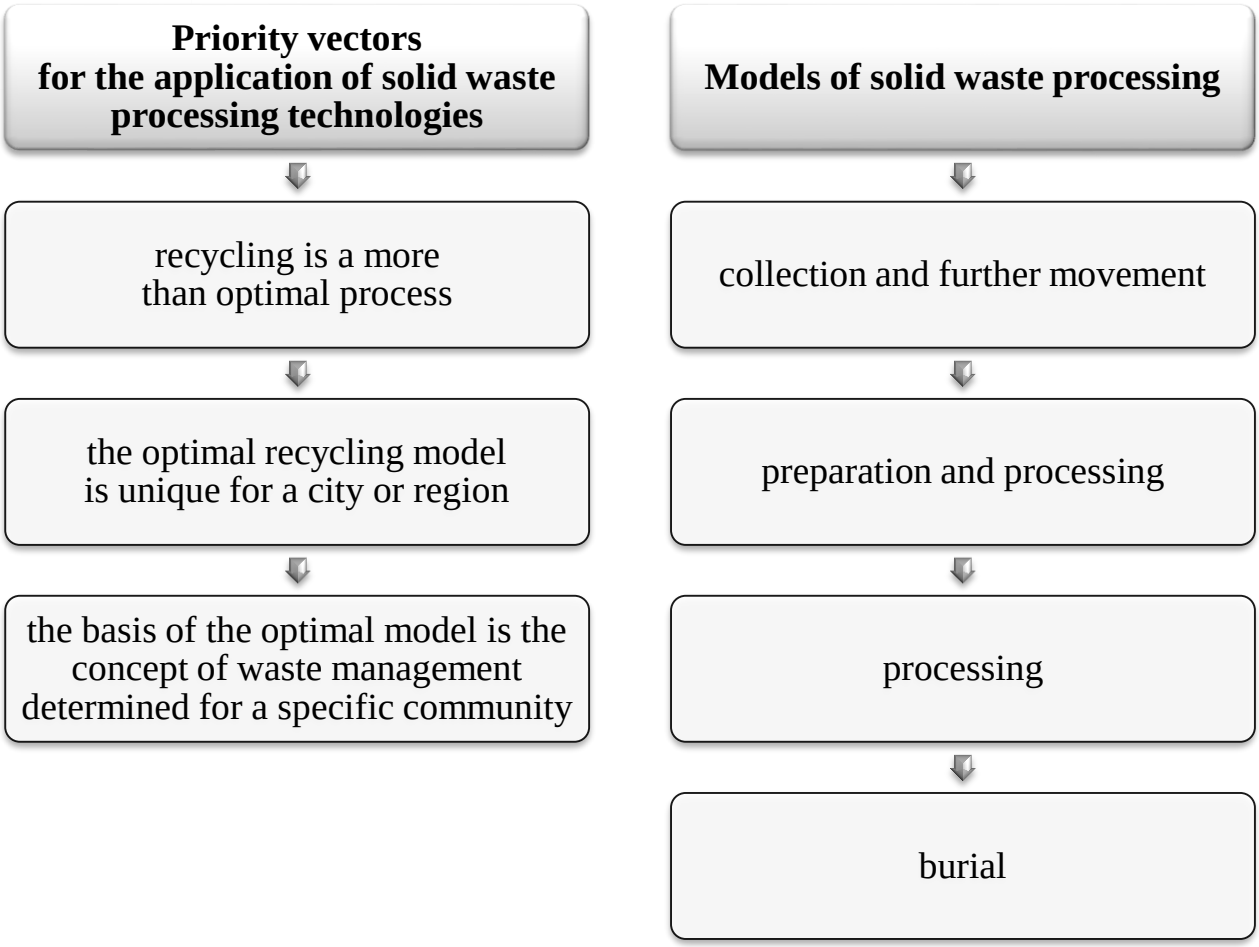

Fig. 5.23. **Comparison of priority vectors for the application of solid waste processing technologies with existing models of solid waste processing.**

Source: constructed by the author

Prerequisites for the utilization of organic matter for the implementation of the circular economy:

- up to 800,000 tons of methane is released annually from such waste, which is equal to 16 million tons of CO_2;
- limited shelf life of organic products, daily large number of expired goods; danger of unsanitary conditions;
- the high cost of logistics and the need for a mobile solution to this issue;
- implementation of waste sorting and application of the recycling mechanism.

