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DISRUPTIVE TECHNOLOGIES FOR ENSURING ECONOMIC AND RESOURCE SECURITY OF UKRAINE¹

ПРОРИВНІ ТЕХНОЛОГІЇ ДЛЯ ЗАБЕЗПЕЧЕННЯ ЕКОНОМІЧНОЇ ТА РЕСУРСНОЇ БЕЗПЕКИ УКРАЇНИ

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This scientific article examines the problems of economic and resource security in Ukraine and emphasises the importance of using disruptive technologies to achieve sustainable development. It was found that disruptive technologies lead to radical changes in production technologies, work organisation, and the socio-economic landscape. They affect the structure of the economy, the labour sphere, and social relations, which contribute to industrial revolutions. Scientists describe the Third, Fourth and Fifth industrial revolutions, which affect the development of the green economy, cyber-physical systems and the harmony between man and technology. Ukrainian researchers are also studying the concept of Industry 4.0 and disruptive technologies, including digital technologies, artificial intelligence, the Internet of Things, and production automation, to increase the competitiveness of the industrial sector and the development of the economy. During their research, the authors discuss four disruptive technologies: renewable energy, cyber security, artificial intelligence and blockchain, and their potential to ensure the country's economic and resource security. Renewable energy can reduce dependence on traditional energy sources and promote sustainable development. Cybersecurity is an essential aspect of the digital world, and disruptive technologies in this field can ensure the adequate protection of information systems. Artificial intelligence can improve productivity and quality of life by automating processes and developing innovative solutions. Blockchain technology can ensure the security and transparency of data management and improve the efficiency of supply chain management. The integration of these disruptive technologies into the economy and resource management of Ukraine can have a significant impact on the country's sustainable development and security. These technologies can increase productivity, reduce risk, improve resource efficiency, and better protect against cyber threats. Disruptive technologies are a critical factor in achieving the economic and resource well-being of Ukraine.

Keywords: sustainable development, digital transformation, disruptive technology, industrial revolution.

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В роботі досліджено проблематику економічної та ресурсної безпеки України і підкреслено значущість використання проривних технологій для досягнення сталого розвитку. Встановлено, що проривні технології призводять до радикальних змін у виробничих технологіях, організації праці та соціально-економічному ландшафті. Вони впливають на структуру господарства, трудову сферу та соціальні взаємини, що сприяє промисловим революціям. Вчені описують Третю, Четверту та П'яту промислові революції, які впливають на розвиток зеленої економіки, кіберфізичних систем та гармонію між людиною та технологіями. Українські дослідники також вивчають концепцію Індустрії 4.0 та проривні технології, зокрема цифрові технології, штучний інтелект, Інтернет речей та автоматизацію виробництва, з метою підвищення конкурентоспроможності промислового сектору та розвитку економіки. Проаналізовано чотири проривні технології: відновлювальну енергетику, кібербезпеку, штучний інтелект та блокчейн, а також їх потенціал для забезпечення економічної та ресурсної безпеки країни. Відновлювальна енергетика може допомогти знизити залежність від традиційних джерел енергії і сприяти сталому розвитку. Кібербезпека є важливим аспектом у цифровому світі, і використання проривних технологій у цій галузі може забезпечити ефективний захист інформаційних систем. Штучний інтелект може підвищити продуктивність та якість життя шляхом автоматизації процесів і розробки інноваційних рішень. Блокчейн технологія може забезпечити безпеку та прозорість управління даними і покращити ефективність управління ланцюгами постачання. Інтеграція цих проривних технологій в економіку та ресурсне управління України може мати значний вплив на сталий розвиток та забезпечення безпеки країни. Використання цих технологій може підвищити продуктивність, зменшити ризики, покращити ефективність ресурсного використання та забезпечити кращий захист від кіберзагроз. Проривні технології є ключовим фактором для досягнення економічного та ресурсного добробуту України.

Ключові слова: сталий розвиток, цифрова трансформація, проривна технологія, промислова революція.

