Centrum Rzeczoznawstwa Budowlanego

Inżynieria Bezpieczeństwa Obiektów Antropogenicznych 1 (2023) 61-69
https://inzynieriabezpieczenstwa.com.pl/

Inżynieria Bezpieczeństwa Obiektów Antropogenicznych

Halting climate change by achieving net-zero CO2 emissions with circular and renewable energy sources

Tomasz STASZEWSKI*[1]

[1] The Polish Association of Appraisers and Experts Witness, Warsaw, Poland

Abstract

This study analyses the role of the circular economy (CE) and renewable energy sources (RES) in bringing human activity to a climate-neutral state. At the same time, it was pointed out that achieving this neutrality allows to achieve a net-zero level of CO2 emissions, as well as significantly reduces the emission of other greenhouse gases into the atmosphere. In order to more fully illustrate the issue of climate change inhibition adopted for analysis in this article, the basic concepts, characteristics of the essence of circular economy and individual types of RES were defined, and it was also shown that the use of these methods in broadly understood human activity is necessary to achieve zero net CO2 emissions, which creates opportunities to stop "extreme climate madness".

The purpose of this article is to present the role of circular economy and renewable energy sources in achieving climate neutrality of human activity, as well as the influence of Putin's imperial policy on the course of this process.

Keywords: environment, greenhouse gases, emissions, circular economy, waste, renewable energy sources, zero CO2 emissions folding

1 Introduction

The natural environment, the well-being of which is the basis for the functioning of human society, is constantly changing. In the past, it was created primarily by nature, and human participation in these changes was small. However, as early as before our era, the idea of environmental protection appeared. The motives for its protection evolved with the development of human society, although it always provided nature with more or less intended benefits. The first protective measures of humans were connected with religious beliefs (animism - belief in the existence of many supernatural forces, in particular gods personified in personal beings, and some peoples chose trees, animals and birds as objects of special worship, believing that they had their spirit - guardian). In addition to the religious theme popular in those distant times, environmental protection was dictated by many other factors, including, in particular, aesthetic and economic reasons(Simonides E.). In Poland, the etymology of protective measures does not result from the beliefs of ancient tribes, but is primarily associated with the rule of the Piasts and the Jagiellonians. The first ordinance (beginning of the 11th century) was issued by Bolesław the Brave, the essence

* **Corresponding author:** E-mail address: (staszewski-tomasz999@wp.pl) Tomasz Staszewski

https://dx.doi.org/10.37105/iboa.169
Received 15 March 2023
Available online 27 March 2023
ISSN 2450-1859, eISSN 2450-8721
Published by Centrum Rzeczoznawstwa Budowlanego

of which was to exclude beavers from the group of game animals, and additionally prohibited the excessive exploitation of forests (Staszewski T.).

When analyzing the issues related to the protection of the natural environment, one can still talk about many other motives and aspirations that have been close to man in the history so far and the evolution of his views. However, it is not about creating a catalog of motives that pushed people to act for nature, but to indicate the oldest manifestations of them, in order to understand the specific dependence and relationship between man and the environment, as well as the ways of mutual interactions (Kornatowska A.). At the same time, it should be noted that almost until the end of the 18th century, the scope and strength of human destructive impact on the natural environment was not large enough to result in rapid climate changes. The noticeable changes in this area were initiated by the rapid development of science, technology and industry (related to the ongoing industrial revolutions), as well as agricultural production, medicine and many other fields. Along with these changes, the impact of humans and their economic activities on the environment grew. As a consequence, apart from many different benefits for individual countries and people, the degradation of the natural environment and the "overproduction" of greenhouse gases and the alarming increase in ecological threats, which result in the observed climate changes, became more and more noticeable.

Halting these changes requires immediate undertaking of measures (including improvements to the existing ones) that ensure climate neutrality of human activity. It is mainly about popularizing circular economy and renewable energy sources.

