Universities for Sustainable Development

SUSTAINABLE PRODUCTION AND CONSUMPTION IN INDUSTRY:

challenges and opportunities

Ministry of Education and Science of Ukraine
Dnipro University of Technology

SUSTAINABLE PRODUCTION AND CONSUMPTION IN INDUSTRY: challenges and opportunities

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The interdisciplinary collection of scientific articles explores new trends in modern understanding the instruments of management for sustainable development in the industrial sector, provides a comprehensive analysis of diverse factors that aggravated energy and environmental problems. A special attention in the studies is given to the issues of sustainability in value chains and circular economy methods. Research results may be of interest to researchers, university students and teaching staff, servants in bodies of public and municipal administration, managers of business structures.

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СТАЛЕ ВИРОБНИЦТВО ТА СПОЖИВАННЯ В ПРОМИСЛОВОСТІ: виклики та можливості

Збірник наукових статей

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INTRODUCTION

This collection of scientific articles is the result of the International joint project “Creation of a German-Ukrainian University Network to ensure the success of students’ studies in engineering and environmental disciplines at Ukrainian universities during war and crisis, 2023” carried out with the support of the German Academic Exchange Service (DAAD).

It should be noted that this project also corresponds to the objectives of the Memorandum of Understanding on implementation of the joint research project on sustainability and e-learning in higher education between the Brandenburg University of Technology Cottbus-Senftenberg (BTU), Cottbus, Germany and Dnipro University of Technology, Dnipro, Ukraine.

In accordance with the DAAD Programme “Digital Ukraine: Ensuring academic success in the minds of the crisis, 2023”, the objectives of the project were designed to support Ukraine's transition to sustainable industrial development under the EU-Ukraine Association Agreement.

While the association process refers to all kinds of sectors of the economy, industry is the main or crucial sector that requires substantial efforts in the context of priorities of the EU Strategy on Sustainable Development up to 2030.The presented materials give an insight to the problems, experiences and perspectives in the key areas of industrial sustainability in Ukraine.

All contributions in this volume represent the personal opinions of their authors. Despite all reasonable efforts, the editors cannot guarantee the accuracy of all information and data provided in this publication.

Editors

Prof. Artem Pavlychenko, Prof. Ludmila Paliekhova

Dnipro-Dresden, February 2024

SECTION 1
SUSTAINABILITY IN INDUSTRIAL CHAINS

"Sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

Gro Harlem Brundtland,
Our Common Future: Report of the World Commission on Environment and Development, 1987

"Our biggest challenge in this new century is to take an idea that seems abstract – sustainable development – and turn it into a reality for all the world's people."

Kofi Annan, former UN Secretary-General,
Dhaka, Bangladesh, 15 March 2001

"The Sustainable Development Goals are more important now than ever. Now is the time to secure the well-being of people, economies, societies and our planet."

António Guterres,
Secretary-General, United Nations,
The Sustainable Development Goals Report 2021

ACHIEVING ENVIRONMENTAL SUSTAINABILITY IN INDUSTRIAL VALUE CHAINS

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Introduction. The 2030 Agenda for Sustainable Development clearly outlines the need for actions to deliver on changes in consumption and production patterns. For the first time, an independent global goal was identified – Goal 12: Responsible consumption and production, which is designed to create the new type of material basis for the realization of all other the challenges of sustainable development, including targets on economic growth in harmony with nature, social development, protecting the environment and tackling climate change.

As emphasized in numerous forums and in the current UN reports, the conventional growth patterns exploiting natural resources are increasingly ill adapted to new economic challenges of increasingly evident resource constraints, rising cleaner production requirements, and energy management. However, industry remains today the biggest user of natural raw materials and energy among all other economic activities, and in most countries, the wasteful production and consumption patterns are not fundamentally changed.

It is clear that the strengthening of material and technical foundations for sustainable development of society must come through pursuing sustained economic reforms aimed at reducing dependence on limited sources of resources and energy. Generally speaking, production systems must evolve from ‘linear’ to ‘circular’ patterns, reducing the need for natural materials, water and energy, reducing pollutant emissions and discharges, in particular toxic substance and greenhouse gases, and wastes generated.

Taking into account the realities of the context of Ukraine's European integration, the problem of achieving environmental sustainability in industry is not only one of the main political challenges for the country, but also a powerful opportunity to get out of extremely critical situation with the resources and waste.

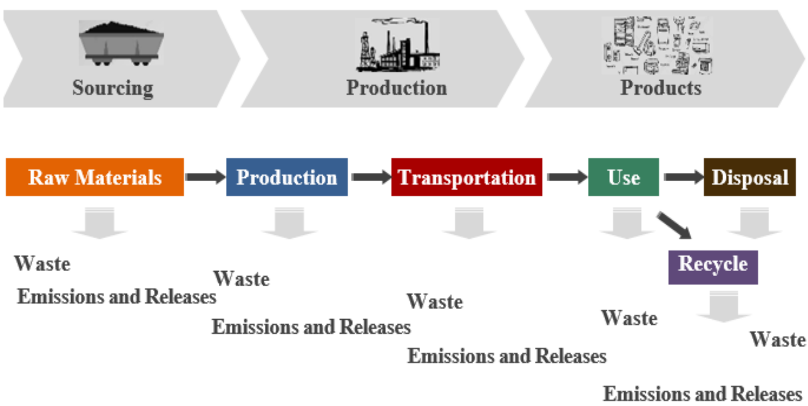
The purpose of the article was to broaden the understanding of sustainability of industry, which goes beyond the traditional production model of Take-Make-Waste. Research proves that Ukraine is included in European industrial value chains, and has a certain responsibility for their environmental sustainability.

Presentation of the main research. According to the UN, the responsibility of production and consumption should cover all global industrial value chains, linking the entire sequence of activities from raw material extraction, production, design, research and development to marketing, delivery and disposal after use.

The greater implementation of the principles and standards of sustainability by all participants in production processes opens up new avenues for increasing the development momentum in and around the value chains. In that process, it is especially important to improve the sustainability of commodity producers that start value chains, and are the most polluting industries (see Figure 1). Obviously, these are mostly developing countries and many new countries with economies in transition such as Ukraine (Palekhov & Palekhova, 2019).

Figure 1

A starting points for responsible consumption and production in industrial value chains



Globalization of business operations and the involvement of companies in international industrial value chains offer some new opportunities for improvement of the economic capacity and structural transformation.

Expanding access of the poor countries to international markets that is currently under way, however, not limited to the trade preferences and concessions accorded to them, but also extended to demands related to the targets of Goal 12. Responsible consumption and production, as we know, in general imply a minimization of the use of natural resources; reduction and caution in the use of toxic materials; as well as reduction the emissions of waste and pollutants over the life cycle of the product.

The UN has defined 11 Targets and 13 Indicators for SDG 12. Targets specify the thematic issues and problems in which the global community intends to produce results from the perspective of sustainable development for a period of 15 years. In addition, indicators represent the metrics for monitoring and reviewing progress on the number and status of their implementation. The metrics for these indicators are detailed and refined by the Inter-Agency and Expert Group on SDG Indicators (UNSD, 2021).

At the same time, not all indicators included into the global SDG indicator framework are fully used for reporting by key international organizations (UN specialized agencies, OECD, EU bodies, etc.). Some of them are used in reporting for OECD countries only. In most cases, the global reports lack explicit indicators for measuring the main environmental problems of the post-Soviet countries, such as environmental efficiency and environmental management, material and energy consumption. Therefore, analysts additionally use a number of other indicators, for example: material footprint; GDP per unit of energy use; the number of ISO 14001 certificates; and Environmental Performance Index (EPI), etc. (Palekhov & Palekhova, 2021).

On the other hand, not all Global Targets for Goal 12 are included in the sustainable development agenda of a number of developing countries and transition economies. Particularly in Ukraine, as shown in the Table 1, there is a lack of a number of targets that would promote the introduction of sustainable production and consumption models, for example - 12.6-12.7, 12.A, 12.C.

Table 1

Relevance of Ukrainian Targets for SDG12 to Global Targets (compiled from MEU, 2017)

Global Targets for SDG 12	Ukrainian Targets for SDG 12
12.2 By 2030, achieve the sustainable management and efficient use of natural resources	12.1 Reduce resource consumption of the economy
12.4 By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks…	12.3 Ensure sustainable use of chemicals through innovative technologies and production
12.5 By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse	12.4 Reduce the amount of waste generation, and increase recycling and reuse through innovative technologies and production
12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle	
12.7 Promote public procurement practices that are sustainable, in accordance with national policies and priorities	
12.A Support developing countries to strengthen their scientific and technological capacity to move towards more sustainable patterns of consumption and production	
12.C Rationalize inefficient fossil-fuel subsidies that encourage wasteful consumption by removing market distortions, in accordance with national circumstances….	

At the same time, increasing global integration, industry complementarity and specialization lead to increasing cross-border challenges, as well as to difficulties in achieving sustainability in global value chains and production networks. The dependency between sustainability of global chains and level of responsibility of specific industries can be gauged by viewing local industrial segments in national economies as parts, or 'nodes', of global production chains. In the case of Ukraine, as shown in Table 2, the industries that present the biggest environmental impact in terms of energy consumption and pollution, make up the main share in the export of industrial products of the country, i.e. take part in global value chains (AEC, 2021).

Table 2

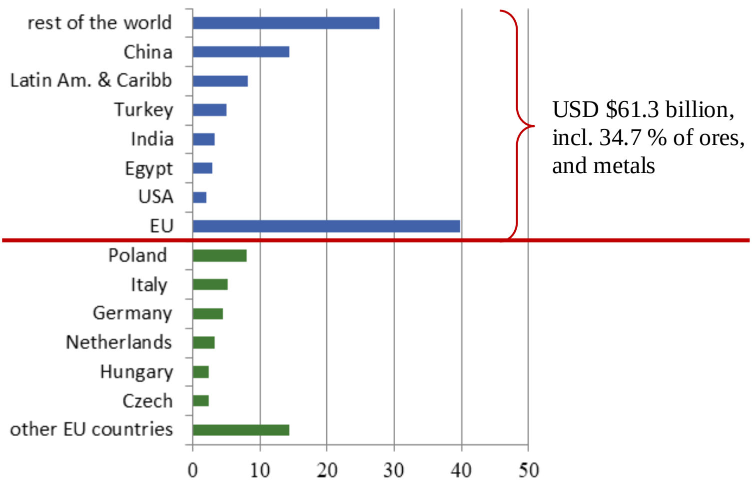
Top 10 export commodities of Ukraine, 2018 to 2020 (compiled from UN Comtrade, 2020)

HS code	**Commodities**	**Value (million US$)**			**%**
		2018	**2019**	**2020**	
All Commodities, million US$		47 334.7	50 054.4	49 230.8	100
1512	Sunflower-seed, safflower or cotton-seed oil	4 113.4	4 273.5	5 319.9	10.8
1005	Maize (corn)	3 506.1	5 218.3	4 885.1	9.9
2601	Iron ores and concentrates, including roasted iron pyrites	2 869.0	3 397.8	4 239.3	8.6
1001	Wheat and meslin	3 004.4	3 658.4	3 594.2	7.3
7207	Semi-finished products of iron or non-alloy steel	3 002.9	2 860.0	2 746.4	5.6
7208	Flat-rolled products of iron or non-alloy steel	2 193.1	1 943.8	1 599.2	3.2
8544	Insulated (including enamelled or anodised) wire, cable	1 476.6	1 465.1	1 351.0	2.7
1205	Rape or colza seeds, whether or not broken	1 010.9	1 282.4	1 007.1	2.1
2306	Oil-cake and other solid residues	921.4	1 012.4	1 177.8	2.4
7201	Pig iron and spiegeleisen in pigs, blocks or other primary forms	1 052.6	801.8	922.2	1.9

For Ukraine, the mining and metallurgy are the main ones for the country’s GDP; in January-November 2021, the products of these industries (ores, and metals and preparations thereof) accounted for 34.7 per cent of the country’s total merchandise exports (see Figure 2). And it is these industries that have led to the low ratings of the country on environmental sustainability indicators: 89th place in the ranking of Environmental Performance Index (based on 24 performance indicators across ten issue categories covering environmental health and ecosystem vitality); and 115th place in the ranking of GDP per unit of energy use (Palekhov & Palekhova, 2021).

Figure 2

Geographic structure of Ukrainian merchandise exports, January-November 2021, % (compiled from Ukrstat, 2021)



Note: Excludes statistical data for the Autonomous Republic of Crimea and the city of Sevastopol, Ukraine, temporarily occupied by the RF.

If considering that approximately 34 per cent of Ukrainian mining and metallurgical products are exported to Europe, the significant impact of these industries on the sustainability of the European economy becomes obvious.

Conclusion. Today the development of the Ukrainian industry, especially the mining and metallurgy (steel and non-ferrous metals) encountered the serious challenges in meeting the requirements of SDG 12. As these industries claim sufficient participation in European value chains, they will have to comply with the sustainability demands (i.e. environmental and energy) that made on industrial companies by the EU. It should also be clear that moving towards responsible production and consumption patterns is not just agreed policies at the national level, but consistent interaction with businesses, especially large ones, in order to intensive promote environmental sustainability in key sectors of the country's economy.

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FINANCIAL AND CREDIT SUPPORT SYSTEM FOR SUSTAINABLE DEVELOPMENT OF INDUSTRY IN UKRAINE

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Introduction. In the context of global sustainable development goals, Ukraine is seeking to promote financial inclusion, i.e., greater access to financial services for all firms, as part of their overall strategies for economic, innovative and equitable development. However, unfortunately, so far no industrial enterprise in Ukraine can rely on financial stability and reliability. Due to a series of stresses over the past few years, they are forced to regularly adapt their production, purchasing and supply programs to a changing external environment, which significantly undermines their internal capabilities. Especially large enterprises are becoming increasingly dependent on the stability of the financial services market.

Fluctuations and limitations in the financial stability of an enterprise become destructive not only for him, but also for his partners in the value chain. Thus, one of the factors affecting the sustainable development of large and medium-sized enterprises is access to means of sustainable sources. At the same time, we are seeing the growing need to receive reliable and timely information on the business activities in different markets along the entire value chain, including the economic, legal, technological and other environment, the state of business operators and service structures – banks, insurance companies, carriers, etc. (Paliekhova, 2021).