Formulation of the problem. Disruptive technologies have become a necessary tool for ensuring the economic and resource security not only of Ukraine but also of the whole world. These technologies can transform traditional industries and create new opportunities to improve productivity efficiency and reduce costs. In this article, we will consider several disruptive technologies that can ensure the economic and resource security of Ukraine. According to Bohdan Danylyshyn, Ukraine ended 2022 with a 30% drop in real GDP. During the Second World War, almost no such volume of GDP decline was recorded within one calendar year [1]. As can be seen from Table 1, none of the analyzed countries had such negative economic growth during the Second World War.

The sharp drop in Ukraine's GDP growth rate is explained by the fact that even before the start of the full-scale invasion, Ukraine's economy was

in a difficult situation, so the war only worsened the situation, as most enterprises were forced to reduce production volumes or stop their work altogether.

Analysis of recent research and publications. Understanding disruptive technologies' impact on economic and resource security is critical to ensuring Ukraine's sustainable development. Proper analysis of the latest research and publications will help to formulate effective strategies for the implementation and use of disruptive technologies to achieve the set goals. Disruptive innovations are an integral part of industrial revolutions, characterized by radical changes in production technologies, labour organization, and the socio-economic landscape. These innovations reflect significant changes in production methods, resource use, and interactions between society, technology, and the environment.

Table 1

GDP growth rate of countries during the Second World War

Country	1939	1940	1941	1942	1943	1944	1945
USA	8.0	7.7	18.2	20.0	19.9	8.4	-4.0
Great Britain	1.0	10.0	9.1	2.5	2.2	-3.9	-4.4
France	7.2	-17.5	-20.9	-10.4	-5.0	-15.5	8.4
Italy	7.3	0.6	-1.2	-1.2	-9.4	-18.8	-21.7
Germany	9.4	0.7	6.3	1.3	2.0	2.5	-28.9
Austria	13.4	-2.6	7.1	-5.0	2.4	2.5	-58.7
USSR	1.9	13.9	-13.9	-23.7	11.3	18.7	-5.2
Japan	13.6	2.5	3.6	0.4	-1.0	1.3	-24.6

Source: [2]

Disruptive technologies are essential catalysts of socio-economic development in general and industrial revolutions in particular. The scientific research of K. Christensen [3] emphasizes the crucial role of economic factors in the implementation and successful deployment of disruptive technologies. Disruptive innovations act as catalysts for industrial transformations, contributing to changes in the structure of the economy, labour sphere, and social relations. This inextricable interaction between disruptive innovations and industrial revolutions determines society's development and its ability to adapt to new challenges and opportunities that arise in technological progress.

Scientists, in their publications, claim that today, humanity has to live simultaneously in the conditions of three industrial revolutions. For example, J. Rifkin [4] describes the Third Industrial Revolution, which promotes the development of a «green» economy and aligns industrial metabolism with biosphere metabolism. K. Schwab and N. Davis [5] argue for the need for the Fourth Industrial Revolution, which lays the foundation for cyber-physical systems capable of autonomously performing production functions without human intervention. In the work of Y. Rymarchyk [6], the influence of the Fourth Industrial Revolution on the production processes of goods and services, their radical changes and potential economic, social and political consequences are determined. The European Union shows active political support and stimulates the implementation of Industry 4.0 concepts within its activities. The document [7] emphasizes the need to adapt to new technological challenges and maximize the opportunities provided by Industry 4.0. This document lays down strategic principles to support innovation, digitalization and modernization of the European industrial sector in the work of A. Raj and G. Dwivedi [8], obstacles to the implementation of Industry 4.0 technologies in the manufacturing sector are investigated in the context of both developed economies and developing countries. The works of M. Pada [9] outline the outlines of the Fifth Industrial Revolution, which aims to achieve harmony between man and technical systems.

