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Greening the Energy Sector and the New Quality of Globalisation

DENYS ILNYTSKYY[1],
YAROSLAVA STOLIARCHUK[2]

ANNOTATION. The article is devoted to a comprehensive study of the processes of greening the global energy complex and its transition to a sustainable development model. The authors prove that digital and network transformation of the world economic system in the first quarter of the 21st century is the main determinant of the fundamental process of creative global economic development, including increasing investment in the innovative development of the green economy. It is stated that the "greening" of the global energy sector is a powerful driver of deep structural modernisation of national models of socio-economic development and recovery of natural capital. It is proved that the significant intensification of international competition between key actors of the world economy for the resource sources of digital and green transformations in the last decade will radically change the competitive landscape of the global economy in the near future. It is determined that the post-industrial model of global technological development shapes a stable basis for the development of the world energy system in the dialectical unity of the energy market and energy environment. Given the current processes of re-industrialisation of national economies, which in the global environment are determined by the ability to develop an innovative ecosystem, the authors support stratification of countries into groups: the first group – those ones that are able to quickly change national energy consumption models based on energy efficient and green technologies; and the second one – those which are not ready for such changes. The authors reveal the impact of global environmental trends on the structural and qualitative dynamics of modern global economic development: active shift of national economic models from expansive growth to intensive use of production factor potential; transformation of the structure of national economic complexes towards the formation of green sectors of the economy and green jobs; dynamic reindustrialisation of traditional industry through the input of new technologies and models of economic activity; deep social transformations of capitalist society; renewal of social values and set of priorities of current and strategic activities of business structures.
The article reveals the impact of the Covid-19 pandemic on the "greening" of the global energy sector and its transition to a sustainable development model: a rapid decline in market demand for fossil fuels; imbalance in global supply chains of vital goods; a rapid decline in investment in the oil and gas sector; increased consumption of renewable energy sources of local origin; and

[1] **Denys Ilnytskyy –** Doctor of Economics, Professor of the Department of International Economics of Kyiv National Economic University named after Vadym Hetman. Sphere of scientific interests: knowledge economy, global scientific and educational space, information resources, intellectual property, economic infrastructure, international economic integration, network economy, green economy. E-mail: ilnytskyy@kneu.edu.ua. ORCID 0000-0001-8528-7845

[2] **Yaroslava Stoliarchuk –** Doctor of Economics, Head of the Department of International Economics of Kyiv National Economic University named after Vadym Hetman. Sphere of scientific interests: global economic development and its asymmetries, global financial market, international economic integration and transnationalisation of national economies, international investment and innovation, global labour market and international labour migration. E-mail: stolyaroslava@kneu.edu.ua. ORCID 0000-0001-9124-6310

increased flexibility in energy network management. The article specifies the essence of the EU's climate ambitions, which are to build a model of competitive development based on systemic decarbonisation of the economy. The authors identify the priority areas for the development of green hydrogen generation in the European Union, which is considered within the framework of the plan for the integration of national energy complexes of the member states of this integration grouping, as well as the implementation of its Green Deal.

KEY WORDS: green economy, smart economy, globalisation, green networking, energy sector, energy transformation, digitalisation, environmental problem, Covid-19 pandemic, EU external energy strategy, integration policy, Green Deal, REPowerEU Plan, green hydrogen.

Introduction

The modern world economy, whose mature model was formed in the early twentieth century, is undergoing profound transformational changes in both its technological base and the entire system of superstructure relations in the first quarter of the twenty-first century. On the one hand, the need for such qualitative changes is caused by the critical aggravation of the global environmental problem, which is concentrated in climate change and environmental parameters of the human environment, as well as the environment reaching its productivity limits. On the other hand, we are all currently witnessing the dynamic unfolding of a number of social transformations, primarily digital and green, which opens up a wide window of opportunity for the global community to fully implement creative concepts, one of which is the smart economy.

As for the energy base of the international economic system, it is currently undergoing a transition from a hydrocarbon-based to a renewable energy supply model in order to achieve the Sustainable Development Goals, which represents an extremely complex and highly controversial process. It is capable of fundamentally changing not only the nature of relations between humans and nature, existing corporate strategies and business models, tools and levers of macroeconomic growth of states and entire regions, but also the structural dimensions of the world economy and geopolitical trajectories of its further development. In the context of the overall methodological framework of the sustainable development paradigm, the renewable energy model guides the global community to meet the energy needs of society without adversely affecting the environment, without disturbing the socio-economic balance and without harming the economic interests of future generations. It is no secret that this will require profound transformational changes in the socio-economic and corporate landscape of the global economy, restructuring of global markets (primarily energy markets), and redrawing of global supply and distribution chains.

The development of a green economy relies on a combination of public and private investment in infrastructure and assets of such quality that it makes it possible to significantly change established principles, values, corporate strategies, business models and business practices. This is primarily about reducing waste, emissions and environmental pollution (in particular, carbon), increasing energy and resource efficiency of economic activity, as well as preventing climate change and biodiversity loss[3]. These measures together make it possible to maintain high levels of employment and income, as well as profitability of enterprises in the current conditions of social and economic change, which has been enshrined in the concept of zero growth for several decades[4].

The urgency of transforming society concerns not only energy production and consumption, but also the entire culture of consumption and behaviour of economic actors[5]. Even the entire capitalist paradigm is facing the challenge of essential transformation due to its contradiction with new values and the speed of economic development[6] . Therefore, it is not only about the growth of the global economy, but also about qualitatively new international systems, mechanisms and relations between its actors.

The purpose of the study is to systematise the arguments that justify the expediency of considering the priorities of "greening" the energy sector in the strategy of post-war recovery of the national economy, as one of the inherent attributes of the new quality of globalisation and a trend in the development of the world economy. To achieve this goal, a number of tasks have been identified, including:

- to reveal the contribution of digital transformation processes to the transition of global processes to a new quality;
- to summarise the key areas of greening the global energy sector;
- to identify regional peculiarities and challenges of greening the energy sector;
- to reveal the impact of the Covid-19 pandemic on the greening of the global energy sector;
- to describe the EU's external energy strategy for 2022 as a reaction to the russian-Ukrainian war;
- to outline the potential of green hydrogen as a priority for the European Union's energy transition.

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[3] Uninets, I. M. "Zelena ekonomika v hlobalnii ekosystemi." [Green economy in the global ecosystem]. *Scientific Notes*, Issue 22 (1) (2021), pp. 69-80. URL: https://vz.kneu.edu.ua/ua/arch_vz/. (In Ukrainian).

[4] Nyangchak, N. (2022). Emerging green industry towards net-zero economy: A systematic review. *Journal of Cleaner Production*, 134622.

[5] Trainer, T. (2007). Renewable energy cannot sustain a consumer society. Springer Science & Business Media. 197 p. DOI 10.1007/978-1-4020-5549-2.

[6] Blauwhof, F. B. (2012). Overcoming accumulation: Is a capitalist steady-state economy possible? *Ecological Economics*, *84*, 254-261.

Theoretical arsenal for research of energy greening processes

International comparisons of the progress of national economies in the development of the digital economy and the digitalisation of all their sectors are also very popular among researchers and those who are engaged in digital transformation. According to international scientometric databases, in particular, Scopus[7] , researchers from countries such as the russian federation, China, the United States, the United Kingdom, and India are most active in researching the formation and development of the digital economy.

A number of domestic scholars have proved that the processes of digital and network transformation should be considered as determinants of the overall creativity of global development, in particular in the field of international investment[8]. These now also include investment in the development of the green economy[9].

Some researchers propose to consider the mechanism of digital transformation solely from the point of view of identifying its institutional components, in particular, the system of state bodies, legal acts and regulatory instruments and measures for the development of the national economy[10]. An important role is also played by scientific works that focus on the study of digitalisation processes exclusively from the methodological standpoint of a particular science. In particular, given the very nature of digital transformation, it is proposed to focus on issues of information interaction – information field management, cybersocialisation, digital communication[11]. An attractive topic is the study of the impact of digital transformation on public administration and its use as a mechanism for social transformation[12].

In an open global post-industrial economy, the issue of regulatory competition between national economies is becoming more acute, which

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[7] SCOPUS. URL: https://www.scopus.com/search/form.uri.

[8] Burmaka, M. "Kreatyvizatsiia hlobalnoho investytsiinoho protsesu" [Creativity of the Global Investment Process]. *International Economic Policy*, vol. 2, no. 29 (2018), pp. 37-54. URL: http://iepjournal.com/journals/29/2018_2_Burmaka.pdf (In Ukrainian).

[9] Orlovska, Yu., Kvaktun, O., Kakhovych, O., and Dryhola, K. "Derzhavne upravlinnia zelenymy investytsiiamy yak faktor staloho rozvytku rehioniv." [Public management of green investments as a factor of sustainable development of regions]. *Investytsii: praktyka ta dosvid [Investments: practice and experience]*, No. 16 (2021), pp. 70-76. [In Ukrainian].

[10] Pustovarov, A. "Formuvannia mekhanizmu tsyfrovoi transformatsii upravlinnia rozvytkom natsionalnoi ekonomiky." [Formation of the mechanism of digital transformation of management of the national economy development]. *Naukovyi visnyk Uzhhorodskoho natsionalnoho universytetu [Scientific Bulletin of Uzhhorod National University]*, Issue 34 (2020), pp. 213-218. DOI: 10.32782/2413-9971/2020-34-36. (In Ukrainian).

[11] Shymchenko, L., Miroshnychenko, D., and Kostenko, D. "Tsyfrova transformatsiia Ukrainy yak mekhanizm efektyzatsii komunikatsii vlady z narodom." [Digital transformation of Ukraine as a mechanism for improving communication between the government and the people]. *Society. Document. Communication.* No. 14 (2022), pp. 304-322. https://doi.org/10.31470/2518-7600-2022-14-304-322 (In Ukrainian).

[12] Byrkovych, T., Byrkovych, V., and Kabanets, A. "Mechanisms of public administration in the field of digital transformation." *Derzhavne upravlinnya: udoskonalennya ta rozvytok*, vol. 9 (2019), http://www.dy.nayka.com.ua/?op=1&z=1488. DOI: 10.32702/2307-2156-2019.9.2. [In Ukrainian].

requires the selection of adequate principles, tools and methods. One of the intermediate results is that, according to Z. Matsuk, effective digital transformation is intended to create an attractive investment climate in the country, as it concerns almost all aspects of life[13]. It should probably be more broadly about the general environment of business and human activity, as the digital dimension can be found in both ease of doing business and global competitiveness rankings. On the other hand, as V. Panchenko, N. Reznikova, and O. Bulatova argue, a new form of neo-protectionism (both digital protectionism and innovation and information protectionism) is emerging in the post-industrial economy[14].