At the same time, it is worth discussing the issue of combining different models of economic systems. So, for example, there are currently no manufacturers of biodegradable tableware in Ukraine. In fact, companies using such products import them from Poland and Sweden. At the same time, in Ukraine, the problem of falsification of such food products, biological dishes and forgery of documents certifying their existence is widespread (Fig. 5.26). In the Netherlands, for example, such bio-packaging or bio-ware can even be consumed, i.e. in this case, not only is the basic ability of biodegradable products to be fully decomposed ensured.

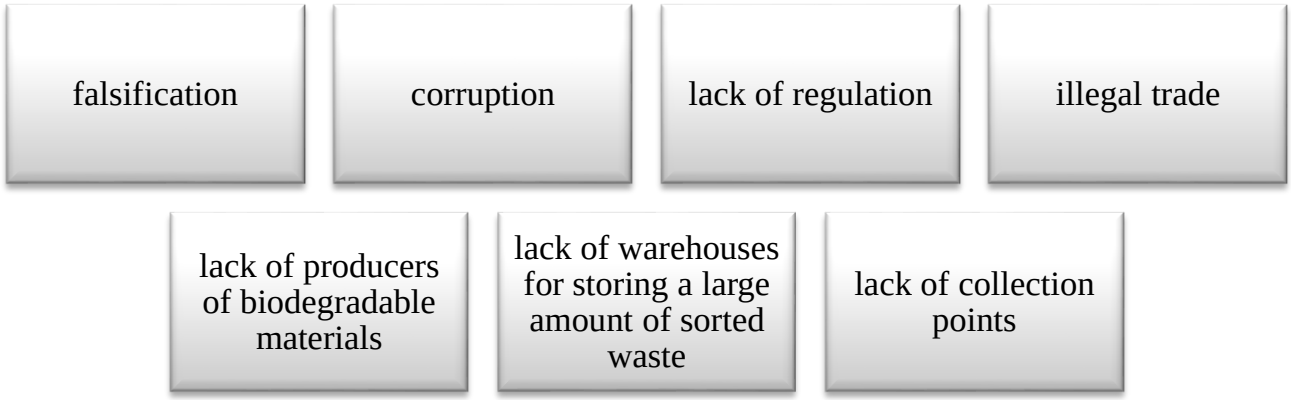

Fig. 5.24. **Systemic obstacles in the implementation of the circular economy mechanism in Ukraine.**

Source: constructed by the author

Accordingly, the question of whether there are prospects for the implementation of such a model of economy in Ukraine and where to start is becoming relevant now. In fact, there is no other way out. In order to teach Ukrainians how to properly handle waste and to explain that in the modern and future world, secondary resources are part of the economy, special educational programs should be implemented in domestic educational institutions, reinforcing them with social advertising and increasing the

payment for garbage removal, with the mandatory condition of establishing control over the quality of waste removal services. This should be gradually established at the legislative level, providing for liability (fines for their violation).

People should be informed about the benefits of products made from recycled raw materials and given the opportunity to use them. Such a campaign was carried out in Germany and cost millions of euros (even fairy tales for children discussed the topic of waste sorting). Only in this way will we be able to ensure a closed cycle in production, and our country will come closer to the circular economy model. Circular economy is like a kind of constructor. Since every living organism is a part of the "food chain", garbage is a link in the industrial chain [395-402].

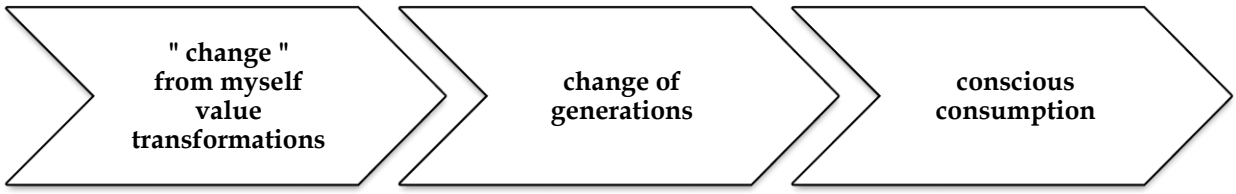

Fig. 5.25. **Necessary stages of implementation of the model of circular thinking among the population in Ukraine.**

Source: constructed by the author

To realize industrial potential, the Ministry of Economic Development of Ukraine has developed a document of the same name, the main directions of which are the following four blocks: energy efficiency, technology promotion - industry 4.0, economic decentralization and smart regulation of industry [100].