Presentation of the main research. Financial and credit support infrastructure is an extremely urgent and universal concern for the implementation of sustainable development goals, technical re-equipment and reduction of emissions and discharges of pollutants. The transformation processes in the financial sector are needed in order to keep global value chains in the face of today's global turmoil and to contribute towards coherent and coordinated support towards sustainable production and consumption. For Ukraine, this problem is especially relevant, because the main economic function of Ukrainian financial and credit system in the period of accession to the EU is the credit and investment activity to support sustainable development projects of their clients.

Ukrainian researchers represent financial and credit infrastructure as a set of interconnected and interacting financial institutions, directly involved in financial activities and contributing to its implementation, that is associated with the movement of cash flows. The results of many also studies showed that the Ukrainian financial structure did not change significantly during the last period.

In 2021, there were 75 banks and 2,084 participants in non-bank financial services markets in the financial market of Ukraine, which include 144 leasing companies that are not financial institutions; 1031 financial companies (licensed for lending, leasing, and factoring, guaranteeing) and 63 insurance brokers. However, a bank-centric model of the financial market (about 90% of assets goes through the banking system) in the country has remained (NBU Statistic, 2022).
As Table 1 shows that over the past 2 years, government lending to projects has decreased by almost 40%. However, in the first months of 2021, the corporate loan portfolio already increased by 1.3% to UAH 747.2 billion (NBU Statistic, 2022).

Table 1

Dynamics of assets of the banking system of Ukraine, UAH billion (compiled from NBU Statistic, 2022)

Indicator	01.01.2018	01.01.2019	01.01.2020
Net assets	1316,85	1254,39	1256,30
Loan portfolio	**1006,36**	**965,09**	**1005,92**
Investments in securities	168,93	198,84	332,27
Highly liquid assets	155,64	191,26	199,50
Official exchange rate, UAH / USD, UAH	28,06	27,67	23,67
Average interest rate on loans in national currency,%	18,80	21,47	17,70
Average interest rate on foreign currency loans,%	8,30	6,88	8,20

The results of the study displayed a positive trend in the development of external financing from 2016 to 2021. However, the share of external financing rose not due to an increase in bank loans but due to informal sources. The researchers found no arguments to support the hypothesis of the existence of a strong statistical relationship between them (Oliynyk-Dunn et al., 2020).

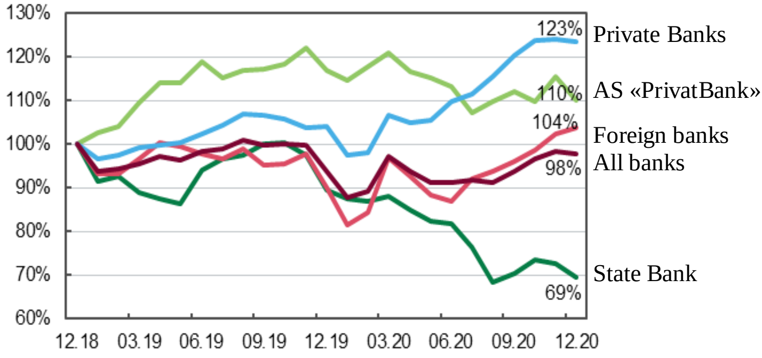
We have also identified additional significant sources of financing for sustainable development projects that are not related to the development of the financial system and those that do not meet traditional notions of financing patterns. In particular, joint projects of partners along value chains are increasingly becoming such sources.

Nevertheless, according to Ukrainian analysts, the Ukraine's financial and credit infrastructure offers favourable prospects for access to the sources of credit, finance and investment necessary to the modernization and sustainable development of industrial enterprises..

Figure 1 represents, in the fourth quarter of 2020, the volume of net hryvnia loans to economic entities increased by 4.2% (+ 4.3% y/y). Real estate lending revived significantly: net hryvnia loans in this segment grew by 7.5% for the quarter and by 11.5% y/y.

Figure 1

Net loans to business entities, in hryvnas (compiled from NBU Statistic, 2022)



Yet, banks have so far weakly adjusted to supporting sustainable development in the industrial sector. Loans for environmental projects accounted for only 5% of total bank lending. As we see from Table 2, during this period, emissions from stationary sources (mainly from pipes of industrial enterprises) decrease very slowly (NBU Statistic, 2022).

Table 2

Emissions of pollutants into the atmospheric air of Ukraine (compiled from NBU Statistic, 2022)

	Unit	2018	2019	2020	2021
Emissions of the main pollutants					
Sulphur dioxide (SO_2)	1000 t/year	716,7	695,8	619,2	595,3
Stationary sources		698,1	676,0	601,0	575,7

The EU is determined to the transition to a low-carbon, more resource-efficient and sustainable economy and has been at the forefront of efforts to build a financial-banking system that supports sustainable growth. Including, In the EU's policy context, sustainable lending is understood as supporting the transparency when it comes to risks related to ESG factors that may also have an impact on the financial system of banks (EU Finance, 2021).

EU integration lies at the core of the updated National Bank of Ukraine Strategy until 2025, which identifies three priorities and 12 strategic goals. The first priority is the promotion of economic recovery and development. The second priority is the development of digital finance as a driver for the further digitalization of the Ukrainian economy (EU Finance, 2021). The third priority is institutional development and operational excellence, which involves implementing the central bank’s digital transformation, and promoting green policies in support of sustainable development.

The sustainability of banking system refers to the ongoing process of taking environmental, social and governance (ESG) considerations into account when making decisions in the credit sector, leading to more long-term investments in sustainable economic activities and projects (Gutiérrez-López et al. 2020).

According to the IFC estimates, $23 trillion in climate-smart investment opportunities exists in the emerging markets globally by 2030, while in Ukraine the estimate is $73 billion. The new Sustainable Finance Policy will help Ukraine tap this potential. At the same time, enterprises should take advantage of new opportunities to improve your sustainability. It is also important to conduct research to develop effective market policies in order to realize own industrial potential in the most rational way and reach the ultimate aim: balancing the company's profitability while reducing the environmental footprint (Paliekhova, 2020).

Based on the information obtained because of market research, it is possible to discover profitable directions of sustainable production, in which it is expedient to direct financial investments, to determine the types of environmentally neutral products, which should be oriented during development of production plan, as well as to choose segments of more sustainable consumers.

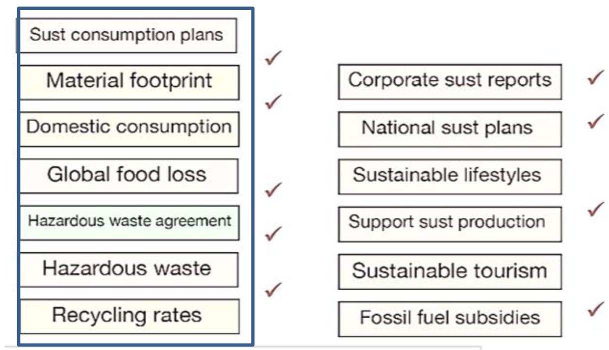
Market studies play an integral role in the planning of sustainable production process, especially strategic planning in value chains. Current circumstances must be highlighted and also utilized in formulating integration strategic plans. The broad spectrum of publications discuss approaches to investments to improve sustainability, namely: (i) disassembly for recycling, (ii) from product to raw material recycling, and (iii) by-products and co-production. (Suzanne et al., 2020).

A crosscutting analysis of the reviewed literature brought forward a number of research gaps and revealed multiple research opportunities to support the “right” investments in development. Analysis show an ever-growing interest in making sustainable the traditional linear industrial processes within a circular economy context. Also in the literature, much attention is paid to the problem of sustainable management. That requires careful and sensible sequencing of management activities, including resource analysis, technology assessment, data dissemination and communication (Sarkar et al., 2022).

The use of sustainability tools in the creation of the production program of the enterprise has a generally recognized importance in the modern economy, as ignoring environmental factors leads to an increase in risks and the emergence of direct and indirect damages. Directly for this reason in the developed countries the management of enterprises invests significant funds in the development of sustainable management, monitoring of external environment, as well as conducts market research (see Figure 2). For example, plastic waste management projects are made in developed nations for achieving sustainable management of plastic waste (Tejaswini et al., 2022).

Figure 2

Main directions of investment projects in the industrial sector (Paliekhova, 2020)



Conclusions. The results of the study displayed a positive trend in the development of the Ukrainian financial and credit support system from 2016 to 2021. Однако the analysis of the current state of the Ukrainian financial and credit sector allowed to identify several problems, in particular: low quality of bank assets in the context of supporting sustainable development projects; insufficient development of alternative sources of financing and lending; high concentration of the market for financial and credit services. It should also be noted that banks should be supportive of large-scale projects that address sustainability issues along value chains.

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PROSPECTS OF BIOECONOMY AS A PRECONDITION FOR SUSTAINABLE DEVELOPMENT IN UKRAINE

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Introduction. Sustainable development as a world goal and at the same time as a new model for production and consumption as well as the resource allocation has been one of the biggest challenge for humanity over the last decades. From one point of view, sustainable development has been agreed and discussed by all the world actors. Common acceptance of its concepts as the only one possible way of making progress turned it into almost new global way of thinking and evaluating efficiency. Nevertheless, from another point of view, in its being proclaimed fair and fully proved as balanced development for current and future generations, the sustainable development agenda still has been contributed poorly and featured by low level of achievement. In terms of it, we find exploring key issues of the sustainable development dynamics and ways of their solving to be topical especially for Ukraine as a developing country.

Presentation of the main research. One of the sustainable development pillars, which is discussed and studied hard now days, is bio economy. In Europe, we may observe a trend towards building a new bio economy strategy for sustainable Europe since as futurists forecast the humanity would face a competition for natural resources due to growing population and climate change. It means that EU officers consider bio economy as a strategic vector for regional development that must be sustainable. They vision sustainability as a steadily growing primary production and processing industries for farming and making goods and services with fewer natural resources consumed and more food and other goods produced. Bio economy is seen as a main assistance mechanism in making a transition towards sustainable society that is based on the resource efficient technologies, depends on renewable sources of energy and keeps the planet safe for future generations. As Europe strives to follow a path of growing competitiveness in the world, its industries must be ensured with stable availability of raw materials and energy. However, some give prognosis that by 2050, oil and liquid gas production is expected to decrease by almost 60 per cent. As one of the sustainable goals states, food waste represents another serious concern. As long as developing and depressed countries meet unprecedented number of hunger people not able to satisfy their basic needs because of absence of any type of agricultural production, an estimated 30 per cent of all food produced in developed countries is discarded. Obviously, major changes are needed to reduce this amount and to tackle the issue (EC, 2021).

At the same time, bio economy as a part of a green strategy has been actively debated and put under critiques. The stumbling block for the bio economy as a model for new society and production is impossibility to leave the era of fossil fuels. Opponents of the bio economy do not believe that renewable energy may meet all the demands from industries and households for energy supply. Some engineers say that no wind, no solar and no water natural sources can provide the amount of renewable energy enough for fast growing economies of the EU and the world (Fatheuer, 2015). Nevertheless, bio economy as being one of paths for sustainable development must be explored and evaluated from various sides.

There are many definitions and statements explaining the term of bio economy, but, in our research, we decided to rely on the definition provided by the European Commission. Thus, according to it, bio economy is "encompassing the sustainable production of renewable resources from land, fisheries and aquaculture environments and their conversion into food, feed, fibre bio-based products and bio-energy as well as the related public goods – is an important element of Europe's reply to the challenges ahead.

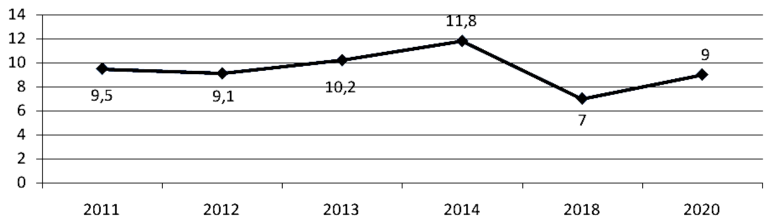
The bio economy includes primary production, such as agriculture, forestry, fisheries and aquaculture, and industries using / processing biological resources, such as the food and pulp and paper industries and parts of the chemical, biotechnological and energy industries" (EC, 2021). By taking into consideration main parts of the bio economy definition provided by the EU, we chose and studied three main indicators that from our perspective fit the term best of all and reflecting the state of bio economy in relation to Ukraine. To do this, we used the following methodology.

First of all, we have divided the essence of bioeconomy into parts and discussed which of them are the most representative and reflective in order to showcase the state of sustainable development and bioeconomy in Ukraine realistically. Thus, we obtained three main indicators that we would have liked to study: value added by agriculture industry, poverty headcount ratio and total number of population over the years. Then, we searched for specific data over the years via the platform of the World Bank. Since it is better for Ukrainian sources of statistics to be verified by more precise and wide international ones, we selected to process information provided exactly from the World Bank platform that usually accumulates correct and reliable information from around the world, giving an opportunity to compare countries' development. Research results as for the data range are given below.

As Figures 1, 2 and 3 shows, Ukraine is now facing its greatest challenges to the achievement of sustainable development goals. They concern such areas of bio economics and sustainable development as agriculture production, poverty and amount of population that, apart from all said above, contribute much to strengthening the convergence of living standards across Ukrainian regions. Over the last decade, agriculture value added in % of GDP has not grown in Ukraine (Figure 1), which is an evidence of the economic stagnation and unsatisfactory readiness of Ukraine to tackle the issue of food, feed and fibre-based production.

Figure 1

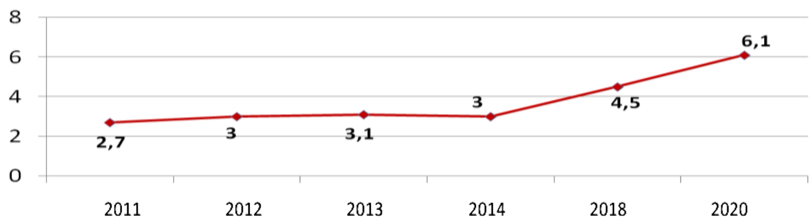
Agriculture, value added, % of GDP, Ukraine (including forestry, hunting and fishing as well as cultivation of crops and livestock production) (compiled from World Bank Data, 2021)



Despite the sustainable development goals call for addressing various inequalities within and across countries, Ukraine has shown steady rise in poverty level over the last decade (Figure 2). The sustainable development goals as well as bio economy incorporate an important fundamental that says that everybody must have equal rights and access to basic services for satisfying natural needs within a country.

