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IMPLEMENTATION OF THE PRINCIPLES OF SUSTAINABLE ECONOMY DEVELOPMENT AS A KEY ELEMENT OF THE PRO-ECOLOGICAL TRANSFORMATION OF THE ECONOMY TOWARDS GREEN ECONOMY AND CIRCULAR ECONOMY

IMPLEMENTACJA ZASAD ZRÓWNOWAŻONEGO ROZWOJU GOSPODARCZEGO JAKO KLUCZOWY ELEMENT PROEKOLOGICZNEJ TRANSFORMACJI GOSPODARKI W KIERUNKU GREEN ECONOMY I CIRCULAR ECONOMY

Abstract

Economic crises often become the source of new business concepts and the transformation of economic systems. Since the global financial crisis of 2008, the importance of implementing the principles of sustainable economic development has been growing as a key element of the green revolution and the transformation of the existing, traditional, brown economy of surplus into a sustainable, green economy of moderation. However, the main factor behind the increase in popularity in the world of science of the issues of sustainable economic development, social environmental responsibility, green economy and circular economy are confirmed by the results of research conducted by climatologists, biologists, ecologists, etc. the process of global warming, the source of which is the growing emission of greenhouse gases, which is a side effect of the development of civilization based to a large extent on the classic model of energy production based on the combustion of fossil fuels. This article deals with a holistic, interdisciplinary approach to the issues of determinants of the implementation of the principles of sustainable development into economic processes, including corporate social responsibility, environmental social responsibility, eco-innovation, green finance and the pro-ecological transformation of the economy towards green economy and circular economy.

Keywords: *sustainable economic development, eco-innovations, pro-ecological reforms, renewable energy sources, green revolution, Coronavirus SARS-CoV-2, COP25*

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Streszczenie

Kryzysy gospodarcze stają się niejednokrotnie źródłem nowych koncepcji biznesowych i transformacji systemów gospodarczych. Od czasu globalnego kryzysu finansowego 2008 roku rośnie znaczenie implementacji zasad zrównoważonego rozwoju gospodarczego jako kluczowego elementu zielonej rewolucji i transformacji dotychczasowej, tradycyjnej, brązowej gospodarki nadmiaru do zrównoważonej, zielonej gospodarki umiaru. Jednak głównym czynnikiem wzrostu popularności w świecie nauki problematyki zasad zrównoważonego rozwoju gospodarczego, społecznej odpowiedzialności środowiskowej, green economy i circular economy są potwierdzane przez wyniki badań klimatologów, biologów, ekologów itd. niekorzystnych zmian klimatu, tj. przede wszystkim postępującego coraz szybciej od końca XIX wieku procesu globalnego ocieplenia, którego źródłem jest rosnąca emisja gazów cieplarnianych, będąca efektem ubocznym rozwoju cywilizacji opartego w dużym stopniu na klasycznym modelu energetyki produkcji energii bazującej na spalaniu paliw kopalnych. W niniejszym artykule podjęto się holistycznego, interdyscyplinarnego ujęcia problematyki determinantów implementacji zasad zrównoważonego rozwoju do procesów gospodarczych, w tym również społecznej odpowiedzialności biznesu, społecznej odpowiedzialności środowiskowej, ekoinnowacji, green finance oraz proekologicznej transformacji gospodarki w kierunku green economy i circular economy. **Słowa kluczowe:** zrównoważony rozwój gospodarczy, ekoinnowacje, reformy proekologiczne, odnawialne źródła energii, zielona rewolucja, , Koronawirus SARS-CoV-2, COP25

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JEL Classification: Q 01, Q 10, Q 20, Q 28, Q 38

Statement of the problem in general outlook and its connection with important scientific and practical tasks.


Introduction to the issues of implementing the principles of sustainable pro-ecological development and pro-ecological transformation of the economy towards green economy / circular economy.

Much scientific data from climatologists' research indicates that the global warming process has entered a strong upward trend and perhaps humanity has little influence on changing the pace of continuing this process. However, regardless of this, we should do everything we can to implement the principles of sustainable pro-ecological economic development, including the necessary pro-ecological reforms, primarily in the energy sector by developing renewable energy sources (Villegas Aguilar PJ, 2018), electromobility, development of organic farming, and improvement of segregation techniques waste, recycling, etc.

The aforementioned pro-ecological reforms implemented in accordance with the principles of sustainable green economy (Chapple K., 2008) are necessary to slow down the

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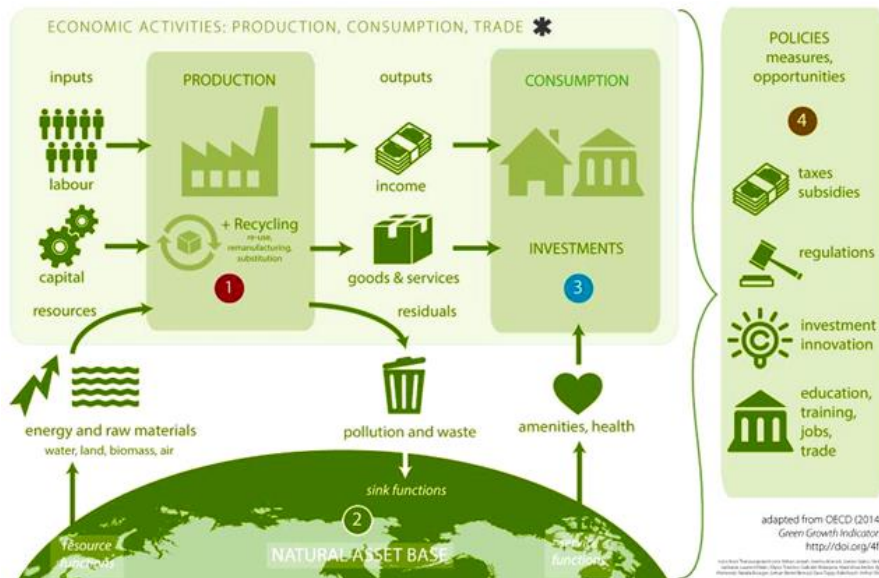
progressive global warming process, at least partially. One of the key elements and goals of the pro-ecological transformation of the economy towards green economy and circular economy (Ngan SL, How BS, Teng SY, Promentilla MAB, Yatim P., Er AC, Lam HL, 2019), i.e. primarily the implementation of pro-ecological reforms consisting in the implementation of the principles of sustainable pro-ecological economic development is the protection of nature, protection of natural biological ecosystems, protection of earth's biodiversity and its preservation for the next generations (Blicharska M., Smithers RJ, Mikusiński G., Rönnbäck P., Harrison PA, Nilsson M., Sutherland WJ, 2019). The terms green economy and circular economy, used many times in this article, are synonymous. Both terms stand for a sustainable economy with one slight difference. Well, the model of sustainable green economy emphasizes the importance of pro-ecological reforms, green revolution, ecological innovations (Kralj J., 2008), green finance (Fullwiler ST, 2015), green logistics, green marketing, etc. In contrast, the concept of sustainable circular economy emphasizes the importance of circular circulation of resources used, including natural and non-living nature raw materials, and thus also environmental sustainability, including the issue of reducing greenhouse gas emissions to the level of eliminating the surplus of these emissions.

The main idea of the New Green Deal, which is to be fully achieved in the European Union by 2050, refers to this issue. This idea is most advanced in terms of the planned practical implementation in the European Union, but in conceptual terms it also applies to a global scale (Barbier, E. B., 2009). However, since in many scientific publications these concepts are used as almost identical, for the purposes of this article it was assumed that they are synonymous and complementary to each other.

An important concept, which also appears many times in this article, is the issue of sustainability, referring to sustainable economic development, i.e. such development that does not disturb the balance in nature, does not cause negative effects on the natural environment, resource depletion, including raw materials of animate and inanimate nature (Goodland R., 1995). The essence of the concept of sustainability refers to the ecological balance prevailing in natural ecosystems characterized by a high level of biodiversity and a zero impact of human civilization on these ecosystems.

The resources of this type of natural, virgin ecosystems are constantly decreasing, while the importance of the idea of sustainability and its use to create more and more complete, complex, macroeconomic and interdisciplinary pro-ecological models of green economies has been growing strongly in recent years (Ocampo J. A., 2011).

Figure 1. Green Growth Indicators Framework.




Source: *Green Growth Indicators 2014* (in: “OECD iLibrary” website, OECD Green Growth Studies, ISSN: 22229523 online, (<http://www.oecd.org/greengrowth/green-growth-indicators>; https://www.oecd-ilibrary.org/environment/green-growth-indicators-2013_9789264202030-en, <https://doi.org/10.1787/22229523>), access: 5.8.2020.

In recent years, the concept of sustainability has been used in relation to various aspects that are components of the pro-ecological transformation of the economy. Many publications describe various issues of sustainable development, sustainable economy, sustainable growth, sustainable production (Sarkis J., Zhu Q., 2018), sustainable logistics, sustainable investments, sustainable trade, sustainable management (Hörisch J., Freeman E., Schaltegger S., 2014), sustainable banking (Bouma, J. J., Jeucken, M., Klinkers, L., 2017), sustainable tourism (Amalu, TE, Ajake, AO, Oba, DO, Okpara, DE, 2012; Aydin B., Emeksiz M., 2018) etc. There is therefore a risk of abuse of this concept in relation to specific, selected, fragmented areas of economic activity, which may have little in common with the idea of sustainability (Montabon F., Pagell M., Wu Z., 2016). On the other hand, in enterprises representing various sectors of the economy and operating both in highly developed countries and in developing countries, where the level of citizens' income is relatively low, pro-ecological reforms are undertaken and ecological innovations are implemented (Chege S. M., Wang D., 2019). More and more companies are adding the issue of environmental policy to their business strategies (Kuo L., Chen V. Y. J., 2013) in order to improve the company's brand image. There are more examples of this type of enrichment of the company's strategy and mission with selected elements of the principles

of sustainable development, social environmental (ecological) responsibility, pro-ecological transformation of the economy in economic entities operating in a given country, in a situation where the so-called . fashion for ecology. The issues of sustainable development, including, inter alia, the implementation of ecological innovations, also referred to as eco-innovations, into economic processes, are particularly developmental issues in recent years. The confirmation of this thesis is, among others, the scale of differentiation in defining the concept of eco-innovation proposed by various public institutions, organizations conducting pro-ecological activities, as well as researchers and scientists dealing with this issue (Pakulska J., 2020). In recent years, the importance of improving complex, multi-faceted analytical models used to assess the level of sustainability of specific economic systems, models built of indicators related to various economic, social and environmental aspects affecting the issue of economic sustainability and co-creating the principles of sustainable development or acting as determinants of the implementation of these principles has also been growing. for economic processes (Bocken NM, Short SW, Rana P., Evans S., 2014; Strezov V., Evans A., Evans TJ, 2016; Whitehead J., 2017). Research is also conducted to improve the methods of measuring the sustainability of the functioning of economic entities, the analysis of eco-enterprise strategies (Stead JG, Stead E., 2000) and the long-term development missions implemented by these entities, applied in these cultural entities organizational, etc. (Naidoo M., Gasparatos A., 2018). The issue of implementing the principles of sustainable pro-ecological development is currently a key topic for the optimal and safe development of civilization and the protection of biodiversity on the planet Earth. In order for the principles of sustainable pro-ecological development to be implemented on a large scale in economic processes, systemic, legal, business changes, etc. are necessary, which are part of the pro-ecological reforms implemented as part of the transformation of the economy towards green economy (Šuligoj M., Štrukelj T., 2017). For this to be possible, it is necessary to significantly increase the scale of the ongoing transformation of the current economies, also known as expansive economies of surplus, operating under the dominance of liberal capitalism (Ryszawska B., 2016) and the principles of classical economics towards sustainable moderation economies (Kołodko G., 2015) also known as green economy and circular economy. The process of this pro-ecological transformation is referred to in the English-language literature as the sustainability transition. It is also necessary to increase the financing of research projects creating technological ecological innovations and their implementation. These processes are an important element of sustainable pro-ecological development. Ecological innovations can also be financed from green finance sources (Zioło M., Fidanoski F., Simeonovski K., Filipovski V., Jovanovska, K., 2017). Pro-ecological reforms are necessary to reduce the negative effects of environmental pollution and the increasingly faster global warming process. The implementation of the principles of sustainable pro-ecological development is necessary to avoid a global climate catastrophe, the climate of Armageddon, which may appear at the end of the 21st century, if the classic economy is not converted to green economy in the next several years. There is little time left to save humanity and the biodiversity of planet Earth.

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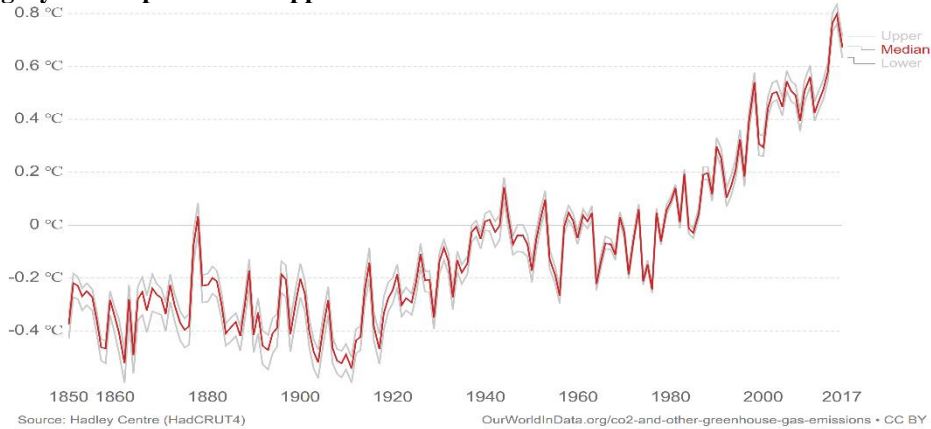
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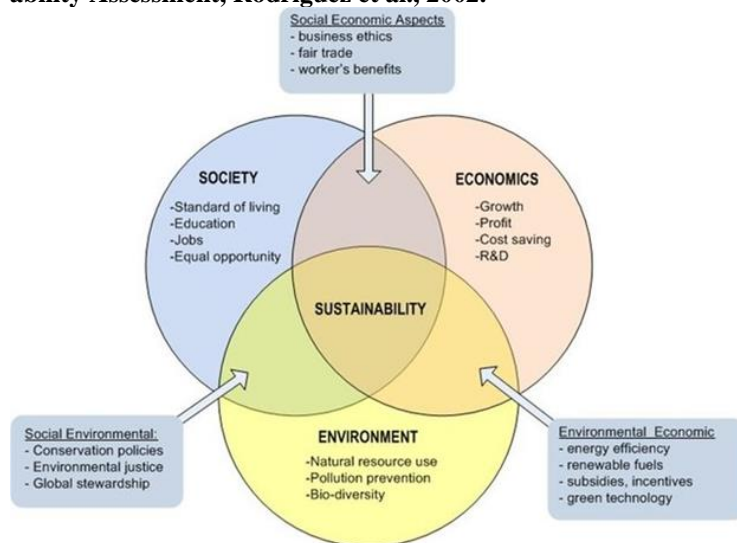
Graph 1. Average global temperature increase from 1961-1990 in degrees Celsius (° C). The red line represents the median of the mean temperature change and the gray lines represent the upper and lower 95% confidence intervals.



Source: Ritchie H., Roser M. (2017). *CO2 and other Greenhouse Gas Emissions* (in:) Internet portal “Our World in Data”, May 2017, (<https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions>), after: Hadley Center (HadCRUT4).

It is very important to promote in the media the necessity to implement the principles of sustainable pro-ecological development in accordance with the philosophy of green economy in order to make the society aware of the highest priority of this issue. The issues of implementing the principles of sustainable and environmentally friendly development should also be included in the curricula at schools and universities. Also non-governmental institutions, public institutions and also companies operating commercially should become involved in promoting the principles of sustainable pro-ecological development in line with the philosophy of green economy, including conducting pro-ecological projects financed from green finance sources. In recent years, there are also more and more commercially operating companies and financial institutions that engage in these pro-ecological activities. Some of these institutions want to improve their image by conducting parasocial marketing campaigns and public relations conferences. It is also good action at the beginning of the path towards disseminating and making the public aware of the highest priority of sustainable pro-ecological development, carried out in order to transform the current economy towards a sustainable green economy (Jänicke M., 2011). The three interrelated main spheres of sustainability are presented in the figure below.

Figure 2. Interplay of the environmental, economic, and social aspects of sustainable development. Mark Fedkin. Adopted from the University of Michigan Sustainability Assessment, Rodriguez et al., 2002.



Source: Utama I, Utama M. (2019). *The Political Law on Coal Mining in the Fulfilment of People's Welfare in Indonesia*, (in:) "Sriwijaya Law Review", Vol. 3 Issue 1, January 2019, pp. 11-25, (<http://journal.fh.unsri.ac.id/index.php/sriwijayalawreview>); https://www.researchgate.net/publication/330762891_The_Political_Law_on_Coal_Mining_in_the_Fulfilment_of_People%27s_Welfare_in_Indonesia).

In view of the above, the current, dominant model of the classical economy should be transformed into a sustainable green economy model in the coming years by implementing the principles of sustainable pro-ecological development, and ecological innovations should be financed from green finance sources. It is now a very important topic for humanity and the biodiversity of planet Earth. Pro-ecological reforms are necessary to reduce the negative effects of environmental pollution and the accelerating global warming process. The implementation of the principles of sustainable pro-ecological development is necessary to avoid a global climate disaster, the climate of Armageddon, which may appear at the beginning of the XXII century, if in the next dozen or so years the pro-ecological transformation of the existing, dominant, traditional brown surplus economy model into a sustainable one is not carried out to a large extent, green economy of moderation. There is little time left to save humanity and the biodiversity of planet Earth.