2 Basic concepts explanation

As part of the analysis of the main problem (*How can climate change be stopped by achieving zero CO2 emissions using circular economy and renewable energy?*) key words (i.e. terms of key importance for the issues discussed in the article and listed in its point 2), the explanation of which is based on selected items of literature on the subject, legal acts and other sources are presented below:

- **"environment" -** *all natural elements, including those transformed as a result of human activity, in particular: land surface, minerals, water, air, landscape, climate and other elements of biological diversity, as well as the interactions between these elements " (art. 3 pkt. 39 ustawy z 24.04.2001r. – Prawo ochrony środowiska, Dz. U. z 2018r., poz. 799 ze zm.);*
- **"climate change" -** changes in the climate which are caused directly or indirectly by human activity, resulting in a change in the composition of the Earth's atmosphere and which are distinguished from natural climate variability observed at comparable periods (United Nations Framework Convention on Climate Change);
- **"negative effects of climate change"** - as defined in Art. 1 of the above-mentioned convention are understood as changes that have occurred in the physical environment or biota, generated by climate change, which have a clear and detrimental effect on the composition, resilience or efficiency of natural ecosystems under control, or on the operation of socioeconomic systems or on health and well-being of the human entity;
- **"greenhouse gases" -** those gaseous components of the atmosphere, both natural and anthropogenic, which absorb and re-emit infrared radiation. They include: CO2 - carbon dioxide, CH4 - methane, N2O - nitrous oxide and freon, ozone (Popularna Encyklopedia Powszechna, Wyd. Fogra, Kraków 1995, tom. 6);
- **"emissions"** - means the release of greenhouse gases and / or their substances into the atmosphere over a specific area, in a given period (Ramowa Konwencja Narodów Zjednoczonych w Sprawie Zmian Klimatycznych – art. 1);
- **"circular economy" -** is defined as an economic model, i.e. "economy based on a spiral system", in which materials and energy flow are minimized without worsening the condition of the environment, and at the same time not limiting economic growth and social and technical progress. It is realized in closed circuits, thanks to the transformation of linear production into an economy of services operating in closed circuits. Circular economy enables the organization of economic activity with the use of feedback processes that mimic natural ecosystems through the cycle: natural resources - transformation into manufactured products or by-products used as resources for other industries. In this sense, circular economy aims at the simultaneous minimization of waste, environmental protection, energy efficiency and economic development (Kulczycka

J., *Gospodarka o obiegu zamkniętym w polityce i badaniach naukowych*, Wydawnictwo IGSMiE PAN, Kraków 2019);

- **"waste" -** in line with z art. 3 ust. 1 pkt. 6 ustawy z 14 grudnia 2012r. o odpadach (Dz. U. z 2018r., poz. 992, ze zm.) waste means any substance or object which the holder discards or intends or is required to discard;
- **RES -** renewable energy sources, which include wind, sun, heat of the Earth's interior (geothermal energy), tides, sea waves, as well as any other energy sources that can be obtained in reproducible processes (Taubman J., *Węgiel i alternatywne źródła energii. Prognozy na przyszłość*, Wydawnictwo Naukowe PWN, Warszawa 2013). In the act of 20 lutego 2015r. o odnawialnych źródłach energii (Dz. U. z 2018r., poz. 1269, 1276, 1544, 1669, 2245) renewable energy sources are understood as non-fossil energy sources including wind energy, solar radiation energy, aerothermal energy, geothermal energy, hydrothermal energy, hydropower, wave, sea current and tidal energy, energy obtained from biomass, biogas, agricultural biogas and bioliquids. However, in the EU directive 2018/2001(REDII) the definition of renewable energy sources is somewhat broader, as it includes ambient energy, tidal, wave and other ocean energies, hydropower, biomass and gas from landfills, sewage treatment plants and biological sources (biogas). In the directive under analysis, ambient energy is understood as naturally occurring thermal energy and energy accumulated in the environment with certain limits, which may occur in the ambient air, excluding the exhaust air, as well as in surface water or sewage. (Dz. Urz. UEL 328/2018, 23.12.2018);
- **"net zero CO2 emissions" -** this is the amount of carbon dioxide emissions (preferably also other greenhouse gases) to the net emission level well below zero, preferably one that makes human activity climate neutral (Bukowski M., *Nowe otwarcie. Polska na drodze do zeroemisyjnej gospodarki*, WiseEuropa, Warszawa 2019).