At the micro level, researchers focus on the study of corporate leadership initiatives, primarily in the field of e-commerce, on a national and international scale[15]. The transition of the world economy to the sixth technological mode implies its systemic digitalisation. Researchers wrote in 2019 that it should also be considered one of the dominants of business transnationalisation[16]. Over time, we can observe the results of the digitalisation of business activities, which are manifested primarily in a radical revision of traditional business practices. For example, the European Central Bank has set as one of its short-term goals a 50% reduction in physical contact with external entities to reduce the environmental impact of business operations[17].

The Covid-19 pandemic has given a powerful impetus to the digitalisation of most socio-economic processes. It is no coincidence that in 2020-2023 there was a surge in research activity in this area. Researchers have tried to cover most aspects of socio-economic development, including specific industries. Active remote employment has added to the arguments for the spread of the concept of the gig economy, with its high role of the Internet, ICT and infrastructure, as well as energy, which allow economic processes to develop even in conditions of minimised direct contact between people[18].

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[13] Matsuk, Z. "Global Challenges and Trends in the Securities Market in Ukraine." *International Economic Policy*, No. 1-2 (32-33) (2020), pp. 153-173. URL: http://iepjournal.com/journals/32-33/2020_7_Matsuk_ukr.pdf. DOI: 10.33111/iep.2020.32_33.07_eng

[14] Panchenko, V., Reznikova, N., and Bulatova, O. "Regulatory Competition in the Digital Economy: New Forms of Protectionism." *International Economic Policy*, No. 1-2 (32-33) (2020), pp. 50-80. DOI: 10.33111/iep.2020.32_33.03_eng. URL: http://iepjournal.com/journals_eng/32-33/2020_3_Panchenko_Reznikova_Bulatova.pdf

[15] Humenna, Yu., and Hura, O. "Tendentsii vprovadzhennia tsyfrovoi transformatsii v diialnist subiektiv hospodariuvannia." [Tendencies of implementation of digital transformation in the activities of business entities]. Vis*nyk SumDU. Seriia "Ekonomika" [Herald of Sumy State University. Series "Economics"]*, No. 2 (2021), pp. 202-210. [In Ukrainian].

[16] Zhylenko, K., and Meshko, N. "Dominants of Business Activity Globalization Processes." *International Economic Policy*, no. 2 (2019), pp. 43-81.

[17] European Central Bank Annual Report 2022. Eurosystem, ECB. 2023. 187 p. doi:10.2866/390483. URL: https://www.ecb.europa.eu/pub/pdf/annrep/ecb.ar2022~8ae51d163b.en.pdf

[18] Antoniuk, L., Ilnytskyy, D., and Sevastiuk, A. (eds.) "Tsyfrova ekonomika: vplyv informatsiino-komunikatsiinykh tekhnolohii na liudskyi kapital ta formuvannia kompetentnostei maibutnoho." [Digital economy: the impact of information and communication technologies on human capital and the formation of competencies of the future]. Ministry of Education and Science of Ukraine, KNEU named after V. Hetman, Kyiv: KNEU, 2021. 337 p. (In Ukrainian).

By harnessing the potential[19] of new technologies, which, in particular, is opening up in the process of digital transformation of national economies, many countries are able to take advantage of the opportunity to reduce or get rid of a number of international raw material dependencies. Thus, countries that in previous years had to spend a significant portion of their financial resources on energy imports are achieving lower energy intensity of GDP and successfully transitioning to green energy. Such achievements can now be observed in small developed economies, in particular, Austria, Belgium, Denmark, Finland, Ireland, the Netherlands, and the United Kingdom[20].

The quantitative development of digital transformation processes in the previous decades has allowed for the formation of a digital space that covers most countries of the world. Its defining feature is not only the fact that it is based on the achievements of scientific and technological progress, but also the emergence of qualitatively new institutional backdrops. First of all, we are talking about the digital economy and the phenomenon of the platform economy. They are based on the active development of informatisation, networking, intellectualisation and individualisation, as well as the emergence of qualitatively new forms of interaction between actors, primarily organisational structures of companies, their business models, and regulatory interaction[21].

The experience of newly industrialised countries is valuable for Ukraine, which is facing the challenge of reindustrialisation, which should take into account energy in the process of innovative renewal of the economic structure. Let's focus on the results of a study by researchers who, in examining the development of Brazilian industry, found that competitiveness factors have high levels of correlation with environmental innovations. Attention should be paid to the high correlation between energy consumption as a result of innovation, and competitiveness, along with a number of other factors, namely,

- improved product quality (99% correlation);
- increased production flexibility (99%);
- reduced production costs (99%);
- reduced consumption of raw materials (96%);
- reduced energy consumption (96%)[22].

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[19] Pandey, N., & Pal, A. (2020). Impact of digital surge during Covid-19 pandemic: A viewpoint on research and practice. *International journal of information management*, *55*, 102171. doi: 10.1016/j.ijinfomgt.2020.102171

[20] Orekhova, T., Tsymbal, L., and Uninets, I. "Modern International Practices of Implementing the Ecosystem Approach at Different Levels of Management." *International Economic Policy*, No. 1 (36) (2022), pp. 124-140. DOI: 10.33111/iep.eng.2022.36.06

[21] Lukyanenko, O., and Nyameschuk, A. "Development of the Platform Economy in the Global Digital Environment." *International Economic Policy*, No. 1-2 (32-33) (2020), pp. 27-49. DOI: 10.33111/iep.2020.32_33.02_eng. URL: http://iepjournal.com/journals_eng/32-33/2020_2_Lukianenko_Niameshchuk.pdf

[22] Tendencias, desafios e oportunidades da ecoinovação para a indústria no Brasil / Confederação Nacional da Indústria, Comissão Econômica para a América Latina e o Caribe (CEPAL). Brasília: CNI, 2023. 80 p. URL: https://static.portaldaindustria.com.br/media/filer_public/23/2b/232bf7fa-7ee0-4807-b32f-54a7a4ff0261/tendencias_desafios_e_oportunidades_da_ecoinovacao_para_a_industria_no_brasil.pdf. (In Spanish).

Post-pandemic recovery is a priority for many countries around the world, as almost all of them have suffered economic losses during the pandemic. Therefore, the challenges of green, digital and other transformations are overlapping with the priorities of recovery from the economic downturn. Australia has even launched a national industrial and economic recovery fund worth about A$15 billion, of which 20% is allocated to the development of renewable energy and emissions reduction technologies[23].

Despite the huge number of publications on topics that directly or indirectly relate to the qualitative transformation of the global economy in general and the energy sector in particular, there is a relative lack of research in certain areas. The domestic scientific and analytical discourse should regularly include research results aimed at identifying global and regional trends, developing and implementing strategies, developing and implementing technological changes, as well as changes in the system of supply and demand factors in global and regional markets, which in the medium and long term can determine the restructuring of the competitive landscape.

Environmental challenge – the need for systemic change

The entire set of contradictions that have accumulated in the global economy as a result of more than 200 years of dominance of the extensive model of resource consumption and wasteful involvement of natural capital in the processes of social reproduction can be effectively resolved only through a systemic transformation of all forms of international economic relations and the entire system of interconnections between them. Environmental, digital and social transformations can be qualified as a comprehensive mechanism for qualitative improvement of the world economy and transition to a new quality of globalisation. Characterising it, we should note the high degree of interconnection with the key transformational changes that the world economy is experiencing in the current environment – green, technological, financial, institutional and regulatory transformations. Taken together, they set qualitatively new trends in global economic development, fundamentally modernise existing corporate business models and strategies, and necessitate a qualitative update of the existing regulatory mechanisms for the international economic system's goals' structure.

Systemically important in this context is digital transformation, which is a continuation of the processes of computerisation, informatisation and intellectualisation, and is based on the processes of digitalisation. In this

[23] Industry, science and resources portfolio: portfolio budget statements 2022-23 budget related paper No. 1.11. Commonwealth of Australia. 2022. https://www.industry.gov.au/sites/default/files/2022-10/October_2022-23_Industry%2C%20Science%20and%20Resources_PBS.pdf.

capacity, digital transformation is nothing more than a solid material basis for the transition of global processes to their new quality as a mechanism of:

- realisation of economic potential in the network economy;
- identification global leaders in the commercialisation of scientific research;
- improvement of the efficiency of management and political processes and decisions;
- attraction of resources from regional entities and better utilising their economic potential on a global scale;
- formation of a global social elevator;
- introduction of the platform concept of the economy as a form of interaction between private management and public administration;
- acceleration of the turnover of product and factor flows;
- creation of new competitive advantages and business models.

The green transformation of the global economy is also making extensive use of the potential of digital technologies to better manage natural resources and waste, minimise the loss of natural capital and move towards its reproduction. Remote monitoring and support, value chain management, inventory and supplier management, access to global labour and consumption markets, financial and other resources, data and knowledge exchange are examples that are being used in the formation of a green economy. The share of renewable energy sources is considered by many researchers to be a determinant of the development of global supply chains in a sustainable network economy[24].

Despite the fact that digital and green transitions are accompanied by a slowdown in economic development (as we wrote about earlier[25]), Chinese researchers have found that the digital transition significantly accelerates the green transformation process, making it more real[26]. Moreover, transformations lead not only to a change but also to the rationalisation of the industrial structure of the economy, including the impact on the energy sector.

As S. Kuznets argued the calculation of the welfare of nations should take into account not only national income or GDP[27]. The point is the need to calculate and take into account the social costs and environmental impacts

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[24] Melkonyan A., Krumme K., Gruchmann T., Spinler S., Schumacher T., Bleischwitz R. Scenario and strategy planning for transformative supply chains within a sustainable economy. *Journal of Cleaner Production*. 2019. Vol. 231. P. 144-160.

[25] Ilnytskyy, D. "Hlobalna konkurentsiia v naukovo-osvitnomu prostori." [Global competition in the scientific and educational space]. Kyiv: KNEU, 2016. 445 p. (In Ukrainian).

[26] Hao, X., Li, Y., Ren, S., Wu, H., & Hao, Y. (2023). The role of digitalisation on green economic growth: Does industrial structure optimisation and green innovation matter? *Journal of Environmental Management*, *325*, 116504. DOI: 10.1016/j.jenvman.2022.116504

[27] Blanco E., Razzaque J. Natural Resources and the Green Economy: Redefining the Challenges for People. Leiden-Boston: Martinus Nijhoff Publishers. 2012.

incurred by society, which can be realised through the integration of the concepts of social and natural capital. The number of applications of this approach is growing, in particular, for some developed countries, the social cost of hydrocarbons has been calculated to range from USD 1 to USD 417 per tonne of CO_2[28]. Therefore, in our opinion, more accurate data and the ability to manage the welfare of nations can be realised through green and digital transitions.