Currently, there are 40,000 industrial enterprises operating in Ukraine, which produce 70% of the country's commodity exports, creating 21% of GDP.

Our country has a significant number of competitive advantages. This is influenced by the following factors: low logistics costs and fairly developed infrastructure, favorable geographical location and access to the Black Sea, availability of production sites, high mineral and raw material potential, free trade agreements with the EU, EFTA states, Canada, the CIS, and educated workers [100].

The Ministry of Economic Development of Ukraine has identified three priority tasks in the implementation of the new industrial policy. First, it is the modernization and growth of industrial production [100] . For this purpose, the government canceled more than 450 outdated regulatory acts. The Ministry of Economic Development of Ukraine is actively engaged in increasing Ukraine's investment attractiveness at the legislative level and is working on an agreement on conformity assessment and acceptability of industrial products with the EU (AAA agreement) [100]. Secondly, it is regional development of industry and smart specialization, i.e. support of cluster initiatives, development of regional infrastructure, support of business projects and innovations, simplification of access to raw materials. Thirdly, it is an increase in the resource efficiency of industry. It is about stimulating innovation, simplifying access to investments, introducing waste management practices and creating the foundations of a circular economy [100].

Therefore, the Ministry of Economic Development proposes to implement a policy of smart specialization in the region. We are already implementing such a project in the automotive sector using the example of how it was done in East Berlin. There are specific areas of industry where Ukraine can make the best use of its potential and be competitive on the world market. Thus, the vision of the industrial strategy of the Ministry of Economic Development of Ukraine largely echoes other program documents on industrial development [100].

5.3. Strategic priorities and means of implementing the inclusive circular economy model in the Circular Economy Roadmap

Thus, all these basic concepts create a basis for the introduction of the Circular Economy Roadmap in Ukraine. Therefore, it is worth clearly delineating the steps and the expected potential results.

***Step* 1.** Understand the foundations of the country before determining its direction.

Expected result. Assessment of the level of circularity of the country compared to other countries. Broad understanding of the existing circular economy policy landscape.

Evaluating the current level of circularity makes it possible to establish appropriate national conditions (ambitions). The basic formation of circularity starts with the areas in which the country is more developed compared to others, which makes it possible to set the level of ambition. It also defines the initial direction to achieve a high level of development based on the decision made.

If a country is performing below their average, it is possible to use existing formulas for success to quickly advance in a particular industry or to move to potentially suboptimal solutions that other countries have developed (eg, large waste incineration infrastructure to avoid emissions).

Existing indicators do not fully characterize the circular economy. Some important indicators, such as the level of sharing and the level of recycling, are simply not yet available at the national level, apart from individual data on activities in specific sectors or programs.

To determine the level of circularity of a country, the use of existing indicators is often the only option.

Four main areas and corresponding indicators:

• productivity of resources. The Resource Productivity Indicator is the European Commission's leading indicator of resource efficiency and therefore ensures high availability and transparency of data. The disadvantage is that the internal consumption of materials depends significantly on the industrial structure in each country and it does not necessarily reflect **environmental costs**:

• circular activity. Ideally, there should be a complete set of indicators, including those related to resumption of activities and exchange of materials. Since these data are not available, recycling rates and eco-innovation indices are chosen as proxy indicators;

• waste production. This indicator is chosen to reflect that the total production of waste generated by industries is quite different from the waste generated by consumers (in municipal waste). As with resource productivity, there are caveats to consider, such as the impact of industrial structure on overall waste production;

• emissions of energy and greenhouse gases. Two indicators were chosen for evaluating the use of renewable energy sources and greenhouse gas emissions by GDP, since the industrial structure largely affects the result.

Measuring transparency and circularity can be applied as part of a circular economy strategic initiative. To ensure comparability with other countries, such measurements can be carried out at the international level, for example, OECD, Eurostat or the UN.

Currently, initiatives aimed at increasing data transparency and/or further development of adequate indicators have been developed. Here are just **a few examples**:

• A 'carbon metric' has been developed **in Scotland** to quantify the impact of waste on carbon emissions, to estimate emissions from the production and processing of materials, and emissions from disposal.

• **In Europe,** the EU resource efficiency and raw material consumption (RMC) indicators illustrate progress in increasing the efficiency of resource use in individual member states and the European Union as a whole.