Ukrainian researchers and scientists also show significant interest in researching the concept of Industry 4.0, industrial revolutions in general and disruptive technologies. The works of L. G. Melnyk, A. G. Krysovaty, G. V. Zadorozhny, and N. Yu. Bryukhovetska

covers digital technologies, artificial intelligence, the Internet of Things, production automation, and other vital components of Industry 4.0 [10; 11; 12; 13]. They also study the experience of other countries and look for ways to adapt these concepts to Ukrainian conditions in order to increase the competitiveness of the industrial sector and develop the national economy.

Highlighting previously unresolved parts of the overall problem. After analyzing the scientific achievements of foreign and Ukrainian scientists, four promising disruptive technologies were singled out which can contribute to achieving economic and resource security in Ukraine in the conditions of war with Russia. These technologies are the result of scientific research and innovation efforts aimed at solving complex challenges facing the country. Implementing these technologies has the potential to change the energy landscape, increase productivity and production efficiency and expand export opportunities. Disruptive technologies create a perspective for sustainable development and strengthening of competitiveness of Ukraine in the global context. The results of these studies can impact various fields, including energy, industry, transport, agriculture and innovation, contributing to the country's sustainable development and ensuring its security.

Formulation of goals. The main task of this scientific article is an overview of disruptive technologies and their possible use to restore the economy of Ukraine in the shortest possible time. To achieve these goals, the article will consider disruptive technologies such as renewable energy, cyber security, artificial intelligence and blockchain. Each of these technologies has the potential to solve critical economic problems and contribute to the recovery of the country's economy. Through the combination of innovative approaches and the involvement of international experience, the work will propose strategic directions for the use of these technologies in the system of economic recovery of Ukraine, which will contribute to rapid economic recovery and increase the country's competitiveness on the international market.

Presentation of the primary research material. Renewable energy. First of all, it should be noted that increasing the share of renewable energy in the energy balance of Ukraine is a goal that needs to be achieved, which is recognized today at all levels, but the approaches to its implementation differ. The energy strategy of Ukraine for the period until 2035 "Security, energy efficiency, competitiveness", sets the goal

of achieving the share of RES at the level of 25% [14]. We can argue for a long time whether this indicator needs to be more ambitious or, on the contrary, easily achievable for us. However, one thing is clear: Today, Ukraine has a chance to choose a vector of development that will include green energy transformation.

According to the International Energy Agency, energy efficiency (40%) and renewable energy sources (30%) will play the most critical role in preventing a global temperature increase of more than two °C and reducing carbon dioxide emissions.

According to the report of the International Renewable Energy Agency (hereinafter – IRENA), “Forecast of global energy changes overview 2023” from 2023, the economic advantages of RES are still underestimated. The share of renewable energy in the global energy balance will increase from 16% in 2020 to 77% by 2050 under the IRENA 1.5°C scenario. The overall supply of primary energy remains stable due to improvements in energy efficiency and the growth of renewable energy sources. Renewables will grow in all final consumption sectors. In contrast, high levels of electrification in sectors such as transport and construction will require a twelvefold increase in the capacity of renewable electricity by 2050 with the level of 2020. Global investment in all energy technologies will reach a record \$1.3 trillion in 2022, yet annual investment will need to more than

quadruple to stay on track to 1.5°C. Compared to the projected energy scenario, which shows a shortfall in the cumulative investment of US\$103 trillion, an additional US\$47 trillion in aggregate investment is needed by 2050 to stay on track to 1.5°C. Research by IRENA and the International Labor Organization (ILO) showed that the renewable energy sector employed approximately 12.7 million people worldwide in 2022, up from approximately 7.3 million in 2012 [15].

Against the background of the high probability of repeated missile attacks by Russia on the energy infrastructure of Ukraine, the question of independence from the CHP and other energy sources is acute. Using solar and wind energy can achieve excellent stability in the power grid. As a result, power outages are minimized. Stable work of the country means a stable level of Ukraine’s GDP.

According to NCRECP data, as of December 31, 2021, the peak of the installed capacity reached 9655.9 MW [16]. In addition, each year, the figures increased rapidly by an average of 2446.1 MW.