3 Role of climate and renewable energy in the process of human activity to achieve climatic neutrality

Currently observed climate changes, which are characterized by significant warming, as well as such extreme phenomena as: droughts, tornadoes, floods, excessive rainfall or its complete absence, melting glaciers, fires, smog, soil, water and air degradation, desertification and soil sterilization, disturbance of biodiversity, the emergence of new epidemics and dangerous diseases that threaten human health and life. The constant and dynamic growth of these extremely harmful phenomena is also a real threat to the further functioning of the "global village" and its inhabitants. This catastrophic picture is also reflected in the threats related to Putin's war with Ukraine and the resulting fuel crisis, which significantly limited the possibility of continuing and taking new measures to limit climate change. However, it should be borne in mind that even the importance of the problems generated by Russia's war with Ukraine cannot lead to the abandonment of actions in the area of ecological security, which is all the more threatened by Putin's barbaric actions.

Bearing in mind the importance of these problems, in particular the current and potential effects that may result from them, they should be solved simultaneously, although using separate methods, adequate for each of them. Due to the subject matter of the considerations carried out in this article, special attention has been focused on activities allowing to achieve economic climate neutrality.(Staszewski T., *Charakterystyka zmian klimatu w latach 1850-2100*, Ostrołęka 2022).

One of these methods is the circular economy, the implementation of which has been one of the priorities of the European Union policy in recent years. The effect of this implementation, in line with the expectations of the promoters of the circular economy concept, should be more efficient resource management, the development of new technologies, reduced pressure on the natural environment and less dependence on raw materials from outside the EU. According to the concept of circular economy, the goal of this innovative model of the economy is to minimize waste and keep products on the market for as long as possible, mainly by returning them to the cycle and reintroducing them into production. Contrary to the concept of linear economy which has been dominant for many years (functioning according to the scheme: raw material acquisition and production - product use - waste storage), circular economy assumes the pursuit of closing the product cycle according to the following scheme: obtaining raw materials, design and production - distribution and use - recovery, recycling and reuse of products, as shown

graphically in the figure below (Gwiazdowicz M., *Gospodarka o obiegu zamkniętym*, Infos nr 6/259, June 6th, 2019.)

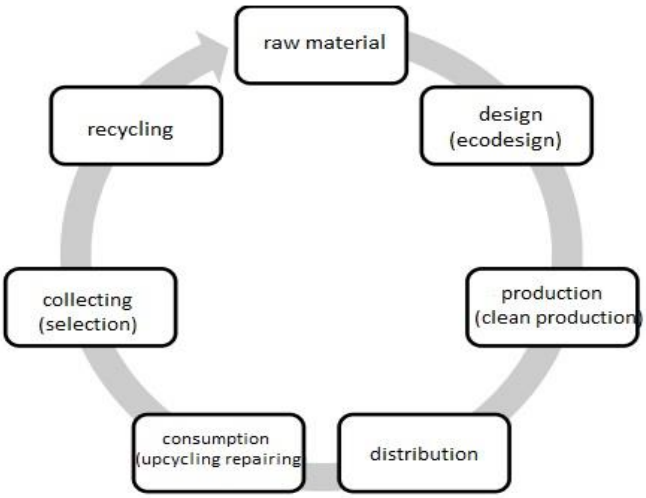

Figure 1. *Circuit diagram of circular economy*

Source: Poranek N., Czajkowski A., Wagstyl Ł., Łaźniewska-Piekarczyk B., Zagospodarowanie odpadów wtórnych jako ostatni element GOZ, Współczesne Problemy Ochrony Środowiska i Energetyki, 2019r., s. 213.