• **In Great Britain,** peculiar schemes – Sankey diagrams – have been developed for visualization and analysis of material flows and circularity of the economy.

• **Statistics Denmark** is implementing a system of physical supply and use tables and physical input-output tables. The system is aimed at supplementing the tables of monetary supply and use and release of resources with information on the amount of materials (natural resources, products and residues) entering the economy.

The key drivers for finding an urgent solution of the climate change and the ozone layer preservation issues are:

- the need to improve the legislative and regulatory framework in this area;
- lack of transparency in the division of responsibilities, poor coordination of public agencies' actions and institutional capacity in planning and taking measures in this area.

• **The Ellen MacArthur Foundation** and **EU funding funds** of the LIFE Program have developed **circularity indicators for companies** to assess the extent to which products or companies work towards promoting the development of a circular economy. The main indicators of material circularity are indicators of recovery of material flows of a product or company, and additional indicators measure additional impacts and risks.

The German government's goal of doubling raw material productivity by 2020 compared to 1994 is expressed in terms of the ratio of GDP to direct

material in tons of abiotic raw materials. The indicator of internal consumption of materials in raw material equivalents is also used, as it takes into account the material flows formed during import production. A third indicator – an indicator of total material consumption – will also be used in the future, if the quality of the data is sufficiently improved, to determine the coverage of unused resources such as mineral extraction.

Let us describe in more detail the national economic indicators of measurement taking into account the three main principles of the circular economy.

Standard setting organizations play an important role in ensuring measurement systems. An example of an organization in this field of activity is: Association of German Engineers (VDI), which develops technical product standards for resource efficiency and recycling, including recycling logistics. It also provides services such as resource screening and development of regional activities to create a network of efficient use of existing resources, which enables the linking of entrepreneurial activities, information and funding.

Political understanding at the highest level of strong partners on possible areas of development allows for a more focused identification of further policy interventions in the project, as well as engaging stakeholders at an early stage of its discussion to find out what policy measures may make sense for the country. This discussion is possible after identifying the opportunities of the circular economy and the barriers associated with them; getting a result for stakeholders as soon as possible is an end in itself. Such a discussion will provide an opportunity to review the direction of the policy in the future, which is important when developing new policy measures. Political agreement can be reached **according to the following six categories**:

- ✓ education;
- ✓ information and awareness;

- ✓ cooperation;
- ✓ business support schemes;
- ✓ public procurement and infrastructure;
- ✓ regulatory limits;
- ✓ financial limits.

For "examples of existing interventions" in implementation, government reports and other sources of information were drawn from several Danish government departments.

Step 2. Set the level of ambition at coordinated activities of interested parties and focusing on a common direction.

Expected result. quantitative measurement.

Establishing the level of national ambitions can be a powerful lever for coordinating the activities of project stakeholders in a general direction. The level of ambition can, for example, influence the choice of a sector of activity (solving the issue of employment as opposed to environmental problems when choosing a focus sector), as well as determine the priority of circular economy opportunities in focus sectors.

National goals can determine the directions of activities of enterprises and investors. For example, the main goals for reducing carbon emissions of the European Union are their reduction by 20% by 2020 and 80% by 2050 compared to the 1990 level, the USA – 26-28% by 2025 compared to the 2005 level, and China – the maximum reduction of CO 2 emissions by 2030 and an increase in the share of non-fossil fuels in primary energy consumption to 20 % by 2030

1. *Quantitative objectives of circularity*. Targets can be established using existing indicators or by developing new indicators. The goals can also be interconnected with the three main principles of the circular economy.

2. *Quantitative "general" goals of national policy.* The circular economy can contribute to the achievement of "general" policy goals, for example, the implementation of the objectives of the EU Program - 2020.

3. *Qualitative circular ambitions.* This may mean setting the main goal - to be "the best in Europe" in preventing the generation of waste, in its disposal, or to become one of the "world leaders" in production.

Step 3. Determination of target industries, focusing on their capabilities in this direction.

Expected result: a set of industries based on a matrix of priorities, reflecting the "role in the national economy" and the "potential of circularity" of the former.

Sector selection is a key tool in the methodology as it defines the focus of the roadmap not only in terms of analysis but also stakeholder engagement. The analysis is predominantly sectoral, as opportunities, barriers and policy options differ across sectors. Stakeholders from the selected sectors (and their wider value chains) should be involved in the analysis process.

Focus sectors (branches) of the circular economy should be singled out, their role in the national economy and their circular potential should be determined.