It is essential to note the rapid growth observed since 2019 in Ukraine. This period was characterized by the commissioning of several power plants generating electricity from renewable sources.

Therefore, the advantages of renewable energy vary from our compliance with

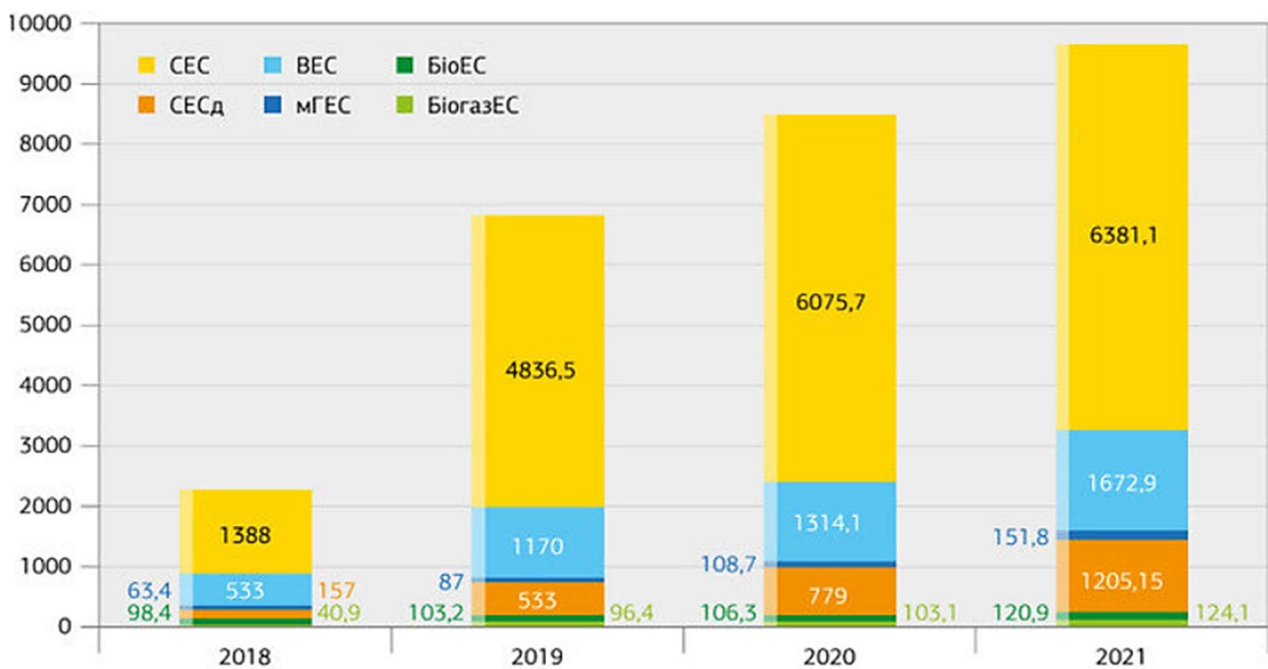


Figure 1. Dynamics of electricity generation from renewable sources in Ukraine in 2018–2021

Source: [17]

environmental obligations to future generations to socio-economic advantages that provide an impetus for further innovative development without harming the environment [18].

Cyber security. With the help of digital technologies, it is possible to increase not only the efficiency of the creation of a particular social product but also to satisfy the needs of people, to balance and use production, technological, labour, intellectual, financial and natural resources, which is a precursor to the emergence of a virtually and especially new way of life in society. The so-called «digital economy». Its key technologies are: «Big data», as well as «Cloud computing», not forgetting the «Internet of Things». All this allows you to collect, store, process and analyze large arrays of digital data of fundamentally different origins, assess their completeness and nature, using them for further optimization of most business processes, quickly make operational and strategic decisions, both for individual companies, as well as entire countries, as well as flexibly and adequately respond to various types of economic changes.