The most important features for the longest possible extension of the product life cycle are its composition, durability, possibility of disassembly and repair and recycling in order to recover and reuse the production of materials used in it. Typically, implementing this concept requires the company to modernize its production system and change its consumption habits. However, it should be emphasized that the adoption of this concept also brings such benefits as: technological innovation; saving in resource management, reducing the amount of waste, as well as reducing the demand for primary raw materials (Gwiazdowicz M., *Gospodarka o obiegu zamkniętym*, Infos nr 6/259, June 6th 2019).

Despite its innovativeness, circular economy is not a new concept, because its idea appeared in the sixties of the last century. In the following years, it was repeatedly improved and improved, although its basic idea referring to the product life cycle and production in balance with the environment, as well as reducing the amount of waste as much as possible and reusing raw materials, remained unchanged and universally applicable in literature and practice (Kulczycka J. red., *GOZ w polityce i badaniach naukowych, Instytut Gospodarki Surowcami Mineralnymi i Energią*, PAN, Kraków 2019, s. 17-18). (Kulczycka J. red., *GOZ w polityce i badaniach naukowych, Instytut Gospodarki Surowcami Mineralnymi i Energią*, PAN, Kraków 2019, s. 17-18).

Circular economy was introduced to the national policy to a greater extent in China in 2002 as the idea of respecting the environment, and not as an environmental management system. Due to the limited access to resources in this country, high energy consumption, the concept of circular economy was implemented, based on a strategy aimed at acquiring resources of the highest possible quality and energy efficiency by: limiting, reusing and recycling. The strategy covered both waste management and the resources that are essential to the country's economic development (Kulczycka J., *GOZ w polityce i badaniach naukowych*, Wyd. IGSMiE PAN, Kraków 2019).

On the other hand, the introduction of circular economy into the policy and strategy of the European Union was of an evolutionary nature. The general nature of this concept was developed in 2014, and its basic principle was to adjust the circular economy model to the economies of individual EU countries. In general, circular economy in European literature was then described as a development strategy that led to economic growth while optimizing resource consumption, and, moreover, requiring a significant transformation of production chains and consumption patterns and redesign of industrial systems in individual Member States. An expression of this is the definition of circular economy (COM-2014/398, 2014) adopted by the EU, and the content of which was shaped as follows: "circular economy is one that allows you to maintain the added value of products for as long as possible and eliminate waste (or at least significantly reduces its quantity)". Then, in 2015, this definition was extended and adopted the following form: "a circular economy is one in which the value of products, materials and resources in the economy

is maintained for as long as possible, and the generation of waste is in line with its essence, kept to a minimum " (Kulczycka J., *GOZ w polityce i badaniach naukowych*, IGSMiE PAN, Kraków 2019).

In Poland, the circular economy was defined in „*Mapa drogowa transformacji w kierunku gospodarki o obiegu zamkniętym"* (Annex to a resolution of the Council of Ministers, 2019, pg. 5). In this document, circular economy is understood as a model of economic development in which - while maintaining the performance condition - the following two basic assumptions are met:

1) the added value of raw materials / resources as well as materials and products is maximized or
2) the amount of generated waste is minimized, and the waste generated is managed in accordance with the hierarchy of waste management methods (waste prevention, preparation for reuse, recycling, as well as other methods of recovery and disposal of waste).

By making a significant generalization of this definition, it can be concluded that the circular economy is a concept in which the value of products, materials and raw materials should be kept in circulation as long as possible, and the generation of waste should be minimized as much as possible.

In addition to the definition of circular economy, the analyzed document also indicates four priorities as part of the Polish transformation towards this model of the economy, as well as identifies tasks that will ensure their implementation. The group of these four priorities includes:

1) innovation, strengthening cooperation between industry and the science sector, which should result in an increase in innovative solutions implemented in the economy;
2) creating and ensuring the proper functioning of the European market for secondary raw materials;
3) ensuring high-quality secondary raw materials;
4) development of the service sector.