Assessment of sector opportunities. Once the target sectors have been identified, the sectoral assessment can begin. To a large extent, it depends on the involvement of representatives of the business sector. First of all, it is necessary to assess the opportunities of the circular economy and define priorities. In order to realize the priority opportunities, it is necessary to assess the economic consequences specific to the sector, to identify barriers and policy directions to overcome them.

For this, it is important to intensively involve enterprises with the aim of:

- obtaining ideas and knowledge to determine the opportunities and barriers of the circular economy in each sector;
- coordination of a common direction for the country and sectors;
- submission of benefits for the business sector and implementation of opportunities.

This can be useful for engaging different groups of enterprises, as economic actors' perspectives on opportunities and overcoming barriers may differ even within the same sector based on business size, business model, production focus and experience in implementing circular business initiatives.

Involvement of foreign enterprises in domestic business will make it possible to implement the best international practices. Industry associations, academics, consumers and other stakeholders in society are also involved in addressing this issue.

This not only helps identify opportunities and barriers to project implementation, but also enables circular economy leaders to share best practices and find partners to implement business opportunities.

Step 4. *Identify opportunities for the circular economy in each industry.*

Expected result. A structured map of the potential opportunities of the circular economy for each sector.

The circular economy encompasses many types of opportunities that can vary widely across sectors and countries. It is useful to systematically identify potential opportunities in each sector before prioritizing them.

Step 5. Determine priorities and detail opportunities of the circular economy.

Expected result. a set (one to three) of prioritized and detailed capabilities for each industry.

A systematic review of opportunities can provide a large number of them for each sector. These opportunities should be prioritized for further analysis.

Accordingly, priority opportunities can be detailed and assessed in terms of sectoral impact, barriers and policy options.

Prioritization and detailing of opportunities, together with two types of analysis (cost quantification and barrier identification) are part of the methodology on which most businesses operate. Although the "roadmap" may contain suggestions based on a review of scientific literature and international practices, only enterprises can provide information about local business realities and opportunities.

Expected performance is a guide for initial prioritization. A classical approach to impact prioritization may also be applied. However, it is best to first assess potential impact (rather than feasibility) early on, when understanding of opportunities is least developed. For example, Denmark has realized that 3D printing of building modules can have a significant impact on the development of the construction sector. However, it is difficult to assess the possibilities of its implementation without a detailed analysis of the project.

An effective scoring method can be used to rank circular economy opportunities.

When ranking opportunities, it is important not only to consider areas of action as separate segments, but also to take into account their systemic consequences.

Prioritizing and detailing opportunities is an iterative process. Capability identification is to some extent necessary for ranking. However, prioritization is necessary to determine which capabilities should be fully detailed.

To realize opportunities, a specific measure can be a useful increase in a certain part of production or the number of products in the value chain. For example, in Denmark, the study of the mechanical engineering sector focused on two main products: pumps and wind turbines. It is also important to assess

how they can be implemented using the following four components of the circular economy:

• circular design, i.e. improvement of materials and design of products (standardization / modulation of components, cleaner material flows and design for easier disassembly), which are the basis of the circular economy;

• innovative business models, changing from forms of ownership to payment models based on the results of activity, contribute to increasing the value of products intended for repeated use;

• core competencies regarding reverse cycles and cascades, which involve the creation of cost-effective, higher-quality collection and treatment systems (either by the producers themselves or by third parties);

• promoting the improvement of cross-cycle and cross-sectoral functioning, which are factors that support the necessary changes at the system level. They provide for high transparency of material flows, alignment of incentives and establishment of industry standards for cross-industry cooperation chains. Other aspects are access to financing and risk management tools and infrastructure development.

Step 6. Sector Impact Quantification.

Expected result. Quantified impact for each circular economy opportunity and scenario.

In order to develop actions and policy measures, it is necessary to assess the economic consequences of each priority opportunity of the circular economy.

Although economic efficiency is the first indicator to implement a circular economy, other indicators such as saving resources and reducing emissions should also be taken into account.

Step 7. Definition of barriers that stand on the way to realizing the opportunities of the circular economy, so that the policy parameters are more targeted.

Expected result. identifying the main barriers for each opportunity, structured by their type in four categories:

- economic;

– market failures;

– regulatory failures;

- social factors.