Instead, along with the advantages and benefits, digitalization can create some cyber threats for activities not only at the level of countries but also at the level of companies, as well as individual citizens. Using technologies for unauthorized and illegal acquisition of data of both legal entities and individuals by third-party

objects and entities can cause significant damage and problems in the functioning of economic activity – turning off large management systems of companies allows depriving them of their property and funds, can block and paralyze the production process, this phenomenon minimizes the efficiency of the economy as a whole. If we talk about Ukraine, then in this case, the National Security and Defense Council stated that in 2020, more than one million different cyber threats were detected. As a rule, most often, victims of hackers were private firms and enterprises [19].

Since the whole world is actively digitized, the task of certain damages caused by cyberattacks will also increase. After analyzing the statistics of the two graphs below, it can be confidently identified the main problem of digitization – security. The number of cyberattacks from 2009 to 2018 was in almost the same range (262,813 – 351,937) except in 2019, but the number of losses only increased every year [20].

The reason for such indicators can be the following factors: improvement of systems, rapid growth of users of Internet services, evolution and creation of new viruses.

Artificial intelligence (AI) has become one of the most critical technologies of recent decades. It can help improve production efficiency, optimize business processes and ensure accurate and fast decision-making. Artificial intelligence can also help ensure the security of national

FBI: The # of Consumer Complaints Received (2009-2019)

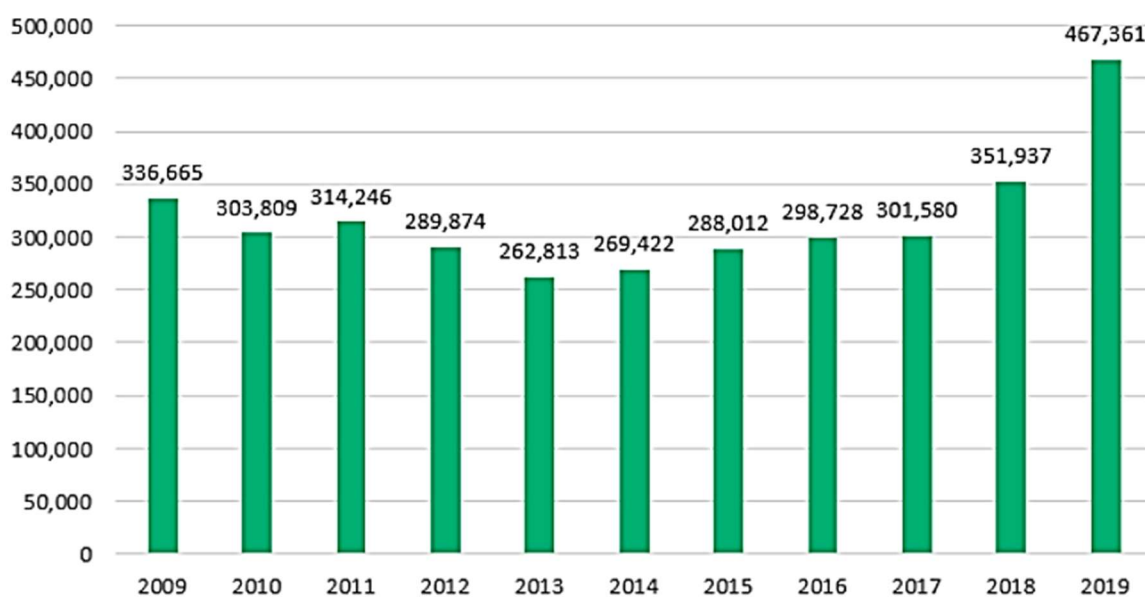


Figure 2. The number of Internet users' complaints about cyberattacks

Source: [20]