In order to ensure the effective implementation of these priorities, it is necessary to follow the relevant tasks set out in its five chapters. In the first chapter, entitled *"Sustainable Industrial Production",* the important role of industry in the Polish economy was emphasized and the opportunities that arise that may ensure its further development are indicated. The second chapter on sustainable consumption indicates the need to modify the existing patterns that operate in this area. At the same time, it was emphasized that so far this area has often been neglected, and in fact its role in the transformation towards circular economy is significant and requires proper appreciation and specific actions. Chapter three *"Bioeconomy"* indicates the need for proper management of renewable resources in the circular economy cycle, which, despite their significant potential in the Polish realities, are used to an unsatisfactory degree. Chapter four *"New Business Models"* presents the possibilities of reorganizing the existing ways of functioning of various entities on the market based on the concept of circular economy. Chapter five of the analyzed document contains information and indications relating to the implementation, monitoring and the possibility of financing circular economy by entities that have decided to transform their activities towards this concept. (*Mapa drogowa transformacji w kierunku GOZ*).

Even on the basis of these considerably generalized considerations, it can be stated that the transformation towards circular economy is an important element of the response to the crisis of the natural environment, depletion of natural resources, climate change, as well as dependence on the import of strategic raw materials from third countries (a painful example is the import of these raw materials from Russia, which as a result of this country's war with Ukraine was in fact completely interrupted, which results in a growing economic crisis, including an unprecedented increase in prices, inflation and deterioration of the living standards of a significant part of the population of the vast majority of the "global village" countries).

Another element contributing to the achievement of climate neutrality by human activity are renewable energy sources (RES for short). In art. 2 points 22 of the Act on Renewable Energy Sources of February 20, 2015. (Dz. U. nr. 478) alternative energy sources have been defined as *"renewable, non-fossil energy sources including wind energy, solar radiation energy, aerothermal energy, geothermal energy, hydrothermal energy, hydropower, wave, current and tidal energy, energy obtained from biomass, biogas, agricultural biogas and bioliquids. "*

In Poland, the energy sector is still dominated by coal (this is the case even in the times of the current fuel crisis and problems with the possibility of purchasing this fossil fuel, which was generated intentionally by Putin). Despite this, a fairly large group of Polish society still believes that coal in our country will remain the dominant fuel for many years to come, because the difficulties with its purchase are temporary and will be quickly overcome by the government. It should be noted here that also in the EU, coal was the dominant fuel until the mid-1990s. It was only in 1996 that the EU consumed more gas than coal, and energy from RES did not yet constitute an important position

in the energy mix. Over the years, the situation has changed dramatically in favor of alternative energy sources, which in the case of our country was much slower. As a consequence, the power industry in Poland, which is based on coal and combustion processes, still contributes significantly to emissions of pollutants into the atmosphere, in particular CO2, but also to many other harmful gases. Despite the progress noted in recent years, the domestic energy mix consists of only 15% of energy produced by RES. In general, the reason for this unsatisfactory state of affairs is not related to the lack of funds, as we had about 65 billion PLN for the development of renewable energy, but it actually remains related to the protection of jobs in mining and not very stable law, in particular relating to the issue of alternative energy sources in relation to fossil fuels (Łucki Z., Misiak W., *Energetyka a społeczeństwo. Aspekty socjologiczne,* Wydawnictwo Naukowe PWN, Warszawa 2018).

One of the fastest growing renewable energy sources in our country is photovoltaics, in which the energy of solar radiation (with the help of a photovoltaic cell) is converted into electricity, and then also into heat. (Klugmann-Radziemska E., *Fotowoltaika w teorii i praktyce*, Wyd. BTC, Legionowo 2010, s. 10).