After determining the priority of circular economy opportunities, barriers that may arise in the process of their implementation should be assessed. The toolkit is the basis for classifying these barriers and analyzing their severity. A thorough analysis of barriers forms the basis for further steps in achieving targeted policy options.

Step 8. Institutional structure.

Expected result. Provision of a powerful institutional component.

Institutional strength must be considered in decision-making: approaches that rely heavily on public procurement, investment, administrative policy interventions, such as the extended producer responsibility schemes that form the basis of the strategy package, are unlikely to succeed when a country's institutions are weak. Alternative approaches could be aimed at voluntary agreements, for example in the packaging industry or food retailing, enabling value chains to function and private sector development based on alternative models, such as performance models for durable goods.

In addition, the prevalence of "gray" markets in the country is determined. A strong informal market does not preclude the application of analytical knowledge aimed at establishing circular policies, although the

collection of sound data may be a more labor-intensive process. From the point of view of implementation, such a workforce can be the basis for intensive formation of secondary markets. Rather than destroying the livelihoods of such workers, the proposed policy aims to capitalize on this workforce, which typically has "access" to waste streams that only formalized waste management systems can provide.

In order to stimulate local authorities to increase the efficiency of their activities (better tools, effective coordination of activities with city services, etc.), national policy can be aimed at:

- formation of repair and reuse markets for existing secondary product flows;
- creation of such markets for new types of products and services;
- potentially improving workers' participation in informal activities by providing them with the information they need.

Available resources:

- ✓ business analytics, including the ability to form value chains, the ability to discuss important production issues with companies and quantify the economic consequences of activities for individual sectors;
- ✓ macroeconomic modeling to quantify the impact in the economy;
- ✓ policy analysis;
- ✓ circular economy;
- ✓ environmental and resource issues;
- ✓ determination of policy directions of a specific country and the context of circularity.

There may also be other reasons for policymakers to limit analytical efforts or to organize activities differently at one or more stages of the process, such as lack of relevant data, lack of time and/or resources, lack of desire to develop a circular economy, different methods of policy analysis, etc.

However, at each stage of the methodology, case studies can be applied to assess existing experience and local resources accordingly. Therefore, the systematic implementation of the steps reflected in the Roadmap model of the inclusive circular economy for Ukraine will enable Ukraine to effectively implement all stages of the circular policy.

By overcoming common barriers to managing the process of implementation and assimilation of an inclusive circular economy, such as the need for better knowledge, financing and regulation, strategic vectors in the Roadmap can improve their approaches to expanding inclusive partnerships.

To **support advanced solutions,** you need:

✓ develop and implement a long-term holistic vision of circular ambitions;

✓ introduce cross-sectoral coordination and promote a culture of cooperation and knowledge sharing within local initiatives;

✓ identify, contact and include non-state stakeholders at the beginning of the transition process - development of a circularity strategy;

✓ to analyze urban metabolism as a basis for the development of a strategic plan for the transition period of identified priority sectors;

✓ to teach consumers (and other interested parties) in society, especially in specific cities, an inclusive approach and participation in order to form circular cities, as the position of citizens is decisive.

To support better financing:

➢ use circular public procurement to create demand for circular innovation;

➢ determine external sources of funding / financing of circular economy initiatives and projects at the EU level and / or at the national level to supplement the own budget of state authorities.

To support regulation:

- promote the space and financing of experiments (pilot projects), (private) innovation, knowledge transfer and compliance for enterprises, research institutions and interested citizens;
- create forums with like-minded cities at national level (and possibly also at EU level) to engage in lobbying for changes to EU and national legislation that currently block the transition to a circular economy;
- continuous monitoring and evaluation of the implementation of circular projects and initiatives, aiming to create a solid knowledge base and provide feedback to guide / adjust the transition process.

The tools should provide:

- stakeholder engagement, including networking and incentives;
- relevant skills and knowledge, both in organizations promoting the circular economy and among target groups of the population and businesses. The development of the circular economy requires specific competences in monitoring and implementation of innovative production processes or cooperation and inter-institutional communication, with the identification and elimination of gaps in these competences at the appropriate levels;
- communication according to the local context (local level) and that all stakeholders are properly informed. Strategies and pilot projects often face a lack of public awareness.

Given the overall goal of an inclusive circular economy – to ensure "closed loop" and ensure a paradigm shift in the so-called paradigm shift, building connections and relationships between different strategic initiatives will ensure:

- expanding the volume of cycles in most areas, making them more efficient or even enabling the closure of new cycles;
- coordination of efforts at different levels of management;

- enabling the exchange of knowledge, spreading existing approaches to the circular economy.