The search for solutions to the global environmental problem leads many researchers to the need for decarbonisation and more efficient use of natural resources. Decarbonisation is directly related to the energy sector, which is the main consumer of fossil fuels (coal, oil, gas). Their use leads to the accumulation of greenhouse gases in the atmosphere, which can be overcome even by investing in the use of existing technologies. The exhaustion of other natural resources has led to the emergence of the circular economy concept, which pays more attention to the full variety of natural resources, including water and metals[29]. It is important to take into account that the impact of the physical existence and use of ICT in production processes, including energy for industrial and domestic consumption, on the approach to sustainable development will have a negative impact, but the positive impact will be mainly observed in terms of reducing pollution and energy and water consumption through the optimisation of unsustainable consumption processes[30].

The large losses of global natural capital can be compensated to some extent by investing at least 1% of global GDP in environmental protection measures[31]. This amount corresponds to USD 0.965 trillion. In 2021, when the volume of international direct investment was about USD 1.6 trillion. Therefore, reaching the level of 60% of investments that meet the criteria for investing in the achievement of sustainable development goals will allow us to start changing the situation for the better. Given that the ideal situation would be when 100% of investments meet the criteria for investing in sustainable development goals, achieving such levels can be considered a realistic goal. At the same time, the lagging behind of certain countries in achieving such levels and principles may in the future form the basis for discrimination against those entities that cause negative environmental impact.

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[28] Economics of the environment. in Essentials of Economics in Context. By Neva Goodwin, Jonathan M. Harris, Pratistha Joshi Rajkarnikar, Brian Roach, Tim B. Thornton. 1st Edition. Routledge. 2020.

[29] Panagopoulos, A., & Giannika, V. (2022). Decarbonised and circular brine management/valorisation for water & valuable resource recovery via minimal/zero liquid discharge (MLD/ZLD) strategies. *Journal of Environmental Management*, *324*, 116239. DOI: 10.1016/j.jenvman.2022.116239

[30] Ciocoiu C. Integrating Digital Economy And Green Economy: Opportunities For Sustainable Development. Theoretical and Empirical Researches in Urban Management. 2011. Vol. 6 (1). P. 33-43.

[31] Stern N. The Economics of Climate Change: The Stern Review. Cambridge University Press, Cambridge, UK. Executive Summary, 2007. – p. 2.

To achieve the goals set out in the Paris Climate Agreement by 2030, including a 40% reduction in greenhouse gas emissions, EU countries will need to invest more than €180 billion annually[32]. According to UNCTAD, in just one year, the accumulated volume of international investment flows related to sustainable development increased by 63% to USD 5.2 trillion. USD in 2021[33]. At the same time, most of the world's 5,000 largest MNEs in 2022 announced a decrease in expected profitability due to price shocks in the energy market and the need to find investment solutions using the potential of alternative energy sources.

In turn, the energy transformation (or energy transition, as it is called) is also based on fundamental pioneering developments in the use of alternative sources for electricity generation, which is turning into a key product not only of the energy sector but also a systemically important product of the entire economic system; technologies for managing CO_2; impact on socio-economic development and its consequences; minimising the impact on climate change; accumulating resources for the implementation of global projects and systemic innovations. To transition to climate-friendly technologies, the global economy needs to invest USD 15 trillion. One of the consequences of which is expected to be an increase in the share of electrification in the structure of energy consumption from the current 20% to 50%[34].

Thus, we can talk about the systemic impact of digital transformation on all subsystems and structural components of the world economy, which has two distinct levels. On the one hand, digital transformation is creating qualitatively new sectors of the global economy and fundamentally changing the current model of international division of labour, specialisation and cooperation between countries, and on the other hand, it is moving traditional sectors of the global economy to a qualitatively higher level of development. At the same time, we are all witnessing the disappearance of a number of economic sectors and types of labour activity, which requires business entities to develop adaptive strategies for competitive development and adjust to new market conditions in global markets. This poses powerful challenges to national governments and international governance institutions, which leads to the actualisation of the entire range of tools for socialising economic development.

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[32] Fatica S., Panzica R. Green bonds as a tool against climate change? JRC Working Papers in Economics and Finance, 2020/10, 2020. - p. 5.

[33] World Investment Report 2022: International tax reforms and sustainable investment. United Nations Conference on Trade and Development, Geneva and New York, 2022, 219 pp. ISBN: 978-9211130492.

[34] Global energy transformation: A roadmap to 2050 (2019 edition), International Renewable Energy Agency, Abu Dhabi. 52 p. ISBN 978-92-9260-121-8 https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Apr/IRENA_Global_Energy_Transformation_2019.pdf?rev=6ea97044a1274c6c8ffe4a116ab17b8f

Digital transformation – the technological basis for updating the processes of globalisation

Over the past decade, the Scopus scientometric database finds for 5 to 15 publications annually upon the keyword "new globalisation". This refers primarily to the challenges of globalisation associated with changes in the international economic order, especially the institutional system due to its inability to address pressing issues. An example of this is, in particular, China's initiative to renew the Silk Road, which is designed to connect a large number of national economies with a belt. The institutional renewal of globalisation also includes the growing role of individual actors in the global economy, including regions, cities and corporations. Some scholars associate the qualitative renewal of globalisation with changes in certain sectors, such as services and higher education, industry with its transition to Industry 4.0, agriculture and the growth of organic markets, and the increasing role of human capital and healthcare systems in the system of mechanisms for socio-economic development.

In our opinion, the expediency of research on the patterns and features of the development of a new quality of globalisation comes from the implementation of the law of dialectics regarding the transition of quantitative changes into qualitative ones. That is why the industrial paradigm of socio-economic development is being replaced by the post-industrial paradigm. The critical mass of global systems has reached the culmination of its development, which is limited by the limits of effective demand, the level of technology achieved, the effectiveness of established institutional proportions, and the slowdown in the growth of macroeconomic indicators, including GDP per capita. It is also necessary to find new drivers of socio-economic development of the global economy, which at the moment can be considered digitalisation and the transition to the priorities and principles of sustainable development (or green transition).

Digital transformation is the material and technological basis for the transition of global processes to a new quality. At the same time, the green transition is mostly seen as a change in ethical principles. However, it should be acknowledged that both green and digital transitions have both tangible and intangible dimensions that should be taken into account to fully exploit the potential of transformational processes.

In the digital space, it becomes quite difficult to use the expansionist methods that were characteristic of the period of industrial development, when markets could be intensely competitive at the level of technology, but at the same time offer various advantages of expanding these markets[35]. Previously, the use of a particular technology was based solely on the need

[35] Regulatory competition in the digital economy: new forms of protectionism. International Economic Policy. 2020. № 1-2.(32-33). С. 50-80

for the final product, without taking into account the full range of dimensions associated with such production, especially those with long-term impacts and consequences. Taking advantage of digitalisation can significantly simplify the monitoring, accounting and analysis processes that precede decision-making in the field of economics and management, as well as other social processes.

Changes affect all dimensions of economic development, which are not only being updated but also undergoing fundamental transformations that lead to the emergence of new sectors of the economy (sharing economy, network economy, digital economy, smart economy, etc.) This includes the emergence of new goods and services, the formation of demand for new competencies, the implementation of competitive strategies for innovative development, as well as the formation and accumulation of new forms of capital and the integration of digitalisation processes into macro- and microeconomic components[36].

Modern national and international development projects, business and infrastructure projects, involve a number of mandatory dimensions: spatial and geographical, financial and economic, market, knowledge and information, raw materials and energy, competence and human, and environmental. The long-term success of large-scale projects can no longer be put at risk by not taking into account all potential challenges and dimensions. While the industrial economy had a default consensus of ignoring environmental or social issues, which made projects more cost-effective in the short and medium term, the post-industrial paradigm and global environmental concerns make this practice no longer acceptable. This is the reason for the 15-year trend towards an increase in the number of basic and applied ESG research covering a wide range of fields of knowledge[37]. Therefore, taking global trends into account has become part of the design and strategic business planning process. The transition of economic sectors to the principles and models of sustainable development also implies the «greening» of the energy sector, which is generally understood as an increase in the share of renewable sources and emissions, as well as the intensification of innovative activities in energy saving and the use of alternative energy sources[38].

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[36] Antoniuk, L., Ilnytskyy, D., and Sevastiuk, A. (eds.) "Tsyfrova ekonomika: vplyv informatsiino-komunikatsiinykh tekhnolohii na liudskyi kapital ta formuvannia kompetentnostei maibutnoho." [Digital economy: the impact of information and communication technologies on human capital and the formation of competencies of the future]. Ministry of Education and Science of Ukraine, KNEU named after V. Hetman, Kyiv: KNEU, 2021. 337 p. (In Ukrainian).

[37] Senadheera, S. S., Gregory, R., Rinklebe, J., Farrukh, M., Rhee, J. H., & Ok, Y. S. (2022). The development of research on environmental, social, and governance (ESG): A bibliometric analysis. *Sustainable Environment*, 8(1), 2125869. URL: DOI: 10.1080/27658511.2022.2125869

[38] Hosseini, S. E., & Wahid, M. A. (2016). Hydrogen production from renewable and sustainable energy resources: A promising green energy carrier for clean development. *Renewable and Sustainable Energy Reviews*, *57*, pp. 850-866.

The extensive growth of the global and national economies that dominated almost the entire twentieth century was based on the expansion potential provided by the liberalisation and intensification of international trade and the movement of production factors. All this time, natural resources were seen as virtually unlimited. However, experts of the Club of Rome and other scientists have long warned about reaching growth limits and regularly confirm and find new evidence for these conclusions[39]. Energy, as a subject of trade and investment, accounts for a significant share of international economic relations, and energy is expected to reach a record 13% of global GDP in 2022.

It should be remembered that in general, in the economy of an industrial society, energy development has become one of the prerequisites for the development of those sectors (agriculture, transport, waste management, information technology, communications) that have become prerequisites for a developed society. Moreover, despite the significant potential of non-conventional energy sources, even fossil, non-renewable sources have a level of efficiency that can also be significantly increased[40]. Therefore, a massive transition to the use of alternative sources will be accompanied by internal changes in all related sectors of the economy (primarily infrastructure, engineering, housing and utilities, education and science, construction, and agriculture), as well as consumer and producer behaviour. The transition from fossil to renewable energy sources, from intensive consumption of natural resources to energy efficiency, resource conservation, and circularity is evidence of the transformation of models from a brown to a green economy[41].

After the global financial crisis of 2007-2008, which symbolises the completion of the global economy, we can observe the intensification of the use of unconventional mechanisms and approaches to overcoming cyclical challenges. Thus, in 2011, the term *Industry 4.0* began to be actively used, symbolising the beginning of the transition of leading countries to qualitatively new technological foundations. After the formation of a mature model of Industry 4.0 is complete, it can be argued that tangible qualitative changes have been observed since the late 2010s, when quantitative changes really turned into qualitative ones. Moreover, theorists from developed and developing countries are already actively discussing the features and

[39] Meadows, D. H., Meadows, D. L., Randers, J., & Behrens, W. W. (2018). The limits to growth. In *Green planet blues* (pp. 25-29). Routledge.