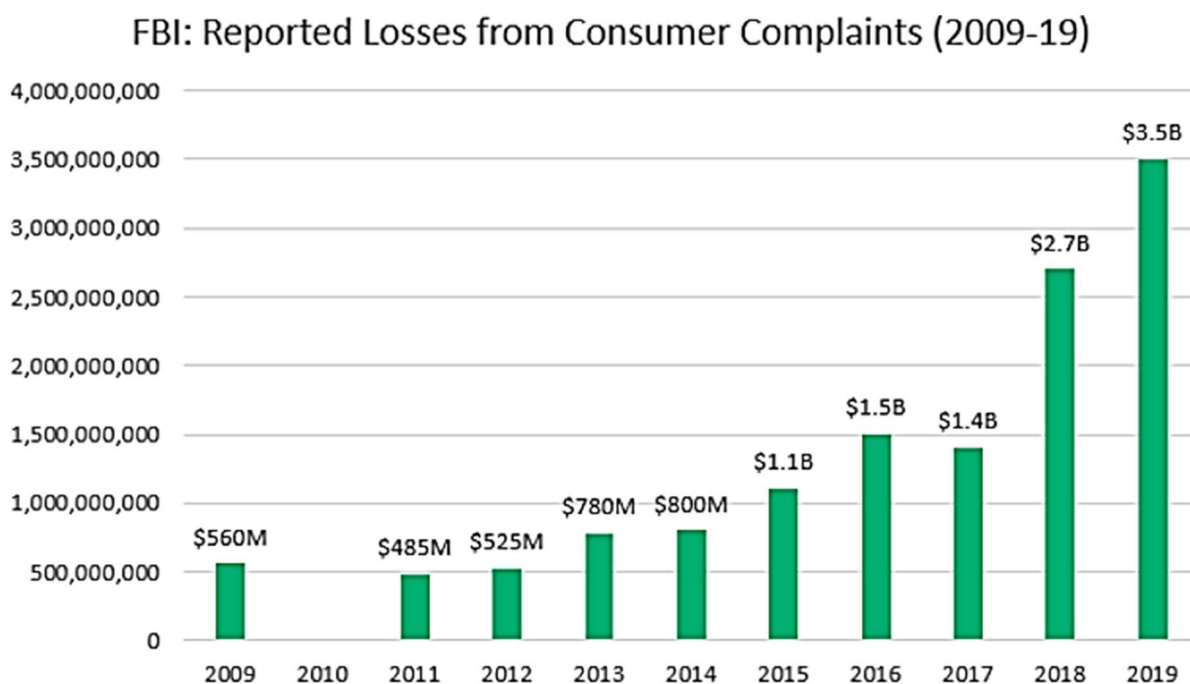


Figure 3. Claimed losses from consumer complaints

Source: [20]

resources, including energy and transportation systems. For example, AI systems can detect dangerous situations and prevent accidents on roads or in energy networks.

Encryption and cryptographic data protection methods have recently moved beyond the scientific and military sectors and are now crucial in areas related to the economy and business. Encryption and cryptography can be used to solve problems related to transaction security and protection against cyber attacks.

Artificial intelligence can be used to protect financial transactions and banking information from cybercriminals. This will help ensure the security of user data and prevent the theft of money from bank accounts. In addition, cryptography can help solve problems related to the security of online commerce and ensuring privacy on the Internet.

AI can also be used to develop e-commerce and international trade. This will allow businesses to conduct secure electronic transactions and store confidential customer information. In addition, technology can help secure supply chains and reduce business risks from data breaches and cybercrime.

In 2019, the OpenAI company initiated a project to develop a generative model based on artificial intelligence, GPT (Generative Pre-trained Transformer). The main goal of the team was to create an artificial intelligence

model capable of understanding and generating text. In 2020, the company introduced GPT 3.0, a generative model with 175 billion parameters and the possibility of unsupervised learning. On November 30, 2022, OpenAI released a product called Chat GPT, which was developed based on the GPT 3.5 generative model [21]. This product is a bot with a dialogue where «communication» occurs. Chat GPT has found wide application in various industries. It is widely used in chatbots for customer support, virtual assistants, content creation, language translation and creative writing. Chat GPT enables organizations to improve user engagement by providing prompt and personalized responses. The conversational capabilities of Chat GPT significantly increase the efficiency and effectiveness of interaction between a person and a computer. After a successful market introduction, several companies started developing their generative models that perform various functions, including generating images and music and creating websites.