Analysis of latest research where the solution of the problem was initiated.

The issue of implementing the principles of sustainable economic development described in this study as a key element of the green revolution based on the concept of green economy and circular economy in recent years has been discussed in various and numerous

scientific publications by scientists operating in various scientific environments and coming from different countries. As a result, this scientific research has gained a global character many years ago. The growing interest of scientists in these issues results from its topicality and high level of relevance of the topic. The increased interest in this issue among scientists in recent years has emerged after the emergence of the global financial crisis in September 2008 (Jessop B., 2011). The global financial crisis that appeared in mid-September 2008 is most often associated with the sources of mainly unethical business practices and violations of security procedures in investment banking (Dmowski A. Prokopowicz D., 2010) in order to generate an even record-high profit than in previous periods while accepting higher and higher credit risk (Prokopowicz D., 2015). However, the use of this type of practice, i.e. accepting too high a level of investment risk while waiting for above-average profits, while ignoring the principles of business ethics (Prokopowicz D., 2016), corporate social responsibility (Stonkutė E., Vveinhardt J., Sroka W., 2018), environmental social responsibility (Murray A., Haynes K., Hudson LJ, 2010), the principles of sustainable development, disregarding the costs and consequences for the natural environment activated to the maximum possible degree of economic growth (Gwoździewicz S., Prokopowicz D., 2015b), stimulating economic activity leading to overproduction, excessive waste generation (Kaseva ME, Mbuligwe S. 2005) etc. can be found in many different economic entities operating in various industries and sectors of the economy. The global financial crisis of 2008 was disseminated in many publications and in the media (Soboń J., Prokopowicz D., 2018) as a crisis mainly related to the banking sector, because most of its direct sources were found in investment banking, in which transactions with high investment risk were undertaken financial with the use of securities, including credit derivatives (Gwoździewicz S., Prokopowicz D., 2019) used to obtain additional sources of financial capital with the help of which mortgage loans were granted for the purchase of more and more expensive real estate with a realistically lower and lower creditworthiness of buyers of these properties. Almost no one noticed the generated speculative bubble on the constantly rising prices of real estate, securities, prefabricated products, raw materials and other assets until it burst (Prokopowicz D., 2019). Huge public aid worth a total of several hundred billion USD annually, granted over several years, was spent from public funds to maintain liquidity in the banking sector and thus to stop the economic recession and then generate a quick return to economic growth, but unfortunately under the current conditions of economic activity conducted for years (Prokopowicz D., 2020a). The restructuring processes applied in this way, which were undertaken in a few corporations, which also received financial support as part of state aid, were mainly aimed at improving profitability so that the State Treasury institution could sell its stake in shares with high profit after 2 or 3 years. from the capital investment made. Thus, the few restructuring processes applied and granted to many economic entities, including banks (Szybowski D., Prokopowicz D., Gwoździewicz S., 2016), contributed to the rapid return of economic growth in the current, traditional formula of classic economy dominance and the continuation of the systems economic activities operating in the model of liberal capitalism, activated by Keynesian state interventionism (Gwoździewicz S., Prokopowicz D., 2015a; Domańska-Szaruga B., Prokopowicz D., 2015), the mild monetary policy of central banking (Prokopowicz D., 2018; Gwoździewicz S., Prokopowicz D., 2018), however, without the large-scale application

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of a thorough transformation of economic processes towards a sustainable, pro-ecological green economy of moderation, i.e. moderate, optimal and close to the level of zero economic growth, postulated for many years in the world of science. The granted state aid essentially prolonged the functioning of economic systems on the existing principles, depriving the society of deeper reflection on the issue necessary to implement the green revolution in the economy. However, on the other hand, in the financial and economic crises that from time to time appear in economic systems functioning in the realities of liberal capitalism, positive aspects can also be found. Well, financial and economic crises often become the source of new business concepts and transformation of economic systems. Since the global financial crisis of 2008, the importance of implementing the principles of sustainable economic development has been growing as a key element of the green revolution based on the concept of green economy and circular economy. However, the main factor behind the increase in popularity in the world of science of the issues of sustainable economic development and the concept of green economy and circular economy are confirmed by more and more research results of climatologists, biologists, ecologists, etc. global warming, the source of which is the growing emission of greenhouse gases, which is a side effect of the development of civilization based to a large extent on the classic model of energy production of energy by burning fossil fuels. According to some concepts of transformation of an economy operating according to the principles of the classical economy, defined, inter alia, as an economy of excess to the green economy, a possible scenario of a multi-faceted, complex transformation process may be a slowdown in economic growth, which is not an economic crisis. This type of transformation process of the economy of excess, also known as the brown economy, towards the economy of moderation, also referred to as the green economy, was described by Ryszawska B. in the publication *Green transformation of the economy as a path to a moderation economy* (Ryszawska B., 2016). The process of this transformation in English-language literature is often referred to as the *sustainability transition*. Many researchers suggest that the 2008 global financial crisis was, in its origin, mainly a financial crisis generated mainly by the use of unreliable business and investment practices applied in investment banking. However, in its development, turning into an economic crisis, also affecting many different economic entities in non-financial sectors, and in some countries also into a debt crisis of the state finance system, the aforementioned crisis acquired a multifaceted character. Some researchers also find in the global financial crisis of 2008 sources deepening the crisis of social and environmental nature, also known as environmental, which has been developing for many years. Jackson T. (Jackson T., 2009) and Kołodko G. (Kołodko G., 2010) are among the researchers who link the global financial crisis of 2008 with the ecological and social crisis. Paradoxically, the strong economic slowdown occurring in many countries in 2020, caused by the development of the SARS-CoV-2 coronavirus pandemic (causing the Covid-19 disease), could have been an opportunity to accelerate the implementation of environmental reforms, but it did not happen. In many countries, during the economic crisis of 2020, interventionist, anti-crisis programs of financial support for commercially operating enterprises were introduced from the funds of the public finance system of the state, i.e. primarily tax breaks and para-tax, temporary exemptions from the payment of social security contributions, granted enterprises under the so-called Anti-crisis shields - non-returnable subsidies to employees' salaries in order

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to preserve jobs despite the fact that enterprises did not conduct their business. Despite the existing situation in 2020, in order to implement further systemic pro-ecological reforms, these opportunities were not used to strengthen pro-ecological state interventionism. In 2020, the governments of individual countries implemented models of interventionist, anti-crisis programs to stimulate economic growth, using the models of easy monetary policy, pro-development fiscal and socio-economic policies known from previous economic crises. Apparently, the recommendations and suggestions of researchers and scientists who analyzed the sources of the global financial crisis and provided recommendations for necessary systemic reforms were misinterpreted in this matter, thanks to which the risk of the emergence of further similar crises was to be significantly reduced. Therefore, for example, the recommendations of Jackson T. (Jackson T., 2009), Kołodko G. (Kołodko G., 2010), Ryszawska B. (Ryszawska B., 2016) regarding the necessity of urgent pro-ecological green transformation of the economy of excess based on the classic energy of burning fossil fuels, overproduction, generating large amounts of waste, high level of environmental pollution, strong income stratification of society, excessive consumptionism, etc. towards moderation economy, reduction of overproduction, reduction of waste generation, reduction of environmental pollution, development of renewable energy sources, etc. These processes, of course, are already taking place in many countries on a limited scale and independent of the economic crisis of 2020 caused by the development of the SARS-CoV-2 coronavirus pandemic.

For many years, researchers and scientists, and in previous centuries also philosophers, were looking for a new, more equitable socially and also in terms of the relationship between man and nature, a model of civilization development, an economic system that is now defined as pro-ecological, more compatible with nature, respecting nature and caring for its protection. Ryszawska B. indicates that in recent years attempts have been made in the scientific community to build a full, multi-faceted model of a sustainable economy, also known as the green economy or the moderation economy (Ryszawska B., 2013). Ryszawska B. (Ryszawska B., 2016) also points out that considerations about the economics of sustainable development and the economy of moderation are also conducted by Kołodko G. in his publications. In the article *Rational needs as the basis of socio-economic development*, Kołodko G. points out that modern economies are not characterized by moderation and that in current economies of excess, various types of deficits are a problem, both in terms of the system and perceived by citizens accustomed to overproduction and excessive consumerism (Kołodko G., 2015). The key issue in this issue is to define and characterize the essence, concept and determinants of the creation and development of a moderation economy, also known as a sustainable economy or a green economy. Defining and characterizing a green economy consists in creating a model of an economic system that is in almost all key respects the opposite of an excess economy. So, if the traditional brown economy of excess is based on fossil fuels, excessive use of resources, growing greenhouse gas emissions and waste, i.e. in fact on overproduction and overconsumption (Kołodko G., 2015), then a sustainable, green economy of moderation is based, among others, on energy generated from renewable energy sources, economical use of resources supported by sustainable waste management (Godswill Awuchi C., Somtochukwu Victory I., 2017) taking into account technologically improved waste sorting and recycling, and also a green economy characterized by falling greenhouse gas

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emissions and reduced amount of litter the terrestrial and marine environment of plastic waste (Sharma S., Chatterjee S., 2017) and the declining overproduction and overconsumption of essentially unnecessary products. According to G. Kolodka, the green economy of moderation should be devoid of "excesses, shortages, imbalances and crises." In the conditions of a balanced economy of moderation, the standard should be moderation in terms of resource consumption, above all, the maximum reduction and / or optimized use of non-renewable minerals (Smith R., 2018) and also renewable resources of living nature, moderation in terms of production and consumption, minimization of the generated waste that is not subject to recycling and adapting to the real possibilities of economic growth, i.e. low and non-interventionist-free, moderate, not burdened with public debt, close to the level of zero sustainable economic growth. In addition, a sustainable economy should consist of business entities respecting the principles of business ethics and corporate social responsibility (Hemingway CA, Maclagan PW, 2004), including individual enterprises, public and financial institutions dominating in specific markets should not be unethical take advantage of their stronger position, should not take advantage of information asymmetry. Many researchers and scientists dealing with the issues of sustainable development indicate strong connections and correlations between the principles of sustainable development implemented in economic entities and respecting the principles of corporate social responsibility (McWilliams A., Siegel DS, 2011; Engert, S., Rauter, R., Baumgartner, RJ, 2016; Baumgartner RJ, Rauter R., 2017). As a result of the ongoing and increasing scale of the implementation of the processes described above, it will be possible to meet other key attributes of a sustainable economy, which include a relatively small income stratification of the society. In the presently existing economies, from the moment when economic research and collecting data on the development of economic systems developing in Europe and on other continents began, i.e. from the 17th century, both nationally and internationally, the scale of differences in the average income of the population in individual countries and the scale of income stratification in the societies of both highly developed and developing countries was constantly increasing. The growing income stratification of the society has often led to dramatic events, i.e. economic revolutions and / or crises, and possibly also high volatility of business cycle trends. Paradoxically, during these dramatic events, financial and economic crises, the scale of income stratification in societies, instead of falling, additionally increased. A similar situation occurred after the global financial crisis appeared in mid-September 2008. In addition, recently there are more and more economic data suggesting a similar situation in connection with the economic crisis that appeared in many countries in the first half of 2020 in connection with the development of the SARS-CoV-2 coronavirus pandemic.

In a sustainable economy, all sectors and markets should function according to the principles of sustainable and environmentally friendly economic development. So, for example, commercial banks and public institutions, not only to improve their image, should effectively invest in pro-ecological economic projects, which will not always be characterized by high profitability. Many commercial banks already provide the so-called green credits by financing the development of green business ventures. However, only some commercial banks conduct their own research on climate change (Buranatomul T. Swierczek FW, 2017) and take into account the issues of global warming and the need to participate in the pro-ecological economy process, actively implementing the principles of

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sustainable development and corporate social responsibility (Lock I., Seele P., 2015).) also to its activities, including credit risk management processes. Still, it is mainly the implementation of the public relations strategy consisting in improving the bank's image and adding to the bank's mission the issue of broadly understood ecology. In the following years, the use of the topic of ecology, sustainable development, eco-innovation, pro-ecological transformation of the economy, green economy, global warming, climate change, etc. should go beyond financial and public institutions, corporations (Stanny E., Ely K., 2008) and other entities. marketing and public relations issues (Andrikopoulos A., Samitas A. Bekiaris M., 2014). In the future, financial institutions should make more and more *green credits* with a view to not only adding to the published economic and financial reporting of their business activities (Frias-Aceituno JV, Rodríguez-Ariza, L., Garcia-Sánchez, IM, 2014; Nobanee H., Ellili N., 2016) columns with information on how many such loans they granted, for what amount, for what types of pro-ecological projects, etc., as well as specific principles of sustainable development, corporate social responsibility (Scholtens B., 2009) and environmental social responsibility (ecological) should become a key philosophy of the long-term mission and development strategy of financial institutions and other economic entities (Kuo L., Chen VYJ, 2013).

However, already now, financial institutions and other economic entities should add the issue of pro-ecological activities, sustainable development, and social environmental (ecological) responsibility to their reporting (O'Donovan G., 2002). The issue of implementing the principles of sustainable development and the impact of the state's environmental policy should, in principle, apply to every key area of the functioning of a financial institution, including a commercial bank. Therefore, the "greening" of banking should also apply to one of the most important determinants of the effective functioning of the bank, ie the credit risk management process. In such a situation, the concept of environmental credit risk management is used in commercial banks and other financial institutions (Weber O. 2012). Therefore, it is also necessary to improve the process of institutional, systemic integration of environmental (ecological) risk management with credit risk management in commercial banks and other financial institutions (Weber O., Fenchel M., Scholz, R. W., 2008). This process should take place successively as part of the implementation of the principles of sustainable development and pro-ecological banking transformation in the context of the parallel improvement of the process of managing the risk of developing cybercrime and the potential loss of data transferred under electronic internet banking systems, including mobile banking (Prokopowicz D., 2020b; Gwoździewicz S., Prokopowicz D., 2020a; Gwoździewicz S., Prokopowicz D., 2020b). The implementation of the principles of sustainable development, corporate social responsibility (Scholtens B., 2009) and social environmental (ecological) responsibility in banking is an important element of the transformation of traditional banking towards sustainable banking, also referred to in the literature as *green banking*, although the concept of sustainable banking is a broader concept *green banking*, because in addition to the issue of financing pro-ecological business ventures, it also includes various aspects of sustainability concerning the functioning of the bank. The growing importance of this issue is emphasized by the fact that the implementation of the principles of sustainable development, corporate social responsibility and environmental (ecological) social responsibility in banking is already taking place in various banks operating practically on

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all continents of the world (Branco MC, Rodrigues, LL, 2006; Achua JK, 2008; Haque S., Deegan, C., 2010; Andrikopoulos A., Krikiani N., 2012; Amran A., Periasamy V., Zulkafli AH, 2014; Camilleri MA, 2015; Kiliç M., Kuzeý C., Uyar, A., 2015).

Only then will financial institutions become a really important factor in the pro-ecological transformation of the current economy towards a sustainable green economy. The question remains whether, given the limited time to carry out the above-mentioned pro-ecological transformation, whether it is possible to leave financial institutions independent in the context of economic liberalism as to when, how, to what extent, with what financial involvement, etc., they will increase their pro-ecological activity. However, should the state, as part of the implementation of an interventionist environmental (ecological) policy, set certain standards, goals, a calendar, etc. of necessary measures to implement the program of increasing the scale of sustainable banking and *green finance* in the economy. Therefore, in the future, commercial financial institutions and the public sector, guided by the principles of sustainable development, will finance the implementation of pro-ecological investment projects accepting only a moderate, fully secured level of credit risk. These entities, applying the principles of business ethics and corporate social responsibility (Pérez A., del Bosque, I. R., 2012), are referred to as sustainable banks, etc., and the funds obtained for the implementation of pro-ecological economic undertakings may come from with the so-called green finance. Sustainability is the main idea in other sectors and industries as well. For example, sustainable tourism (Arsić S., Nikolić D., Živković Ž., 2017) does not cause an increase in greenhouse gas emissions and the devastation of visited historical sites and areas of specific natural environments. On the other hand, sustainable marketing does not create excessive demand for unnecessary products that generate overproduction and an increase in the produced non-recyclable waste. Therefore, in sustainable marketing, no aggressive advertising campaigns, including price promotions, are used, during which consumers are misled to a certain extent when viewing advertisements and spots presenting specific offers of products or services. Sustainable logistics (Blome C., Paulraj A., Schuetz K., 2014) is about optimizing energy consumption, developing electromobility (Bridle R. and Kitson L., 2014), using mainly intermodal land transport and reducing greenhouse gas emissions. Sustainable transport logistics also consists in replacing the use of non-biodegradable or hardly biodegradable plastic in packaging with biodegradable materials (Padmanabhan S., M. R., 2016), i.e. having a short decomposition time in the natural environment.