Figure 2

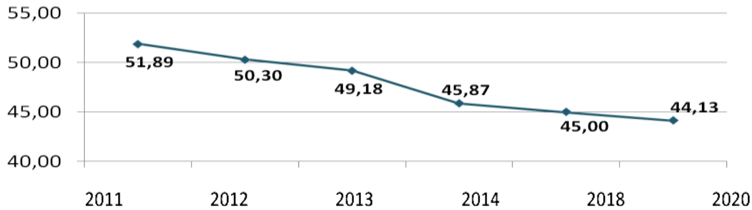
Poverty headcount ratio at 1.9 US dollar per day, % of population, Ukraine (compiled from World Bank Data, 2021)



Yet according to the poverty ratio in Ukraine, we may find the principle broken in reference to inequality within it. While compared with the rest of the world, Europe may be said to meet equality goals, Ukraine that is striving to join the European Union, has still stayed far behind. In addition, while in Europe, few people face extreme poverty and undernourishment and in general there is widespread access to key services (including health and education) and infrastructure, in Ukraine in 2020, more than 6 per cent of total population lived at 1.9 US dollar per day and less. Moreover, the share of such people rose dramatically from about 3 per cent in 2011 showing maintenance of the strong disparities across Ukrainian regions in equity. Thus, trends in relation to some equity measures are not moving in the right direction in Ukraine, breaking the principles of sustainable development and bio economy (Europe SD Report, 2020). Another negative trend preventing Ukraine and its society from meeting sustainable development goals and building up bio economy is dramatic decrease in total number of population (Figure 3).

Figure 3

Population, total millions, Ukraine (compiled from World Bank Data, 2021)



It shrank from almost 52 million of Ukrainians in 2011 to more than 44 million in 2020. Participants of the latest Dnipro Economic Forum representing business, government and public service sectors delivered relatively pessimistic assumption of population scenario ahead, which was a prognosis that by 2030 Ukraine will have had about 35 millions of people. Despite shrinking population trend is also common for European countries, it provokes alarm against the backdrop of rapidly rising number of population in China. Certainly, this scenario would not be welcomed by countries striving to avoid it by means of various political measures.

Obviously to tackle the issues blocking the achievement of sustainable development goals, Ukraine needs an integrated and comprehensive approach to implementing bio economy principles and must communicate clearly against them. Therefore, taking into account indicators analysed above, we should assume that an integrated approach to the sustainable development goals and bio economy must focus on three broad areas: agriculture production; addressing the problem of poverty and undernourishment; and negative trend of population amount. Achieving the objectives of the 2030 Agenda, the sustainable development goals and the Paris Agreement in Ukraine requires us to address negative impacts generated by poverty, agriculture underproduction and shrinking population, including those embodied into them.

Conclusion. Whereas sustainable development goals and bio economy remains to be seen as a long-term future prospect, attempts to prevent climate change, poverty, declining population and food crisis must already affect current policy-making. All indictors discussed above in reference to Ukraine, in fact are topical for countries around the world and reflect fundamental challenges than must be tackled. Moreover, we offer to consider them now as the central issues of the global environmental crisis and at the same time as a starting point for numerous political initiatives focused on building up bio economy and achievement of sustainable development goals. Unlike sustainable development, which remains a long-term objective, the notion is that the bio economy and political measures focused on it can already make a significant contribution to the reduction of poverty level, increase in agricultural production and stop of rapid decline in total number of population in Ukraine.

The bio economy measures may finally serve Ukraine as strategic developments that would eventually substitute the current production and consumption system; today, however, the focus is on the concept's potential to solve environmental challenges. We may assume that Ukraine's reply to the above mentioned challenges preventing the achievement of sustainable development goals should concern integrated projects encompassing three main areas: recovering wide territories left uncomfortable for living after mining and metallurgical industries' closure due to introduction of specific innovations-based engineering solutions; then invoking the principle of equality based on the tool of minimum basic income for all citizens; and taking into mind challenges arising due to the industrial revolution 4.0 requiring substitution of human beings with robots.

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SUSTAINABLE DEVELOPMENT INDICATORS IN INDUSTRIAL VALUE CHAINS

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Introduction. The destabilizing processes of globalization taking place in the modern world economy require economic, social and environmental changes. Sustainable development indicators help track these changes which are studied every year and used to better understand the state of the country and further development in the future. This article explores indicators to assist stakeholders in assessing collectively progress in industrial value chains.

Presentation of the main research. Indicators are calculated based on a set of data and used for the exchange of scientific and technical information, which is very important for the development of society. It is worth noting that the world is actively developing evaluation criteria and indicators of sustainable development.

Sustainable Development declared in Rio de Janeiro as a program of Human Development Goals for the near future, is interpreted differently by scientists who define their main components depending on the emphasis on its components. In our opinion, in the modern world the Sustainable Development Goals (SDGs) are increasingly related to the economic sphere which is closely related to the environment.

As is well known, sustainable development is managed development. In particular, O. V. Pyrikov noted that the basis of this manageability is a systematic approach and modern information technologies that allow us to quickly model various variants of development directions, predict their results with high accuracy and choose the most optimal one (Pyrikov, 2013). To do that, however, it is important to define what indicators of sustainable development are in order to better understand and effectively calculate the current state.

A sustainable development indicator is an indicator derived from primary data that usually cannot be used to interpret changes, that allows you to judge the state or changes of an economic, social, and environmental variable in general. The main purpose of introducing indexes is to assess a situation or event, to predict the development of the current situation and develop its solution (Lukyanenko, Karaeva, 2012).

Also, appropriate information support should be quite important for calculating data because it must meet such requirements, namely, have integrity, reliability, be controlled, have protection against unauthorized access, be flexible, standardized and unified, have the ability to quickly adapt as well as mandatory minimization of information input and output (Pyrikov, 2013).

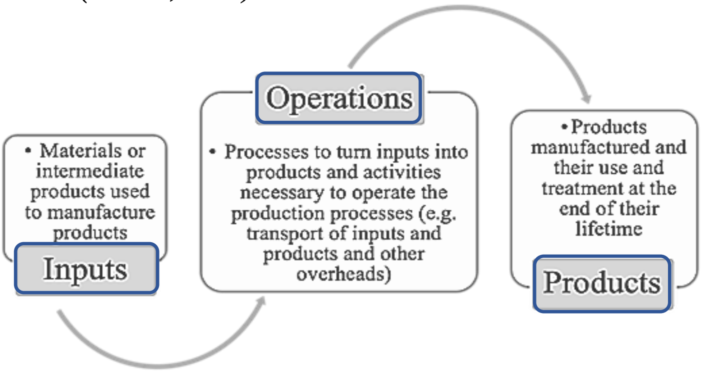
The need to develop indicators of Sustainable Development was noted in the «Agenda for the 21st century» adopted at the UN Conference. Including two main approaches to measuring the sustainability of development are shown. The first is to build a detailed program of indicators, each of which evaluates the solution of individual tasks in a set of Sustainable Development Goals. This approach has been implemented in the most common indicator systems of the Organisation for Economic Co-operation and Development (OECD) and the United Nations Commission on Sustainable Development (CSD). The second approach involves the use of a single integral index which according to a certain methodology, combines standardized indicators for assessing the state of various spheres of development (Palekhova, 2020).

However, it should be noted that integral indices are not so widely used for complex measurement of development constancy. As the experiences prove, the main difficulties of their construction consist in choosing a measurement system for quantitative and qualitative assessment as well as objectively determining the weight of indicators when aggregating them (Palekhova, 2020).

The Figure 1 indicates the basic interaction between a facility and the environment, and the impact it may have on the environment throughout the «lifecycle» of the products that it produces. Even though the actual production processes are far more sophisticated, environmental impacts are principally formed in the following three stages: inputs, operations, products (OECD, 2011). The OECD's sustainable production indicators are worth considering as the model presents and provides advice on eighteen of the most important and widespread quantitative environmental indicators in the three stages of production – input, operations and products.

Figure 1

Basic relationships between manufacturing and the environment (OECD, 2011)



These indicators will mainly help internal management and decision-making and can be used for all types of production. The Figure 2 shows the indicators that track water and energy consumption processes as well as greenhouse gas emissions to more accurately measure the impact of recycling technologies in value chains. Consequently, the value chain method helps enterprises better analyze its state, identify and systematize production operations for competitiveness and optimization. Of course, only after the project is completed can the sustained impact be measured.

In addition, indicators are selected in such a way that they can characterize both long-term development results and current results and processes. The use of indicators allows you to track progress, identify and take measures to address the problems of the SDGs.

Businesses can assess what new business models to implement in order to advance towards the Sustainable Development Goals along the value chain. In manufacturing sustainable value creation plays an important role which is associated with economic, environmental and social obligations.

In addition, in order to identify policy choices, enterprises need to analyze what impact the external environment has and what gaps exist between the current state and the planned.

Figure 2

Overview of the OECD Sustainable Manufacturing Indicators (Paliekhova, 2020)

Inputs	Operations	Products
I1 Non-renewable materials intensity	O1 Water intensity	P1 Recycled/reused content
	O2 Energy intensity	P2 Recyclability
	O3 Renewable proportion of energy	P3 Renewable materials content
I2 Restricted substances intensity	O4 Greenhouse gas intensity	P4 Non-renewable materials intensity
	O5 Residuals intensity	P5 Restricted substances content
I3 Recycled/reused	O6 Air releases intensity	P6 Energy consuption intensity
	O7 Water releases intensity	P7 Greenhouse gas emissions intensity
	O8 Proportion of natural land	

We agree with scientists (eg. Zajtzeva, 2018) who claim that the concept of sustainable development in its current form is largely a reflection of the complexity of society as a whole.Enterprise development is becoming more and more difficult to convert into profit indicators since it requires comprehensive problem solving in various areas within the economic, social, environmental challenges.

The turbulence of changes in the world leads to constant research and development of up-to-date indicators for effective calculation of the current state. After a certain period of time, analytical groups globally update information in accordance with the relevant targets and indicators for the achievement of the SDGs. For example, in March 2021, the 52-nd session of the UN static commission updated current information on the relevance of indicators and their level classification based on changes made by Inter-agency and Expert Group on Indicators SDGs for data transmission, tracking and other statistical purposes (SSDG Indicators, 2021).

Conclusions. The results of the theoretical study show that to diagnose the progress of the SDGs necessary to move on to the most advanced and progressive measurement indicators with the help of which the work of sustainable development indicators in dynamics. The large number of indicators included in the system makes it difficult to use them in many countries due to the lack of necessary statistics. Despite this fact, it is the ease of use and transparency of indicators that helps to fully assess trends in the economic, social, and environmental development of society and outline positive stages on the way to sustainable development.

It has been shown that indicators of sustainable development are important guides for business development in value chains, including with regard to the choice of development strategies, products and markets. In order to consider the development of an enterprise as sustainable it is necessary to take into account not only the results of its economic activities and other benefits but also its role, mission, functions in certain value chains. The prospect of further research is a detailed analysis which should be based on publicly available indicators, and data from independent (private) centers for assessing sustainable development.

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VULNERABILITY OF SOME GLOBAL VALUE CHAINS IN CRISES

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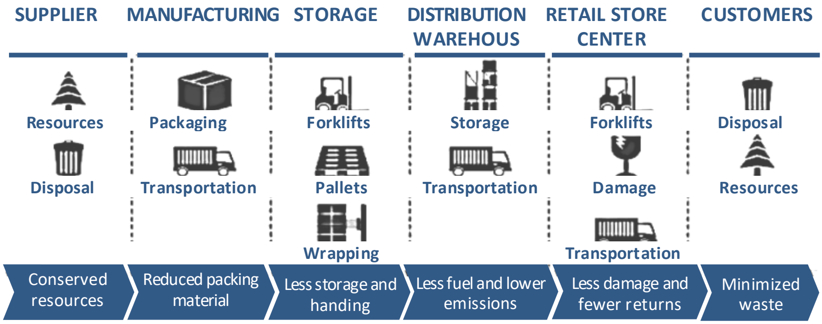
Introduction. A supply chain is defined as the entire process of making and selling commercial goods, including every stage from the supply of materials and the manufacture of the goods through to their distribution and sale. The literature pays sufficient attention to the architecture of their construction, however, there are practically no studies devoted to their vulnerability under the influence of global external factors.

Presentation of the main research. The definitions of the concept emphasize that supply chains include various entities, such as raw material extractors, service and component suppliers, a material product manufacturer or a producer of services, distributors, and end customers (e.g. Felea et al., 2013; Stock et al., 2009; Sweeney, 2011). Figure 1 below shows that supply chain includes various flows as well as various entities; materials and services flow from suppliers toward customers, payment flows from customers toward suppliers, and information flows are transmitted in both directions across the chain (Blanck, 2015).

The concepts underlying supply chain management have been around for many decades and cover a wide range of related but initially fragmented activities. The literature shows that supply chain management can be viewed in terms of different processes such as logistics, strategic planning, information services, marketing and sales, finance and so on. However, today the function of supply chain management is considered as a new challenge for achieve sustainable patterns of production and consumption (Hou, 2023). Besides the potential cost savings attributed to packaging materials, and decreased handling, storage, and transportation costs, etc., the main expected results from the stability and quality of fulfilling obligations by the actors of supply chain. The common objective must be that the supply chain as a whole was able to deliver in the uninterrupted and most efficient manner in accordance with the principles of openness and accountability (Paliekhova, 2020).

Figure 1

The stages of sustainability in the supply chain (compiled from Blanck, 2015; Paliekhova, 2021)



Given that, management for supply goes beyond the interests of a specific buyer and supplier it is essential to integrate strategies of these enterprises into broader regional and industrial development chains and networks (Paliekhova, 2021; Hou, 2023).

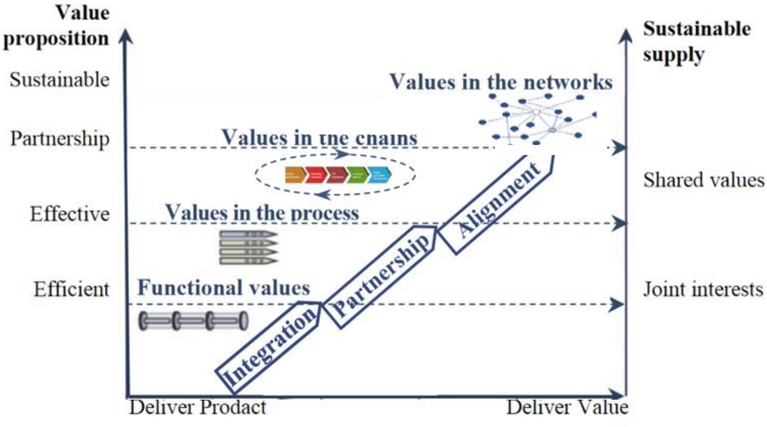
The Figure 2 also shows that the supply chain as a sustainability tool emerges when participants synchronize their respective processes and adopt a philosophy of supply chain management that has a unified strategic consideration of sustainability already in the network format. Businesses need further to pursue the partnerships for sustainable production and consumption through building sustainable their supply chains of local and national level, involving authorities, civil society and other partners in these processes.