[40] Guidance note on Directive 2012/27/EU on energy efficiency, amending Directives 2009/125/EC and 2010/30/EC, and repealing Directives 2004/8/EC and 2006/32/EC Article 14: Promotion of efficiency in heating and cooling Accompanying the document Communication from the Commission to the European Parliament and the Council Implementing the Energy Efficiency Directive - Commission Guidance. Commission Staff Working Document. EU. URL: https://eur-lex.europa.eu/legal-content/EL/TXT/?uri=CELEX:52013SC0449.

[41] Sulich A., Zema T. Green jobs, a new measure of public management and sustainable development. *European Journal of Environmental Sciences*. 2018. Vol. 8, No. 1. P. 69-75.

prospects of *Industry 5.0.*[42]*;* [43]. In any case, energy efficiency issues are a critical component both at the macroeconomic level and at the level of individual industries, institutions, and even products[44].

Despite the fact that the global pandemic of 2020-2023 has reduced economic activity and distanced people, many countries have managed to minimise its negative impact through the spread of digital solutions. Humanity has witnessed not so much an increase in the quantitative scale as a change in the nature of the global economy. First and foremost, we are talking about a breakthrough in the development of network formats and platform business models at all levels, from micro to global[45]. This suggests that the global economy is facing a qualitatively new palette of economic forms, when multinational business entities are organically integrated into the architecture of the global networked economic fabric. Digital and green transformations are leading to new architectonics of the global economy, its new quality, even with a similar component composition, which will obviously also undergo diversification.

Regional peculiarities and challenges of greening the energy sector

The need to combine the potential of green and digital transformation can be demonstrated by a number of examples. One such example is the successful launch of an international monitoring tool, the Energy Policy Tracker[46], which was the result of an initiative supported by numerous international think tanks and universities. Digitalisation has made it possible to systematise the efforts of 37 countries that are the world's major energy producers and consumers. Experts have found that the dynamics of energy production by 2030 is almost twice as high as the level that could positively affect the dynamics of global warming[47]. Moreover, it can be concluded that the countries of the world can be divided into two groups

– countries whose level of development and economic structure allows for rapid implementation of measures to reduce energy consumption from

[42] Carayannis, E. G., & Morawska-Jancelewicz, J. (2022). The futures of Europe: Society 5.0 and Industry 5.0 as driving forces of future universities. *Journal of the Knowledge Economy*, No. 13. pp. 1-27.

[43] Huang, S., Wang, B., Li, X., Zheng, P., Mourtzis, D., & Wang, L. (2022). Industry 5.0 and Society 5.0-Comparison, complementation and co-evolution. *Journal of manufacturing systems*, *64*, pp.424-428.

[44] Nonoyama, K., Liu, Z., Fujiwara, T., Alam, M. M., & Nishi, T. (2022). Energy-efficient robot configuration and motion planning using genetic algorithm and particle swarm optimisation. *Energies*, no. *15*(6), 2074. 20 p. URL: https://www.mdpi.com/1996-1073/15/6/2074/pdf

[45] Lafuente, E., Ács, Z. J., & Szerb, L. (2022). Analysis of the digital platform economy around the world: A network DEA model for identifying policy priorities. *Journal of Small Business Management*, 1-45.

[46] The energy policy tracker. URL: https://www.energypolicytracker.org

[47] The Production Gap Report 2021. SEI, IISD, ODI, E3G, UNEP. 2021. 104 p. URL: https://productiongap.org/wp-content/uploads/2021/11/PGR2021_web_rev.pdf.

fossil sources, but which lack the conditions for implementing these measures, and

– countries that are not ready to reduce energy consumption from fossil sources, primarily due to a lack of capital and technology.

The speed of economic structure change is becoming a factor that determines the competitiveness of national economies and market positions of companies. Maintaining a competitive position in traditional and new markets increasingly affects both business profitability and its relationship with national strategies for social and economic development. Therefore, the G-20 group of countries has already started implementing certain initiatives, in particular in the context of post-pandemic recovery, which directly or indirectly support the environmental transformation of the energy sector, with the total amount of investments reaching about USD 300 billion. This is a significant amount of public investment. Such significant amounts of public investment indicate that the stakes in the global competitive game have been raised.

The asymmetry of socio-economic and industrial development in the regional dimension causes differences in the relevance and attitude to green transformations. While such opinions may seem understandable and possible, the study of national specifics will allow more effective use of the potential at both the regional and sectoral levels. For example, a study of the green transformation that has been developing in China in recent decades has revealed that it is better deployed not only in those eastern regions with greater industrial potential, but also where regional innovation systems are more mature[48]. A characteristic feature of the positive developments observed in China's economy is that they are based on well-thought-out local plans for the implementation of technological innovations and general national plans. In particular, according to the results of the 13th Five-Year Plan for 2016-2020, the energy intensity of value added decreased by 16%, 171 green industrial parks were built, and more than 20,000 types of green products were introduced.

The objectivity of differences in starting conditions has long been an integral part of the policies implemented in the EU. They are observed not only between national economies, but even between regions of countries, which proves the relevance of the EU regional policy mechanisms and the European local-regional taxonomy[49] . An example of this is, in particular, the establishment of the Social Climate Fund, the relevance of which is due to the scale of the impact of global climate change on the social dimension at national and local scales. The Social Climate Fund (SCF) is intended to

[48] Gu, X.; Pan, L. The Impact of Industrial Green Transformation on Regional Economic Development in China: An Empirical Study Based on Spatial and Threshold Effects. Sustainability 2022, 14, 12913. https://doi.org/10.3390/su141912913

[49] Chuzhykov, V.I., and Fedirko, O.A. "Lokalizm proty hlobalizmu (ievropeiskyi metodolohichnyi keis)." [Localism versus globalism (a European methodological case)]. *Rehionalna ekonomika [Regional Economy]*, No. 4 (2021), pp. 44-56. (In Ukrainian).

complement the European Social Fund, with resources of about EUR 99 billion for 2021-2027, and is designed to improve countries' responses to challenges in employment, education and skills, social inclusion through social innovation and international cooperation, including in the areas of energy saving, renewable energy and green transformation. The size of the JCF is closely linked to the mechanism of the renewed emissions trading system as part of the EU's commitments under the first and second Kyoto Protocols on climate change and the Paris Agreement, by which the EU aims to achieve a 40% reduction in emissions by 2030 compared to 1990 levels, and will most importantly direct resources and investments to such important measures and projects:

- Improving the energy efficiency of buildings;
- decarbonisation of heating and cooling in buildings, including the integration of energy from renewable sources;
- Providing improved access to mobility and zero- and low-emission transport[50].

Moreover, other instruments are also used by the EU to achieve climate goals. In particular, the European Regional Development Fund, which since 2014 has been tasked with improving energy efficiency and since 2021 with reducing carbon intensity as a means of preventing environmental risks in the context of managing regional competitiveness and employment, and the Cohesion Fund are also used to manage resources, with a foreseen amount of €350 billion for 2021-2027. The Cohesion Fund provides support to EU regions with a GNI per capita below 90% of the EU average (for 2021-2027, these are Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Portugal, Romania, Slovakia, Slovenia and Spain), with around 37% of resources being allocated to climate action, including the development of trans-European networks, other transport infrastructure and environmental projects.

Urban regions in the modern economy are important actors in the development of the green economy, which is primarily due to the high concentration of anthropogenic impact on the environment. Although the management of green transition processes may have national peculiarities, research shows that they should have a multi-level architecture (global, national, regional and local levels). At the local level, projects aimed at reducing environmental pollution and improving fixed assets, which leads to improved productivity of production factors, are best implemented[51]. At the

[50] Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a system for greenhouse gas emission allowance trading within the Union and amending Council Directive 96/61/EC. Document 02003L0087-20230301. 02003L0087 - EN - 01.03.2023 - 014.001. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02003L0087-20230301

[51] Zeng, M., Zheng, L., Huang, Z., Cheng, X., & Zeng, H. (2023). Does vertical supervision promote regional green transformation? Evidence from Central Environmental Protection Inspection. *Journal of Environmental Management, 326*, 116681. https://doi.org/10.1016/j.jenvman.2022.116681

regional level, the focus can be on larger-scale systemic projects, at the national level – on systems as a whole and policies (educational, research, statistical, environmental, international, etc.), and at the global level – on setting global goals and defining national commitments. For example, leading experts expect Latin American countries to use the potential and strategic opportunity of green transformations to overcome structural challenges such as weak social protection systems, low productivity, immature institutions, and environmentally unsustainable development, which should improve national models of socio-economic development[52]. Even though renewable energy sources account for up to 1/3 of the energy balance in Latin America, which is significantly higher than the global average of 13%, the potential for increasing productivity is still great, which can significantly improve welfare in the region.

To overcome the environmental and competitive challenges faced by less developed countries, OECD and EU countries offer recommendations based on the findings of monitoring programmes and projects. One example of this is the regular release of analytical reviews of the socio-economic development of different regions of the world, including the countries of Southeast Europe[53]. A significant part of such studies is devoted to the issues of green and digital transformation, namely the development of regulatory frameworks and energy markets, structural changes in national energy sectors (which encourage countries to develop and implement national energy and climate plans), consideration of energy packages and participation in energy associations, the combination of which has a long-term impact on the international and global competitiveness of the countries of the region[54].

The impact of the Covid-19 pandemic on the greening of the global energy sector

The Covid-19 pandemic has had a powerful impact on the global energy sector, its greening and transition to a sustainable development model. Thus, in most countries of the world, in 2020-2022, the rapid decline in gross domestic product and crisis trends in national economies were largely overcome by the issuance of monetary liquidity and its «injection» into the economy. This resulted in an imbalance in the global financial system, an inflationary spiral, and a global rise in prices for goods and services. Let's look at specific figures:

[52] OECD et al. (2022), Latin American Economic Outlook 2022: Towards a Green and Just Transition, OECD Publishing, Paris, https://doi.org/10.1787/3d5554fc-en.

[53] OECD (2021), *Competitiveness in South East Europe 2021: A Policy Outlook*, Competitiveness and Private Sector Development, OECD Publishing, Paris, https://doi.org/10.1787/dcbc2ea9-en.

[54] OECD (2021), «Energy policy (Dimension 12)», in Competitiveness in South East Europe 2021: A Policy Outlook, OECD Publishing, Paris. DOI: https://doi.org/10.1787/0c8c0d7a-en

in the period 2000-2020, according to McKinsey experts, the net value of global assets increased 3.2 times (from USD 160 to 510 trillion), and their total value almost quadrupled (from USD 440 to 1540 trillion, respectively)[55].