Sustainable production involves the production of durable consumer and investment goods, i.e. without the use of deliberate aging of manufactured products or prefabricated products, consisting in shortening their useful life (Angelakoglou K., Gaidajis G., 2015). In addition, sustainable economy is also characterized by optimization, successive reduction of the processes of transforming natural, natural landscapes and green areas into intensified agricultural production and the rapid development of urban agglomerations. This process should be replaced by the development of sustainable ecological agriculture and the development of sustainable construction technologies, zero-energy construction and a greater degree of protection against possible climate changes (Camilleri M., Jaques R., Isaacs N., 2001), construction defined, among others, as sustainable architecture (Zavadskas EK, Antucheviciene J., Vilutiene T., Adeli H., 2018), green construction and sustainable agglomerations developed with the use of smart technology referred to as

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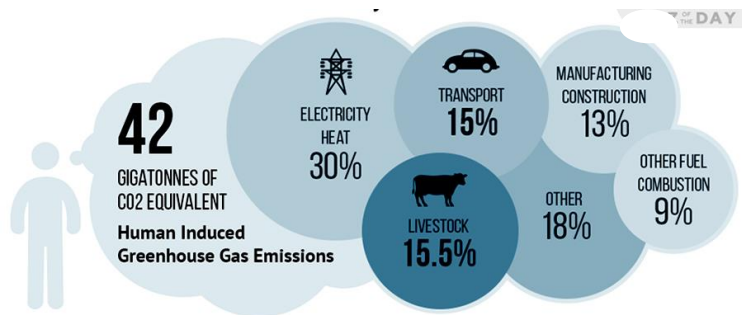
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sustainable, pro-ecological smart city. In the thus formed sustainable economy of moderation, redundant products should no longer be created, sold at seemingly attractive price promotions, from which their producers derive high profits by allocating them to the production of further redundant products, the "possession and consumption of which no longer improves consumer satisfaction" (Kołodko G., 2015).

The above theses have been confirmed by the results of research conducted, among others, by the Food and Agriculture Organization. The conducted research shows that the power industry and car communication are not the only main sources of greenhouse gas emissions. The main emitters of greenhouse gases in 2005-2015 also included intensified livestock farming and the associated increase in the production and sale of meat and dairy products on a global scale during this period. World meat production has more than doubled in 30 years, from 145.3 million tonnes in 1983 to 310.4 million tonnes in 2013. This increase is projected to continue to 355 million tonnes by 2024. Milk production increased by 50% over the same period and is expected to increase by 19% over the next 11 years (*Global Greenhouse Gas Emissions from Livestock*, 2016). The current trends in the consumption of food and the marketing of food products, unfortunately, do not support the implementation of the principles of sustainable development in the agricultural sector. The graphic below shows the annual greenhouse gas emissions for the period 2005-2015 according to the data from the Report published by the Food and Agriculture Organization.

Figure 3. Emissions of Greenhouse Gases by Sectors (annual emission in the period of: 2005 – 2015).



Source: *Global Greenhouse Gas Emissions from Livestock*, (in:) “Knoema.com” website, Data Driven, August 1, 2016, (<https://knoema.com/infographics/maodxb/global-greenhouse-gas-emissions-from-livestock>), for Report by the Food and Agriculture Organization, EDGAR, World Resources Institute, access: 5.8.2020.

Ryszawska B. (Ryszawska B., 2016) also points out that contemporary problems of increasing greenhouse gas emissions and pollution of the natural environment as well as other negative effects of the development of civilization for nature, such as adverse climate changes, including accelerating the process of global warming, decreasing green areas, the decreasing scale of biodiversity of natural ecosystems, depletion of non-renewable resources, diminishing amount of clean fresh water, etc. and socio-economic, related

to the large and growing income stratification of societies, unequal access to many consumer goods are, on the one hand, the source of growing social discontent and on the other hand, they increase the risk of a serious climate crisis in the future. Solving these problems in the future will be possible not through pro-ecological measures implemented at present on a limited scale and to a degree differentiated in individual countries, but through thorough structural reforms of entire economic systems, including production and consumption processes, towards achieving economic sustainability. In this process, the so-called the economic transition should involve practically all types of economic entities and institutions functioning in modern economies, i.e. operating commercially in various sectors and branches of enterprises, public and financial institutions, non-governmental organizations, investment funds (Sørensen OB, Pfeifer, S., 2011), institutions associating certain types of companies and corporations as well as individual citizens, including teachers, politicians, engineers, scientists, people active in the media, etc. The aforementioned systemic transformation of the traditional, brown, expansive economy of surplus towards a sustainable, green economy of moderation, i.e. the pro-ecological transition of the economic system (Zacher L., 2011) has been defined as a multi-faceted, complex, long-term process of fundamental changes, transformation of the economic system, in which various economic entities and institutions representing all sectors and branches of the economy undergoing systemic transformation are involved (Geels FW, 2011) towards achieving sustainability and increasing the importance of ecology.

Therefore, Ryszawska B. (Ryszawska B., 2016) after Geels FW (Geels FW, 2011) introduces to this issue the notions of *multilevel perspective*, borrowed from Geels, denoting a methodological research concept developed for the purpose of analyzing the transformation of the economy as a multi-faceted, complex process consisting in *sustainability transition*, that is, sustainable change. Also Loorbach DA and Lijnis Huffenreuter R. (Loorbach DA, Lijnis Huffenreuter R., 2013) indicate that for several decades the growing and more and more frequent economic, environmental, social and political crises increasingly determine the growing pressure to carry out a specific transformation systemic, including pro-ecological social and economic reforms. A particularly strong overtone in this regard appeared after the global financial crisis of 2008. As part of pro-ecological socio-economic reforms, the traditional economy of excess, generating economic imbalances, large income disproportions in society, overproduction, excessive consumptionism, production of non-biodegradable waste, emitting greenhouse gases and generating the increasingly frequent financial, economic, ecological, political and recently also pandemic, i.e. caused by the Coronavirus SARS-CoV-2 should be transformed by implementing the principles of sustainable development, increasing the scale of corporate social responsibility (Lock I., Seele P., 2015), implementing ecological innovations, developing renewable energy sources etc. an economy of moderation, functioning in accordance with the concept of green economy and circular economy. Loorbach D. A. and Lijnis Huffenreuter R. (Loorbach D. A., Lijnis Huffenreuter R., 2013) also refer to the aforementioned pro-ecological, systemic transformation of the economy as the concept of *sustainability transition*.

According to McIntosh M. (McIntosh M., 2013), the processes of transformation of economies have already begun in various aspects. For at least a few years, some countries have seen the transformation of the energy sector, consisting in the development of renewable

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energy sources and their replacement of traditional energy, where electricity was mainly generated in power plants burning hard coal, lignite, oil mazout or other minerals. Parallel to this pro-ecological transformation of the energy sector, the process of developing electromobility began (Bridle R. and Kitson L., 2014). In this way, the amount of greenhouse gas emissions released into the atmosphere is reduced. This type of economy transformation process is shifting away from a high-carbon economy and moving to a low-carbon economy. However, this is not the only aspect of the ecological transformation of the economy. McIntosh M. (McIntosh M., 2013) suggests that, in parallel to the pro-ecological transformation of the energy sector, there is also a socio-economic transformation in other areas. Among these other transformations, McIntosh M. (McIntosh M., 2013) also includes the processes of transition from a society of deep inequalities, income disproportions, property stratification of society to the development of egalitarianism, and the transition from the daily practice of violating human rights to socially just communities in which the scale of business ethics and corporate social responsibility applied in economic activities. Røpke I. (Røpke I., 2013) supplements the above-described concept of sustainability transition with a description of the transforming production and consumption systems, including, inter alia, the social engineering system of energy production and distribution, the system of transport logistics, supply and production of agricultural crops and their processing in the agri-food industry. According to the statement of Ryszawska B. (Ryszawska B., 2016), the multifaceted and interdisciplinary nature of the pro-ecological and systemic transformation of the economy, referred to as the *sustainability transition*, has not yet been fully holistically described and examined, because the vast majority of researchers and scientists operate, conduct research, etc., increasingly narrowly specialized disciplines. McIntosh M. (McIntosh M., 2013) emphasizes the importance of education, which should include, among others, the issues of the process of transformation of the traditional economy towards a sustainable economy functioning in accordance with the principles of sustainable development and according to the concept of green and circular economy described in this article. Geels F. W. (Geels F. W., 2013) in his work entitled *The impact of the financial-economic crisis on sustainability transitions: Financial investment, governance and public discourse* explains that, as part of the *sustainability transition* process, the transformation of the economy can take place in many ways, i.e. through:


- a) a thorough reconstruction of the existing capitalist economic system,
- b) "green" industrial revolution,
- c) "green" growth.

Stern N. (Stern, N., 2007) pointed to the growing importance of the issue of the climate crisis in recent years as a result of discussions on explaining the sources, specificity and effects of the 2008 global financial crisis.

In view of the above, the discussions on the ecological transformation of the economy suggest that the general public awareness of the importance of the natural environment in the context of the development of human civilization is changing. As a result of the ongoing changes, individual aspects of the pro-ecological transformation of the economy and the role of the natural environment are no longer studied and described only as independent, unrelated issues representing various scientific disciplines, various sectors and industries of the economy and various institutions that have not cooperated so far. (Awan

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U., Kraslawski A., Huiskonen J., 2018). Through the ongoing transformations of research processes and the interpretation of the issues of transformation of the economy implemented according to the concept of *sustainability transition*, individual aspects of the pro-ecological transformation of the economy and the role of the natural environment gain a broader, interdisciplinary, holistic approach and are becoming more and more multifaceted, complex, systemic, etc. (EEA, 2010).

Rockström J. (Rockström J., 2009) in the work *A safe operating space for humanity* informs about the growing risk of human crossing the essential, crucial for the planet Earth, the future of civilization development and life on Earth, the border of safe socio-economic development. Indication of the possible crossing of the border of safe socio-economic development by humans is important in the context of the negative effects of the development of civilization, which have been increasing in the last few decades, including the growing greenhouse gas emissions, the growing amount of non-recyclable waste and, consequently, the increasing environmental pollution, the declining biodiversity of natural ecosystems, the ever faster processes of climate change, including the global warming process, and the intensifying negative effects of these climate change processes, e.g. more and more frequent droughts in farmlands (Noohar A., Qashqaizadeh N., Heydarzadeh M., Aydoun MR, Panahi M., 2016) and forest fires. A particularly important issue is the indication of the possible crossing of the aforementioned border of safe socio-economic development soon, in the coming years in connection with the increasingly faster processes that cause the development of civilization to approach this border. The increase in the number of these problems in the world of science in recent years is confirmed by the increase in the citation rate of the aforementioned work, *A safe operating space for humanity* by Rockström. The issue of possible crossing the border of safe socio-economic development has been discussed for several years in many research works and publications on the consideration of the need for systemic change in development, transformation of socio-economic systems and attempts to define a new, more pro-ecological model of sustainable economy, which should be immediately pursued in order to avoid a high risk of the projected crossing of the safe border of socio-economic development.

The issue of the aforementioned high risk of the projected border crossing of safe socio-economic development is based on the results of research on the projected continuation of the global warming process over the next several dozen years and on the negative effects of this process in the form of increasing climatic disasters and weather anomalies. Crossing the aforementioned limit is associated with triggering a kind of chain reaction of irreversible acceleration of both the global warming process and other negative effects of the expansive development of civilization, which include, among others, the decline in biodiversity, environmental pollution caused by the development of industry and intensive agriculture, the deteriorating state of the atmosphere, which reduces depletion of the ozone layer in the atmosphere, acid rainfall acidifying land waters, diminishing resources of drinking water, more and more frequent forest fires, shrinking green areas, including natural ecosystems, etc. About the possible exceeding of the aforementioned border of safe social development in the near future economic activity was already written in the 1970s by Meadows, D. (Meadows, D., 1973), i.e. in the period of the earlier global economic crisis, referred to as the raw material crisis in connection with a significant increase in the price of bars crude oil and its economic and technological effects. Ryszawska B.

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(Ryszawska B., 2016) in her work *Green transformation of the economy as a path to a moderation economy* (*Zielona transformacja gospodarki jako droga do gospodarki umiaru*) defines the mentioned limits of safe socio-economic development as the limits of a safe symbiosis between humans and the Earth's environment. Rockström J. (Rockström J. and coop., 2009) indicates that the last 12 thousand. The Holocene years ended with the advent of the first industrial revolution.

On the other hand, the aforementioned industrial revolution started what the Nobel laureate Paul Crutzen called the anthropocene epoch. The transition from the Holocene to the Anthropocene is related to climate change, which is the result of industrial development, and the expansive development of civilization, taking into account the negative effects of this development on the natural environment. Rockström J. (Rockström J. 2009) points out that in connection with the potential crossing of the safe socio-economic development, it is necessary to carry out a systemic, pro-ecological transformation of the economy in accordance with the concept of *sustainability transition*, however, at present, humanity has not yet developed a complete plan as it should be efficiently and efficiently realize. On the other hand, the process of systemic, pro-ecological transformation of the economy, at least in the first stages of this transformation, is carried out with the simultaneous solving of the existing problems of the development of civilization and taking up challenges (Czaja S., Becla A., Włodarczyk J., Poskrobko T., 2012) concerning the social and economic development economic conditions, which include, inter alia, declining resources of some types of non-renewable resources, intensifying climate disasters and weather anomalies as a result of deepening unfavorable climate changes, the growing scale of environmental pollution causing deterioration of human living conditions, rapid population growth in developing countries characterized by low incomes per capita, an increase in international migration of people seeking better living conditions, rapid technological progress generating new risk categories, constantly activated by state intervention gospodarczy (Fiedor B, Kociszewski K., 2010) measured mainly by imprecise macroeconomic quantitative measure, ie Gross Domestic Product. The aforementioned examples of domestic, international and global problems of the development of civilization and socio-economic development have been repeatedly described in scientific and other publications in previous years. However, they were usually not described in a holistic, interdisciplinary, multi-faceted approach, taking into account the urgent need to conduct a pro-ecological transformation of the economy in order to create a sustainable economy in the future, operating in accordance with the principles of sustainable development and according to the concept of green economy and circular economy.

In a situation of activation of economic growth in the formulas in which it is usually done, i.e. in the formula that also dominates in many countries when stimulating economic activity during the Coronavirus pandemic, there is a return to a high level of consumption of natural resources, energy, production of non-recyclable waste and continuation of the process generating imbalances in natural ecosystems. In this way, the vicious circle of feedbacks of the expansive market economy, referred to in this article as the economy of surplus, has been confirmed. Dietz and O'Neil (Dietz R., O'Neil D., 2013) defined this type, which is still the dominant formula of the economy, as the *economy of more*, which means the constant pressure of activating economic growth, the growing scale of production and consumption, constantly growing competition motivating to increase profits in

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enterprises, excessive use of information asymmetry in financial transactions (Healy PM, Palepu KG, 2001), growing dividends expected by citizens from shares in capital companies, expected increase in profitability on assets operating on financial markets, growing household incomes, the need to constantly raise the standard of living, mainly as part of the growing scale of consumerism. However, in this way the scale of negative aspects of the traditional development of civilization continues to grow and it is not known how to change this process and effectively transform the economies of excess towards sustainable moderation economies.

Randers J. (Randers, J., Green, C., 2012) points to the growing risk of exceeding the limit of optimal civilization development in the context of human economic activity in the conditions of limited resources of animate and inanimate nature on the planet Earth, Randers J. published his vision in 2012 futurological development of civilization until 2052, in which it suggests that until the middle of the 21st century, the development of civilization will be determined mainly by several factors. According to Randers, these factors include the system of liberal capitalism as the dominant model of economic relations, the activation of economic growth in order to maximize it, the development of the social functions of the state with a democratic political system, a high level of social participation, inter-generational social justice and the growing level of social awareness of climate change and the need to implement the principles of sustainable development. However, the aforementioned social aspects and the growing general public awareness of citizens are only the beginning of the road within the pro-ecological transformation of the traditional economy of excess to a sustainable green economy of moderation. The specificity, characteristics, together with a description of the essence and main determinants of the hitherto dominant model of traditional surplus economy have been presented by Hawken P. and co-authors (Hawken, P., Lovins, A. and Lovins, L., 2000) in the publication *Natural Capitalism. The next industrial revolution*.

In the context of recently emerging global financial and economic crises, as well as other crises locally and regionally every few or several years, and the almost permanent interventionist activation of economic processes related to these crises, the awareness of many people, including politicians, entrepreneurs and consumers as well as some economists, a high level of economic growth is considered desirable and is almost exclusively interpreted in positive terms. This type of conviction has led to the fact that if information about weakening economic growth appears in the popular and official media, the decline in economic activity and the falling level of the Gross Domestic Product are usually perceived in negative terms. In many political and business circles, this type of information most often causes anxiety and pressure to launch interventionist anti-crisis instruments, Keynesian socio-economic policy in order to quickly restore high economic growth. Therefore, according to Jackson, questioning the necessity of activating economic growth, suggesting the need to reduce GDP as a derivative of the pro-ecological transformation of the economy, questioning the legitimacy of activating economic processes as a priority of socio-economic policy is perceived in many business and political environments as eminently idealistic, ideological, surreal and revolutionary (Jackson T., 2009). Ryszawska B. (Ryszawska B., 2016) claims that answers should be sought to the questions regarding the definition of the meaning of continuing economic growth in the context of an excess economy. As part of the considerations on the sense of continuing the

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processes of activating economic growth and maintaining it at a high level, there is a concept of separating from the commonly functioning concept of economic growth its negative effects, i.e. increasing environmental pollution, increasing greenhouse gas emissions, growing heaps of non-biodegradable and non-recyclable waste etc. This type of solution to the problem of the still dominant globally pressure on the traditionally interpreted economic growth in economies of excess could be a compromise for the expectations of economists representing traditional views on the domination of classical economics in the development of modern economies and of ecologists, who have been pointing to the negative aspects of the development of civilization and they try to undermine some of the fundamental assumptions of economics known and still valid since the first industrial revolution. The concept of separating negative aspects, effects, manifestations, externalities and costs of economic growth was called the concept of *decoupling*. The concept of *decoupling* applied to economic growth consists in subtracting negative externalities from the traditionally interpreted concept of economic growth, i.e. subtracting such negative effects of the development of civilization as, above all, increasing environmental pollution, increasing amounts of waste, shrinking green areas, decreasing biodiversity of natural ecosystems, shrinking resources of animate and inanimate nature, growing greenhouse gas emissions, accelerating the global warming process, deepening negative effects of climate change, etc.