Of course, if businesses wish to, or have to, transform the strategy of participation in the supply chain into a strategy of partnership and then into a strategy of synchronous management, they are welcome to do that. The difficulty however is that the reliability of each of operators can be actually crucial for this.

Some of them show incapacity to deal with the small setbacks or fall into circumstances of force majeure (natural disasters, disorganization of the country's Government, etc.) that would close down the production for an indefinite period.

Figure 2

From supply chains to value chains (compiled from Blanck, 2015; Paliekhova, 2021)



Others show the internal shortcomings, such as incapacity to carry out the conversions of their strategies in accordance with the mechanism of the restrictions or requirements in specific supply and value chains. However, if some products are not uninterrupted supplied, a substantial part of production may be delayed or even rejected, producing destructive results, market failures and the appearance of suppliers with poor security.

To illustrate how strongly one type of supply can affect the overall sectoral development processes, consider the situation of the semiconductor chip shortage caused directly or indirectly by COVID 19 pandemic. The 2020–2021 global shortage of integrated circuits affected more 169 industries. Supplies of chip needed for manufacturing were unavailable for months. Unsatisfied demand caused shifts that rippled up the supply chains. The crisis led to decline in the output of carmakers, problems for broadband providers and dozens of other manufacturers that require semiconductors. Indeed, the supply chain crisis was the result of disruptions coupled with the boom in demand caused by CCOVID-19. Shortages of workers and manufacturing facilities have only made the issue worse. At the same time, and more profoundly, COVID-19 was not the only factor behind the shortage. The situation showed us the fragility and vulnerability of value chains with the growing trends towards globalization (Wu et al., 2021). Summarizing the facts, we can highlight the key lessons to retain from the unmet demand for chips are as follows.

Firstly, it was the digitalization of work and life. Lockdowns spurred the digitization of all types of activities and, as a result, an increase in demand for chips. Laptop sales hit their highest level in a decade; home networking gear (webcams, monitors, home appliances, etc.) were snapped up as office work moved out of the office and so on. Secondly – insufficient planning and forecasting. Insufficient planning and monitoring, and ineffective synchronization of the activities of the main value chains were the key factors that resulted in disruptions of so many related industries. Automotive has particularly shown a lack of focus on strategic value chain management. Companies chaotically cut production, and then rushed to resume orders late in 2020. Nevertheless, it was too late.

Thirdly – weak links in the supply chain. In the panic and confusion, large producers began to build up inventories. For example, China's chip imports climbed to almost $380 billion in 2020, up from about $330 billion the previous year. Fourthly – unpreparedness of chains to respond quickly to natural disasters. For example, a bitter cold snap in Texas led to power outages that shut semiconductor plants clustered around Austin. A fire at the plant of Japan's Renesas Electronics Corporation, a major manufacturer of automotive chips, led to a force majeure. Its production was stopped for several months.

The feature of industrial markets is that difficulties in supply chain cannot be solved simply and quickly. In particular, integrated circuits are the tiniest yet most exacting product ever manufactured on a global scale. In this case, it takes up to 3 years to put up such manufacture and not less than a year to add capacity to an existing one.

Conclusions. Thus, the case with the shortage the shortage proved that industrial supply chain management is quite vulnerable to external factors, as well as there is insufficient attention from managers to growingly some supplying problems for the last several years. The situation analysis confirmed that other strategies, based on active partnership between suppliers and their customers (including joint strategic planning for value chains), are required. It is important for all participants in the value chain to work out a set of principles and interrelated strategies on the supply and creation of value that potentially reduce vulnerability due to different situations, increase behavioural agility and resistance.

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EFFECTIVE SUSTAINABLE VALUE CHAIN PRACTICES FOR METALLURGICAL INDUSTRY PERFORMANCE IMPROVEMENT

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Introduction. In the context of the concept of sustainable development, current and future social, environmental, and economic problems are interrelated and should be addressed in an integrated manner. Achieving sustainable consumption and production is an integral component of the Sustainable Development Goals (SDGs). Sustainable consumption and production are reflected as a means of intersectoral interaction to achieve many of the SDGs and directly Goal 12: "Responsible consumption and production" – SDG 12 (Department of Economic and Social Affairs, 2021).

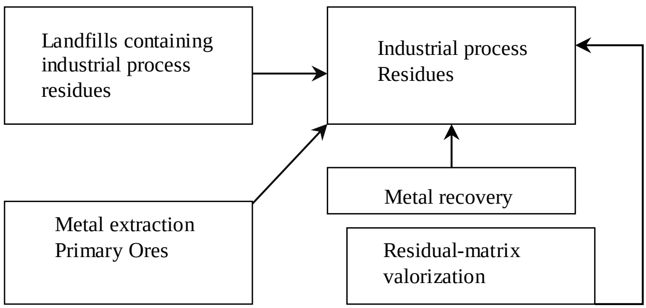
It should be noted that industrial enterprises in Ukraine are leading in the world in terms of specific energy consumption and resource intensity of products, as evidenced by the GDP per unit of energy use. The reason for this situation there is the lack of a well-grounded state energy policy, which assumes the presence of established industry indicators of energy intensity; the state relevant body responsible for compliance with the established rules; an effective policy of taxation and subsidies for industrial enterprises; principles of responsible environmental management in society.

Presentation of the main research. The value chain management paradigm based on sustainable development initiatives has led to further changes in business behaviour regarding the strategy of enterprise interaction in the supply chain. Traditional theories cannot provide a comprehensive explanation of sustainable development management in these chains. The modern theory of supply chain management is unable to explain and predict the behaviour of the original sources of sustainability (Acharyulu et al., 2015).

A value chain model developed by Porter with five main activities and four supporting activities can be used as a common one. This model cannot be used directly in the metallurgical sector, as the expansion of metallurgical plants has become a constant process of their growth and survival. Due to the nature of the activity, another variant of the value chain for the metallurgical industry is being developed with five main activities and six auxiliary activities (Acharyulu et al., 2015). In integrated metallurgical plants steel is manufactured from basic raw materials like iron ore. The main production units are the raw material handling plant, coke ovens. In addition to these main production units, there are several auxiliary units like power plants. Four technical work packages examine various aspects of waste-free assessment of industrial process residues (see Figure 1).

Figure 1

Mapping of flow sheets (Acharyulu et al., 2015)

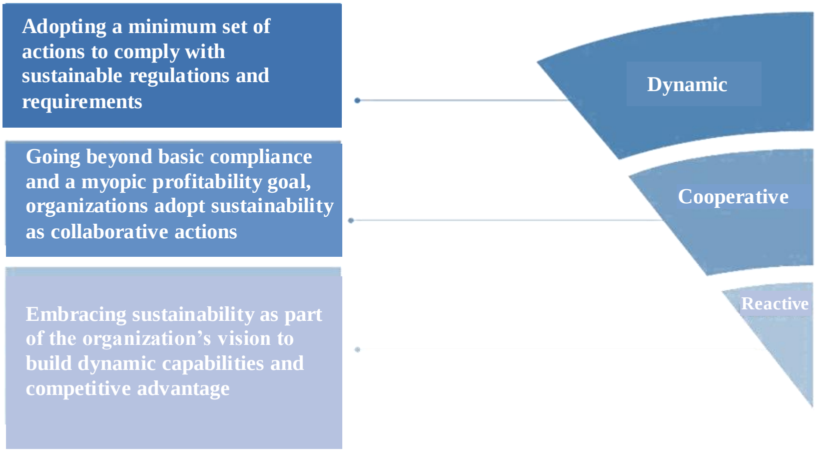


Natural resources, especially metals, are gradually depleting from the crust. Therefore, secondary sources such as industrial residues, waste and side-streams could potentially act as a more sustainable critical metal supply. This approach is at the very heart of the circular economy principles and, actually, from that point of view, European countries have ‘inherited’ a large quantity of industrial waste (Kuvaieva et al., 2021).

Sustainable practices must meet two criteria: (1) they must improve environmental health, meet ethical standards to enhance social justice and increase economic viability; (2) the environment must be a priority, then society and the economy (see Figure 2).

Figure 2

Types of value chains (Kuvaieva et al., 2021)



Reactive	Cooperative	Dynamic
R1 Waste, water and air management	C1 Strategic cooperation with supply chains	D1 Innovation and design of environmental products
R2 Energy consumption and emission reductions	C2 Environmental management system ISO	D2 Corporate Social Responsibility Program
R3 Purchase of harmless and non-toxic substances materials	C3 Green production	D3 Corporate management of green image
R4 Product Recovery	C4 Reverse logistics	
R5 Assessment of supplier sustainability	C5 Supply Chain Integration System	
	C6 Green delivery and distribution	

The efficient use of energy, or energy efficiency, has been widely recognized as cost-efficient means to save energy and to reduce greenhouse gas emissions. Up to 1/3 of the worldwide energy demand in 2050 can be saved by energy efficiency measures (Kuvaieva, 2021). Energy management systems offer a structured and integrated approach to improving energy efficiency. Cooperative value chain includes the introduction of ISO 14001. ISO 50001 is based on the continuous improvement management system model, which is also used for other well-known standards such as ISO 9001 or ISO 14001. This makes it easier for organizations to integrate energy management into their overall efforts to improve quality and manage the environment.

Ukrainian metallurgical enterprises also have experience in creating sustainable value chain throw ISO standards. Azovstal was the first among enterprises in the metallurgical industry in Ukraine that proceeded to new standard implementation, having concluded contract for certification conduct with auditing company «TÜV SÜD Ukraine», and the first enterprise that passed certification audit for compliance with international standard ISO 50001:2011.

Conclusions. In the context of supply chain management, sustainable supply chain management (SSCM) is a management concept that goes beyond supply chain performance indicators – cost, time and flexibility. SSCM considers the management of the integration of economic and non-economic issues into the supply chain. The implementation of these practices includes use of high quality components, ensuring longer product life; optimization of packaging design: compliance with the rules and use of the service life of packaging material; elimination of toxic materials and reduction of emissions; cooperation with suppliers who follow the basic guidelines for sustainable development.

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SECTION 2 CIRCULAR ECONOMY: RECYCLING AND INNOVATIVE TECHNOLOGIES

"Building the circular economy requires innovative solutions that transform industries through new materials, energy and ingredients alongside new business models, designs, logistics and recovery solutions. ... Concerted action targeted at changing the way industries do business is needed to accelerate the circular transition."

Circular Trailblazers: Scale-Ups Leading the Way Towards a More Circular Economy. White Paper. World Economic Forum, January 2021

"The transition to a more efficient and circular use of raw materials in the automotive sector is far more than an environmental issue; it's the only way to meet the ever-increasing demand for mobility in the context of finite natural resources. Circular economy innovation has been continuously contributing to Renault's industrial competitiveness and increasing net profits for the past five years."

Jean-Philippe Hermine, Vice-President, Strategic Environmental Planning, Renault-Nissan Alliance, France. Driving the Sustainability of Production Systems with Fourth Industrial Revolution Innovation. January 2018

CIRCULAR ECONOMY: MEASURING THE MATERIAL FOOTPRINT

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Introduction. Today the circular economy is declared as one of a key pathway for sustainable development. In this direction, the EU has adopted the Circular Economy Action Plan for Europe, which will contribute to achieving the Sustainable Development Goals, especially SDG 12. The results of major reform measures should contribute to lowering natural resource inputs and minimizing waste, and finding crosscutting approaches that will make dramatic progress for a cleaner and more competitive Europe possible (EU CEAP, 2020). However, for Ukraine, the search for circular coherence in industry is a radically new strategy and that the significant efforts are required (Palekhov & Palekhova, 2020).

This article discusses the challenges and principles of transition to the circular economy for a reduction in the material footprint. Particular focus has been placed on examining the methodology for calculating the material footprint applied by the EU. Approaches to assessing the material footprint of the metallurgical value chain in Ukraine are proposed.

Presentation of the main research. As is known, the circular economy is an alternative to a traditional linear economy (viz. make, use, and dispose). Under a new production and consumption model, we keep resources in use for as long as possible, extract the maximum value from them whilst in use, then recover and regenerate products and materials at the end of each service life (WRAP, 2021). In this way, the circular economy creates extended opportunities for economic growth and sustainable development.

As emphasized in the literature, there is no single approach or model of how to carry out the circular economy analysis. Nevertheless, the thematic evaluations cover usually the following fields: (1) material footprint; (2) fossil-fuel and energy consumption; (3) industrial and household waste; (4) environmental aspects and greenhouse gas emissions. Reducing the material footprint can be considered one of the most difficult and outstanding issue.

In the light of the European policy on “accelerating circularity in the context of the single market,… the sharing and collaborative economy, ... less dependence on primary materials” (EU CEAP, 2020), countries must strive to reduce the consumption of existing natural resources. The centrally planned economies of the European Union are increasingly open to market circular forces, and a tremendous readjustment is occurring in all industries, which reduces the consumption of primary commodities.

Yet, the situation is much more complex and nuanced. As the global sustainability reports indicate, the higher is the contribution of an economy to the regional and global GDP, the higher is its material footprint, since the production and final consumption in those countries linked on material resources from other countries through international supply chains. A sharp contrast in material footprint can be seen between the strongest economies (e.g. Denmark, Netherlands Sweden, and Germany, France, United Kingdom).

At the same time, a low material footprint characterizes all weak economies (e.g. Bulgaria, Serbia, and Ukraine), although they take different part in global value chains as raw material suppliers (Palekhov & Palekhova, 2020).

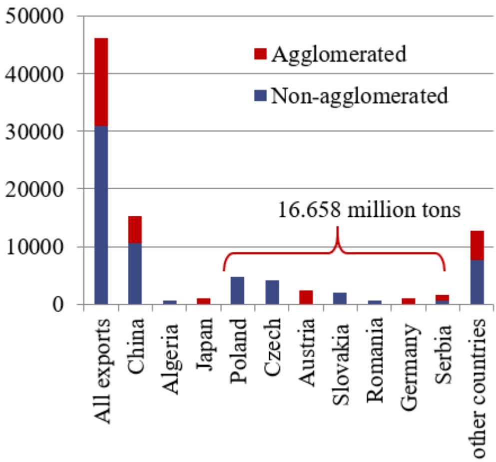
In particular, according to World Mining Data 2020, Ukraine ranks 7th in the world for iron ore mining. In 2020, the total volume of iron ore production amounted to 163.30 million tons, of which 28.3 per cent were exported (see Figure 1). As we can see, more than one third of iron ore exports account for the Top 7 importer countries from EU, thereby Ukraine directly increases their material footprint.