Artificial intelligence can help solve problems related to the security of the energy sector. This is possible due to the creation of safe control and monitoring systems that will avoid possible threats to the security of energy networks.

Blockchain is a distributed database that allows information to be stored and transferred without intermediaries. This technology can

ChatGPT and Comparisons, Worldwide

Monthly Visits Desktop & Mobile Web Worldwide

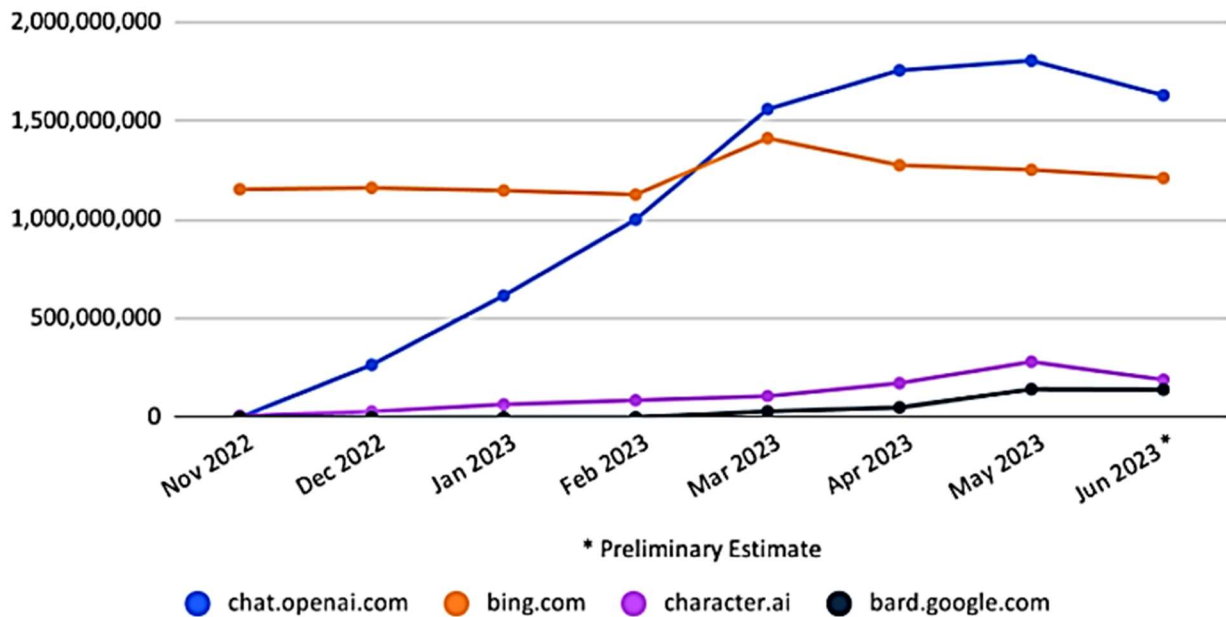


Figure 4. Schedule of monthly visits to the Chat service GPT and its main competitors

Source: [22]

provide security and transparency in finance, logistics, medicine and other industries that are important for the country's economic and resource security. Blockchain can help enable efficient and secure trade and supply chain management. Blockchain technology has become one of the most discussed technologies in recent times, especially in the context of its use in the economy.

IBM identifies five key advantages that are inherent in blockchain technology and contribute to its widespread use:

1. Increased security: The use of blockchain provides a high level of security, as the data stored in the blocks is protected by cryptographic methods, which makes it vulnerable to unauthorized access and changes.

2. Greater transparency: Blockchain provides transparency as all network participants can access a single distributed ledger, allowing real-time monitoring and verification of transactions and actions.