In addition, the full application of the separation of negative externalities from economic growth should also include the effects of the aforementioned decoupling carried out according to the *decoupling* concept, namely the costs of rehabilitating the degraded natural environment, which will not appear if the mentioned external effects do not appear earlier. Ryszawska B. (Ryszawska B., 2016) points out that despite the knowledge, humanity still does not know how to implement in practice the concept of *decoupling*, i.e. separating the negative externalities of civilization development from economic growth, i.e. using it to carry out a traditional pro-ecological transformation economy of excess to a sustainable economy of moderation. It can therefore be assumed that, with a high degree of probability, humanity will still not solve this problem in the next few years, and it is the next 10-20 years that the most depends on exceeding the limit of optimal development of the global economy. The high risk of exceeding this limit will mean that the development of civilization will enter the phase of an irreversible chain reaction accelerating the global warming process. Therefore, according to Ryszawska B. (Ryszawska B., 2016), the legitimacy of activating economic growth, i.e. something that is constantly practiced in many highly developed and developing countries, basically regardless of the political systems prevailing in individual countries and forms of governance.

Therefore, in many scientific publications, economic growth has already been questioned as one and the key guarantor of a high standard of living for people in individual countries and in the context of the development of the global economy. During these conferences, attention was also paid to the growing income stratification on an international scale and in terms of the social structure of the human population inhabiting the planet Earth. Despite the growing international trade, the increase in the liberalization of international capital flows, the income stratification is not falling and there are many examples suggesting the reverse processes, i.e. the increase in the international polarization of equip-

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ping individual national economies with various categories of capital necessary for effective economic development. This is especially true of the countries with the lowest per capita incomes, as the scale of poverty in these countries, rather than falling, tends to increase. And the international and global economic crises that occur every few or several years usually additionally increase the scale of this unfavorable diversification. Ryszawska B. points out that the almost constantly growing scale of the above-mentioned income stratification and the number of people living in poverty, mainly in the southern hemisphere, in the context of growing prosperity in the highly developed countries of the northern hemisphere, should be a reason for shame and guilt among the decision makers responsible for shaping and the functioning of the dominant model of economic relations and the concept of socio-economic development dominating in the last few decades in highly developed countries (Ryszawska B., 2016).

In the literature on the subject, there are more and more arguments suggesting a far-reaching imperfection of economic growth as a measure of the socio-economic situation and the standard of living of citizens. For example, Stiglitz, J. (Stiglitz J., Sen A., Fitoussi J., 2009) indicates that economic growth expressed in GDP, informing about the quantity and value of produced and delivered to individual domestic and foreign markets for products and services, unfortunately does not inform about the material, economic and financial situation of citizens. It does not contain data describing the welfare of societies. Moreover, as Ryszawska B. (Ryszawska B., 2016) points out, the issue of imperfections and limitations of GDP as a macroeconomic measure of economic growth is also dealt with by the European Commission, which issued its recommendation on this issue in the communication entitled: *GDP and beyond. Measuring progress in a changing World*.

The comparison of the traditional "brown" economy of excess and the sustainable "green" economy of moderation has been presented many times at conferences held annually in the last dozen or so years under the patronage of the United Nations on the issues of implementing the principles of sustainable development into economic processes. Ryszawska B. (Ryszawska B., 2013) in the publication entitled: *Green economy - theoretical foundations of the concept and measurement of its implementation in the European Union (Zielona gospodarka – teoretyczne podstawy koncepcji i pomiar jej wdrażania w Unii Europejskiej)*, listed the key differentiating determinants and thus identification with which it is possible to distinguish and identify the brown economy of excess and the green economy of moderation.

In this document it was pointed out that it is necessary to revise the characteristics of the dominant and desired model of the economy as a socio-economic system which, while developing effectively, should ensure an increase in the welfare of citizens, but taking into account the principles of sustainable development. Therefore, it is necessary to redefine the target model of the developing economy as a socio-economic system in such a way that with the growth and / or maintenance of a high standard of living, good economic and financial situation of citizens, the principles of corporate social responsibility and social environmental responsibility (ecological transformation), pro-ecological transformation of economic processes and implementation of the principles of sustainable development. In the above-mentioned document, according to the state of the EU central authorities, the target model of the economy should take into account the multifaceted process of pro-ecological transformation taking place in all key sectors and sectors of the

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economy, which has been called "green economy", i.e. a development in which especially an important issue is the constant improvement of techniques and increasing the expenditure incurred, among others on environmental protection. According to the theorem of Barbara EB (Barbier EB, 2009), unlike the currently dominant brown economy model, largely based on classical energy generating energy based on the combustion of fossil fuels and other non-renewable resources of animate and inanimate nature, a new model a much more pro-ecological economy, i.e. a sustainable, green economy, of moderation should refer to the principles of environmental economy, in the energy sector, it should be based on the development of renewable energy sources and ensure more balanced relations between the economy and natural ecosystems.

The economic model that we call the *brown economy* is the result of a liberal, capitalist concept of the market in which the free movement of capital, goods, services and labor was to ensure economic growth and, consequently, the well-being of entrepreneurs, capital owners and, as a result, all citizens. The main measure of economic growth, and indirectly of welfare, in this model is GDP. It is assumed that growth is unlimited and GDP grows mainly through the use of natural resources, including energy resources. A side effect is the emission of gases into the atmosphere, waste and post-production and post-consumption pollution. An even further-reaching effect is the destruction of natural ecosystems, the loss of biodiversity, and a negative impact on human physical and mental health. Globally, economic growth leads to excess goods and overconsumption in some countries, and to poverty, food shortages and a lack of access to education and health in others. Continuation of the management method within the *brown economy* may deepen anthropopressure (resource consumption, greenhouse gas emissions, threat to biodiversity) and increase the threats to human health and quality of life.

At the beginning of the first industrial revolution, the precursors of the then new direction in the history of economic thought, i.e. classical economics, described the then economic reality of the beginnings of a brown surplus economy, defined key, fundamental economic concepts, and explained the operation of the economy and its economic entities. The precursors of classical economics, especially Adam Smith, believed that the developing liberal capitalist system and the development of international trade would in the future lead to an increase in the incomes of all economically cooperating countries and that the differentiation in economic development and prosperity, economic living conditions of citizens would decrease between individual countries. However, two centuries later, it turned out, on these issues of decreasing income inequality internationally, the creators of the classical economy were seriously wrong, because it is the aforementioned disparities in terms of economic development of countries, income and economic situation of citizens, etc., instead of decreasing it has grown to an even greater size. Currently, supporters of the necessary pro-ecological transformation of a brown, expansive economy of excess to a green, sustainable economy of moderation also believe that after the implementation of this plan, the development of civilization will be improved to such an extent that humanity will avoid serious threats resulting from possible climatic disasters, drastic weather anomalies, heavy pollution of the natural environment threatening human existence, a significant decline in biodiversity of natural ecosystems, etc. However, unlike the precursors of classical economics, the current pro-ecologically oriented researchers and scientists know what should be done regarding the mentioned system transformation, but

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they do not know how this transformation based on the concept of *sustainability transition* would be realized.

Ryszawska B. (Ryszawska B., 2016) indicates that the concept of a sustainable, green economy of moderation appeared many years ago in the world of science. The characteristics of the essence of the green economy of moderation appeared as part of the work of the Club of Rome in the context of the problem of trying to define the limits of the optimal development of civilization. Meadows D. (Meadows D., 1973) pointed to the aforementioned limits of the growth of the optimal civilization development as early as 1973. Even earlier, i.e. in 1967, Mishan E. (Mishan E., 1967) pointed to the negative externalities of the development of civilization, including the costs of rapid production and consumption growth in liberal, capitalist economic systems.

Schumacher E. (Schumacher E. 1981) in the early 1980s proposed the concept of a comprehensive analysis of economic processes taking place in the economy and pointed to the negative effects of these economic processes and blamed these economic processes for the growing scale of ecological and social problems and crises, which appeared then in many regions of the world and gained more and more global importance. Much earlier, because already in the 1960s, the limitations of the natural capacity of the planet Earth were pointed out. Boulding K. (Boulding K., 1966) suggested that the development of human civilization was burdened with an ecological risk, as it may exceed the potential of the aforementioned natural capacity of the Earth. At the end of the 20th century, Ostrom E. (Ostrom E., 1999) emphasized the importance of managing the common goods, suggesting the need for a joint, social solution to the growing environmental problems resulting from the increasing exploitation of natural resources. In animate and inanimate nature. On the other hand, the issue of the essence and the growing importance of the idea of sustainable development was already highlighted in the 1980s (Brundtland Commission, 1987).

Ryszawska B. (Ryszawska B., 2016) indicates that the increased interest in the transformation towards a green economy / moderation economy resulted from a critical debate on the systemic crisis. There was a conviction among politicians about the need to look for an alternative path of development. The process of economic, social and even civilization transformation was automatically, as well as in a controlled, activated and accelerated manner. One of its dimensions is the actual implementation of the postulates of a moderation economy. This process is taking place on an unprecedented scale and involving a wide range of stakeholders (business, governments and consumers). This is reflected in the actions of international organizations and countries that reacted to the crisis by presenting new development strategies and new policies focused around the idea of sustainable development, green growth and green economy, understanding them as the most effective in the process of economic recovery. Business entities are departing from the business as usual model and looking for new business models, including the idea of *corporate sustainability*. The same process is happening among consumers who are in favor of sustainable consumption and co-consumption.

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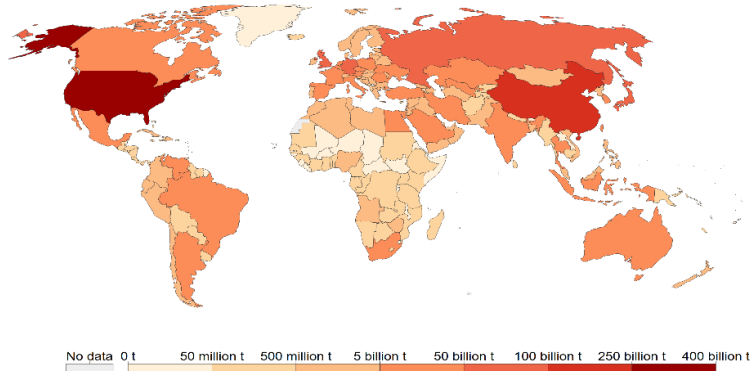
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Graph 2. Cumulative CO2 emissions, 2016 Total carbon dioxide (CO2) emissions represent the total sum of CO2 emissions since 1751 (in tonnes).



Source: Global Carbon Project (GCP); Carbon Dioxide Information Analysis Centre (CDIAC)
OurWorldInData.org/co2-and-other-greenhouse-gas-emissions/ • CC BY

Source: Ritchie H., Roser M. (2017). CO2 and other Greenhouse Gas Emissions (in:) Internet portal “Our World in Data”, May 2017, (<https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions>), after: Hadley Center (HadCRUT4), after: Global Carbon Project (GCP); Carbon Dioxide Information Analysis Center (CDIAC).

On the basis of the verification of opinions, considerations, conclusions and research theses contained in the cited publications, the main research aspects and an image of the issue of implementing the principles of sustainable economic development as a key element of the pro-ecological transformation of the economy based on the concept of green economy and circular economy were first formulated. The formulated main research aspects and the image of the analyzed topic served as the basis for determining the goals and research methods used in this study. The goals and research methods are presented in the next subchapter of this article. The basis for these main components of the research process, which was carried out in this study, was to define a synthetic picture of the issue of implementing the principles of sustainable economic development after collecting research data and verifying the conclusions contained in the quoted publications. A synthetic picture of the issue of implementing the principles of sustainable development into economic processes can be described as follows: Economic crises often become a source of new business concepts and transformation of economic systems. Since the global financial crisis of 2008, the importance of implementing the principles of sustainable economic development has been growing as a key element of the green revolution and the transformation of the existing, traditional, brown economy of surplus into a sustainable, green economy of moderation. However, the main factor behind the increase in popularity in the world of science of the issues of sustainable economic development, social environmental responsibility, green economy and circular economy are confirmed by the results of research conducted by climatologists, biologists, ecologists, etc. the process of global warming, the source of which is the growing emission of greenhouse gases, which is a side effect of the development of civilization based to a large extent on the classic model of energy production based on the combustion of fossil fuels. This article deals

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with a holistic, interdisciplinary approach to the issues of determinants of the implementation of the principles of sustainable development into economic processes, including corporate social responsibility, environmental social responsibility, eco-innovation, green finance and the pro-ecological transformation of the economy towards green economy and circular economy.

Before starting the research, collecting and developing research results on various aspects of the implementation of the principles of sustainable development into economic processes, the author of this study reviewed the literature on the above-mentioned issues. Determining and specifying the research problem, which was then characterized and analyzed in this article, was preceded by a review of literature publications and available source materials, in which the key issues of the pro-ecological transformation of the existing, dominant, traditional model of brown surplus economy to a sustainable green economy were already considered. The literature review shows that the individual issues related to the implementation of the principles of sustainable development into economic processes, corporate social responsibility, social ecological (environmental) responsibility, and the pro-ecological transformation of the economy towards green economy and circular economy described in various publications were examined only in selected issues, however, no attempts were made to make a synthetic approach to this issue, i.e. one that would integrate various key aspects of the subject, the considerations taken would have the attribute of interdisciplinarity, and the conclusions from the research would also be a derivative of a fully synthetic approach. This type of research approach was used in this study. One of the key methodological premises of the sustainable development issues in this study was the use of a synthetic research approach to achieve an interdisciplinary combination of various aspects of the described and studied sustainability issues, taking into account social, economic, financial, ecological and environmental aspects. The key conclusions that were formulated in the summary part are a derivative of the synthetic research approach used.

Based on the content of the studied source materials and expert publications, it has been shown that in recent years the issue of the pro-ecological transformation of the economy towards green economy and circular economy has been one of the most developing areas of both practical, business approach and scientific research on this issue.


The studied content of scientific literature publications, analysis of source materials and normative regulations show that due to the increasingly faster global warming process, it is necessary in the next 20-30 years to carry out a pro-ecological transformation of the existing, dominant, traditional model of brown excess economy into a sustainable, green economy of moderation. Conclusions and suggestions resulting from the previously conducted research, described in the content of the studied literature, were used to formulate key research theses and goals of the research undertaken.

Aims of paper. Methods

Before writing this article, a review of the literature dealing with the implementation of the principles of sustainable development into economic processes, corporate social responsibility, ecological (environmental) social responsibility, pro-ecological transfor-

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mation of the existing, dominant, traditional model of brown excess economy into a sustainable, green economy of moderation was carried out. The literature review was also preceded by the clarification of the key issues of this subject, which were analyzed, the definition of the goals of the undertaken research and the formulation of key research questions and theses. The subject of this work, initially defined conceptually and axiomatically, was also clarified after the aforementioned review of the publications of other researchers on the issues of implementing the principles of sustainable development into economic processes, corporate social responsibility, ecological (environmental) social responsibility, pro-ecological transformation of the economy towards green economy and circular economy. In view of the above, this article analyzes the issues of the pro-ecological transformation of the economy towards green and circular economy in a synthetic approach.

The analysis of source materials shows that the analyzed issues of the topic of the pro-ecological transformation of the economy towards green economy and circular economy were described and considered in the scientific literature only in selected, few aspects. On the other hand, no attempts were made to conduct research that would consist in developing a synthetic approach to this issue. The full synthetic approach would integrate the various key aspects described in this article, the considerations taken would have the attribute of interdisciplinarity, and the conclusions from the research would also receive the feature of a synthetic approach. This type of research approach was used in this study. One of the key methodological premises of the issues of sustainable development in this study was the use of a fully objective description of all premises, conditions, components of the analyzed topic and factors affecting individual aspects of sustainable development. By analyzing the issues of sustainable development, green economy and circular economy, the authors of this study verified the theses and conclusions formulated by the authors of the cited publications. The verified theses and conclusions, which often represented a different view, heterogeneous assessment of the key aspects of the topic in terms of their level of significance and identified correlations, were used to formulate key research questions and theses for this study. Based on the verification of theses, conclusions were formulated and included in the summary part. While formulating these conclusions from the conducted research, the principles of scientific objectivity, impartiality and the synthetic nature of the research approach were followed.

Based on the studied source materials and expert publications, it was noticed that, until recently, poor literature describing the issues of sustainable development, green economy and circular economy has been significantly expanded with new titles in the last few years. On the publishing market, in the area of the above-mentioned topics, there were mainly original monographs and interpretations of specific normative studies and commentaries on legal regulations. However, the largest gap in the scope of the research issues concerns the attempt to interpret the entirety of issues in a synthetic approach, relating to the practical implications of the process of implementing the principles of sustainable development into economic processes in order to carry out a pro-ecological transformation of the economy towards green and circular economy.

During the research, various research methods were used, which are listed below. Various research methods were used in the work, including:

a) descriptive and comparative methods,

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- b) inductive reasoning,
- c) deductive reasoning,
- d) descriptive vector method,
- e) method of media observation.