Some methodologies already exist that can help directly or indirectly measure the effectiveness of practical implementation of the circular economy (e.g. Eurostat’s Handbook for estimating raw material equivalents). As defined by the General Commission for Sustainable Development, material footprint quantifies the demand for material extractions triggered by consumption and investment by businesses, households and governments (GCSD, 2018).

It should be noted that there are some methods and procedures for estimating the material footprint, depending on the type of country, resources, economic sector, etc.

Figure 1

Impact of export of Ukrainian metallurgical products on the material footprint of European economies, 2020 (compiled from Ukrstat, 2021)



Top-7 EU countries-partners in Ukrainian export of iron ore and concentrates

Poland	10,0%
Czech	8,8%
Austria	5,3%
Slovakia	4,9%
Serbia	3,6%
Germany	2,4%
Romania	1,5%
	36%

Eurostat on an EU-wide level uses an input-output method based on input-output tables from national accounts and Material Flow Accounts (MFA), and today efforts are being made to apply this metric internationally. For that purpose, Eurostat has developed the Handbook as the methodological tool for country-level estimates of product flows in raw material equivalents (RME) (Eurostat, 2021a). In addition to this, Eurostat publishes annual results on Raw Material Equivalent (RME) of product flows at EU-28 level.

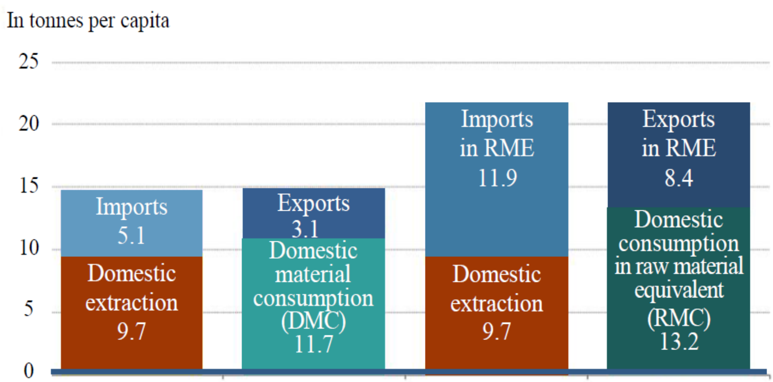
According to the Handbook, resources are divided into enlarged groups: biomass, metal ores, non-metallic minerals and fossil energy materials/carriers. The measuring indicators are the following: (1) Domestic Material Consumption (DMC); (2) Raw Material Equivalents (RME); (3) Raw Material Consumption (RMC) or 'Material Footprint'.

DMC (or 'apparent consumption') take into account the full range of raw materials actually being mobilized in order to satisfy domestic demand for goods and services from resident economic agents, but does take into account the tonnage of materials extracted domestically (to which imports are added and exports subtracted). Raw Material Consumption (RMC), otherwise referred to as the 'Material Footprint', is Domestic consumption expressed in 'Raw Material Equivalent' (RME).

For calculating RMC, the total imports and exports (tonnages registered in customs statistics) are measured in terms of RME. This results in an increased trade balance, i.e. the consumption level, when expressed as RME (the real material footprint or RMC) is higher than the weight of apparent consumption (DMC). Based on this methodology, the data in the Figure 2 shows that in France the actual consumption of raw materials (RMC, 873 Mt or 13.2 t/cap) is higher than the weight of apparent consumption (DMC, 777 Mt or 11.7 t/cap). It is thus estimated that, by the Eurostat, EU imports in 2019 were 2.0 times higher, and exports were 3.1 times higher when expressed in RME than recorded in EW-MFA.

Figure 2

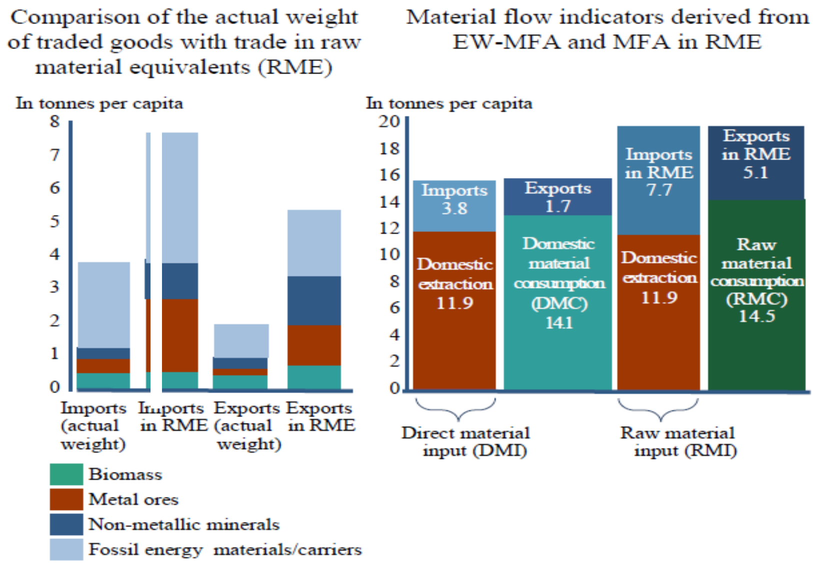
Material Footprint of France, apparent and in terms of Raw Material Equivalent, 2014 (GCSD, 2018)



The derived global material footprint (RMC) was 14.5 tonnes per capita in the EU in 2019 and 2.9 per cent higher than DMC (see Figure 3).

Figure 3

EU's Material Footprint, 2019 (compiled from Eurostat, 2021b)



Conclusions. The circular economy can make a significant contribution to the sustainability through transitioning to reducing the national material footprint. Research confirms the following facts:

- Export flows of raw materials directly and indirectly affect the real material footprint of importing countries.
- Quantifying the differences between the indicators Domestic Material Consumption (or "apparent consumption") and Raw Material Consumption (or "real consumption") shows that these indicators do not match. The European economy generally have a RMC larger than DMC, whereas the reverse is observed for net exporters.
- Countries with stable or declining DMCs may actually have a growing material footprint.

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RECYCLING AND WASTE-FREE TECHNOLOGIES IN METALLURGY

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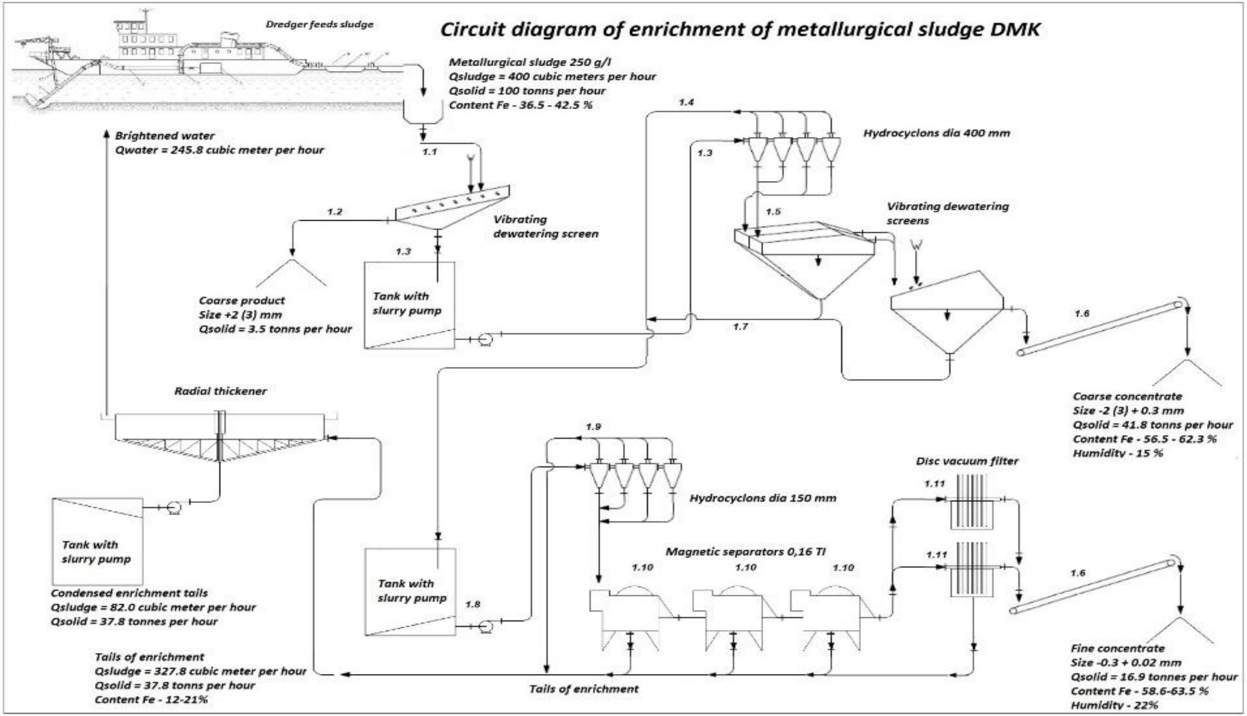
Introduction. The article presents review and an analysis of slags and sludge in the Ukrainian metallurgy. The volume of production and the degree of slag processing is lower compared to the European indicators. The volume of production and the degree of sludge processing is considerably lower than the European indicators. The main processing technologies and their disadvantages are considered. New technological schemes for deep concentration of sludge are proposed.

Waste-free technology of ferrous metal ores processing is a modern concept of sustainable development in ferrous metallurgy, which starts from exploration of deposits to industrial or domestic use of finished products. On the other hand, the finished products or waste become a source of raw materials for another redistribution, where they will produce the same or more frequently different type of marketable products.

Presentation of the main research. Metallurgical enterprises of Ukraine produce slags in large quantities. Pyrometallurgical processes are huge sources of waste if not recycled and disposed of properly. With a rapid increase of resource consumption, free land for filling a large amount of metallurgical slag is decreasing throughout the world, and as a result the cost of disposal is becoming higher. The impact of global warming and natural resource conservation are common environmental problems in the world (Shaposhnykova, 2019). Moreover, slag warehouses result in air, water and soil pollution, as well as negatively affect the health and growth of plants and vegetation, etc. We looked at the slag and sludge research trend and found that there is a significant increase in slag processing. The ideal goal is to develop a sustainable systemic cycle that can transform all the valuable resources that are taken out as waste into useful products and achieve absolute recycling (Slag Processing, 2021).

Figure 1

Circuit diagram of the apparatus for deep processing of agglomeration and blast furnace sludge



The metallurgical industry directs its efforts to minimize and recycle slags to meet the environmental objectives. Various metallurgical slags are formed during the mining, refining and steel alloying processes (Kovalenko et al., 2008). Due to the large amount of slag and stricter environmental regulations, the processing and disposal of these slags are an attractive alternative to reduce and ultimately eliminate disposal costs, minimize environmental pollution, and save resources preservation.

Conclusion. There are a lot of technologies used for processing slag and sludge from the metallurgical industry, and no one can provide with the deep processing of dust from the agglomeration and blast-furnace departments.

A general gravitational-magnetic circuit diagram of the apparatus for processing sinter, blast-furnace and steel-smelting sludge is proposed. It will allow additional extraction of iron with a content of β = 56-62% and a finished product yield of γ = 25-45%, depending on the mining zone. Processing tailings are a mixture of quartz and limestone grains with a content of υ = 6-18%, which can be used as a mineral filler. Thus, it is possible to deeply process wastes from blast-furnace, sintering and steel-making industries, followed by additional extraction of conditioned iron concentrate, suitable for charging blast furnaces, and obtaining mineral raw materials for construction.

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IMPROVING THE EFFICIENCY OF IRON ORE PROCESSING: DEMAGNETIZATION

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Introduction. The article presents an analysis of modern methods for improving the process of magnetic enrichment of iron-containing raw materials. The technical path of development of our civilization requires the ever-growing use of iron. For its production, iron ores are used, which are processed to increase the iron content.

The mineral of magnetite has a strong magnetic susceptibility, therefore it is easily enriched using magnetic separation. Before enrichment, it have to be grinded to a particle size of less than 50 microns in order to separate magnetite and rock (silica) particles from each other. Grinding is carried out in three stages in ball mills. After the mill, the material is classified by size and particles larger than the specified size are returned to the mill. This is called the circulating load, which can exceed 200 per cent in the case of magnetite enrichment.

Presentation of the main research. After each stage of grinding, magnetic separation is applied to remove rock (silica particles) and increase the quality of the concentrate. However, magnetite has not only magnetic susceptibility, but also great residual magnetization. This means that after magnetic separation, the magnetite particles themselves become magnets and are attracted to each other, forming floccules.

During hydraulic classification, large floccules return to the mill – see Figure 1, a). This increases the circulating load and reduces the efficiency of the mill.

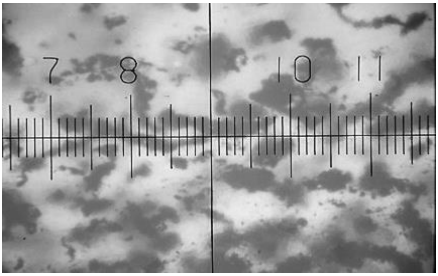
In addition, silica particles are trapped inside the floccule, which reduces the quality of the concentrate. To solve the problem, magnetite particles have to be demagnetized.

To demagnetize a large ferromagnetic body, it should be placed in an external alternating magnetic field, for example, in a solenoid, where maximum magnetic field induction exceeds residual magnetization, and then the field strength should be gradually decreased to zero (see Figure 2, b).

Figure 1

a) Optical testing of the magnetized slurry
b) Optical testing of the slurry, demagnetized at 50 kHz

a)



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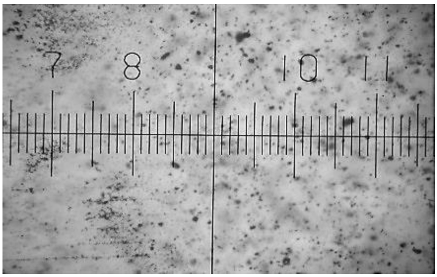


You can reduce the field strength, either by slowly removing the body from the solenoid, or by reducing the current through the solenoid. Now solenoids operating at an industrial frequency of 50 Hz are used to demagnetize magnetite. The efficiency of such demagnetization is low. The reason for this is that the magnetized magnetite particles in the suspension have time to rotate following the external magnetic field, and are not completely demagnetized.