As for the direct impact of Covid-19 on the global energy sector, it was clearly manifested in several trends. First of all, it is worth noting the sharp decline in market demand for fossil fuels and energy prices due to the introduction of quarantine measures and the corresponding curtailment of many economic activities. In particular, in the first quarter of 2020 alone, according to the International Energy Agency, global energy demand decreased by 3.8%, followed by a 6% decline by the end of the year (Figure 1). It is no coincidence that already in March 2020, the OPEC group reached an agreement to reduce global oil production, which was subsequently supported by the G20 countries.

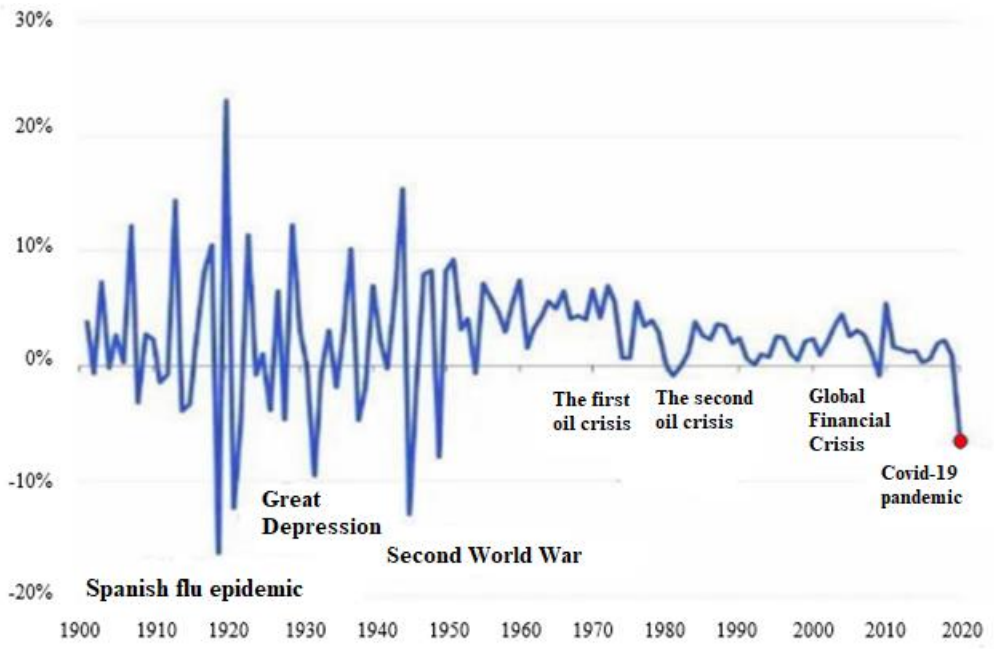

Figure 1. Changes in global energy demand in 1900-2020, %.

Source: based on data from [56].

[55] The Rapid Growth in Global Wealth. McKinsey. 2021. 196 p. URL: https://www.mckinsey.com/~/media/mckinsey/industries/financial%20services/our%20insights/the%20rise%20and%20rise%20of%20the%20global%20balance%20sheet%20how%20productively%20are%20we%20using%20our%20wealth/mgi-the-rise-and-rise-of-the-global-balance-sheet-full-report-vf.pdf

[56] International Energy Agency. URL: www.iea.org

Secondly, the Covid-19 pandemic has also clearly crystallised a number of vulnerabilities in the global economy's supply chains for vital goods and technological equipment for the healthcare system, which has directly affected the energy sector. First and foremost, we are talking about renewable energy sources and batteries, a significant part of which has been suspended due to the rapid decline in their production, the destruction of trade channels for materials, components and manufactured goods, as well as the closure of borders and international ports[57].

Third, there was a certain decline in investment in the oil and gas sector (where investment in 2020-2021 decreased by about a third[58]), with a significant increase in the riskiness of investment in fossil fuels and a decrease in the risk of investment in clean energy sources. This trend was accompanied by the long-term return on investment in green energy at a much lower level than in the hydrocarbon sector. This confirms the historical irreversibility of the global trend of greening the global energy complex and its transition to a sustainable development model, which opens up unprecedented opportunities to increase the value of capitalist accumulation available to finance large-scale green energy infrastructure projects. And the scale of the required funding is quite substantial: according to the International Energy Agency, between USD 220 billion and USD 329 billion will need to be invested annually in the development of renewable electricity generation infrastructure (excluding hydroelectric power plants) in 2015-2040 alone. In case of continuation of traditional *business as usual,* and from 323 to 590 billion in case of full-scale implementation of the green energy transition[59]. The World Economic Forum's estimates are even more ambitious: 13.5 trillion US dollars. USD 13.5 trillion in total financing for the period 2015-2030, or 900-950 billion in annual terms[60].

Fourthly, during the Covid-19 spread, there was an unprecedented increase in the consumption of renewable energy sources in all global regions due to the lockdown, lower operating costs of power generation and priority access of consumers to the power grids in accordance with the established regulatory requirements[61]. It should be noted that renewable energy sources are primarily of local origin and application.

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[57] Evans A., Bazilian M.D. Susceptibilities of Solar Energy Supply Chains. Global Policy Opinion. 2020. URL: https://www.globalpolicyjournal.com/blog/16/04/2020/susceptibilities-solar-energy-supply-chains.

[58] Laverón F. The role of the electricity sector in the energy transition after COVID-19. Forum, COVID-19 and the energy transition, No. 123, 2020. P. 36-39.

[59] Chala, V.S. "Instytutsionalna struktura zelenoho finansuvannia v rozbudovi hlobalnoi zelenoi ekonomiky." [Institutional structure of green financing in the development of the global green economy]. *Ekonomika ta suspilstvo [Economy and Society],* Issue No. 34 (2021). URL: https://economyandsociety.in.ua/index.php/journal/article/view/1025/983. [In Ukrainian].

[60] Delivering the Green Economy through Financial Policy. Technical Paper. Frankfurt School of Finance & Management, UNEP Collaborating Centre for Climate & Sustainable Energy -Finance, March 2014. 83 p. URL: https://wedocs.unep.org/bitstream/handle/20.500.11822/26621/Green-Economy.pdf?sequence=1&isAllowed=y - p. 5.

[61]IEA. Covid-19 impact on electricity. IEA. Paris, 2020. URL: https://www.iea.org/reports/covid-19-impact-onelectricity.

The impact of the Covid-19 pandemic on the global energy sector deserves special attention, including: widespread consumer involvement in the electricity sector; increased flexibility in managing network congestion; and a fundamental change in energy consumption behaviour and corporate business models of energy companies towards their increasing compliance with the environmental requirements of consumers, national governments and investors, etc. While national governments are most interested in ensuring national energy security, investors are actively putting on the agenda the issue of compliance with environmental requirements and standards in the field of sustainable development by investment objects, often resorting to a significant reduction in the share of oil, gas and coal companies in their investment portfolios[62]. For example, the Inflation Reduction Act adopted in the United States in August 2022, along with reforming the national tax system, also provides for large-scale investment funding for green energy and climate change programmes and projects. In particular, it is planned to invest about USD 370 billion for these purposes by 2031. USD 271 billion will be spent on tax credits for renewable energy and green electricity generation; USD 36.6 billion – on residential and commercial energy, as well as clean electricity generation; USD 30 billion – on nuclear energy; USD 13.2 billion – on clean hydrogen energy; USD 10.4 billion – on the development of alternative fuels (Fig. 2).

To summarise, the synergistic impact of these trends on the functioning of the global energy sector and its transition to a sustainable model has both positive and negative consequences, which are determined not only by the economic, but also by political, social and environmental aspects of further trends in its structural dynamics in global coordinates. It is worth noting that the same electrical corporations actively moved to the development and implementation of qualitatively new business models more than a decade ago, due to the dynamic introduction of renewable energy sources and radical changes in information technology. Therefore, although there are a number of uncertainties about the post-pandemic trajectories of structural diversification of the global energy sector, the Covid-19 crisis has become a powerful impetus for accelerating the transition of the global energy sector to a sustainable development model. At the same time, it has clearly determined qualitatively new opportunities and threats to its further development in the context of modernising corporate strategies and business models of energy companies and systematically implementing green energy technologies.

[62] Kuzemko C., Bradshaw M., Bridge G., Goldthaude A., Jewell J., Overland I., Scholten D., Van de Graaf T., Westphal K. Covid-19 and the politics of sustainable energy transitions. *Energy Research & Social Science*. 2020. Vol. 68. URL: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7330551/.

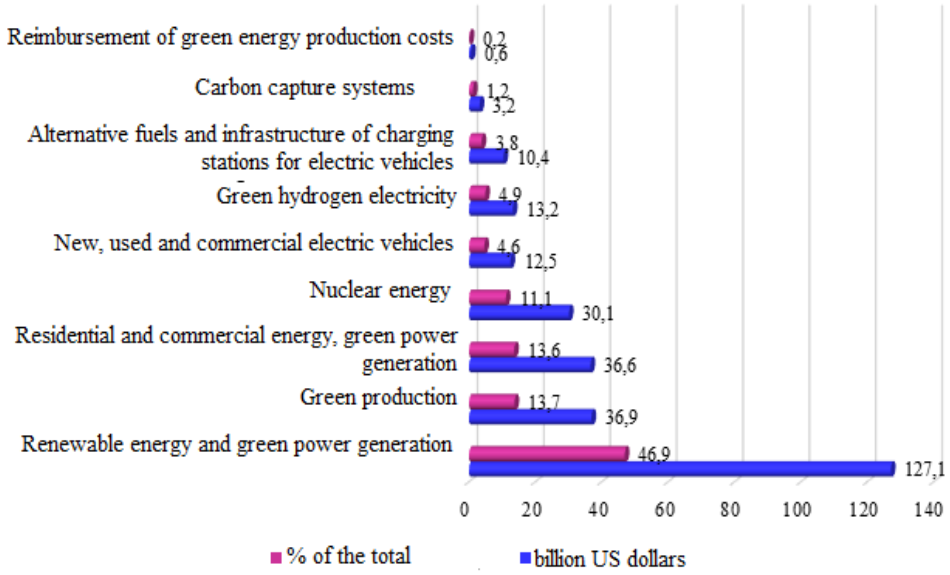

Fig. 2. Structure of US federal budget expenditures on tax credits for green energy and climate change programmes in 2022-2031

Source: based on data from[63].

For example, European and American electricity companies are demonstrating a high level of resilience to the impact of the Covid-19 pandemic, increasing their capital expenditures and forming qualitatively new business structures in the future. Most national governments, especially those of the European Union, are actively implementing large-scale anti-crisis economic recovery programmes aimed not only at restoring economic activity and creating new jobs, but also at systematically implementing the green vector of national competitive development based on decarbonisation and digitalisation of all spheres of human life.