3. Instant Traceability: Blockchain enables accurate tracking of the origin and movement of goods or assets, as each transaction is recorded in blocks, ensuring ambiguity and immutability.

4. Increased speed and efficiency: Blockchain can speed up the processing of transactions and operations because it eliminates

the need for intermediaries and allows data to be exchanged directly between participants.

5. Automation: Blockchain can automate the execution of deals and contracts, simplifying processes and reducing the risk of errors or fraud [23].

Considering these advantages, IBM has identified several industries where implementing blockchain technology can significantly increase competitiveness. Among them are the logistics industry, banking and financial sector, health care, pharmaceutical industry, public sector and insurance industry. Introducing blockchain in these areas can help improve efficiency, reduce costs, and optimize business processes [23].

Analyzing the market capitalization, it can be noted that the blockchain has gained popularity, mainly thanks to cryptocurrencies. To get a general idea of the state of the market, it can be referred to the data provided on the TradingView website [24]. According to these data, the total capitalization at the end of December 2017 was 535.6 billion dollars. To date, the total capitalization is estimated at 1.1 trillion. Dollars At peak values of about 3 trillion. Dollars in November 2021.

Based on this information, blockchain is a highly secure technology that provides benefits such as anonymity, transaction protection, and information privacy.



Figure 5. Total market capitalization of cryptocurrencies

Source: [24]

Conclusions. The problem of economic and resource security in Ukraine is fundamental and highly urgent. In a changing world landscape and global challenges, disruptive technologies can become a vital tool for increasing productivity efficiency and reducing costs.

Ukraine has experienced a significant drop in real GDP, comparable to the fall in GDP during World War II. This indicates the difficult economic situation of the country. In order to ensure the sustainable development of Ukraine, the proper use and implementation of disruptive technologies is extremely important.

Analysis of recent research and publications emphasizes the critical role of disruptive technologies in socio-economic development in general and industrial revolutions in particular. These technologies contribute to radical changes in production processes, labour organization, and the socio-economic landscape. Implementing disruptive innovations contributes to structural changes in the economy, labour sphere and social relations. Ukraine should actively create a favourable environment for innovative development, promoting the introduction of technologies that will ensure sustainable economic growth, rational use of resources and increase the country's competitiveness.

Cyber security, artificial intelligence and blockchain – and their potential to ensure the

economic and resource security of Ukraine were considered. Analyzing these technologies, we can conclude that their implementation is essential for the country's development.

Renewable energy opens up vast opportunities for sustainable development and reducing dependence on traditional energy sources. The use of renewable sources, such as solar and wind energy, can contribute to the reduction of emissions of harmful substances, the conservation of natural resources and the creation of new jobs.

Cyber security is fundamental in today's digital world, where dependence on information technology is increasing. Ensuring protection against cyber-attacks and data breaches is necessary for economic stability and the protection of confidential information. The use of disruptive technologies in the field of cyber security can provide adequate protection of information systems and reduce the risks of cyber threats.

Artificial intelligence (AI) is significant in economic development and productivity. The use of AI can contribute to the automation of processes, the improvement of the quality of products and services, and the development of new innovative solutions. The application of AI in various fields, from agriculture to medicine, can stimulate economic development and improve the quality of life of citizens.

Blockchain technology, which is based on a decentralized recording system, has great potential to ensure the security and transparency of data management. Using blockchain can help fight corruption, increase trust in business transactions, and ensure the efficiency of supply chain management. This technology can impact various fields, including finance, logistics, medicine and public services, contributing to improved efficiency, security and transparency. In general, the integration

of disruptive technologies, such as renewable energy, cyber security, artificial intelligence and blockchain, into the economy and resource management of Ukraine can have a significant impact on ensuring sustainable development and strengthening security. These technologies can help increase productivity, reduce risk, improve resource efficiency, and protect against cyber threats. Disruptive technologies are a crucial factor in ensuring the economic and resource well-being of Ukraine.

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