Conclusions to Chapter 5

The adaptation of the global inclusive circular economy model to the realities of Ukraine allowed us to draw the following conclusions.

1. In general, corporate responsibility in European companies came as a result of harsh punishment for non-compliance with environmental standards. A bad reputation affects the quotation of shares of corporations on international exchanges and economically substantiates the potential consequences of colossal losses for the company. Extended producer responsibility has a successful experience in neighboring European countries. However, it is important to comprehensively understand what opportunities such an environmental protection strategy opens up for companies in Ukraine. For Ukraine today, it is important to reduce the level of disposal of household waste from 95% to 30% and to minimize the total amount of waste to be buried from 50% to 35%. When dealing with household waste, separate collection should be introduced, the optimal areas for the placement of regional waste transfer stations, sorting lines, waste processing plants and landfills should be determined, which requires the construction of such a network at the expense of local self-government. For industrial waste, it is necessary to create funds, the operators of which will be regional state administrations, and the fillers will be enterprises that don't have environmentally safe disposal technologies.

2. If we talk about **potential exits for Ukraine**, there are several simple options: cheap burial; construction of waste processing plants; high environmental taxes. Ways to solve the problem of the culture of intermediaries and consumption in a circular chain: local collection of gas,

fertilizers placed outside the city, for heating their stores, creation of "food" hubs a small aggregate retailer to centralize collection "out city recycle" centralized processing outside the city at a large processing plant.

3. The directions of state policy in the direction of the formation of the circular economic environment of Ukraine are education, information and lighting, joint circular platforms, circular smart schemes, circular purchases and infrastructure, regulatory framework, fiscal shifts. Necessary steps towards the formation of a circular policy in Ukraine are ensuring responsible consumption and changing the business model.

4. The vector of EU work with potential waste involves the prevention of waste generation; preparation for reuse; processing. Barriers to the adaptation of the circular economic environment in Ukraine are defined as the following: lack of an expert environment, weak relevant legislative framework, lack of legislative regulation, lobbying by large companies, ignorance of the problems of waste sorting, circular economy.

5. Individual **stop factors** for the implementation of the circular economy mechanism in Ukraine are falsification, corruption, lack of regulation, illegal trade, lack of producers of biodegradable materials, lack of warehouses for storing a large amount of sorted waste, lack of collection points. The stages of changing circular thinking in Ukraine can be called the following: self - challenge, generational change and conscious consumption.

6. Implementation of the system of Extended Producer Responsibility in Ukraine is **an effective way to solve the problem of waste** and environmental pollution, an effective step for the implementation of a closed-loop economy. It has been established that the situation in Ukraine, where 93% of household waste ends up in landfills, is similar to Romania, Bulgaria, Poland and some other EU countries, where waste still exists and a significant part of it is not reused or properly processed. For rapid economic growth, Ukraine

needs to reorient itself and change its philosophy of thinking through the implementation of a global inclusive circular economy (inclusive-circular business models), that is, to overcome a kind of circular gap. The concept of "inclusion" is not given due attention, although the introductory part defines the terms "inclusiveness", "inclusive growth", "inclusive society" and "inclusive institutions". They are almost always combined with the term "balanced", which in this context is perceived as a synonym for the concept of "inclusive".

7. It is argued that for rapid circular economic growth, Ukraine needs to reorient the vectors of economic development and change the philosophy of thinking through the implementation of inclusive-circular business models in order to overcome the circular gap within the framework of business participation in global circular chains of creating added value in the form of: local collection (collection of secondary resources located outside the city, for heating shop premises); creation of food hubs (using a small number of retailers to centralize collection); centralized processing outside the city at a large processing plant (outsite cycle). The main reasons for the slow implementation of circular economy ideas in Ukraine are highlighted. Deterrents are defined. The implementation of inclusive and circular business models for Ukraine will ensure: wider inclusiveness of the population; formation of human value; ensure people's well-being; waste management and poverty alleviation; active involvement of people in activities as proactive citizens, and not only as consumers; ensure data transparency and consumer protection; encourage inclusiveness in the informal sector; ensure the effectiveness of decisions regarding the role of women in society and the economy; determination of powers of ecosystem players; appropriate political interventions; geographical "transfer of ideas".

The main results of the study were published in: [25;26; 28; 29; 30; 31; 46].

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