The EU's external energy strategy as a response to the russian invasion of Ukraine

It is well known that one of the key priorities of the European Union's integration policy at all stages of its evolutionary development is to provide member states' economies with imported energy, which is considered a key

[63] Bertrand S. How the Inflation Reduction Act and Bipartisan Infrastructure Law Work Together to Advance Climate Action? Environmental and Energy Study Institute, 12 September 2022. URL: https://www.eesi.org/articles/view/how-the-inflation-reduction-act-and-bipartisan-infrastructure-law-work-together-to-advance-climate-action.

component of the energy security of this integration grouping. In order to ensure it, since 2000, the European Union has been persistently implementing its foreign energy policy aimed at creating the most favourable conditions for energy supply to all member states in the international arena. It is within the framework of foreign energy policy that the EU's strategy for the development of renewable energy and the fight against climate change is most actively and consistently implemented through the deep convergence of its energy, climate and digital components. As for the energy and climate components of the EU's integration policy, they are focused primarily on energy conversion, decarbonisation of the fuel and energy complex of this integration grouping and its transition to low-carbon and carbon-free technologies.

In turn, the digitalisation of the EU energy sector is associated with the installation of second-generation smart meters; development of the energy Internet, decentralised energy systems and smart mobility infrastructure; expanding the use of digital services and predictive analytics in the energy sector, automation of mutual settlements between energy producers and consumers; digitalisation of services for energy trading, etc. It should be emphasised that the EU energy sector's shift away from a raw material orientation was largely due to the international commitments undertaken by member states to reduce greenhouse gas emissions.

The main motivational incentives for the implementation of a common foreign energy policy by the European Union in the last twenty years are both a significant lack of its own energy resources (primarily oil, gas and coal) and a steady increase in the internal energy needs of this integration grouping due to several waves of its expansion, as well as a significant intensification of international competition for energy resources, routes of their supply and infrastructure capacity for their processing between traditional and new global centres of energy consumption. These motivations actually determine the strategic goals of the European Union's common foreign energy policy. These include, first of all, increasing the security of energy supplies; strengthening the competitive position of European producers in global markets; providing member states with sufficient volumes of energy at affordable prices; achieving environmental sustainability and combating climate change.

The russian-Ukrainian war has become a powerful impetus for the greening of the European energy sector and its transition to a sustainable development model. Having begun on 24 February 2022, it objectively forces the European Union to consider the issue of its own energy supply from a fundamentally different perspective, namely, to protect European consumers from rising energy prices by reducing dependence on russian supplies and accelerating the transition to carbon-free energy technologies. First and foremost, we are talking about significant disruptions in the supply of energy resources to EU member states, which the russian federation has resorted to in order to exert economic and political pressure on this integration bloc

(which costs European taxpayers almost 100 billion euros annually)[64]. They have caused not only a rapid increase in energy prices and a deep imbalance in regional oil, gas and coal markets, but also a significant disruption of investment activity in the energy sector and threats to European countries' implementation of measures to decarbonise their national economies. Thus, in response to the reduction in energy supplies from russia, a number of EU countries were forced to return to coal-fired power generation and actively seek alternative channels for importing fossil fuels. This has already given grounds for Eurosceptics to question the economic feasibility of the EU's green energy transition strategy.

In response to russia's invasion of Ukraine, the EU adopted the External Energy Strategy – the REPowerEU Plan – on 18 May 2022. Since this document was announced by the European Commission long before the russian-Ukrainian war and the official Brussels' sanctions response, its final text was significantly revised to reflect the new geopolitical realities. In particular, it included new sets of issues related to providing assistance to the energy complexes of European countries that have suffered the most from russian aggression.

The REPowerEU plan envisages a profound qualitative transformation of the European Union's energy system through the implementation of a set of measures. Along with diversifying geographical gas supply routes, overcoming the shortage of oil and petroleum products, increasing coal imports, and promoting the idea of combating methane leaks and counteracting technical flaring and flaring of natural gas in the international arena, the plan pays considerable attention to the green energy transition. As you can see, all the proposed measures are aimed, on the one hand, at reducing the European Union's dependence on russian oil and gas supplies, and, on the other hand, at accelerating the process of greening the regional energy sector by eliminating the consumption of fossil fuels and overcoming the climate crisis. Particular emphasis is placed on the need to strengthen partnerships with other countries and regions of the world in terms of financial support, transfer of necessary technologies, and direct expansion of trade relations in the energy sector. In order to achieve these goals of greening the European energy complex, it is planned to invest an additional 210 billion euros in the green energy transition by 2027 alone, which is seen by Europeans as an advance payment for the EU's energy independence and security.

As of today, €225 billion in loans from the *Recovery and Resilience Facility (RRF) are* already available under the REPowerEU Plan. Of this amount, €10 billion will be spent on natural and liquefied gas supply infrastructure; €2 billion on the oil infrastructure network; and the rest will

[64] REPowerEU: A plan to rapidly reduce dependence on Russian fossil fuels and fast forward the green transition. May 2022. URL: https://ec.europa.eu/commission/presscorner/detail/en/IP_22_3131.

be spent on the green energy transition of EU member states and diversification of sources of imported natural gas supplies[65]. Thus, reducing imports of russian hydrocarbons will save European consumers about €100 billion a year, which will be used to provide financial support to the private and public sectors at the national, cross-border and European levels[66]. Additionally, the European Commission has increased the financial resource of the RRF by €20 billion in the form of grants accumulated from the sale of carbon credits under the European emissions trading system.

If we characterise the priority areas of the EU's green energy transition, the main one is to increase the target for the share of renewable energy sources in total energy consumption from 40 to 45% by 2030 in accordance with the requirements of the "Fit for 55" package. Achieving this goal requires the implementation of a set of measures to:

1) doubling the current solar photovoltaic capacity by 2025 and installing an additional 600 GW of solar power generation capacity by 2030;

2) implementation of the Solar Roof initiative, which provides for the gradual introduction of regulatory obligations to install solar power generating panels on commissioned residential, public and commercial buildings;

3) accelerating the process of introducing heat pumps for the accumulation of geothermal and solar thermal energy and its subsequent supply to centralised and municipal heating systems;

4) implementation of instruments for the development of biomethane industrial partnership and financial incentives to increase its production to 35 billion m^3 by 2030, including within the framework of the EU's Common Agricultural Policy;

5) the introduction by EU Member States of special zones for renewable energy based on a significant simplification of the necessary permitting procedures in regions with lower environmental risks and the provision by the European Commission of access to its existing databases on environmentally sensitive regions as part of a digital mapping tool of information data related to the energy, industrial and infrastructure sectors of the EU economy[67].

Thus, the current External Energy Strategy confirms the EU's unconditional commitment to the key idea of transition to green energy through enhanced energy saving and energy efficiency, reduced price pressure, stimulation of renewable energy development and intensification of energy diplomacy. Thus, with one instrument, the EU is responding to both the challenges of sustainable development and military aggression.

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[65]REPowerEU at a glance. European Commission. URL: https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/repowereu-affordable-secure-and-sustainable-energy-europe_en.

[66]REPowerEU: A plan to rapidly reduce dependence on Russian fossil fuels and fast forward the green transition. URL: https://ec.europa.eu/commission/presscorner/detail/en/IP_22_3131.

[67]Ibid.

Green hydrogen is a priority for the EU's energy transition

One of the key areas of the European Union's energy transition is the development of green hydrogen generation, which is currently being considered as part of the plan to integrate the national energy complexes of the member states of this integration grouping, as well as the implementation of its Green Deal and the carbon border adjustment mechanism to recover the European economy from the Covid-19 pandemic and ensure maximum protection of national producers from the economic expansion of China and russian federation.

It is worth noting that green hydrogen is already being actively used in various sectors of the economy in the EU, but so far only at the local level. First of all, we are talking about the UK and the Netherlands, where green hydrogen is used to heat individual residential buildings; Germany, where a number of trains run on hydrogen cells; Austria, where green hydrogen is used in the smelting of low-carbon steel, etc.[68]. However, all of these examples, as we see, represent only image projects that can be scaled up at the pan-European level only after the systematic implementation of all key components of the Hydrogen Strategy of this integration grouping.

The main strategic goal of the development of green hydrogen energy in the EU is to reach an annual production of 10 million tonnes of hydrogen by 2030[69]. Although this goal was set in the EU Hydrogen Strategy 2020, today this integration bloc focuses on building energy cooperation in this area with the participation of international partners through the conclusion of relevant trade and investment agreements. In particular, as for the trading platforms for green hydrogen imports, the regions of the North Sea, the Southern Mediterranean and Sub-Saharan Africa (Namibia and South Africa), as well as Ukraine and Japan are considered as such. Thus, active work is underway with our country to develop mechanisms for strategic partnership in the production and supply of green hydrogen and biomethane to the EU.

It should be added that the choice of these regions and countries as international partners of the EU is not accidental, as they, according to the International *Renewable Energy Agency (IRENA)*, have all the technical capabilities to establish green hydrogen production at a price below USD 1.5 per kg by 2050. USD per 1 kg, which enables it to effectively compete with natural gas as an energy commodity. At the same time, by the end of the period, Europe itself will be able to produce clean hydrogen with an energy value of no more than 88 exajoules per year (or 280 thousand GWh), which

[68] Krasynskyi, V. "Klimat-kontrol: chomu Yevropa robyt stavku na voden i shcho proponuiut Ukraini." [Climate control: why Europe is betting on hydrogen and what is being offered to Ukraine]. *RBC-Ukraine*, 13.08.2021. URL: https://www.rbc.ua/ukr/news/klimat-kontrol-pochemu-evropa-delaet-stavku-1628597339.html [In Ukrainian].

[69] A Hydrogen Strategy for a climate neutral Europe. European Commission, 8 July 2020. 24 p. https://faolex.fao.org/docs/pdf/eur208381.pdf.

is more than twenty times less than in the Middle East and North Africa[70]. Therefore, the first step of the European Commission towards the development of the green hydrogen energy sector is the formation of the Mediterranean Green Hydrogen Partnership, one of the links of which is the EU's cooperation with Egypt and Morocco. At the same time, the European Clean Hydrogen Alliance is currently actively developing an investment programme and forming a portfolio of investment projects. For example, the Hydrogen pipeline alone currently includes more than 750 projects accumulated within the Alliance. In addition, investment in clean hydrogen is also actively supported through the institutional platform of the InvestEU Strategic European Investment Window, which has already resulted in fifteen EU Member States including green hydrogen as a priority plan for the recovery of their national economies and their transition to green «rails» for a total of €9.3 billion[71].