The use of sunlight for the production of electricity and heat takes place with the use of appropriate devices, processes and related technologies. These include: photovoltaic panels and solar collectors as well as various types of energy carriers. The use of solar energy to generate electricity and heat using the above-mentioned devices, processes and technologies usually applies to housing, services, industry, the public sector, as well as farms. Another source of renewable energy is wind energy. It should be noted, however, that the use of wind energy infrastructure requires open areas (arable fields and meadows, which constitute approximately 60% of our country's area). However, due to the specificity of this infrastructure (huge windmills and poles that are used to install them), densely populated areas and protected areas included in NATURA 2000 are practically excluded from the development of wind energy in those places. More than 75% of the entire RES energy pool is energy obtained from biomass. Its production uses waste from the wood and agricultural industries as well as forest biomass. Yet another type of energy that comes from renewable sources is biogas, which is usually produced in biogas plants located near landfills and sewage treatment plants. (Ciepielewska M., *Rozwój odnawialnych źródeł energii e Polsce w świetle Unijnego Pakietu Klimatyczno-Energetycznego oraz ustawy o odnawialnych źródłach energii*, email: mciepielewska2@gmail.com, accessed October 4, 2022). The production of agricultural biogas, which uses feedstock in the form of natural fertilizers, waste from the agri-food industry and energy crops, is gaining more and more popularity in Poland. (Zegar J. S., *Współczesne wyzwania rolnictwa*, Wydawnictwo Naukowe PWN, Warszawa 2012, s. 56-58).

A specific renewable energy source is geothermal energy coming from the inside of the earth, using the heat of our planet's interior, which heats the groundwater. Some of these waters come to the surface as steam or warm (hot) water, which, after being used for energy purposes, is "given back" to our planet. In addition to using it for heating purposes, it is also useful in recreation, fish farming and agricultural production. The heat flux density distribution for Poland shows that the warmest sources of geothermal waters are in the following regions: Dolnośląskie, Wielkopolskie, Lubuskie, Śląskie and Opolskie (Taubman J., *Węgiel i alternatywne źródła energii. Prognozy na przyszłość*, Wydawnictwo naukowe PWN, Warszawa 2013, s. 204-209).

Water energy (hydropower) is a commonly known and used source of renewable energy for a long time. In Poland (similarly in other countries), it is produced by hydroelectric power plants (reservoir and run-of-river, as well as damming and derivative power plants, regardless of the method of obtaining the head). Relatively good conditions for the construction of small hydropower plants exist in the Carpathians, the Sudetes, as well as in Pomerania and Roztocze areas.

Environmentally and human-friendly are also tidal power plants that generate electricity through the use of special devices that use sea flows and tides. As the tides increase, so does the amount of energy produced. It should be noted that these power plants operate both during high tide and low tide, which is not the case in the case of obtaining energy from winds (windless days, storms and hurricanes). Mostly, these types of power plants are built in narrow estuaries, straits and bays (Małachowski K. (red.), *Gospodarka a środowisko i ekologia*, Wyd. CeDeWu, Warszawa 2021). In addition, it is also possible to use nuclear and fusion energy, as well as methane hydrates from the bottom of the seas and oceans, natural gas found in rocks, oil from shale and tar sands, as well as roads and highways as an energy source.

4 Limiting climate change

The main cause of the numerous problems related to the climate is undoubtedly global warming, the source of which is the increase in emissions of CO2 and other greenhouse gases, which is primarily the responsibility of man, or rather his irrational activity. Stopping rapid warming requires cumulative emissions of carbon dioxide (including other greenhouse gases) to at least net zero levels. It is a fully justified task, which must be absolutely implemented both at the global, national and local level. In the case of some countries (e.g. Poland), significantly limit the scope of measures aimed at zero CO2 emissions (including other greenhouse gases). Paradoxically, this crisis may accelerate the development of renewable energy sources, and thus also the popularization of a low-emission economy and a circular economy. Only in the event of a significant reduction of CO2 emissions to the atmosphere by humans (of course, this is about their activities) will it be possible to increase the support of nature, because the fraction of carbon dioxide absorption will be greater, which is shown graphically in the figure below.