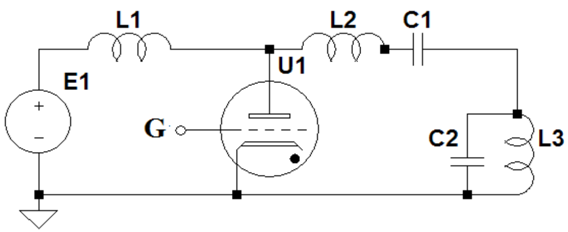
In this case, the field should change so quickly that the smallest particles do not rotate due to the forces of inertia and friction. Calculations show that the frequency of changes in the external magnetic field should exceed 50 kHz ($50 \cdot 10^3$ Hz). In this case, magnetite is completely demagnetized, which is confirmed by practice (Berezniak et al., 2015).

Figure 2

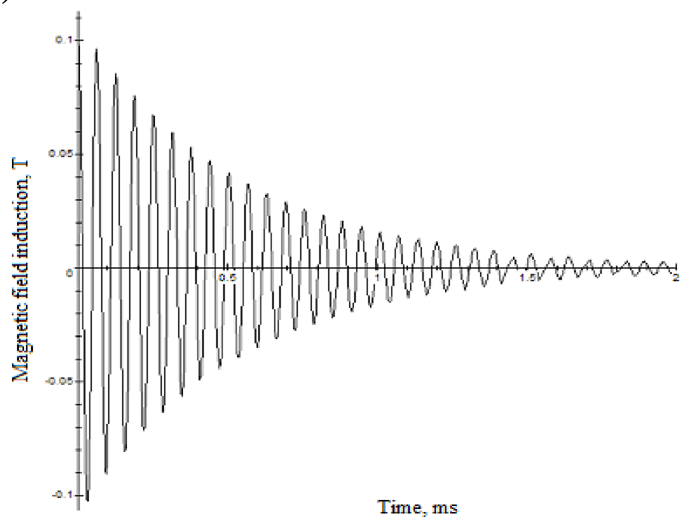
a) Schematic diagram of the pulsed generator of damped oscillations with the thyratron, L3 – solenoid

b) Dependence of the magnetic field induction in the center of the coil in time

a)



b)



It is energetically more advantageous to demagnetize magnetite in a pulsed mode. For this, damped oscillations of the required frequency are excited in an oscillatory circuit formed of a solenoid and a capacitor. In this case, all particles inside the solenoid are demagnetized. What is more, the pulse repetition interval should be less than the period, when the suspension is in the solenoid (see Figure 2, a).

The size of particles can be indirectly estimated from the rate of their sedimentation (precipitation, settling), which in the case of demagnetized magnetite is more than seven times less than that of magnetized – see Figure 1, b).

At the same time, the classification efficiency of demagnetized magnetite in a hydrocyclone increases from 76 to 84 in terms of percent (Mladetskyi et al. 2018).

Hydrosizer is a more efficient hydraulic classification device. In laboratory conditions, the classification efficiency for a size of 40 microns is 96.8 per cent. This is higher than with a Derrick fine screen at the same specific capacity. In addition, large particles in the overflow of the hydrosizer are mainly represented by quartz and intergrowths of quartz with magnetite.

Conclusion. Complete demagnetization of magnetite during its enrichment can reduce the circulating load on the mills and improve the quality of the concentrate. It increases the efficiency of magnetite ore processing in general, and reduces the cost of magnetite concentrate.

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SUSTAINABLE PRODUCTION: TECHNOLOGICAL CHALLENGES FOR UKRAINE

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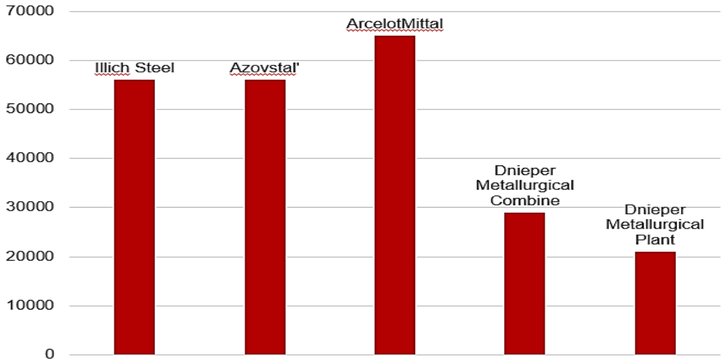
Introduction. Sustainable development involves equalizing the quality of life of the population of different countries and it's further growth. Improving the quality of life must be based on new advances in science. Modern conditions require everyone to reduce resource consumption, switch to other types of materials and energy sources, and introduce advanced non-resource intensive and waste free technologies, reducing the burden on the environment and human health. In November 2018, the European commission announced the implementation of a long-term climate protection strategy to achieve the goals stated in the Paris agreement. This has posed a technological challenge to Ukraine: technologies and approaches need to be changed to ensure that the products meet environmental requirements. (Latysheva et al., 2019). The article aims to review the main directions of innovative technology development in the leading industries of Ukraine, such as metallurgy, information technology, aircraft construction, space industry, and medicine.

Presentation of the main research. Metallurgy can be considered the main industry of Ukraine. As is known, the metallurgical cycle has the following stages: ore beneficiation, pig iron smelting in blast furnaces, metal production in open-hearth furnaces or converters, casting of billets on special rolling mills, production of metallurgical products from billets. Each of these stages is harmful to the environment, energy-intensive, dangerous for employees of relevant enterprises. The Figure 1 shows the average level of carbon dioxide emissions in tons per year.

Due to the use of the latest technologies in the field of 3D printing, this figure can be significantly reduced (Tarasenko, 2014). An example of such technology is xBeam 3D Metal Printing from Ukrainian developers, which reduces the use of raw materials in the production of titanium, parts from 20-30 to 3-5 kilograms.

Figure 1

Emission level of metallurgical enterprises of Ukraine, t. CO2 for a year (Kuznetsov, 2020)



The technology allows reducing the level of harmful emissions by 6 times.

Revolution 4.0 makes metallurgical production safer and more efficient. Thus, since 2020, within the framework of the industrial digitalization program "Industrialization 4.0", the Ukrainian company INTECH has opened a new direction of digital solutions based on artificial intelligence, machine vision, and the Internet of Things. There is an integration of machine learning algorithms in the steelmaking process to optimize the use of ferroalloys. Algorithms can learn to work with any task, for example – to control the shortcomings of slabs or fix the defect and its type in the cold rolling shop at a speed of more than 20 meters per second.

The information technology industry has the fastest growth in Ukraine (Galuta, 2020). In the last 5 years alone, the level of exports of IT services has increased more than 4 times. In recent years, there have been several breakthroughs that have been used in our world. For example, Looksery - developed by the Odessa team – is a program for mobile devices that allows you to use filters to improve the quality of photos and videos in real-time. In 2015, Snapchat bought startup Looksery for about $ 150 million. Grammarly is a real-time English spell checker. Today 5 million people worldwide use it.

There are also interesting examples of innovative solutions in the field of aircraft construction (Galuta, 2020). These include BAK (unmanned aerial vehicle complex), Gorlytsia, Strategic BAK, Target Complex, as well as various specialized modifications of ANTONOV aircraft. Leading development in medicine is the portable Cardiomo device, which can prevent more than 40 different diseases, especially heart disease.

The first batches of Cardiomo were ordered by the Okhmatdyt Institute of Cardiology. The developers also have about 700 orders from around the world, including medical universities and nursing homes. The inventors estimated that when large-scale production of the device is established, it will be able to save the lives of 16 million people each year (Galuta, 2020).

Conclusions. The use of the latest technologies in the main directions of Ukraine's development allows increasing the quality, quantity, and usefulness of proposals while reducing the harmful impact on the environment for the health of citizens. Thanks to sustainable development, which involves more and more Ukrainian companies and developers, new areas of research and jobs are being offered in Ukraine and around the world.

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RESOURCE COSTS OPTIMIZATION AND ENERGY CONTAINMENT REDUCING IN ROLLING PRODUCTION

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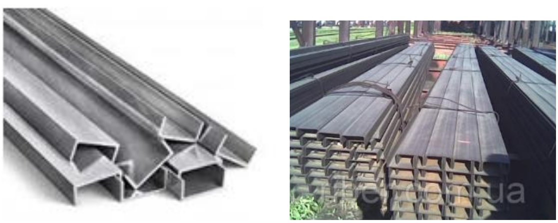
Introduction. Compliance with the Sustainable Development Goals of Ukraine for the period up to 2030 involves ensuring the transition to rational models of consumption and production (UkrSDGs, 2019). A necessary prerequisite for stable national economic growth is the sustainable industrialization of our country and the introduction of innovative technologies into production.

In modern conditions of metallurgy development, the main task for the enterprise becomes the search for internal reserves for the decrease in expenses, the use of energy, resource-saving technological modes. The enterprise's economic activity is the development of such production programs, which much attention would be paid to reducing the specific costs of raw materials and energy resources; maximum use of stocks of raw materials.

In this paper, we consider the enterprise, which produces rolled products of a wide range. Figure 1 shows an example of such products. To justify the enterprise's operation program quantitatively, we use mathematical modeling, system analysis and optimization methods.

Figure 1

Rolled products: a) channel; b) shipment of products



a) b)

Presentation of the main research. The exclusivity of the issue is because a significant part of metal losses at the enterprise falls on the final operations of the technological cycle when the manufactured metal already laid a lot of energy resources. One of the main criteria of the rolling production efficiency is the cost ratio of metal, which equals the ratio of the metal weight used to fulfill some order to one of all the order's products. The closer this ratio is to the unit, the more efficiently the enterprise performed the whole technological operations from steel smelting to shipment of finished products.

The technological process of manufacturing rolled products, regardless of the type of smelting unit, contains several operations, each of which significantly affects the performance of the following (Hnatushenko et al. 2021). Traditionally, we adjust each of them to some technological optimality criterion based on the already known results of previous stages. Mostly we solve the problem of minimizing the cost of metal in rolling production at the cutting finished products and (partially) cutting ingots into blanks. Therefore, we propose a mathematical model of the problem of finding such a plan for forming ingots, which would allow subsequent operations to cut blanks and finished products the minimum of possible scraps, thereby minimizing the cost factor of the metal.

Thus, the technological process of rolling production includes the following operations: 1) steel smelting, 2) casting of ingots in the mold, 3) heating of ingots, 4) rolling of blooms, 5) cutting of blooms with a steam hydraulic knife, 6) rolling of preform billet, 7) cutting of a preform, 8) heating of rod blanks, 9) rolling of profiles of finished products, 10) cutting of profiles of finished products, 11) final processing of finished products. Each of the operations significantly affects the performance of the following. From the above sequence, it is seen that the cutting of the ingot is carried out in two stages. On the first - the whole ingot is divided into redistribution blanks, the length of which can lie in the range from 2.4 m to 3.2 m with a step of 0.05 m. On the second - each redistribution blank is rolled into a finished product (channel, corner, beam, lunch ...) and divided into measuring rods with a length of 12, 11.7, 9 or 6 m according to the order (determined by the customer's logistics requirements).

We formulate the mathematical model under the following assumptions. Firstly, we know the number of blooms of a cross-section, which must use to manufacture products according to plan. Secondly, there is a correspondence between the moulds and blooms, i.e. it is known from which mould we roll the metal into ones of a given cross-section. Thirdly, we cut each redistribution blank into bars of only one size. This division we carry out taking into account the pre-calculated by the brute force method of the optimal length of the workpiece for each type of product, i.e. for each partition rod length. Since some sections of blooms involve the manufacture of not only one finished product type but several, combining blank lengths in different quantities, we can use the maximum length of the resulting bloom (the entire mass of the ingot). We solved several model problems of minimizing the amount of metal used to make orders, the size of which does not exceed the volume of one smelting. The computational results indicate that the proposed mathematical and software introduced into the production process will reduce metal losses to 4-5%, which is almost twice lower than the losses now (Zheldak et al., 2021).

Conclusions. A feature of the proposed approach is the formulation of the problem of the available metal distribution between the moulds cutting of the ingots obtained from them for processing blanks provides a minimum number of scraps at this and subsequent stages of rolling shaped profiles.

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SECTION 3 CLIMATE CHANGE AND ENVIRONMENTAL PROTECTION

"Promoting environmental sustainability can build resilience at all levels of society and realize multiple benefits."

Realizing the Future We Want for All:
Report to the Secretary-General,
New York, June 2012

"27 European Leaders have signed up to the European Commission's proposal for taking climate action to a new level of ambition ...And it is more than cutting emissions. It is about green finance. It is about restoring biodiversity. It is about a new circular economy that creates jobs and prosperity while preserving nature. Many things have to change, so that our planet can remain the same for the next generation... Let us walk this road together!"

Ursula von der Leyen,
President of the European Commission,
Climate Ambition Summit,
Brussels, 12 December 2020

"The ultimate goal of mitigation is to preserve a biosphere which can sustain human civilisation and the complex of ecosystem services which surround and support it. This means reducing anthropogenic GHG emissions towards net zero to limit the warming, with global goals agreed in the Paris Agreement."

Climate Change 2022: Mitigation of Climate Change.
Contribution of Working Group III to the Sixth Assessment
Report of the Intergovernmental Panel on Climate Change, 2022

STRATEGIC ENVIRONMENTAL ASSESSMENT IN SPATIAL PLANNING

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Introduction. As is known, any military conflicts undermine the prosperity, economic and social outcomes achieved as the result of joint efforts of all peace-loving countries. Russia's invasion of Ukraine sent shock waves round the world. Russia's destructive military aggression has sparked a humanitarian crisis for the Ukrainian people, and has jeopardized a global environmental and energy security. It is understandable that two years of bitter fighting on the territory of Ukraine exhausted the country, have shifted policy attention and priorities away from important global programs on climate and nature, pollution and more.

At the time of this writing in early 2024, the end date of the Russia's bloody war remained highly uncertain. Yet, despite these difficult times, the SDGs remain the roadmap for achieving sustainable development for Ukraine by 2030 and beyond. In the aftermath of the Russian withdrawal from Ukrainian areas, we have to restore and promote sustainable use of terrestrial and aquatic ecosystems, sustainably manage forests and land, and halt biodiversity loss. In particular, we are mindful of our commitments under the Convention on Biological Diversity (CBD) and the Paris Climate Agreement. Throughout the recovery planning process, it will be essential to ensure alignment with the European environmental standards at all levels of management. Our task today is to continue to implement, as far as possible, progressive tools for sustainable development, which include strategic environmental assessment (SEA).