The choice of methods was determined by the type of research materials in which various aspects of the studied ecological transformation of the economy towards green economy and circular economy were described. In order to present the key issues of the topic, to explain particularly important dependencies, connections, and correlations between the components of the issue of implementing the principles of sustainable development into economic processes, corporate social responsibility, ecological (environmental) social responsibility, pro-ecological transformation of the economy towards green economy and circular economy - mainly a descriptive method. The comparative method was used primarily in the comparisons of selected aspects of the studied problem of comparing the existing, dominant, traditional model of brown surplus economy and sustainable green economy of moderation. Inductive reasoning was used to select unambiguous facts and aspects of the problem of practical implications of the process of implementing the principles of sustainable development to economic processes that meet the indisputable condition in their experimental verification. Deductive reasoning was widely used through the rational formulation, selection and ordering of axioms that did not have to be certainties. However, they had to meet the condition of being able to present complex problems in the form of models and diagrams. The axioms formulated with this method were built and developed in the process of logical binding of facts. The descriptive-vector method was used in this article by highlighting the important factors of the problem of sustainable development and to explain the essence of the pro-ecological transformation of the economy with an indication of the appropriate direction of impact. The literature review was also carried out with the use of the method of media observation, consisting in the observation of selected issues of the researched issues described by journalists specializing in specific areas of economic issues.

In connection with the above, guided by the principle of scientific objectivity, impartiality and syntheticity of the research approach, on the basis of the verification of the content of the cited publications, the following main research thesis was formulated for the purposes of this study: Due to the increasingly faster global warming process, it is necessary in the next 20-30 years carrying out a pro-ecological transformation of the existing, dominant, traditional brown economy model of surplus into a sustainable, green economy of moderation. At the end of this study, a reference was made to the verification of the research thesis.

Exposition of main material of research with complete substantiation of obtained scientific results. Discussion.

Barriers to the development of renewable energy sources and the implementation of the principles of sustainable development

In the context of the analysis of barriers to the development of renewable energy sources and the implementation of the principles of sustainable development, the following questions arise: Do the main barriers to the development of renewable energy sources include the lobbying of enterprises from the energy sector producing electricity and heat based

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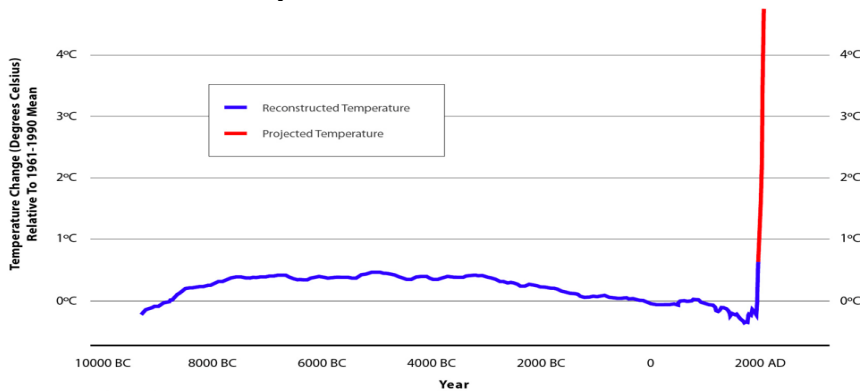
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on traditional fossil fuel combustion energy? Are there no financial resources in most countries for financing high-budget pro-ecological projects from public finance funds? Should there be new, new ecological innovations, new technological solutions in the field of renewable energy sources, electromobility in the field of automotive, new generations of batteries, photovoltaic panels, energy storage and transmission stations, hydrogen engines, etc. (García-Trivino P., Llorens-Iborra F., García-Vázquez CA, Gil-Mena, AJ, Fernández-Ramírez LM, Jurado F., 2014) to make the production and use of electricity produced from renewable energy sources profitable, to become a profitable business? Do the barriers to the development of renewable energy sources include the growing consumption of electricity in developing economies? (Shahbaz M., Hye QMA, Tiwari AK, Leitão, NC, 2013) Should public aid programs be developed, e.g. in the form of financial subsidies granted to citizens from public funds of the state for the purchase of an electric car and / or for economic entities operating in the electricity automotive sector? (Bridle R. and Kitson L., 2014). If this process takes a long time, there may not be enough time to implement the necessary reforms aimed at disseminating a model of sustainable, pro-ecological development based on the concept of green economy in the global economy. If this process lasts much longer than until 2030, there may not be enough time to carry out the necessary reforms to reduce greenhouse gas emissions and, consequently, the process of climate warming on the planet Earth will significantly accelerate, this process will become irreversible and will continue to accelerate and at the end of the 21st century will lead to a global climate catastrophe that threatens the lives of all mankind and most other forms of life on Earth.

Graph 3. Global warming. Earth temperature change in the years: 10,000 BC - 2000 AD and a forecast of an increase in the average temperature on the Earth at the end of the 21st century.



Source: Science & ClimateProgress.org

Many companies in commercial sectors are not interested in implementing the principles of sustainable development due to the additional costs they would have to bear (Mittal V. K., Sangwan K. S., 2014). Without state aid, without an appropriate economic policy taking into account the principles of sustainable development, without normative regulations that would force commercial enterprises to implement the principles of sustainable

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development, the process of developing pro-ecological reforms will be slow, too slow. And yet the global warming process is progressing faster and faster, humanity has less and less time to introduce the necessary pro-ecological reforms, primarily limiting greenhouse gas emissions, improving segregation, recycling and waste disposal (Kanakaraj, J., Velappan, KC, Chandra Babu NK, Sadulla S., 2006), development of energy based on renewable energy sources, replacement of plastic with biodegradable materials, development of electromobility, protection of biodiversity of natural natural ecosystems, etc. (Janishevski L., Santamaria C., Gidda SB, Cooper HD, Brancalion PHS, 2015).

Due to the fact that many companies in the commercial sectors are not interested in implementing the principles of sustainable development, the role of universities and research institutes is crucial in this matter. Only these centers are currently the key promoters of the necessity to implement the principles of sustainable development. Scientists should promote the introduction of the necessary pro-ecological reforms in the available forms and media, thanks to which it will be possible to implement sustainable economic development based on the concept of green economy in the economies of individual countries. This is one of the most important global problems of the 21st century.


In addition to universities and scientific institutes, more and more non-governmental organizations, organizations created from the bottom by communities inform about the need to implement the principles of sustainable development, about the need to develop ecological innovations, implement pro-ecological reforms, etc. (Wheelen TL, Hunger JD, Homan AN, Bamford CE, 2018) . Thus, more and more, the problems of ecology appear in discussions not only in the scientific community but also in politics. In many countries, political organizations such as the Green Party wins an increasing number of seats in parliaments in various countries. The problems of ecology are more and more often discussed internationally at international scientific conferences and UN climate summits.

From time to time, conferences and climate summits are held in various countries around the world. In principle, everyone agrees on the importance of implementing the necessary pro-ecological reforms into economic processes. Apart from representatives of companies extracting energy resources for the needs of traditional energy based on burning fossil fuels and those power plants of traditional energy, probably everyone agrees that in order to slow down the advancing global warming processes that are unfavorable for the natural environment, it is necessary to implement pro-ecological reforms as soon as possible, mainly to develop renewable energy sources on a larger scale. In addition, pro-ecological innovations should be implemented on an industrial scale as soon as possible.

In December 2018, this type of climate summit was held in Katowice, Poland. It was a climate conference as part of the 24th session of the Conference of the Parties to the United Nations Convention on Climate Change, referred to as the UN climate summit, i.e. COP24 (Conference of the Parties) on the Earth's climate policy. UN climate summits, i.e. COP (Conference of the Parties) are global conferences during which actions for climate policy are negotiated. Poland hosted them twice - in 2008 in Poznań and in 2013 in Warsaw. In December 2018, the climate summit is now being held for the first time in Katowice, Poland. During this summit, conferences were held, discussions were held on the need to develop a sustainable development policy and the need to develop ecological, renewable energy sources in order to generate future reductions in greenhouse gas emissions and thus limit the increase in the average annual temperature on the Earth's surface.

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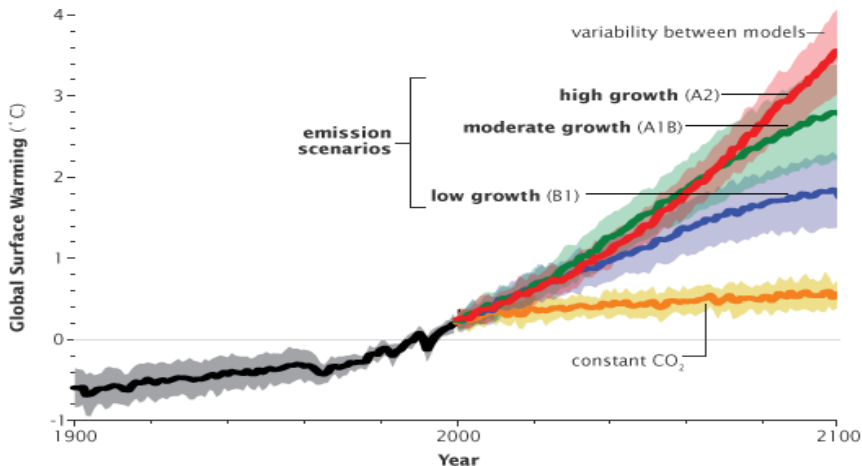
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As part of the above-mentioned UN climate summit in December 2018, the following were held: the 24th Conference of the Parties to the United Nations Framework Convention on Climate Change (COP24), the 14th Meeting of the Parties to the Kyoto Protocol (CMP 14) and the Conference of the Paris Agreement signatories (CMA 1). The event was attended by approximately 20,000 people from 190 countries, including politicians, representatives of non-governmental organizations as well as academia and the business sphere.

A report by the United Nations International Panel on Climate Change (IPCC) shows that levels of greenhouse gases on the globe are the highest in 800,000 years. Their further emission, which, according to the authors of the report, is mainly due to the combustion of fossil fuels, will lead to climate change, which will be all the greater, the more intense the release of gases into the atmosphere. The report is a synthesis of previous IPCC findings.

Graph 4. Global warming. CO₂ greenhouse gas emissions, forecast of the increase in average temperature on Earth.



Source: NOAA, NASA.

The lectures given during the aforementioned climate summit show that the process of global warming has significantly accelerated in recent years, and therefore, in the black scenario of future climate change, the temperature on the Earth's surface may rise by 4 ° C by the end of the 21st century. The forecast analyzes show that if the development of industry proceeds in the same way as in previous years, i.e. without implementing ecological innovations, without limiting greenhouse gas emissions, etc., there is a risk that by 2050 the average temperature on the Earth's surface may increase by another one degree ° C. It would have been an increase in the average temperature on the Earth's surface since the end of the first industrial revolution, by two degrees since the beginning of the 20th century. Then the rate of climate change will increase so much that the process of

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climate warming on Earth may escape out of any control and then a person will not be able to stop this process or slow it down significantly. In such a black scenario, the average temperature on the Earth's surface by the end of the 21st century may increase by as much as four degrees Celsius. Then there will be several times the increase in all negative externalities of climate change compared to the present state. The scale of emerging climatic disasters, including tornadoes, droughts (Galluccio M. C., Abbafati M., 2005), volcanic eruptions, glacier melting in mountain peaks and in the Arctic Circle zone will accelerate significantly. Melting permafrost in the Arctic region will release another million tonnes of methane and the greenhouse effect will accelerate even more, and in the 22nd century the increase in the average temperature on the Earth's surface may reach a geometric rate. Then it will be a catastrophe not only for human civilization but also for a large part of life on Earth. Paradoxically, man as a rational, intelligent being who has evolutionarily gained an advantage over all other forms of life on Earth and has subjugated the entire planet to himself, can lead to self-destruction. Or maybe it is not too late to implement a new pro-ecological economy to at least try to stop greenhouse gas emissions and reverse the unfavorable processes of global warming? It is therefore necessary to promote and implement the principles of sustainable development as part of the new green economy. It results from the discussions that it is necessary to develop ecological innovations, new environmentally friendly energy sources, and the development of electromobility of means of transport. It is essential to develop and massively implement renewable energy sources. In addition, it is important to increase the scale of afforestation as forests and their flora absorb a large part of greenhouse gas emissions. The development of ecological innovations, the industrial implementation of new technological solutions regarding renewable energy sources, the development of electromobility in the automotive industry, increasing the efficiency and automation of waste segregation and recycling, afforestation of civilization degraded areas, rehabilitation of the degraded natural environment, etc. cannot be implemented in the long-term in large investment projects financed mainly from public funds, because they would generate high public debt and the investment projects themselves would be pro-growth, so they would be a contradiction of "the post-growth economy".

Figure 4. Deforestation of forests on planet Earth in 1990-2015.



Source: Joest A. (2020) *Bamboo, the super plant for community empowerment, to combat the effects of climate change and greener production chains* (in:) "AnnJoest.com" website, System Innovation for Sustainable Development, (<https://annjoest.com/bamboo-the-super-plant-for-community-empowerment-to-combat-the-effects-of-climate-change-and-greener-production-chains>), access: 5.8.2020.

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These recommendations appear, for example, at symposia, conferences and UN climate summits where it is discussed what needs to be done to slow down the global warming process of the planet Earth. Some of the results of research on greenhouse gas emissions and projections of the continuation of the Earth's climate warming process suggest that man has only a decade of time to implement and disseminate these necessary changes, which include primarily: developing ecological innovations, implementing new technological solutions on an industrial scale concerning renewable energy sources, development of electromobility in the automotive industry, increasing the efficiency and automation of waste segregation and recycling, afforestation of civilization degraded areas, rehabilitation of a degraded natural environment, etc.

Recently, such a conference was held in December 2019 in Madrid. It was one of the most important conference climate events that took place in 2019. Great hopes were placed at this conference that the goal that was not achieved in December 2018 during COP24 in Katowice will be achieved. Unfortunately, during the 25th session of the Conference of the Parties to the United Nations Convention on Climate Change, i.e. during the UN climate summit, i.e. COP25 (Conference of the Parties), which took place in Madrid in December 2019 on climate policy on Earth, also did not achieve the key goal of signing an agreement by all countries of the world on the successive reduction of greenhouse gas emissions (*COP 25 Climate Conference in Madrid*, 2019). The problem is that it is precisely those countries that have some of the largest economies, the most heavily industrialized, and the major emitters of greenhouse gases that are not interested in signing this agreement. Delegates from almost 200 countries of the world present at the COP25 conference confirmed only what had been stated many times before, that urgent measures should be taken to counteract the progressive global warming process (*The UN Climate Change Conference COP 25*, 2019). The participants of the above-mentioned COP25 climate summit, as in the previous year, during the corresponding COP24 conference in Katowice, discussed the final form of the agreement on the implementation plan for the Paris provisions of 2015. The general assumptions of this plan were established during COP24, while COP25 was to be the development of a calendar and implementation mechanism for the article on reducing CO₂ emissions established during the 6th agreement of 2015. Unfortunately, the goal was not achieved.

Catherine Abreu, representing the Climat Action Network, said in her speech that the final text of the COP25 summit statement calls for urgent action on the reduction of greenhouse gas emissions to reduce the gap that has arisen between the commitments and the goals of the Paris Agreement, in order to limit the projected level of global warming to +1.5 - 2 degrees C. However, the agreement signed during COP25, as well as with COP24, is wishful and not binding, so it does not fulfill its key role. Due to the lack of a binding agreement, it will be necessary to revise the existing strategy and develop a new climate concept before the next corresponding COP26 climate conference, which is to be held in December 2020 in Glasgow, USA. The development of a new climate concept, which all countries of the world will join if possible, is necessary, because if this does not happen, with the current scale of greenhouse gas emissions, the pace of the global warming process will accelerate and will cause an increase in the average temperature of the atmosphere at the Earth's surface by the end of the 21st century. it may exceed 3 degrees C. The UN Secretary General Antonio Guterres presented a negative assessment of the

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COP25 climate summit in Madrid, who said that another opportunity to take constructive steps to start solving the climate crisis has been missed. In his speech, the UN Secretary General also added that 2020 should be a breakthrough year in terms of signing a binding agreement by all countries of the world, not just a wishful one. Under the binding agreement, all countries of the world should undertake to respect the Paris arrangements, and thus to take pro-ecological actions that, according to scientists, are necessary to achieve neutrality in terms of CO₂ emissions, i.e. carbon neutrality by 2050 (*UN Climate Change Conference - December, 2019*). The high rank of the COP25 climate confrontation was primarily due to the fact that 2020 is the year in which the provisions of the Paris Agreement were to enter into force and the last moment for each country to present a proposal for its participation in the annual reduction of greenhouse gas emissions in the following years. Unfortunately, these key goals have not been achieved. There was no unanimity on the issue of consent to a successive, significant reduction of CO₂ emissions to the atmosphere. The procedure of the arrangements made at the COP climate conferences is that decisions are taken unanimously. Negotiators representing individual countries first work in specific teams to refine working versions of prepared texts of proposed solutions to specific issues being the subject of a specific conference session. During these works, disputable issues are included in the so-called square brackets until all negotiators accept certain proposed solutions. The peculiarity of the COP25 climate conference was that a significant part of the meeting time was devoted to discussing the multifaceted impact of climate change on the oceans and their biosphere. Therefore, the COP25 Conference was also referred to in the media as "Blue COP". The aforementioned problem of the correlation of climate change and the biosphere of assessments was included in one of the reports of the Intergovernmental Panel on Climate Change (IPCC).