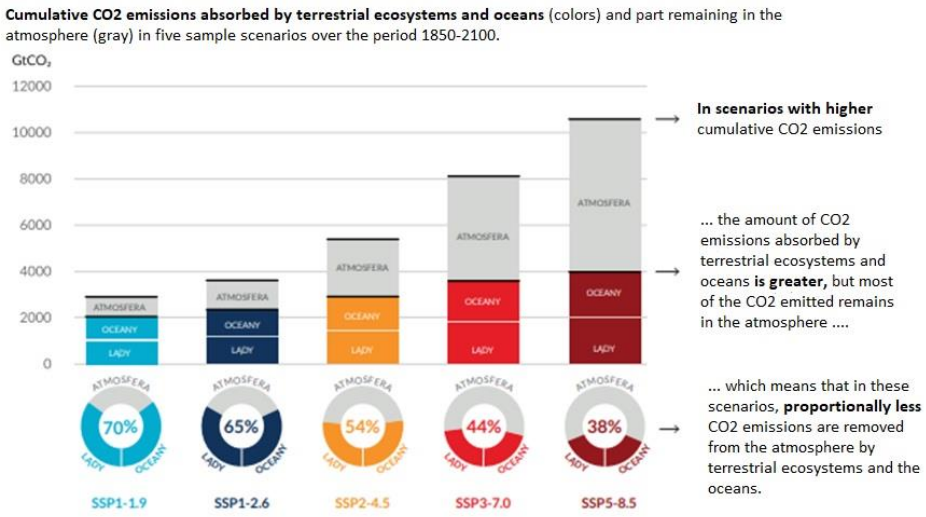

Figure 2. *Cumulative anthropogenic CO2 emissions absorbed by oceans and land by 2100 for 5 exemplary scenarios*

Source: Podsumowanie dla Decydentów (w:), Zmiany Klimatu 2021, Fizyczne Podstawy Naukowe. Wkład I Grupy Roboczej do Szóstego Raportu Oceny Międzynarodowego Zespołu ds. Zmiany Klimatu, Warszawa 04.11.2021, s. 27

As CO2 emissions increase (moving to the right), the amount of CO2 that enters the atmosphere increases, although at the same time absorption by land and oceans increases. Despite this, the fraction of CO2 entering the atmosphere increases more than the fraction of CO2 that is absorbed by the oceans and land. This relationship was expressed in the analyzed figure 2. It should be emphasized, however, that in the case of all five scenarios presented in this figure, CO2 emissions are above zero net. Therefore, in each of these cases, global warming will continue. This means the necessity to intensify actions limiting the emission of CO2 and other greenhouse gases to a greater extent. You should also be aware that zero net CO2 emissions are a minimum, as to reduce the "extreme madness" of the climate one should strive to achieve net emissions well below zero, preferably one that makes human activity climate neutral.

5 End

The considerations carried out in this study have shown that the inhabitants of the "global village" are not defenseless against the increasingly intense climate change. Stopping it is still possible and accessible to humans. However, it requires an in-depth analysis of activities to date, in particular those that are not rational and purposeful. However, just analyzing these actions is not enough for the goal of halting climate change to be achieved. Concrete and immediate actions are necessary, or rather broader and more meticulous implementation of what has been invented and tested in practice by people.

Contemporary humans, in the field of the issues studied in this article, already have a lot of knowledge, as well as numerous instruments and methods of action that can "tame" the raging climate and remove the threats that leave uncertainty about the existence of the human species, as well as the planet that is our home. Among the proven, but still not fully used methods are new models of the economy, including the circular economy. See the diagram of which is presented below.

Figure 3. *Circular economy diagram*

Source: Gwiazdowicz. M., *„Gospodarka o obiegu zamkniętym”*, Infos nr 6 (259) z 6 czerwca 2019r., s. 1

The considerations carried out in the article, as well as the above figure, indicate that circular economy may be useful as an economic system, which, inter alia, in order to preserve natural resources, takes into account the need to reuse products and materials. In this way, additional value can be created for the economy, the environment and people. According to the concept of circular economy, in order for the individual components of the product to be biodegradable or fully recyclable, products should be properly designed. Based on the concept of circular economy, the ideas of industrial ecology should also be developed in parallel, which also takes into account the need to use waste as an input to production processes. Along with the dissemination of circular economy in practice, efforts should also be made to transform the existing energy based on fossil fuels (mainly coal) into a more modern one, based on renewable energy sources (biomass, biogas, solar energy, wind energy, water energy, geothermal energy, tidal energy, etc.).