This paper reflects upon the origins and current state of the strategic environmental assessment, based on a review of existing literature, international initiatives and practical experience. It provides a brief overview of how SEA has evolved, the role of SEA in planning and decision-making processes, and raises the question about the application of this institution in the context of the tasks of post-war Ukraine.

Presentation of the main research. Currently, the world has developed a whole spectrum of instruments to promote sustainable development. Of these, in Ukraine, in particular, environmental certification of products, environmental management systems, environmental audits, environmental monitoring etc. are adapted and widely used. Among instruments used for planning and managing sustainable development, a one of the leading places can be given to the institution of environmental assessment.

The application of environmental assessment instruments must "provide a solid bases for decision-making at all levels and to contribute to a self-regulating sustainability of integrated environment and development systems" (UN 1993, p. 473). The purpose of environmental assessment is to prevent environmental degradation by providing decision-makers with relevant information about the environmental implications of a proposed activity to allow for a rational decision on whether or not to authorise the development. There has already been general agreement in world practice that the modern institute of environmental assessment includes two fully developed processes: project-level Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA).

It should be noted that the Plan of Implementation of the Sustainable Development Goals adopted at the World Summit on Sustainable Development (WSSD) includes explicit reference to the Institute for Environmental Assessment (see paragraphs 19, 36, 62 and 135 of the WSSD Implementation Plan). Implicit reference to strategic environmental assessment (for example, para 136) aims to further develop methodologies for sustainable decision-making at policy and strategy levels.

Let us remember that only at the end of the seventies did the most progressive states began to transition from policies of mitigating the consequences of environmental damage to the policies of prevention of adverse impacts. The EIA process was applied for the first time on a regular basis in the USA after the US National Environmental Policy Act – NEPA was released in 1969. Based on USA experience, EIA systems were established throughout the world, for instance Canada in 1973, Australia in 1974, West Germany in 1975, France in 1976 and others (Glasson et al., 2005). The Council Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment unified the EIA procedure and made it mandatory for all member states of the European Communities – now European Union.

Later, the Espoo Convention (1991) set forth the requirements for EIA procedure, which reflected the new format of regulating social and economic development, namely:

- Impacts on the natural environment are studied with other elements of the environment – social factors and population health;
- Public participation is an obligatory element of EIA procedure;
- Process of environmental assessment includes adequate informing of the public about the proposed activity and its potential impacts on the environment including human health.

In response to ideas of sustainable development, it was eventually realised that it is necessary to incorporate environmental considerations at a more strategic level, when the major decisions concerning development activities are not yet taken. This procedure was eventually named ‘strategic environmental assessment’ or SEA (Thérivel & Partidário, 1996).

However, it took many years until SEA became a viable tool for environmentally sustainable development planning. On the 21st of July 2001 the European Parliament and the European Council jointly adopted the Directive 2001/42/EC on the assessment of the effects of certain plans and programmes on the environment, providing a unified legal format for SEA procedure in states - EU member. The objectives of the SEA Directive (Art. 1) support the environmental policy of the European Union through strengthening the integration of environmental considerations and sustainable development principles in the preparation and adoption of development strategies.

An important event for Ukraine and other non-EU countries was the adoption of the Protocol on Strategic Environmental Assessment to the Convention on Environmental Impact Assessment in a Transboundary Context. The above Protocol was adopted on 21 May 2003 by the Extraordinary Meeting of the Parties to the Convention of 25 February 1991 on Environmental Impact Assessment in a Transboundary Context held in Kiev, from 21 to 23 May 2003.

On 20 March 2018, the Ukrainian Parliament adopted Law "On Strategic Environmental Assessment", which was based on the Protocol on SEA and the Directive 2001/42/EC[1]. The Law indicated that SEA is part of the work on state spatial planning documents: urban planning documentation, plans or schemes of projects that are subject to an environmental impact assessment (EIA) procedure or that may affect protected areas and objects. SEA applies to all areas, from urban planning and energy to agricultural and water planning. In particular, the Law contains a provision requiring mandatory public consultations on draft urban planning documents at the local level, such as general urban plans, zoning plans, and detailed territory plans, with respect to matters of strategic environmental assessment.

Conceptually, SEO forms strategic frameworks at every level of spatial planning that contribute to improving the sustainability of complex social-ecological systems. The SEA procedure is considered as a tool for integrating environmental concerns into the strategic planning at all levels of public administration.

Figure 1 shows that integration of SEO procedure into spatial planning process contributes to the pursuit of self-regulating sustainability (see also Partidario, 2007-2012; Fischer, 2007). Figure 2.2 displays the basic steps of SEA and how they can be integrated into the strategic decision-making process, while providing necessary information at all relevant stages.

[1]In general, although the SEA Directive served as foundation for the SEA Protocol, there are some major differences between these two documents, including differences in provisions for assessing the environmental impacts and preparing the environmental report (see Palekhov, 2014 for details). In particular, in addition to the provisions of the SEA Directive, the SEA Protocol adds two more aspects that should be taken into account while preparing the environmental report: the interests of the public (Art. 7 para 2c) and the information needs of the decision-making body (Art. 7 para 2d). At the same time, the SEA Protocol does not establish direct links to the protected areas, while the SEA Directive contains explicit provisions requiring that "any existing environmental problems which are relevant to the plan or programme including, in particular, those relating to any areas of a particular environmental importance", are identified, described and evaluated (Annex I of the SEA Directive).

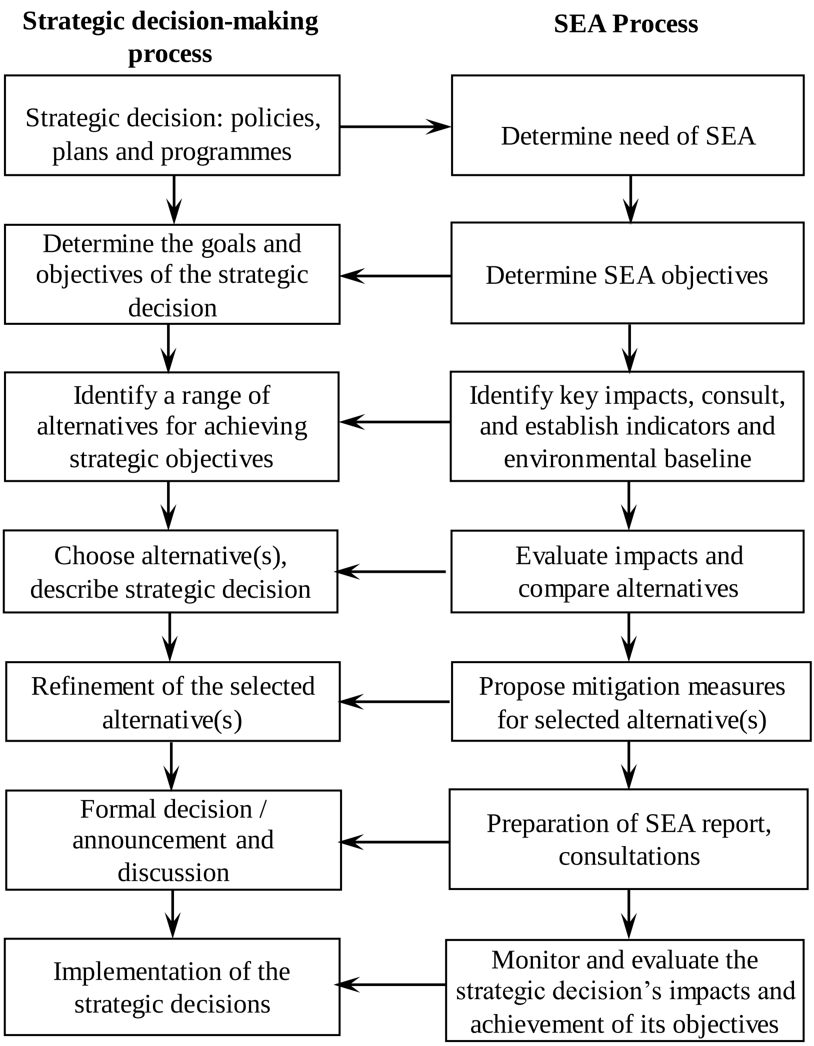
Figure 1

SEO principles in spatial planning (based on Partidario, 2007-2012)

It has been studied that warfare ecology covers all three stages of warfare – preparations, war, and postwar activities. Each stage affects biophysical and socioeconomic systems as coupled systems (Machlis & Hanson, 2008). Russia's military actions have led to large-scale environmental changes over a large territory of Ukraine. Pollution from the war has already affected 70% of surface water and soil, has directly harm wildlife and biodiversity. Studies have confirmed the cascading effects of warfare on ecosystems, biodiversity and social values (Chumachenko et al., 2023).

Figure 2

Integration SEA into the strategic decision-making process (modified from Palekhov, 2014)



Although much is understood about the negative impact of war, historical examples of post-war reconstruction in different countries suggest that underestimating the severity of wartime damages to ecosystems and natural resources reduces the effectiveness of recovery plans and programs. An integrated approach in restoring the environment after military-technogenic activities remains an important challenge for Ukraine. The concept of SEA provides the key to reconceptualise planning for post-war reconstruction.

However, despite the awareness of the importance of environmental aspects for decision-making in public development management, integration of SEA into the territorial restoration planning process is still very weak, more often it remains as a tool to argue for the usefulness of some approach. As a result, the policy decision model may be consistent with government guidelines, but at the same time it may focus only on resource supply and rely on subjective expert assessments without a clear consumption threshold.

In this regard, in May 2023, amendments to the Law on SEA came into force. The main changes include: 1) creation and administration of the Unified Register of Strategic Environmental Assessment; 2) liability for offenses in the field of SEA. The amendments aim to make the post-war reconstruction process in Ukraine more environmentally sustainable, socially responsible and transparent to the public.

Conclusions. The mission of SEA in spatial planning for post-war reconstruction is to provide systematic, on-going process for evaluating, at the earliest appropriate stages of decision-making, relating to the reconstruction and sequential development of territories (districts, cities, regions, countries, etc.), ensuring full integration of relevant biophysical, economic, social and political considerations to promote the concept of sustainable development.

Through application of a range of suitable, situation specific methods and techniques, SEA is supposed to add environmental sustainability to policies, plans and programmes, relating to territorial development. SEA obligates the responsible authority (i.e. the proponent or initiator of the strategic action, legislative body or executive power) to systematically adjust the targets of strategic decisions, their contents and implementation methods to the objectives of environmental policy and environmental targets, including health aspects, and restoring opportunities for future generations.

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IMPACT OF ROAD TRANSPORT NOISE POLLUTION ON THE ENVIRONMENT OF URBANISED AREAS

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Introduction. It is known that road transport is a source of significant negative impact on the environment and human health. It is believed that the main damage to the environment from motor transport occurs as a result of exhaust gas emissions. Thus, according to the state report on the state and protection of the environment, road transport is in first place in terms of pollutant emissions in the country. Its share increases every year (Freitas et al., 2018).

However, such an environmental aspect of motor transport as noise is not given due attention and its impact on the human body has not been fully studied. Meanwhile, the largest area of noise pollution on the territory of cities (up to 80%) is caused by the impact of motor transport flows.

Noise is sound vibrations in the audible frequency range that can have a harmful effect on human safety and health. According to the World Health Organisation, noise is the second most significant environmental problem for human health after atmospheric air quality. When a person is exposed to noise levels of 40 dB or higher on average over the course of a year, adverse health effects such as sleep disturbance and wakefulness can occur. At long-term average exposure to noise levels above 55 dB, blood pressure rises, the central nervous system is depressed, respiration and pulse rate change, metabolism is disturbed, cardiovascular diseases, stomach ulcers, hypertensive diseases, mental disorders occur (Kou et al., 2021). The danger of noise exposure is aggravated by the property of the human body to accumulate acoustic irritations.

According to studies, noise from motor vehicle traffic poses the greatest risk to human health, as motor vehicle traffic is a source of constant linear noise in the immediate vicinity of residential areas. It was found that residential populations responded more acutely to lower levels of traffic noise compared to those on pavements and near-maintained areas. Significant shifts were found at noise levels of 40-50 dBA on the part of the hearing organ, central nervous system, visual analyser. It is noted that the share of night time, when people are most sensitive to noise, with increasing noise levels is growing especially intensively. In the European Union social losses of the negative impact of noise from motor transport on the human body are estimated at €40 billion (Freitas et al., 2018).

Also in places with high noise levels there is a high concentration of pollutants in the surface layers of atmospheric air. For example, a direct correlation between the values of the equivalent noise level from motor transport flows and concentrations of fine particles in the atmospheric air has been found.

Presentation of the main research. The Shevchenkovsky district of Poltava (Ukraine) was chosen for the study. The district occupies the south-western part of the city, on the right bank of the Vorskla River. This area is characterized by dense buildings, increased intensity of the traffic flow, active movement of municipal transport and the presence of stops for disembarking passengers. The district is the most densely populated area of the city, where, according to official statistics, 139 thousand people live. In order to measure the noise characteristics of the traffic flow, as well as to assess the impact of traffic flow parameters on noise levels, it is necessary to carry out field surveys of problematic sections of the street network, as they are the most effective method of analysing the situation on the roads.

Field surveys consist of recording specific conditions and indicators of traffic actually occurring during a given period of time. This group of methods is currently the most widespread and is characterised by great diversity. In-situ surveys are the only way to obtain reliable information on the condition of roads and allow for an accurate characterisation of existing traffic and pedestrian flows and also in places with high noise levels there is a high concentration of pollutants in the surface layers of atmospheric air.

Places for measurements were chosen on straight horizontal sections of a street or highway with a steady speed of vehicles. In addition to determining the noise level, the intensity of the traffic flow was determined, i.e. the number of vehicles moving during a set time interval. Time interval selected 15 min. The noise levels from traffic flows were measured in accordance with GOST 20444–2014, using the Testo 815 sound level meter, the technical data of which are as follows: measurement range – 32…130 dB; error – ±1 dB; working temperature – 0…+40 °C.

The sound level meter was pre-calibrated. Each measurement lasted 15 minutes. The microphone was directed towards the traffic flow and located at a height of 1.5 m ± 0.1 m from the level of the roadway coverage. The intervals between readings of sound levels were 5–7 s. The countdown is made during the entire measurement period, both in the presence of vehicles on the site, and in their absence. The survey results showed that the measured sound level significantly exceeds the maximum permissible sound level (55 dBA) for all measured values of flow intensity and distance from the road (see Table 1).