Therefore, great hopes are placed on the next COP26 Climate Conference, which is to be held in Glasgow, USA in December 2020. Perhaps the current pandemic of the SARS-CoV-2 coronavirus (causing the Covid-19 disease) will increase the general social-ecological awareness of societies of many countries as well as politicians and entrepreneurs, which may significantly affect the decisions that will be taken in December in Glasgow during the COP26 climate conference. Perhaps a positive aspect of the aforementioned pandemic will be the development of a new climate concept, i.e. one that may significantly expand the Kyoto Protocol declarations and take into account the provisions of the Paris Agreement. The development of a new climate concept, to which all countries of the world should join, is necessary to save the planet Earth from the intensifying negative effects of ever faster climate changes. Otherwise, the process of warming the Earth's climate will accelerate and by the end of the 21st century, the average temperature at the Earth's surface may increase by as much as 4 degrees C, which will mean that all glaciers will melt, the surface of seas and oceans will rise by 20 meters, and droughts will become more frequent and intensifying (Van Loon AF, 2015), stepping and desertification of many of the present green areas, a significant reduction in the area of arable land for agricultural production of crops, a reduction in areas suitable for human livelihood, numerous fires, an increase in volcanic activity, increasingly frequent climatic disasters such as tornadoes and rainstorms, the release of methane from the thawing soils of permafrost in the polar regions, and then the acceleration of the greenhouse gas emission process and the inability to reverse this process by humans. These adverse effects of climate change

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include the rapidly declining numbers of pollinating insects in recent years, mainly due to climate change and the inappropriate and excessive use of chemical pesticides, plant protection products, some of which are lethal to bees and other inquiries. In this way, productive and intensively managed agricultural crops negatively affect biodiversity, disturb the balance in nature and increase the risk of a strong decline in yields in the future (Dainese M. et al., 2019).

In recent years, among scientists and organizations promoting the need to develop environmental protection systems, there have been concerns that the only main positive effect of these climate conferences and summits is the promotion in the media of the need to apply these pro-ecological reforms. On the other hand, the issue of essential, justification, determinants and economics of environmental protection processes has been discussed in scientific publications for many years (Pearce D. W., Turner R. K., 1990). However, the scale of actions taken in this direction, the scale of the increase in expenditure supported by subsidies from state budgets for the development of energy based on renewable energy sources, for the development of electromobility, and improvement of waste sorting and recycling processes is still small in relation to the needs. However, in recent years something has finally started to change. First of all, in the European Union, the process of introducing regulations to start pro-ecological reforms and lead to The New Green Deal by 2050. The New Green Deal, adopted at the end of 2019, under which the European Union is to achieve full neutrality in terms of greenhouse gas emissions by 2050, is another milestone in the European environmental policy launched many years ago (Camilieri M. A., 2015).

Ryszawska B. (Ryszawska B., 2016) points out that the European Union and its member states are convinced that a resource-efficient and low-emission economy offers a win-win option for all countries, regardless of the structure of their economies and the level of development. After the global financial crisis in 2008, interest in the issues of sustainable development and the need to carry out a systemic, pro-ecological transformation of the economy grew. A particular increase in interest in these issues and the development of pro-ecological reforms, the introduction of legal norms whose task is to accelerate the processes of pro-ecological transformation of the economy occurs in the European Union (Reichel A., De Schoenmakere M., Gillabel J., Martin J., Hoogeveen Y., 2016). In recent years, in the context of the pro-ecological transformation of the economy that has already begun, in addition to environmental, ecological, economic and energy aspects, the importance of social factors, including general social awareness in the field of sustainable development, has also increased (Warner K., Zommers Z., Wreford A., Hurlbert M., Viner D., Scantlan J., Tamang C., 2019). However, in the general public awareness, the issues described in this article are usually associated with the concept of ecology, which can sometimes be interpreted as a linguistic abuse caused mainly by the marketing activities of companies selling to citizens, e.g. photovoltaic panels to be installed on the roof of a house, waste segregation containers, organic pesticides, home wastewater treatment plants, installations for retaining rainwater, food products produced from agricultural crops grown without the use of chemically produced pesticides, electric scooters and other vehicles, insect houses installed in city parks, etc. and specifying in advertising campaigns this type products as organic. It is a linguistic abuse because the overwhelming majority of these products, despite the fact that they can fit into the broadly understood concept of

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pro-ecological transformation of the economy towards green economy and may be an important factor in implementing the principles of sustainable development in a given municipality, enterprise, household, etc., still with the essence of the concept ecology may have little in common. The concept of ecology, when properly applied, should only refer to the processes taking place in natural ecosystems and the relationships between various species of flora, fauna, fungi and microorganisms inhabiting specific natural ecosystems. In the previous sentence, the term "natural ecosystems" was intentionally used, because the concept of ecosystems itself is also becoming an overused concept in various other areas of knowledge that are not substantially related to ecology. Therefore, more and more often the term "ecological" is replaced by the adjective term "green".

In connection with the above, legal norms are introduced in the European Union, which force individual countries to introduce pro-ecological reforms, e.g. in the energy sector and in the production of packaging, in electromobility, etc. (Pakulska J., 2018). These types of problems can be solved through international cooperation. This international cooperation should develop not only in Europe but on a global scale, because the global warming process applies to the entire globe (Freedman M., Jaggi, B., 2005). In recent years, also some financial institutions, such as the World Bank, spend more and more money on pro-ecological investments. In addition to the World Bank, in recent years the number of commercial banks operating nationally or internationally, which grant more and more loans for pro-ecological projects, i.e. green credits. Such banks include, for example, Industrial & Commercial Bank of China, Agricultural Bank of China, Bank of China, The Bank of Tokyo-Mitsubishi UFJ. These banks are among the financial institutions that granted the most green credit for pro-ecological investments in 2015. For example, the Industrial & Commercial Bank of China granted 702,843 billion loans to ecological protection, clean energy, environmental protection, resource recycling and other green economic development projects in 2015. Thanks to these investments made by this single bank, in 2015 the estimated greenhouse gas emissions were reduced by the following values: Dust - 12 139 tons, CO₂ - 44 496 tons, SO₂ - 1 339 tons, NO_x - 669 tons (Ryszawska B., Zabawa J., 2018). The given examples of commercial banks providing green credits confirm the growing trend of interest of financial institutions in investing in projects implementing the principles of sustainable development. The growing scale of sustainable banking (Bouma, J. J., Jeucken, M., Klinkers, L., 2017) and green finance may suggest the growing profitability of this type of projects, if green credits-financed pro-ecological projects, e.g. in companies producing photovoltaic panels, for the development of electromobility, turbines for wind turbines, waste segregation containers, biodegradable plastic substitutes, prefabricated products for the construction of zero-energy houses, etc. are not covered by subsidies from the state public finance system. Of course, in the initial stage of development of sustainable banking, which in the framework of green finance provide green credits, it may be reasonable to cover this type of financing of pro-ecological economic ventures with state guarantees. State guarantees granted from the public finance system for crediting economic projects that are part of the strategy of implementing the principles of sustainable development and transforming the current economy towards green economy should be correlated with the importance of the financed economic undertakings in the context of environmental policy priorities, i.e. recognition

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of certain types of pro-ecological activities and reforms, such as the development of renewable energy sources, are particularly desirable in the pro-ecological transformation of the economy.

More and more institutions are becoming promoters of the necessary introduction of the principles of sustainable development, however, the scale of real measures to promote sustainable pro-ecological development is still too small.

Key determinants of the implementation of sustainable pro-ecological development according to the concept of green economy and circular economy

Since the 1990s, some countries have been gradually introducing pro-ecological measures and reforms, which at the beginning of the 21st century were recognized as key elements of sustainable development. Well, factors such as effective waste segregation (Mbeng LO, Phillips P. S, Fairweather, R., 2009), recycling, reduction of plastic packaging, development of renewable energy sources, electromobility in the automotive industry, afforestation, architectural ecological innovations, etc., were considered one of the most important factors in the implementation of sustainable pro-ecological development based on the concept of the new green economy and the circular economy (green and circular economy). According to the findings of the above-mentioned UN climate summit, which took place in Katowice in December 2018, plastic packaging, including plastic cutlery, straws and dishes, should be gradually withdrawn from production and use and replaced with biodegradable ones made of certain grains and vegetables. In recent years, many innovative solutions have emerged in terms of replacing plastic packaging with a substitute made of plants, such as packaging made of banana leaves used in supermarkets in Thailand and Vietnam (Liotta E., Marsha A., 2019).

At the end of 2018, the European Parliament passed legal norms, according to which this type of plastic packaging and plastic cutlery, straws and dishes will be withdrawn from 2021. This is one of the important activities towards the real implementation of sustainable pro-ecological development based on the concept of green, new economy. In addition, it is necessary to increase the efficiency of recycling and reduce toxic waste thrown into the environment. For example, a cigarette end discharged into the environment pollutes approx. 1000 liters of water. This is just an example that suggests the necessity to continue taking further pro-ecological actions. On the one hand, the role of the state and the media in terms of pro-environmental education of society is important.

On the other hand, the industry producing various types of waste, polluting the natural environment, the industry producing non-degradable or difficult-to-degradable and toxic packaging and products currently not recyclable should be burdened with the costs of implementing new recycling technologies, rehabilitating the degraded natural environment and removing toxic waste from this environment. Only then will the economic pressure force the creation of new ecological innovations, the production of goods from biodegradable materials or materials that can be safely neutralized or incinerated in waste incineration plants. Electricity necessary to power the above-mentioned pro-ecological projects should come as much as possible from the development of renewable energy sources. In addition, it is necessary to develop electromobility in the automotive industry, etc. Only the synergy of these various pro-ecological projects will generate new categories of added value that will increase the economic efficiency of these processes in the future. Only in this way will it be possible to realistically implement sustainable pro-

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ecological development based on the concept of green economy and the circular economy (Moktadir M. A., Rahman T., Rahman M. H., Ali S. M., Paul S. K., 2018).

Sustainable development is what is most lacking in human civilization, which is developing faster and faster. We know that you should strive for sustainable development. We know what the world should look like if this sustainable development was fully implemented, and basically if it objectively realized itself through the favorable economic conditions created for it. However, we do not know at all how to quickly make the necessary transformation of entire economies and individual enterprises to create these appropriate economic conditions so that the economic development of human civilization is realized in the formula of fully sustainable pro-ecological development (Mårtensson K., Westberg K., 2016), i.e. in line with the priorities of green economy and circular economy.

The basic principles that would have to be met in order to conclude that the economic development of a civilization is realized in the formula of fully sustainable pro-ecological development are as follows:

1. Full renewable resources and materials used in the production of economic goods, ie consumer and investment goods. It is necessary to improve the technologies that enable the achievement of full renewal of raw materials and other resources of animate and inanimate nature used in production processes (Vernizzi S., Zaroni A. B., Moggi S., Cantele S., 2019).

2. Well-developed recycling, recovery of secondary raw materials for the purposes of their industrial or other re-use. Improving transport logistics (Rześny Ciepłńska J., 2016). and waste segregation processes, including the implementation of the Industry 4.0 technology should increase the scope of automation and robotization of waste segregation processes and improvement of recycling.

3. Full biodegradability of non-recyclable waste. It is necessary to continue research in the field of creating new types of materials, including biodegradable material innovations, which should in the future solve the problem of land and sea pollution with plastics (Marks D., Miller M. A., Vassanadumrongdee S., 2020).

4. In the energy sector, in terms of energy production, over 90 percent. generated energy should be generated in power plants using renewable energy sources (Ren J., Tan S., Evan M., Sovacool B. K., Dong L., 2015). Permanent improvement of systems for efficient storage and transmission of energy produced. In companies operating in other sectors of the economy, including the issue of greenhouse gas emissions and pro-ecological transformation, implementation of the principles of social environmental (ecological) responsibility in the development strategy and long-term mission (Saka C., Oshika, T., 2014) and in economic and economic reporting addressed to investors. financial (Lock I., Seele P., 2015), in reporting on the overall business activity (Prado-Lorenzo JM, Rodríguez-Domínguez L., Gallego-Álvarez I. García-Sánchez IM, 2009) as well as in the context of similar information concerning greenhouse gas emissions, presenting this issue in terms of sectors, industries, markets, etc., generated in central, public institutions of national and international statistics (Rankin M., Windsor C., Wahyuni D., 2011).

5. In the automotive industry and other means of transport, electromobility should dominate and / or vehicles equipped with engines, the driving force of which is based on the combustion of hydrogen with oxygen (Ren J., Gao S., Tan S., Dong L., 2015). Such ve-

hicles would be environmentally neutral. In the first stages of the development of electromobility in a given country, public aid programs should be developed, e.g. in the form of financial subsidies granted to citizens from public funds of the state for the purchase of an electric car and / or for economic entities operating in the electricity automotive sector (Bridle R. and Kitson L., 2014).

6. Development of ecological innovations that are applicable in various branches and sectors of the national economy. It is necessary to create new patents, inventions, including pro-ecological innovations thanks to the application and development of scientific research in such fields of knowledge and scientific disciplines as energy, materials science, nanotechnology, biotechnology, microbiology, genetics, environmental engineering, construction (Rajkovich NB, Okour Y. , 2019), smart technologies, Industry 4.0 technologies etc. It is necessary to improve business models in enterprises in order to improve the efficiency of eco-innovation processes and their implementation (Boons F., Lüdeke-Freund F., 2013).

7. Organic farming should prevail in agriculture, where the problem of using chemical plant protection products has been fully eliminated. New cultivars resistant to fungal, viral and bacterial diseases, as well as pests, are created thanks to the use of biotechnology, genetics and ecology (Crutzen P., 2002). Organic farming, to which the principles of sustainable development are implemented, i.e. sustainable organic farming should replace intensive, productive agricultural crops in order to reduce the use of chemical pesticides causing mass extinction of pollinating insects, reduce the scale of environmental pollution with artificial fertilizers, etc., reduce the negative impact of intensive agricultural production on the natural environment, generating imbalances in nature and reducing biodiversity (Dainese M. et al., 2019).

8. Improved transport logistics systems have significantly reduced the problem of wasting food produced. It is necessary to improve the e-logistics and data transfer systems in the Internet and the risk management of transport logistics, including distribution and supply logistics (Masi D., Day S., Godsell J. (2017). The eating habits should also change. correlated with the development of organic farming and the limitation of industrial meat production.

9. Protection of biodiversity and restoration of natural ecosystems (Pearce DW, Turner RK, 1990), afforestation of civilization degraded areas, improvement of nature protection systems, cleaning of natural environments from civilization pollution in order to increase the balance between the development of civilization and the negative effects of this development on the natural environment (Mekonnen Alemu M., 2016). An important factor in these processes is the production, using modern genetics, of new varieties of plants and forest trees, which will absorb much more CO₂ than today. The use of Industry 4.0 technology, including Big Data Analytics, Internet of Things, etc. in the process of improving systems for monitoring and protecting the biodiversity of natural ecosystems (França Costa W, Sousa R, Giannini T, Albertini B, Saraiva A, 2018).

10. Incorporation of the principles of sustainable development and corporate social responsibility (Burke L., Logsdon JM, 1996) among the key determinants of organizational culture (Baumgartner RJ, 2009), mission, long-term development strategy, strategic corporate management (Vernizzi S., Zanoni AB, Moggi S., Cantele S., 2019; Baumgartner RJ, Rauter R., 2017), business concept development planning, risk management

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in enterprises and financial institutions (Pérez A., del Bosque, IR, 2012) etc. to both business entities operating within the SME sector as well as large corporations operating mainly domestically or internationally, including those operating globally (Amini M., Bienstock CC, 2014). Development and implementation of the strategy of sustainable development of the corporation, sustainable organizational culture, etc. in enterprises (Engert S., Baumgartner R. J., 2016; Dentchev N. A., 2004).

11. Development of sustainable finance (Jeucken M., 2004) within commercially operating financial systems and the public financial system. A large share of the commercially operating financial sector, including commercial banks operating within the so-called *sustainable banking* financed through *green finance* (Fullwiler ST, 2015), including, in particular, *green credits*, the implementation of pro-ecological economic enterprises, creation and implementation of eco-innovations and other projects that constitute important components of the transformation process of the existing economies to sustainable *green economy* and *circular economy* (Zioło M., Fidanoski F., Simeonovski K., Filipovski V., Jovanovska, K., 2017). In the initial stage of development of the commercial *green finance* system, i.e. before such projects become fully economically viable, they should be covered by state guarantees. Development of domestic and international financial markets specialized in transactions related to the financing of pro-ecological projects, i.e. *Greening Financial Market* (Dziawgo, L., 2014).

12. The growing importance of the issues of sustainable development, pro-ecological transformation of the economy, models of green and circular economy economic systems, eco-innovation, etc. by promoting in the media, social campaigns (Kongrut A., 2010), public relations (Nmere ON, Ok VO, Abugu JO, Chukwubuzo Alio F., Anetoh JC, 2020) and the inclusion of these issues in education at various levels of education (Barth M., Godemann J., Rieckmann M., Stoltenberg U., 2007; Cebrián G., Junyent M., 2015).

13. Development of international cooperation in the field of implementing the principles of sustainable development. Establishing an international institution whose task will be to coordinate the transformation processes of the existing national economies into sustainable economies that are increasingly approaching the green economy and circular economy models. All countries of the world should be associated in this type of organization and should respect the adopted plans of systematic, successive reduction of greenhouse gas emissions. The global plan to reduce greenhouse gas emissions and other key aspects of sustainable development (*Global Green New Deal*) adopted for the planet Earth should be based on the plan of the Green New Deal established for the European Union, according to which the EU area is to become an emission neutral area by 2050, ie the emission of greenhouse gases is to be reduced to the level that will be absorbed by nature and possible new technologies created for this purpose, absorbing the surplus greenhouse gas emissions (Barbier EB, 2009).