In the realities of the current situation marked by climate change and Putin's war with Ukraine, as well as the energy crisis generated by him and resulting inflation, rising prices and limiting economic activity, it is undoubtedly much more difficult to implement measures to stop climate change. Appreciating these and other problems, however, one cannot abandon the concern for the climate, but on the contrary, it is advisable to accelerate the implementation of the broadly practiced circular economy and renewable energy sources, because thanks to them it will be possible to significantly reduce CO2 emissions to the atmosphere, which will increase support nature, because the fraction of absorption of this gas will be greater, as shown graphically in Figure 2. The impact on the effects of any projects improving the activities of all entities that affect the condition of the climate undoubtedly depends on prevention and education, which should cover the widest possible group of the human population, but also any other entities that should take care of the environment.

Bibligraphy

1. Bukowski M., (2010) Nowe otwarcie. Polska na drodze do zeroemisyjnej gospodarki, Warszawa: WiseEuropa.

2. Ciepielewska M., (2016) Rozwój odnawialnych źródeł energii e Polsce w świetle Unijnego Pakietu Klimatyczno-Energetycznego oraz ustawy o odnawialnych źródłach energii, Łodź: Gospodarka w Praktyce i Teorii

3. Gwiazdowicz M., (2019) Gospodarka o obiegu zamkniętym, Warszawa: Infos nr 6/259.

4. Klugmann-Radziemska E., (2010) Fotowoltaika w teorii i praktyce, Legionowo: Wyd. BTC.

5. Kulczycka J. red., (2019) GOZ w polityce i badaniach naukowych, Kraków: Instytut Gospodarki Surowcami Mineralnymi i Energią, PAN.

7. Łucki Z., misiak W., Energetyka a społeczeństwo. Aspekty socjologiczne, Wydawnictwo Naukowe PWN, Warszawa 2018r.

8. Małachowski K. (red.), (2021) Gospodarka a środowisko i ekologia, Warszawa Wyd. CeDeWu.

9. Mapa drogowa transformacji w kierunku gospodarki o obiegu zamkniętym, Załącznik do uchwały Rady Ministrów z 2019r.

10. Podsumowanie dla decydentów (w:), Zmiany Klimatu 2021, Fizyczne Podstawy Naukowe. Wkład I Grupy Roboczej do Szóstego Raportu Oceny Międzynarodowego Zespołu ds. Zmiany Klimatu, Warszawa 04.11.2021r.

11. Popularna Encyklopedia Powszechna, (1995), Kraków: Wyd. Fogra.

12. Poranek N., Czajkowski A., Wagstyl Ł., Łaźniewska-Piekarczyk B., (2019) Zagospodarowanie odpadów wtórnych jako ostatni element GOZ, Współczesne Problemy Ochrony Środowiska i Energetyk.

13. Ramowa Konwencja Narodów Zjednoczonych w Sprawie Zmian Klimatycznych.

14. Staszewski T., (2022) Charakterystyka zmian klimatu w latach 1850-2100, Ostrołęka

15. Taubman J., (2013) Węgiel i alternatywne źródła energii. Prognozy na przyszłość, Warszawa: Wydawnictwo Naukowe PWN.

16. Ustawa z 24 kwietnia 2001r. – Prawo ochrony środowiska, Dz. U. z 2018r. poz. 799 ze zm.

17. Ustawa z dnia 20 lutego 2015r. o odnawialnych źródłach energii, Dz. U. z 2018r. poz. 1269, 1276, 1544, 1669, 2245.

18. Zegar J. S., (2012) *Współczesne wyzwania rolnictwa*, Warszawa: Wydawnictwo Naukowe PWN,