In general, the current EU Hydrogen Strategy envisages the installation of electrolysers with a total technological capacity of 40 GW by 2030 so that by 2050 green hydrogen and renewable energy will completely replace hydrocarbons from the energy balance of this integration bloc. At the same time, the European Union estimates the cost of investment in green hydrogen production facilities alone at about 470 billion euros[72]. At the same time, hydrogen investment projects will be financed by both national governments and special funds, as well as global initiatives and the private sector, in order to make such investments profitable as soon as possible and strengthen their competitive position compared to investments in traditional energy sources. In addition, high hopes are also placed on the introduction of an import carbon levy in 2026 and the gradual reduction of the EU's current CO2 emission quotas, which will encourage investors to invest in green hydrogen and renewable energy.

In addition, the European Union has firm intentions to develop and implement international standards and certification methods for the global hydrogen market at the supranational level on the basis of its own regulatory framework with the subsequent formation of the *Global European Hydrogen Facility*. The European Union is also currently developing an extensive infrastructure network of external interconnectors for the transportation of renewable gases and electricity using the updated TEN-E regulation, which will give such initiatives the status of «projects of mutual interest» and thus support them at the supranational level.

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[70] Global energy transformation: A roadmap to 2050 (2019 edition), International Renewable Energy Agency, Abu Dhabi. 52 p. ISBN 978-92-9260-121-8 https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Apr/IRENA_Global_Energy_Transformation_2019.pdf?rev=6ea97044a1274c6c8ffe4a116ab17b8f

[71] Key actions of the EU Hydrogen Strategy. European Commission. URL: https://energy.ec.europa.eu/topics/energy-systems-integration/hydrogen/key-actions-eu-hydrogen-strategy_en#an-investment-agenda-for-the-eu.

[72] Climate control: why Europe is betting on hydrogen and what is being offered to Ukraine. *RBC-Ukraine*, 13.08.2021 URL: https://www.rbc.ua/ukr/news/klimat-kontrol-pochemu-evropa-delaet-stavku-1628597339.html

Conclusion

Overcoming the global environmental problem in key regions of the world is beginning to be seen as a priority vector of socio-economic development. Digital and green transformations are considered to be the drivers that, in the current environment, can qualitatively update global and national models of socio-economic development and natural capital restoration. The world is witnessing competition between key economic actors in terms of the effectiveness of realising the potential of digital and green transformations, which can dramatically change the competitive landscape in the coming decades. The energy sector is the subject of efforts that is currently a priority vector for the renewal of the global economy.

The Covid-19 pandemic and russian aggression against Ukraine are triggers that are used as additional arguments for implementing transformations at the level of national economies and companies. The technological basis that has made it possible to approach the state of formation of an integral global information space has opened up prospects for the formation of such unity in many sectors of life, including the energy sector. The reindustrialisation of national economies in a competitive environment is determined, among other things, by the ability to build an innovation ecosystem at the level of countries and companies. Countries can be divided into at least two groups – 1) those that are able to quickly implement measures to change energy consumption, and 2) those that are not ready to reduce energy consumption. The pandemic has led to a number of trends in the global economy, namely: 1) a sharp decline in market demand for fossil fuels, 2) the presence and sensitivity of vulnerabilities in the supply chains of essential goods, 3) a drop in investment in the oil and gas sector, 4) an increase in the consumption of locally produced renewable energy sources, 5) increased flexibility in the management of energy networks. The combination of these trends has a synergistic effect on the functioning of the global energy sector and its transition to a more sustainable model.

Key global economic actors are implementing competitive development strategies that include digital and green transitions as an integral component. Their effectiveness will lead to a qualitative upgrade of both national models of socio-economic development and the renewal of the characteristic features of globalisation processes. These include, first and foremost, a shift from expansionary growth to intensified use of the potential of production factors; transformation of the structure of national economies and the global economy; re-industrialisation of traditional industry through new technologies and models of economic activity; approaching social transformations; updating values and a set of priorities for current and strategic activities.

The greening of the energy sector is one of the EU's priority strategies and a leading vector for investing significant funds. The EU's climate

ambitions are to create a competitive model based on the decarbonisation of the economy and bring the global economy closer to overcoming the environmental crisis. Green hydrogen energy is an area in which the interests of the EU's green course and Ukraine's post-war recovery coincide in the long term.

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References

1. Antoniuk, L., Ilnytskyy, D., and Sevastiuk, A. (eds.) "Tsyfrova ekonomika: vplyv informatsiino-komunikatsiinykh tekhnolohii na liudskyi kapital ta formuvannia kompetentnostei maibutnoho." [Digital economy: the impact of information and communication technologies on human capital and the formation of competencies of the future]. Ministry of Education and Science of Ukraine, KNEU named after V. Hetman, Kyiv: KNEU, 2021. 337 p. [In Ukrainian].

2. Bertrand, S. "How the Inflation Reduction Act and Bipartisan Infrastructure Law Work Together to Advance Climate Action?" Environmental and Energy Study Institute, 12 September 2022. URL: https://www.eesi.org/articles/view/how-the-inflation-reduction-act-and-bipartisan-infrastructure-law-work-together-to-advance-climate-action.

3. Blanco, E., and Razzaque, J. "Natural Resources and the Green Economy: Redefining the Challenges for People." Leiden-Boston: Martinus Nijhoff Publishers, 2012. 275p.

4. Blauwhof, F. B. "Overcoming accumulation: Is a capitalist steady-state economy possible?" *Ecological Economics*, No. 84 (2012), pp. 254-261.

5. Burmaka, M. "Kreatyvizatsiia hlobalnoho investytsiinoho protsesu" [Creativity of the Global Investment Process]. *International Economic Policy*, vol. 2, no. 29 (2018), pp. 37-54. URL: http://iepjournal.com/journals/29/2018_2_Burmaka.pdf [In Ukrainian].

6. Byrkovych, T., Byrkovych, V., and Kabanets, A. "Mechanisms of public administration in the field of digital transformation." *Derzhavne upravlinnya: udoskonalennya ta rozvytok*, vol. 9 (2019), http://www.dy.nayka.com.ua/?op=1&z=1488. DOI: 10.32702/2307-2156-2019.9.2. [In Ukrainian].

7. Carayannis, E. G., and Morawska-Jancelewicz, J. "The futures of Europe: Society 5.0 and Industry 5.0 as driving forces of future universities." *Journal of the Knowledge Economy*, (2022), no. 13, pp. 1-27.

8. Chala, V.S. "Instytutsionalna struktura zelenoho finansuvannia v rozbudovi hlobalnoi zelenoi ekonomiky." [Institutional structure of green financing in the development of the global green economy]. *Ekonomika ta suspilstvo [Economy and Society],* Issue No. 34 (2021). URL: https://economyandsociety.in.ua/index.php/journal/article/view/1025/983. [In Ukrainian].

9. Chuzhykov, V.I., and Fedirko, O.A. "Lokalizm proty hlobalizmu (ievropeiskyi metodolohichnyi keis)." [Localism versus globalism (a European methodological case)]. *Rehionalna ekonomika [Regional Economy],* No. 4 (2021), pp. 44-56. (In Ukrainian).

10. Ciocoiu, C. "Integrating Digital Economy and Green Economy: Opportunities For Sustainable Development." *Theoretical and Empirical Researches in Urban Management*, Vol. 6 (1) (2011), pp. 33-43.

11. Delivering the Green Economy through Financial Policy. Technical Paper. Frankfurt School of Finance & Management, UNEP Collaborating Centre for Climate & Sustainable Energy -Finance, March 2014. 83 p. URL: https://wedocs.unep.org/bitstream/handle/20.500.11822/26621/Green-Economy.pdf?sequence=1&isAllowed=y.

12. Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a system for greenhouse gas emission allowance trading within the Union and amending Council Directive 96/61/EC. Document 02003L0087-20230301. 02003L0087 – EN – 01.03.2023 – 014.001. URL: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02003L0087-20230301.

13. EC. "REPowerEU at a glance". *European Commission*. 2023. URL: https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/repowereu-affordable-secure-and-sustainable-energy-europe_en.

14. EC. "REPowerEU: A plan to rapidly reduce dependence on Russian fossil fuels and fast forward the green transition". May 2022. URL: https://ec.europa.eu/commission/presscorner/detail/en/IP_22_3131.

15. European Central Bank Annual Report 2022. *Eurosystem*, ECB. 2023. 187 p. doi:10.2866/390483. URL: https://www.ecb.europa.eu/pub/pdf/annrep/ecb.ar2022~8ae51d163b.en.pdf.

16. European Commission. "A Hydrogen Strategy for a climate neutral Europe." 8 July 2020. 24 p. https://faolex.fao.org/docs/pdf/eur208381.pdf.

17. Evans, A., Bazilian, M.D. "Susceptibilities of Solar Energy Supply Chains." *Global Policy Opinion*, 2020. URL: https://www.globalpolicyjournal.com/blog/16/04/2020/susceptibilities-solar-energy-supply-chains.

18. Fatica, S., Panzica, R. "Green bonds as a tool against climate change?" JRC Working Papers in *Economics and Finance*, 2020/10, 2020. 28 p. URL: https://publications.jrc.ec.europa.eu/repository/bitstream/JRC121894/jrc121894_green_bonds_as_a_tool_against_climate_change_final_tr.pdf.

19. Goodwin, N., Harris, J. M., Rajkarnikar, P. J., Roach, B., Thornton, T. B. "Economics of the environment." In *Essentials of Economics in Context*, 1st Edition, Routledge, 2020.

20. Gu, X., Pan, L. "The Impact of Industrial Green Transformation on Regional Economic Development in China: An Empirical Study Based on Spatial and Threshold Effects." *Sustainability*, 2022, no. 14(19), 12913. https://doi.org/10.3390/su141912913

21. Guidance note on Directive 2012/27/EU on energy efficiency, amending Directives 2009/125/EC and 2010/30/EC, and repealing Directives 2004/8/EC and 2006/32/EC Article 14: Promotion of efficiency in heating and cooling Accompanying the document Communication from the Commission to the European Parliament and the Council Implementing the Energy Efficiency Directive – Commission Guidance. Commission Staff Working Document. EU. URL: https://eur-lex.europa.eu/legal-content/EL/TXT/?uri=CELEX:52013SC0449.

22. Hao, X., Li, Y., Ren, S., Wu, H., & Hao, Y. "The role of digitalisation on green economic growth: Does industrial structure optimization and green innovation

matter?" *Journal of Environmental Management,* 2023, no. 325, 116504. DOI: 10.1016/j.jenvman.2022.116504.

23. Hosseini, S. E., & Wahid, M. A. "Hydrogen production from renewable and sustainable energy resources: A promising green energy carrier for clean development." *Renewable and Sustainable Energy Reviews,* 2016, no. 57, pp. 850-866.