14. Development, improvement and implementation of systems improving the compliance with the principles of corporate social responsibility and business ethics in enterprises and institutions (Ryszawska B., 2016). Implementation of system programs and solutions to improve the implementation to economic entities, institutions, households, etc. and compliance with the principles of environmental social responsibility (Bouma, J. J, Jeucken, M., Klinkers, L., 2017). Strengthening intergenerational and interregional justice, social trust in the context of the systemic transformation of the current economy to

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a sustainable green economy and circular economy. **15. Sustainable production and consumption** (Ryszawska B., 2016) of various consumer goods replacing overproduction and overconsumption. The era of deliberate product aging is over. The model of the economy described in many publications as the social market economy, which is in fact a continuation of the technologically modernized economic neoliberalism, developed state interventionism (economic interventionism financed by the public finance system of the state within the framework of anti-crisis programs activating social and economic policies) and globalized capitalism (Achankeng EJ, 2003) is replaced by a sustainable, social, green economy.

16. Zero or low but optimal sustainable ecological economic growth (Jackson T., 2009). Transformation of economic growth in such a way that this growth takes place without using up natural resources (Ryszawska B., 2016). A significant part of the current economic growth, which has been taking place in the conditions of the classical economy in the future, will be involved in the reclamation, restoration of civilization degraded through the development of the natural environment industry and other aspects of the implementation of the principles of sustainable pro-ecological development into economic processes, carried out in accordance with the assumptions of green economy and circular economy (Ngan, SL, How, BS, Teng, SY, Promentilla, MAB, Yatim, P., Er, AC, Lam, HL, 2019).

We know what to do. We now know how to create conditions for these processes to automatically, objectively, market-start to operate on a large scale, to become economically viable, i.e. to make the current economic reality described by various concepts of neo-classical economic trends with elements of state interventionism (but not directed to so far to ecology) it has undergone reforms leading to the transformation into sustainable development implemented in the green economy and circular economy formula. It is necessary to continue research and increase research expenditure in the field of life sciences, including, inter alia, such fields of science, knowledge and scientific disciplines as energy, materials science, nanotechnology, biotechnology, microbiology, genetics, environmental engineering, construction, smart technologies, industry 4.0 etc. In the field of improving analytics regarding the study of the implementation progress in the economic processes of enterprises (microeconomically), sectors and branches of the economy (mesoeconomically) and entire economies and their pro-ecological transformation towards sustainable green economy and circular economy, Big Data Analytics analytical platforms (Gwoździwicz S., Prokopowicz D., 2017), artificial intelligence (Zahraee SM, Khalaji Assadi M., Saidur R., 2016; Vinuesa R., Azizpour H, Leite I., Balaam M., Dignum V., Domisch S., Felländer A., Langhans SD, Tegmark M., Fuso Nerini FF, 2020) and other technologies information ICT and advanced processing of big data sets developed as part of the current, fourth technological revolution known as Industry 4.0. Conducted research in these fields of science should lead to the creation of new technological solutions and ecological innovations that will be used in the improvement of systems and instruments for environmental and climate protection in the 21st century.

International cooperation and the new Green Economic Order in the EU

We already know from the results of research conducted in the field of climatology that the main source of the global Warming process, which has accelerated in recent years, is the emission of greenhouse gases, which has been increasing since the end of the first

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industrial revolution. The problem of the increase in greenhouse gas emissions and the increasingly faster global warming process is a global problem. Therefore, international cooperation should be developed in the field of the development of energy based on renewable energy sources, including, inter alia, supporting less developed economies to also develop solar energy, gradually replacing it with traditional energy based on burning fossil fuels. In addition, technological development successively contributes to the creation of more and more perfect photovoltaic panels that can produce electricity not only in climatic zones characterized by high insolation. Modern photovoltaic panels, currently installed on the roofs of houses and industrial buildings, production halls, etc., can produce electricity even in the temperate climate zone with poor sunlight, in cloudy weather. Therefore, installations and power plants equipped with photovoltaic panels can be built almost all over the world in order to develop pro-ecological energy based on renewable energy sources. Therefore, wherever possible, solar energy should be developed as the most neutral for the natural environment. An important issue is also the improvement of the institutional control of the system of subsidies granted from the state public finance system, i.e. subsidies for the implementation of economic projects carried out as part of the process of implementing the principles of sustainable development and pro-ecological transformation of the economy, e.g. financial subsidies for financing the construction of wind farms, installation of panels photovoltaic or other investment projects as part of the development of renewable energy sources. It is an important issue of the practical implications of the process of implementing the principles of sustainable development into economic processes, because in many countries there have been irregularities in the issue of subsidies granted, involving extortion of public funds by private economic entities. For example, in Italy such irregularities have already been detected and described in 2013 (Caneppele S., Riccardi M., Standridge P., 2013). Another issue of the practical implications of the process of optimizing the development of renewable energy sources is taking into account the national geographic and climatic conditions in order to choose the right development strategy for such energy sources as photovoltaics, wind turbines, hydroelectric plants, nuclear power plants, etc., taking into account the relative relationships and possible synergies and the hybrid formula of team development selected distributors of renewable energy sources (Zhou W., Lou C., Li Z., Lu L., Yang H., 2010). Another important issue of the practical implications of the process of implementing the principles of sustainable development into economic processes is the development of international cooperation in order to gradually increase the scale of global coordination and standardization of the pro-ecological transformation of individual national economies.

Development of international cooperation in order to better and more effectively integrate political, business and social activities in the field of implementing the principles of sustainable pro-ecological economic development, which is the main idea of the transformation of the economy towards green economy (Jänicke M., 2011), introducing ecological innovations, including reforming the energy sector and development renewable energy sources, development of electromobility, improvement of waste segregation, development of recycling is still insufficient in the context of the needs resulting from forecasts of the negative effects of forecast climate changes.

Protecting the biodiversity of natural biological ecosystems (Janishevski L., Santamaria C., Gidda S. B., Cooper H. D., Brancalion P. H. S., 2015) is one of the main challenges

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of sustainable ecological development to be implemented in the 21st century. However, the problem is the implementation of the principles of sustainable pro-ecological development to commercial economic processes. It is not easy to combine the philosophy of green economy with the foundation of commercially operating economic processes, i.e. with classical economy. It is essential that business circles cooperate with other types of organizations, including pro-ecological social institutions and the world of science.

An example of the particularly high importance of international cooperation for the promotion of sustainable pro-ecological development is cooperation between countries in Europe, which is coordinated by international institutions and institutional bodies of the European Union. But what does this issue look like on a global scale? Is international cooperation on a global scale sufficient or should it be increased? The answer to this question is in the affirmative, however, each country implements mainly and above all its individual and not global policy of economic development. Unfortunately, individual, national interests do not always coincide with the goals resulting from the need to implement pro-ecological reforms in the conditions of international cooperation, so that these reforms are implemented on a global scale.


Currently, the largest scale of reforms in terms of implementing the principles of sustainable development and the introduced pro-ecological regulations has been implemented in the European Union. In the European Union, methodological standards are being created, the aim of which is the international unification of activities undertaken in the field of implementation of the principles of sustainable development into economic processes and in the field of creating a strategy for the implementation of the pro-ecological transformation process of individual sectors of the economy towards building a sustainable green economy and circular economy. The methodological, analytical, research, etc. standards developed by the central institutions of the European Union should be used by individual countries taking specific pro-ecological activities (Steuer R., Hametner M., 2013). The use of internationally unified standards and indicators relating to sustainability issues (Morse, S., 2015) increases the effectiveness of international cooperation in the context of globalization of the issues of sustainable development.

Legal norms are introduced in the European Union, which motivate individual countries to introduce pro-ecological reforms, eg in the energy sector and in the production of packaging, in electromobility, etc. Such problems can be solved through international cooperation. This international cooperation should develop not only in Europe but also on a global scale, because the global warming process applies to the entire globe. In recent years, also some financial institutions, such as the World Bank, spend more and more money on pro-ecological investments. More and more institutions are becoming promoters of the necessary introduction of the principles of sustainable development, however, the scale of real measures to promote sustainable pro-ecological development is still too small.

The European Union plans to create 100% of the energy sector by 2050. based solely on renewable energy sources. Is it real? Yes, in my opinion it is real. On December 13, 2019, an important piece of information was announced in the media: The New Green Deal has been adopted. This date will go down in history. By 2050, the European Union will achieve climate neutrality, i.e. the increase in greenhouse gas emissions is to be stopped and the emissions are to be absorbed. The key issue is the correct interpretation of the

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findings regarding the answer to the question: what is this climate neutrality to be? - because there are already incorrect interpretations of these findings in the media. The implementation of the Green New Deal is needed for Europe and for planet Earth. However, as is usually the case, any complex, multi-faceted plan is never perfect. After diagnosis, imperfections should be eliminated and the shortcomings corrected on an ongoing basis. Currently, as a real drawback of this adopted plan to be implemented in the next 30 years, the possibility of a significant and unfavorable change in the structure and relation of the cultivated area to the forested area, wastelands, etc. in Europe is indicated.


It is not the goal of this plan that by 2050 almost all of Europe will be forested and most of the agriculture and industry will migrate outside Europe. Of course, afforestation is needed, but maintaining agriculture in Europe is also essential to ensuring food security for Europeans. As part of the afforestation, forests will be created in which genetically modified trees will absorb several times more CO₂ than today, and only electric cars and / or vehicles equipped with hydrogen will drive on the roads (Li Y., Wu Y., Zhang Y., Wang S. , 2019) and the emergence of many new ecological innovations that we do not know yet.

Unfortunately, still 85 percent in Poland. energy in Poland is generated from the combustion of hard and brown coal. Unfortunately, Poland has not signed an agreement on the commitment to climate neutrality by 2050, i.e. the commitment to transform the energy sector so that by 2050 100% produce energy based solely on renewable energy sources. The concept of climate neutrality means that by 2050 a state of complete circular CO₂ emitted and absorbed by nature, and possibly also by technological solutions created for this purpose, is to be achieved. In the near future, we will read in history textbooks about this anti-environmental decision of the Polish government. Another important question that arises now is the following: When all countries in the world sign a similar agreement and a commitment that by 2050 they will achieve climate neutrality, i.e. all greenhouse gas emissions, including mainly CO₂, will be absorbed, i.e. not actually generated by human surplus greenhouse gas emissions to the atmosphere? This question will probably remain an open question for at least the next few years.

In line with the above, all countries of the world should sign a similar agreement as soon as possible and undertake that by 2050 they will achieve climate neutrality, i.e. all greenhouse gas emissions, mainly CO₂, will be absorbed, i.e. there will be no human-generated surplus of greenhouse gas emissions. to the atmosphere. In this way, it would be possible to significantly slow down the ever faster global warming process and avoid the climate catastrophe predicted by climatologists, more and more often referred to as the climate Armageddon, which may occur at the end of the 21st century, if mankind does not take appropriate rapid measures to implement pro-ecological reforms in the energy sector and other branches of the economy. The graphic below presents the level of differentiation in the implementation of the principles of sustainable development.

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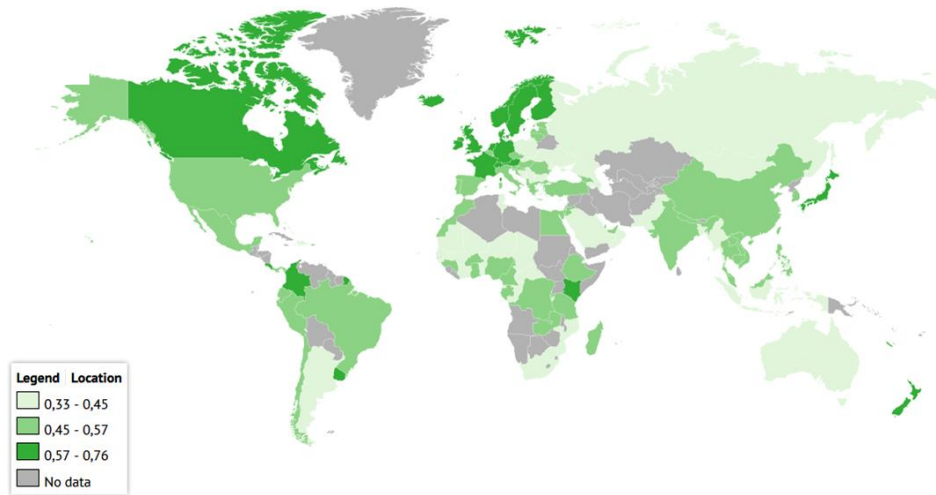
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Figure 5. Global Green Economy Index, 2018 (in percentile 0-1, higher = better).

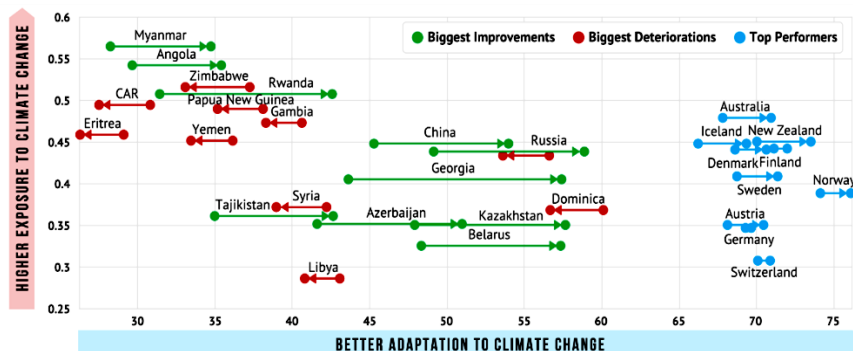


Source: *Global Green Economy Index, 2018*, (in: “Knoema.com” website, Data Driven, March 11, 2019, (<https://knoema.com/infographics/enedcw/global-green-economy-index-2018>), access: 5.8.2020.

Despite the measures taken as part of the implementation of the principles of sustainable development, undertaken projects to implement eco-innovations, etc. in order to successfully reduce greenhouse gas emissions and increasing temperature in the world, the climate is still warming. In recent years, the process of climate warming has been recorded even year to year. This means the need for countries to prepare for the negative effects of the ongoing global warming process and to adapt to these climate changes. Therefore, an important issue that is being investigated is the analysis of the progress of works on the implementation of the principles of sustainable development in individual countries (*Adapting to Climate Change: How Ready is Your Country?*, 2020).

Therefore, the processes of adaptation of individual countries to climate change are measured, for example, with the use of the Notre Dame Global Adaptation Initiative (ND-GAIN) National Index. With the help of this Index, the adaptation of 192 countries to projected climate change over the past 23 years has been measured. This index takes into account the two main determinants of this adaptation - sensitivity (the degree of a country's vulnerability and ability to adapt to the negative effects of climate change) and readiness (a country's ability to translate investments into adaptation) - and compares individual countries according to their level of preparedness for climate change.

Graph 5. Biggest Movers in Climate Change Adaptation (Change in Notre Dame Global Adaptation Index ND-GAIN from 1995 to 2017).



Source: *Adapting to Climate Change: How Ready is Your Country?*, (in:) "Knoema.com" website, Data Driven, January 15, 2020, (<https://knoema.com/infographics/wemjthe/adapting-to-climate-change-how-ready-is-your-country>), for: Notre Dame Global Adaptation Initiative, access: 5.8.2020.

The largest changes recorded in the ND-GAIN Countries Index are as follows (*Adapting to Climate Change: How Ready is Your Country?*, 2020):

- developed countries occupy leading positions,
- least developed countries show the greatest improvement,
- the greatest improvement was recorded in Rwanda, Georgia, Burma, Azerbaijan and Tajikistan - mainly in terms of improving the preparedness components,
- the improvement in Rwanda was due to an 80 percent reduction in child malnutrition and an improved business environment,
- Georgia improved by 31.5 percent, mainly due to a reduction in vulnerability to changes in water supply and improved corruption control in the economic sphere,
- Myanmar has improved access to drinking water and improved the enrollment of children in schools and improved corruption controls,
- Azerbaijan and Tajikistan have improved the control of corruption and strengthened political stability.

Pro-ecological strategy towards the global warming process

In the current situation, an important research question that arises when it comes to choosing a strategy for the global warming process is the following: should counteracting or adaptation to the ongoing process of climate change be applied? Which strategy should be applied in the worsening climate crisis? Therefore both strategies should be applied. On the one hand, until around 2030 (according to the most negative scenarios for the development of climate processes) the tipping point of the constantly accelerating global warming process is not exceeded, everything possible should be done to slow down unfavorable climate change. On the other hand, in these issues and aspects of climate change and related climate phenomena, which are no longer affected by humanity, the only thing left to do is to prepare for these changes and adapt living and living conditions to the progressing, inevitable effects of climate change. Regardless of the real possibilities of

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slowing down the progressing global warming process, man should reduce all or most of the surplus of greenhouse gas emissions as soon as possible, reform the energy sector by developing renewable energy sources and carry out other pro-ecological reforms to implement the principles of sustainable pro-ecological development carried out as part of the transformation of the current economy towards a sustainable green economy (Jänicke M., 2011), in order to intensify activities in the field of nature protection, protection of natural biological ecosystems, protection of the earth's biodiversity and its preservation for future generations in the coming years. The need to implement the principles of sustainable pro-ecological development into economic processes carried out in accordance with the assumptions of green and circular economy in order to intensify activities in the field of nature protection, protection of natural biological ecosystems, protection of earth's biodiversity and its preservation for future generations in the coming years. The key issue of implementing the principles of sustainable pro-ecological development is long-term planning of transformation processes of the current economies to sustainable green and circular economy. Long-term planning of pro-ecological reforms and system changes, implementation of large investment projects, e.g. in the ecologically transformed energy sector, should cover not the next few years, but at least the next several dozen years (Jin Z., Bai Y., 2011). In view of the above, another important research question, to which researchers and scientists are trying to formulate the most precise answer possible, is the question formulated as follows: Has the global warming chain reaction already begun? Has the irreversible process of a chain reaction of climate change to the global warming process already started or will it begin in the perspective of the next 30 years? Research shows that the tipping point of the growing amount of CO₂ in the atmosphere may be exceeded by around the middle of the 21st century at the latest. If this tipping point is exceeded, then subsequent climate changes will be an irreversible process. The approximate, indicative tipping point has been designated for the year 2050, because then the maximum amount of CO₂ will be emitted into the atmosphere, which is responsible for increasing the temperature of the Earth's atmosphere to the possibly safe level, which will not yet cause the climatic Armageddon in the next several decades. However, exceeding this level of CO₂ emissions and the emission of another, analogous amount of billion tons of CO₂ emissions that were emitted from the end of the 19th century to 2030 will, according to the most accurate estimates, increase the average temperature of the atmosphere at the Earth's surface by min. 2 degrees Celsius, which will result in the appearance of the climatic Armageddon at the beginning of the XXII century, i.e. mass, permanent droughts covering most of the areas currently inhabited and used by man, mass fires, the increase of volcanic eruptions, especially strong and harmful to humans and other forms of life sun rays e.t.c.

Continuation of the process of greenhouse gas emissions and the related increasingly faster global warming process will result in:

- increasing drainage of many land areas,
- reduction of the acreage of many natural green areas producing oxygen and absorbing carbon dioxide,
- increase in the scale and frequency of fires,
- thawing of permafrost in polar, arctic regions, which will release millions of tons of frozen methane,

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- the freezing of glaciers and the rise of the surface of seas and oceans,
- etc.

All these processes will accelerate the progressing global warming process in the coming years and will trigger a kind of chain reaction of the constantly accelerating global warming process. In view of the above, pro-ecological reforms in the global scope should be implemented in the shortest possible time by around 2030 so that the reduction of greenhouse gas emissions proceeds efficiently enough to allow a significant slowdown of the global warming process and that the above-mentioned tipping point is not exceeded. More optimistic estimates give mankind about 30 consecutive years to carry out the necessary pro-ecological reforms consisting in the implementation of the principles of sustainable development into economic processes so that these processes are carried out according to the concept of green economy and circular economy. Well, on the basis of research carried out using the Monte Carlo statistical method, it was calculated that the combustion of 1 trillion tons of minerals will release another billion tons of CO₂, which will increase the temperature by another 2 degrees C. It is estimated that half of the fire has already been burned and the temperature has increased by about 1 ° C from the end of the first industrial revolution, ie from the 19th century. Based on the research carried out according to this methodology, it is estimated that in the following 30 years will burn the other half and then climate change will enter into irreversible processes. At over 95 percent the accuracy of climate models is estimated. At 66 percent the validity of the model is estimated with this 1 trillion tons. Therefore, there was relatively little time left to implement the principles of sustainable development into economic processes so that these processes could be implemented according to the concept of green economy and circular economy.

The 17 UN Global Goals for Sustainable Development as an integrated multi-faceted formula of a global sustainable development plan

In a broader sense, the principles of sustainable development have been included in the scope of 17 global goals officially known as the United Nations Sustainable Development Goals or SDG. The UN SDG Sustainable Development Goals, also defined as the Global Goals, were adopted by all UN member states in 2015. In short, the SDG goals play the role of an international call for urgent action, which by 2030 should lead to the eradication of poverty, protection of the planet's biodiversity, unfavorable climate change and ensuring peace and well-being for all (*Sustainable Development Goals*, 2020). The UN SDG's Sustainable Development Goals superseded the Millennium Development Goals and significantly expanded them with the perspective of achieving them by 2030. According to the UN Global Compact and the entire United Nations, the sector of commercially operating business entities plays a particularly important role in achieving the goals of the SDG. The public sector should support and coordinate the achievement of the SDG goals, but without the active involvement of the private sector in this process, it would not be possible to achieve these ambitious goals by 2030. The establishment of the UN SDG Sustainable Development Goals was preceded by several important events that led to the development of the final SDG formula. After the global financial crisis of 2008, interest in the issues of global economic, social and climate change problems has increased. In 2012, during a conference in Rio de Janeiro (Rio + 20), the document "*The future we want*" was prepared, which contained the framework of the Sustainable Development Goals planned at that time. Already at that time, key strategic objectives were defined,

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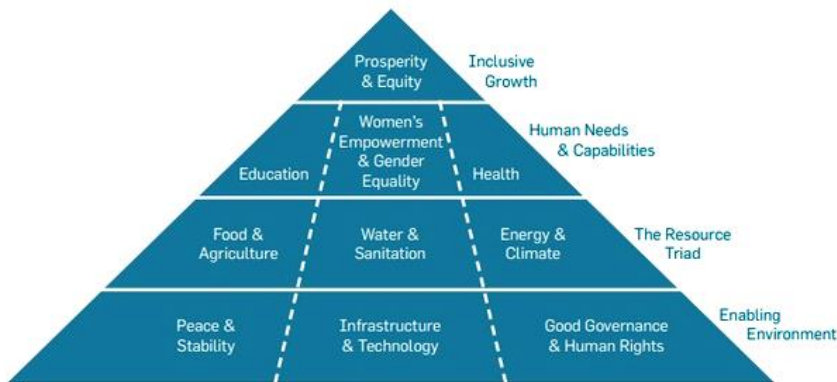
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the implementation of which was to lead to pro-social, pro-ecological and reducing economic disproportions existing between rich and poor countries in the world of transforming socio-economic processes in order to e.g. eradicate poverty, improve health, education and the rule of law in low-income countries, and strengthen nature conservation systems. As part of the Rio de Janeiro (Rio + 20) conference, an open group was established with the task of developing and clarifying the future goals of sustainable, long-term development for the 68th UN General Assembly, which was to be held in 2013. conference in Rio de Janeiro (Rio + 20), the UN Global Compact organization began to create new programs for the sector of commercial economic entities, which were submitted to the UN Secretary General and presented at the United Nations General Assembly in August 2013. The new recommendations for private sector entities developed in this way were based on a survey conducted by the UN Global Compact together with its local, national partners. The surveys provided the necessary information, thanks to which it was possible to precisely develop a new sustainable development plan implemented more efficiently, because with the business involved in this sustainable development. The graphic below presents recommendations for private sector business entities, broken down into four main blocks: Development, Human Needs and Capabilities, Raw Materials Triad and Environment favorable to Human Development (*Sustainable Development Goals*, 2020). The aforementioned recommendations consisted of ten points showing how business can influence the implementation of new solutions in priority areas. These recommendations make people aware of the particularly important role of commercially operating business entities, thanks to which the process of achieving Sustainable Development Goals (SDGs) should be conducted more efficiently as part of mutual international cooperation and cooperation of various types of organizations, public institutions and business entities.

Figure 6. Recommendations for the private sector to support the achievement of SDG goals. (divided into four main blocks: Development, Human needs and abilities, Raw material triad and Environment conducive to human development).



Source: *Sustainable Development Goals*, (in:) "United Nations Global Compact" website, United Nations Global Compact. Network Poland, 2015-2020, (<https://ungc.org.pl/sdg/sustainable-development-goals/>), for: Report Global Compact LEAD consultations, access: 5.8.2020.

Then, on September 25-27, 2015, at the UN headquarters in New York, the summit of the 2030 Agenda for Sustainable Development took place. This summit of the 2030 Agenda for Sustainable Development was attended by representatives of over 100 countries as well as representatives of religious groups, large corporations, and non-governmental organizations and others typical of civil society. During this summit, a document was adopted called "Transforming our world: Agenda for Sustainable Development - 2030". This document, signed by representatives of over 100 countries and many different organizations, describes the characteristics of the 17 UN Sustainable Development Goals (SDGs). The goals of the SDG can be fully effectively implemented if the process of their implementation will take the form of mutual international cooperation and have a global, not regional dimension, limited only to some countries. In addition, the process of achieving the SDG goals should be monitored so that it is possible to verify the progress in achieving the SDG goals within specified time intervals and to improve the methods and methods of the goal achievement process. Therefore, the implementation of the SDG objectives should be monitored using a set of indicators for assessing social, economic, health, normative, environmental, educational and other changes. The use of this system of controlling the progress towards SDG goals represents a significant positive change compared to the limited evaluation tools of the previous Millennium Goals (*Sustainable Development Goals*, 2020). All The 17 UN Global Goals for Sustainable Development are shown in the figure below.

Figure 7. The 17 UN Global Goals for Sustainable Development.



Source: The 17 Global Goals for Sustainable Development, (in: "Global Goals.org" website, 2015-2020, (<https://www.globalgoals.org>; <https://worldslargestlesson.globalgoals.org>), access: 5.8.2020.

The objectives of the SDG have been defined much more broadly in relation to the issues of pro-ecological reforms and the implementation of eco-innovations in specific sectors and sectors of the economy. In line with the adopted goals, according to the United Na-


tions, in addition to environmental (ecological) policy, sustainable development also includes economic, social, cultural, educational, etc. policies, i.e. basically all key aspects of human existence in the modern world. And social responsibility does not only include ecology and business, but also the issue of reducing the scale of income stratification, providing people in the poorest countries with basic living conditions, i.e. providing food, water, medical care, the education system, peace, and social justice.

In view of the above, the implementation of these UN SDG Sustainable Development Goals will contribute to the creation of a better world by 2030, because by then these goals, in accordance with the adopted declarations, should be achieved. In addition to the pro-ecological transformation in the energy sector and increasing the scale of environmental protection, the key and most important goals of the SDG include eliminating poverty, reducing the scale of inequalities in national and international terms, and ensuring decent living conditions for people around the world. On the other hand, urgently tackling climate change issues was also included in the SDG's key objectives. For the achievement of these goals by 2030 to be fully realistic, governments of individual countries, enterprises, civil society, non-governmental institutions, media and the public should be involved in their implementation. The effective implementation of these ambitious goals requires the involvement of innovation, creativity, know-how, new technologies, financial resources and many other pro-ecological and pro-social capital categories. All decision-making environments should cooperate with each other with a view to the long-term implementation of the SDG goals (*The 17 Global Goals for Sustainable Development*, 2020).

The Sustainable Development Goals of the UN SDG also serve as a call for urgent, solidarity-based cooperation of all countries in the world, including highly developed countries with high incomes per citizens, and countries with middle income and the poorest, where many people do not have medical care, basic conditions living conditions, including food and water. The scope of the UN SDG's Sustainable Development Goals also includes promoting the development of prosperity while taking measures to protect the biodiversity of the planet Earth and counteract the negative effects of the ongoing climate change and also counteract the progressive climate change. In line with the objectives of the SDG, reducing the scale of poverty should be implemented through sustainable economic growth, i.e. one that takes into account basic social needs, i.e. education, health, social protection and creating conditions for ensuring employment in the conditions of parallel implementation of pro-ecological reforms and strengthening of environmental protection systems, which should effectively counteract climate change processes that are unfavorable for humans and the biosphere. In addition, now, from 2020, issues related to the SARS-CoV-2 coronavirus pandemic causing the Covid-19 disease have also been added to the above goals related to the provision of healthcare. Therefore, it is necessary to create conditions for the development of international cooperation, exchange of information on conducted research and conducting joint research, setting up international research teams that will, as soon as possible, develop, create and implement a vaccine against the SARS-CoV-2 coronavirus and also in the field of development and providing all citizens of planet Earth with the necessary information, medical assistance and the necessary means, devices and instruments of anti-pandemic and sanitary safety (*17 Goals to Transform Our World*, 2020).

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The implementation of the 17 Sustainable Development Goals should take place in a system of integrated actions, i.e. in line with the assumption that projects implemented in one area affect processes implemented in other areas of SDG objectives. Implementation of the SDG objectives carried out in an integrated manner should contribute to increasing the scale of social, economic and environmental balance. In order to reduce the disparities in economic development and reduce the scale of income stratification as part of the implementation of countries' obligations to achieve the SDG goals, highly developed countries support the economic development of countries with the lowest income. In this way, the elimination of such basic problems, which mainly concern the communities of the poorest countries, such as poverty, hunger, AIDS, discrimination against women and lack of medical care should be implemented (*Sustainable Development Goals*, 2020).

Conclusions

The future development of civilization, the protection of biodiversity and the scale of slowing down of unfavorable climate change processes probably depend on the scale of the pro-ecological transformation of the economy that will take place in the next 2-3 decades. If in the period of the next max. For 20-30 years, renewable energy sources will be developed on a massive scale, replacing traditional energy based on the combustion of fossil fuels, perhaps it would be possible for mankind to avoid the climatic catastrophe, which may appear at the beginning of the XXII century. The international COP24 climate agreement concluded in Katowice in Poland in December 2018 turned out to be late and insufficient, as most countries do not intend to develop high-budget projects for the construction and development of power plants based on renewable energy sources. Similarly, another international COP25 agreement, which took place in Madrid in December 2019, was also not successful. Still not all countries in the world are interested in signing an agreement on a successive reduction of CO₂ emissions (*The UN Climate Change Conference COP 25*, 2019). In addition, changes in the automotive industry, changes directing the development of the automotive industry towards electromobility are progressing too slowly. The problem is serious because it concerns the future of all mankind in the perspective of the next 2-3 generations, but the necessary changes and reforms in the implementation of the principles of sustainable pro-ecological development into economic processes are progressing too slowly. At the current pace of changes, there may not be enough time to implement the necessary pro-ecological projects and then the problem of global warming will become an irreversible and constantly accelerating process! Then, at the latest at the beginning of the XXII century, the planet Earth, humanity and a significant part of life forms of flora and fauna await the climatic Armageddon.

If, in the coming years, renewable energy sources are developed on a massive scale, replacing the traditional energy based on burning fossil fuels, perhaps mankind would be able to avoid a climate catastrophe in the 21st century. Therefore, different types of renewable energy sources, electromobility in the automotive industry and ecological innovations should be developed in each country, depending on the level of development, financial possibilities, climate and economic conditions. The economy will have to systematically change towards sustainable pro-ecological development if the process of warming the Earth's climate accelerates in the coming decades (Štrukelj T., Nikolić J., Zlatanović D., Sternad Zabukovšek S., 2020).

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Regardless of the real possibilities of slowing down the progressing global warming process, man should reduce all or most of the surplus greenhouse gas emissions in the shortest possible time, reform the energy sector by developing renewable energy sources and carry out other pro-ecological reforms to implement the principles of sustainable pro-ecological development and carry out a pro-ecological transformation of the current one, the dominant traditional brown economy model of excess to a sustainable green economy of moderation. Thanks to this pro-ecological transformation of the economy, it will also be possible to intensify in the coming years activities in the field of nature protection, protection of natural biological ecosystems, protection of the earth's biodiversity and its preservation for future generations (Pearce D. W., Turner R. K., 1990).

Therefore, the 21st century is the last moment to introduce global sustainable development based on the development of RES energy (Ren J., Tan S., Evan M., Sovacool BK, Dong L., 2015) and ecological innovations created and implemented in various sectors and economic sectors. Sustainable development should be analyzed and measured in correlation with the analysis of economic growth and the share of individual sectors in the economic development of the country, taking into account the transformation of traditional energy sources into renewable energy, environmental reclamation and recovery of secondary raw materials and the created ecological innovations. It is imperative to change the development strategy based on the intensification of the exploitation of the Earth's resources into a sustainable development strategy. It is necessary to develop new energy technologies based on renewable energy sources to slow down the progressive greenhouse effect of the Earth, to reduce the risk of emerging dramatic natural disasters. It is necessary to develop ecological innovations (Boons F., Lüdeke-Freund F., 2013), while it may not be too late to do so, in order to save the biodiversity of the planet Earth for future generations (França Costa W, Sousa R, Giannini T, Albertini B, Saraiva A, 2018) against the climatic Armageddon, which may already appear at the beginning of the XXII century. The issue of urgent pro-ecological transformation of the energy sector is multi-faceted, because the urgent need to develop energy based on renewable energy sources results from the following interrelated factors:

- a) reduction of greenhouse gas emissions,
- b) diversifying sources of electricity and heat,
- c) the depletion of traditional energy resources, i.e. hard coal, lignite, crude oil, etc., and the protection of wood raw materials,
- d) projected increase in electricity consumption due to the development of electromobility and other industries (Sadorsky P., 2010),
- e) the impact of the projected climate change on energy consumption in industry and households, i.e. the projected increase in energy consumption due to the growing number of refrigerators, refrigerators, air conditioners, cooling fans in households, offices and some production processes (Halimi BZM, 2011) .

Ryszawska B. (Ryszawska B., 2016) suggests that the process of systemic, multi-faceted transformation of economic processes from the currently dominant model of the expansive, brown economy of excess to the model of a sustainable, green economy of moderation has already started. Until recently, the aforementioned concept of pro-ecological transformation was postulated mainly or exclusively within the still narrow scientific discipline called ecological economics or the economics of sustainable development.

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On the other hand, the aforementioned transformation of the economy taking place in certain aspects, e.g. the development of renewable energy sources, waste sorting, recycling, the development of electromobility (Bridle R. and Kitson L., 2014), etc., has already been implemented in many countries around the world. In a situation of deepening the scale of the processes taking place as part of the above-mentioned transformation, these processes increasingly acquire a coordinated, multi-faceted, complex and global character, i.e. approaching the concept of sustainability transition. On the other hand, despite the fact that the transformation of the economy has started in the right direction, its scale is still insufficient in view of the pace of growing environmental pollution, greenhouse gas emissions and ever faster climate change, including the global warming process.

Therefore, it was entered in the introductory part of this study entitled *Aims of paper. Methods* the following research thesis: Due to the ever faster global warming process, it is necessary in the next 20-30 years to carry out a pro-ecological transformation of the existing, dominant, traditional model of brown excess economy to a sustainable, green economy of moderation, - has been confirmed.

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