24. Huang, S., Wang, B., Li, X., Zheng, P., Mourtzis, D., & Wang, L. "Industry 5.0 and Society 5.0-Comparison, complementation, and co-evolution." *Journal of manufacturing systems*, 2022, 64, pp. 424-428.

25. Humenna, Yu., and Hura, O. "Tendentsii vprovadzhennia tsyfrovoi transformatsii v diialnist subiektiv hospodariuvannia." [Tendencies of implementation of digital transformation in the activities of business entities]. Vi*snyk SumDU. Seriia "Ekonomika" [Herald of Sumy State University. Series "Economics"]*, No. 2 (2021), pp. 202-210. (In Ukrainian).

26. IEA. "Covid-19 impact on electricity." *IEA*. Paris, 2020. URL: https://www.iea.org/reports/covid-19-impact-on-electricity.

27. Ilnytskyy, D. "Hlobalna konkurentsiia v naukovo-osvitnomu prostori." [Global competition in the scientific and educational space]. Kyiv: KNEU, 2016. 445 p. [In Ukrainian].

28. Industry, science and resources portfolio: portfolio budget statements 2022-23 budget related paper No. 1.11. Commonwealth of Australia. 2022. https://www.industry.gov.au/sites/default/files/2022-10/October_2022-23_Industry%2C%20Science%20and%20Resources_PBS.pdf.

29. International Renewable Energy Agency. "Global energy transformation: A roadmap to 2050 (2019 edition)." Abu Dhabi. 52 p. ISBN 978-92-9260-121-8 URL: https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Apr/IRENA_Global_Energy_Transformation_2019.pdf?rev=6ea97044a1274c6c8ffe4a116ab17b8f

30. Key actions of the EU Hydrogen Strategy. European Commission. URL: https://energy.ec.europa.eu/topics/energy-systems-integration/hydrogen/key-actions-eu-hydrogen-strategy_en#an-investment-agenda-for-the-eu.

31. Krasynskyi, V. "Klimat-kontrol: chomu Yevropa robyt stavku na voden i shcho proponuiut Ukraini." [Climate control: why Europe is betting on hydrogen and what is being offered to Ukraine]. *RBC-Ukraine*, 13.08.2021. URL: https://www.rbc.ua/ukr/news/klimat-kontrol-pochemu-evropa-delaet-stavku-1628597339.html (In Ukrainian).

32. Kuzemko, C., Bradshaw, M., Bridge, G., Goldthaude, A., Jewell, J., Overland, I., Scholten, D., Van de Graaf, T., Westphal, K. "Covid-19 and the politics of sustainable energy transitions." *Energy Research & Social Science*, 2020, Vol. 68. URL: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7330551/.

33. Lafuente, E., Бcs, Z. J., & Szerb, L. "Analysis of the digital platform economy around the world: A network DEA model for identifying policy priorities." *Journal of Small Business Management,* 2022, pp. 1-45.

34. Laveryn, F. "The role of the electricity sector in the energy transition after COVID-19." Forum, *COVID-19 and the energy transition*, 2020, No. 123, pp. 36-39.

35. Lukyanenko, O., and Nyameschuk, A. "Development of the Platform Economy in the Global Digital Environment." *International Economic Policy*, No. 1-2 (32-33) (2020), pp. 27-49. DOI: 10.33111/iep.2020.32_33.02_eng. URL: http://iepjournal.com/journals_eng/32-33/2020_2_Lukianenko_Niameshchuk.pdf

36. Matsuk, Z. "Global Challenges and Trends in the Securities Market in Ukraine." *International Economic Policy*, No. 1-2 (32-33) (2020), pp. 153-173. URL: http://iepjournal.com/journals/32-33/2020_7_Matsuk_ukr.pdf. DOI: 10.33111/iep.2020.32_33.07_eng.

37. Meadows, D. H., Meadows, D. L., Randers, J., & Behrens, W. W. "The limits to growth." In *Green planet blues* (pp. 25-29). Routledge. 2018.

38. Melkonyan, A., Krumme, K., Gruchmann, T., Spinler, S., Schumacher, T., Bleischwitz, R. "Scenario and strategy planning for transformative supply chains within a sustainable economy." *Journal of Cleaner Production*, 2019, Vol. 231, pp. 144-160.

39. Nonoyama, K., Liu, Z., Fujiwara, T., Alam, M. M., & Nishi, T. "Energy-efficient robot configuration and motion planning using genetic algorithm and particle swarm optimization." *Energies*, 2022, no. 15(6), 2074. 20 p. URL: https://www.mdpi.com/1996-1073/15/6/2074/pdf.

40. Nyangchak, N. "Emerging green industry towards net-zero economy: A systematic review." *Journal of Cleaner Production*, 2022, No. 378, 134622.

41. OECD (2021), "Energy policy (Dimension 12)," in C*ompetitiveness in South East Europe 2021: A Policy Outlook*, OECD Publishing, Paris. DOI: https://doi.org/10.1787/0c8c0d7a-en.

42. OECD (2021), Competitiveness in *South East Europe 2021: A Policy Outlook, Competitiveness and Private Sector Development*, OECD Publishing, Paris, https://doi.org/10.1787/dcbc2ea9-en.

43. OECD (2022), "Latin American Economic Outlook 2022: Towards a Green and Just Transition," OECD Publishing, Paris, https://doi.org/10.1787/3d5554fc-en.

44. Orekhova, T., Tsymbal, L., and Uninets, I. "Modern International Practices of Implementing the Ecosystem Approach at Different Levels of Management." *International Economic Policy*, No. 1 (36) (2022), pp. 124-140. DOI: 10.33111/iep.eng.2022.36.06.

45. Orlovska, Yu., Kvaktun, O., Kakhovych, O., and Dryhola, K. "Derzhavne upravlinnia zelenymy investytsiiamy yak faktor staloho rozvytku rehioniv." [Public management of green investments as a factor of sustainable development of regions]. *Investytsii: praktyka ta dosvid [Investments: practice and experience],* No. 16 (2021), pp. 70-76. (In Ukrainian).

46. Panagopoulos, A., & Giannika, V. "Decarbonised and circular brine management/valorisation for water and valuable resource recovery via minimal/zero liquid discharge (MLD/ZLD) strategies." *Journal of Environmental Management*, 2022, no. 324, 116239. DOI: 10.1016/j.jenvman.2022.116239.

47. Panchenko, V., Reznikova, N., and Bulatova, O. "Regulatory Competition in the Digital Economy: New Forms of Protectionism." *International Economic Policy*, No. 1-2 (32-33) (2020), pp. 50-80. DOI: 10.33111/iep.2020.32_33.03_eng. URL: http://iep-journal.com/journals_eng/32-33/2020_3_Panchenko_Reznikova_Bulatova.pdf.

48. Pandey, N., & Pal, A. "Impact of digital surge during Covid-19 pandemic: A viewpoint on research and practice." *International journal of information management*, 2020, no. 55, 102171. doi: 10.1016/j.ijinfomgt.2020.102171.

49. Pustovarov, A. "Formuvannia mekhanizmu tsyfrovoi transformatsii upravlinnia rozvytkom natsionalnoi ekonomiky." [Formation of the mechanism of digital transformation of management of the national economy development]. *Naukovyi visnyk Uzhhorodskoho natsionalnoho universytetu [Scientific Bulletin of*

Uzhhorod National University], Issue 34 (2020), pp. 213-218. DOI: 10.32782/2413-9971/2020-34-36. (In Ukrainian).

50. SEI, IISD, ODI, E3G, UNEP. "The Production Gap Report 2021", 2021. 104 p. URL: https://productiongap.org/wp-content/uploads/2021/11/PGR2021_web_rev.pdf.

51. Senadheera, S. S., Gregory, R., Rinklebe, J., Farrukh, M., Rhee, J. H., & Ok, Y. S. "The development of research on environmental, social, and governance (ESG): A bibliometric analysis". *Sustainable Environment*, 2022, no. 8(1), 2125869. URL: DOI: 10.1080/27658511.2022.2125869

52. Shymchenko, L., Miroshnychenko, D., and Kostenko, D. "Tsyfrova transformatsiia Ukrainy yak mekhanizm efektyzatsii komunikatsii vlady z narodom." [Digital transformation of Ukraine as a mechanism for improving communication between the government and the people]. *Society. Document. Communication.* No. 14 (2022), pp. 304-322. https://doi.org/10.31470/2518-7600-2022-14-304-322 (In Ukrainian).

53. Stern, N. "The Economics of Climate Change: The Stern Review." Cambridge University Press, Cambridge, UK. Executive Summary, 2007. 712 p.

54. Sulich, A., & Zema, T. "Green jobs, a new measure of public management and sustainable development." *European Journal of Environmental Sciences*, 2018, Vol. 8, No. 1, pp. 69-75.

55. Tendencias, desafios e oportunidades da ecoinovaзro para a indъstria no Brasil / Confederaзro Nacional da Indъstria, Comissro Econфmica para a Amйrica Latina e o Caribe (CEPAL). Brasнlia: CNI, 2023. 80 p. URL: https://static.portaldaindustria.com.br/media/filer_public/23/2b/232bf7fa-7ee0-4807-b32f-54a7a4ff0261/tendencias_desafios_e_oportunidades_da_ecoinovacao_para_a_industria_no_brasil.pdf. (In Spanish)

56. The Rapid Growth in Global Wealth. McKinsey. 2021. 196 p. URL: https://www.mckinsey.com/~/media/mckinsey/industries/financial%20services/our%20insights/the%20rise%20and%20rise%20of%20the%20global%20balance%20sheet%20how%20productively%20are%20we%20using%20our%20wealth/mgi-the-rise-and-rise-of-the-global-balance-sheet-full-report-vf.pdf

57. Trainer, T. "Renewable energy cannot sustain a consumer society." *Springer Science & Business Media,* 2007, 197 p. DOI 10.1007/978-1-4020-5549-2.

58. Uninets, I. M. "Zelena ekonomika v hlobalnii ekosystemi." [Green economy in the global ecosystem]. *Scientific Notes*, Issue 22 (1) (2021), pp. 69-80. URL: https://vz.kneu.edu.ua/ua/arch_vz/. (In Ukrainian).

59. United Nations Conference on Trade and Development. "World Investment Report 2022: International tax reforms and sustainable investment." Geneva and New York, 2022, 219 pp. ISBN: 978-9211130492.

60. Zeng, M., Zheng, L., Huang, Z., Cheng, X., & Zeng, H. "Does vertical supervision promote regional green transformation? Evidence from Central Environmental Protection Inspection." *Journal of Environmental Management*, 2023, no. 326, 116681. https://doi.org/10.1016/j.jenvman.2022.116681.

61. Zhylenko, K., and Meshko, N. "Dominants of Business Activity Globalization Processes." *International Economic Policy*, no. 2 (2019), pp. 43-81.

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