Table 1

Results of measurements of noise characteristics at different intensity of motor traffic flow

Hourly traffic intensity by vehicleson types on road section, pcs/15min					Equiv. sound level, dBA	Measurement conditions
Total	including					
	cars	trucks	Bus	Minibuses		
75	69	3	1	2	73,00	t_{air} = -1 0C V_{wind} = 1 m/s Duration of measurements = 2 min Flow velocity = 60 km/h Distance from road = 7,5 m
80	85	1	1	3	75,00	
93	87	2	2	2	77,50	
98	92	1	2	3	77,70	
116	106	1	1	8	78,40	
126	112	0	1	13	78,70	
131	116	3	3	8	78,80	
135	122	7	2	4	79,20	
138	129	3	2	4	79,40	
151	138	0	2	11	79,70	
151	140	1	4	6	79,70	
156	142	2	1	11	79,80	
164	157	1	1	6	79,90	
173	162	3	4	4	80,00	
181	170	3	5	3	80,10	
189	185	1	1	2	80,20	
200	190	3	2	5	80,30	

As a result of the correlation analysis it was concluded that under the current traffic flow parameters (high traffic intensity with a significant predominance of passenger cars in the traffic flow structure) the equivalent sound level is influenced by the total number of cars, while the influence of individual groups of cars (trucks, buses and minibuses and other types) is insignificant (Table 3).

Table 2

Results of noise measurements at different distances from the road

<table>
<tr><th>Distance from the road</th><th>Equivalent sound level dBA</th><th>Maximum sound level dBA</th><th>Minimum sound level dBA</th><th>Measurement conditions</th></tr>
<tr><td>0</td><td>79,9</td><td>83,1</td><td>78,4</td><td rowspan="8">t air = -1 0C
V wind = 1 m/s
Duration of measurements = 2 min
Flow velocity = 60 km/h</td></tr>
<tr><td>2</td><td>78,5</td><td>78,8</td><td>73,1</td></tr>
<tr><td>5</td><td>77,2</td><td>78,3</td><td>73,0</td></tr>
<tr><td>8</td><td>74,2</td><td>74,4</td><td>71,7</td></tr>
<tr><td>10</td><td>72,0</td><td>74,2</td><td>71,6</td></tr>
<tr><td>15</td><td>68,8</td><td>70,6</td><td>68,3</td></tr>
<tr><td>20</td><td>67,8</td><td>68,2</td><td>67,5</td></tr>
<tr><td>25</td><td>66,1</td><td>66,6</td><td>65,3</td></tr>
</table>

Table 3

Dependence of the equivalent sound level on the amount and composition of traffic flow

Factors	Dependence of equivalent sound level on factors (correlation coefficient value)
Amount of vehicles	0,869
Amount of passenger cars	0,834
Amount of trucks	0,023
Amount of buses	0,375
Amount of minibuses	0,317

The following main methods can be used to protect against noise (Ivanisova et al., 2021): 1) technical – eliminating the causes of noise generation or attenuating it at its source; 2) planning – reducing noise levels along its path of propagation; 3) organisational or administrative. The most radical and costly are technical measures that target noise sources. However, the effectiveness of measures to reduce the noise of vehicles in operation is rather low. Reduction or elimination of noise at the source should be achieved, first of all, in the design process.

Noise reduction in the city should be facilitated by the development of low-noise means of transport, such as electric cars, cars with hybrid engines, highly efficient silencers and afterburners. However, the automotive industry cannot be restructured in a short time to produce new modes of transport. Low-noise cars or electric vehicles will not be able to replace the entire fleet of modern cars. Therefore, the first and foremost means of combating urban traffic noise should be architectural, planning, construction and organisational. Reduction of noise levels penetrating into the premises from external sources should be ensured by rational room layout, compliance with measures for sound insulation of enclosing structures (walls, ceiling and floor), sanitary-technical and engineering equipment of buildings. Protection of the residential area from transport noise should be provided by rational urban planning means. In this case, the means of protection from urban noise are distance, application of artificial shielding means and plants.

In order to reduce the negative noise impact from traffic, acoustic screens are used along with other noise protection structures and technical and organisational measures. Noise shields reduce traffic noise through absorption, wavelength change, reflection, or diffraction. Noise shields are installed along roads, usually in the form of a wall, embankment or a combination of both. The type of screen is selected based on accessibility of the area, type of material, cost, aesthetics, and public convenience. Buildings and structures with reduced requirements to noise regime (consumer services, trade, catering, communal, public, cultural and educational, administrative and economic institutions) can also be used as screens.

In this case, they should be placed along the noise sources in the form of frontal, if possible continuous, development. Plants are also good sound absorbers. Even coniferous plants can reduce the level of noise emitted by cars by 6-9 dB. Positive results in the fight against noise can be achieved by using special planting methods - in several rows. The best results are demonstrated by a combination of trees and shrubs. However, according to studies, plants are ineffective in combating low frequency noise.

Therefore, to protect against noise from lorries and large buses, given the prevalence of low-frequency engine noise, it is necessary to use other measures (Banerjee, 2008). Organisational and administrative measures are aimed at preventing or regulating the operation of certain noise sources over time. These include redistribution of traffic flows along city thoroughfares; restriction of traffic at different times of the day in certain directions; changes in the composition of vehicles (e.g., banning the use of lorries and buses with diesel engines on some city streets), etc.

Conclusions Noise pollution has unique properties, namely: its level can change in short time intervals and does not accumulate in the body. However, persistent noise has a significant impact on health. Among the factors that also contribute to an increased noise load in the study areas are the movement of passenger and light freight vehicles, the lack of free traffic combined with a large number of intersections, stops and illegal parking along the roads, as well as the lack of acoustic protection, including roadside landscaping. . Ensuring landscaping of roadside areas in residential areas of the city adjacent to highways is necessary, because due to dense development along the roads a large number of residential buildings, public premises, office buildings are concentrated.

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DEVELOPMENT OF THE ENVIRONMENTAL MONITORING SYSTEM AS A BASIS FOR ENSURING SUSTAINABLE DEVELOPMENT OF LOCAL COMMUNITIES

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Introduction. Sustainable development is development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs. In Ukraine, from January 1, 2020, the Basic Principles (Strategy) of the State Environmental Policy of Ukraine for the period up to 2030 (hereinafter - the Eco-Strategy-2030) were introduced. The document explains the root causes of environmental problems and declares "the introduction of an ecosystem approach to sectoral policies and the improvement of the system of integrated environmental management." There are 5 goals: 1) the formation of environmental values and principles of sustainable consumption and production in society; 2) ensuring the sustainable development of Ukraine's natural resource potential; 3) ensuring the integration of environmental policy in the decision-making process for socio-economic development of Ukraine; 4) reduction of environmental risks in order to minimize their impact on ecosystems, socio-economic development and public health; 5) improvement and development of the state system of environmental management (Law of Ukraine 2697-VIII, 2019).

All the goals of the 2030 Eco-Strategy correspond to the global and national Sustainable Development Goals and are aimed at: balanced use of natural resources, mandatory presence of environmental requirements in all spheres of life, reduction of environmental risks and proper environmental governance.

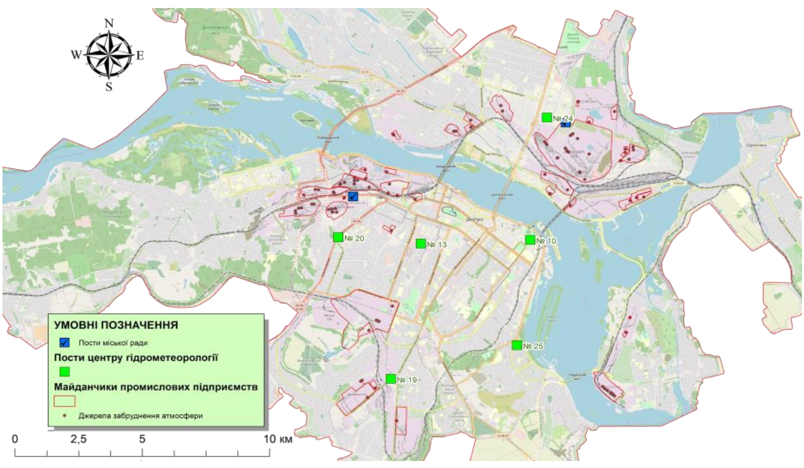
Presentation of the main research. According to the environmental passport of Dnipropetrovsk region, emissions of harmful substances into the atmosphere amounted to 534.7 thousand, which is 42.2 thousand tons (7.3%) less than last year. As part of the emitted pollutants, carbon oxides amount to 274,719 thousand tons; dioxides and other sulfur compounds - 60,857 thousand tons; substances in the form of suspended solid particles - 52.22 thousand tons; methane - 115,967 thousand tons; nitrogen compounds - 28,298 thousand tons; metals and their compounds - 0.619 thousand tons, etc. In addition, during the reporting period, the atmosphere received 20.5 million tons of carbon dioxide - the main greenhouse gas that affects climate change (EcopassDnipro, 2021).

The city of Dnipro is characterized by a high level of air pollution. More than 200 enterprises of various profiles are registered in the city of Dnipro, which emit more than 100 types of pollutants into the environment. In recent years, there has also been a significant increase in motor transport, which accounts for about 40% of total emissions of toxic substances into the atmosphere.

Observations of air quality in Dnipro are carried out at 6 stationary posts by the Dnipropetrovsk Regional Center for Hydrometeorology, which remained from 26 posts from the observation system, launched about 30 years ago (see Figure 1).

Figure 1

Scheme of atmospheric air quality monitoring posts in Dnipro (EcopassDnipro, 2021)



In connection with the European integration processes of Ukraine in recent years there have been significant changes in its environmental legislation. Today in the field of air monitoring the following legal documents are in force: Law "On Atmospheric Air", Law "On Metrology and Metrological Activities", PKMU №391 "On Approval of Regulations on the State Environmental Monitoring System", as well as PKMU of August 14 2019 №827 "Some issues of state monitoring in the field of air protection", repealing the PKMU of March 9, 1999 № 343 "On approval of the Procedure for organizing and conducting monitoring in the field of air protection", the main document used for over 20 years to organize a monitoring system, which in fact still operates a network of city observation posts of the hydrometeorological center.

However, it is difficult to correctly interpret the data of the Hydrometeorological Center on air quality due to the lack of a system of continuous registration of pollutants, and their incomplete list in accordance with current standards.

Conclusions. Thus, among the main reasons for the inefficient functioning of the state environmental monitoring system as a basis for sustainable development of local communities can be identified imperfect regulatory framework, low level of coordination of environmental monitoring entities, extremely insufficient funding. The solution to these issues may be cooperation with industrial enterprises and agencies responsible for collecting thematic source information necessary for the implementation of the program of state monitoring of ambient air with the assistance of local governments.

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PROBLEMS OF ANTHROPOGENIC IMPACTS ON THE ENVIRONMENT AT THE INDUSTRIAL REGIONS

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Introduction. According to the UN concept, one of the main conditions for sustainable development is precisely the greening of any production. The European Parliament adopted a resolution on the climate and environmental emergency on 28 November 2019. This document is a key strategic priority of the European Union's policy, which means that it should be considered as one of the most important challenges in the process of European integration of Ukraine (Andrienko et al., 2017).

The Concept for Implementation of the State policy on Climate change up to 2030 approved by the order of the Cabinet of Ministers of Ukraine dated 7 December 2016 No 932-р, primarily provides for the prevention of the process of climate change due to the reduction of anthropogenic emissions and the transition to low-carbon development of the state. The Government's 2020 Priority Action Plan includes included the key stages for the implementation of the reforms to meeting the European good governance standards on a reasonable and transparent hierarchy and accountability system on these issues.

Presentation of the main research. In 2020, the "anti-rating" of the most polluted Ukrainian regions was performed. Dnipropetrovsk oblast was at the top of it and other areas also showed serious environmental challenges. Industrial enterprises of mining and metallurgical, fuel and energy, chemical complexes and transport are the main sources of air pollution. Consider the impact of the main areas of activity on the environmental situation at the Dnipropetrovsk region.

1. The impact of industrial activities on the environment.

The territory of the Dnipropetrovsk region has about 500 industrial enterprises. Manganese, iron ore, uranium, kaolin, coal, granite and so on, these are the minerals that the land of Dnipropetrovsk is rich in. Coal mining leads to the formation of dumps, large waste mounds. Burning coal to generate electricity leads to significant air pollution in the region. Toxic waste from heavy industry pollutes land and water resources. The largest dump pits are concentrated in Kamianske city and Kryvyi Rih city, which cause air pollution and natural disasters. According to the results of radiometric observations in the region over the past five years, no increase in radionuclides in the atmosphere has been detected.

In the Dnipropetrovsk region, there is a comprehensive program for 2016-2025 to prevent climate change, in which 25 industrial enterprises have the greatest impact on the environment of the region take part. Providing comfortable and environmentally friendly conditions for the life of both the population in general and production is the main strategic objective of the program. But, due to the changes of legal relations between the state and industrial business, and the strengthening of legislation on environmental protection, industrial enterprises today have higher obligations to its impact on the environment, than those of the past.

2. Pollutant emissions in the Dnipropetrovsk.

Residents of the Dnipropetrovsk region live in an environment where urban smog, particle and toxic pollutants cause serious health problems. Figure 1 illustrates the dynamics of pollutant emissions during 2012 – 2019.

Figure 1 shows that emissions of pollutants gradually decreased during recent years. The emissions decreased by 385.022 thousand tons or 40% in 2019 compared to 2012, which is associated with the modernization of the production sector of the region. Figure 2 graphically depicts the volume of air pollutants in the cities of the Dnipropetrovsk region in 2019.

The Figure 2 indicate that more pollutant emissions in Dnipropetrovsk region were recorded in Kryvyi Rih (268328.3 tons) and Kamianske (83,335.8 tons).

3. Renewable energy policy.

In the Dnipropetrovsk region, the energy industry takes an important role, especially when it comes to green energy, as the region is the leader in terms of the number of solar power plants installed by households. It should be noted that Dnipropetrovsk prefers solar energy and is among the top three in the number of solar installations; the region put an enormous amount of capacity – 389 MW.

Figure 1

Dynamics of pollutant emissions into the atmosphere from stationary sources of pollution in Dnipropetrovsk region, thousand tons (compiled from EcopassDnipro, 2020)

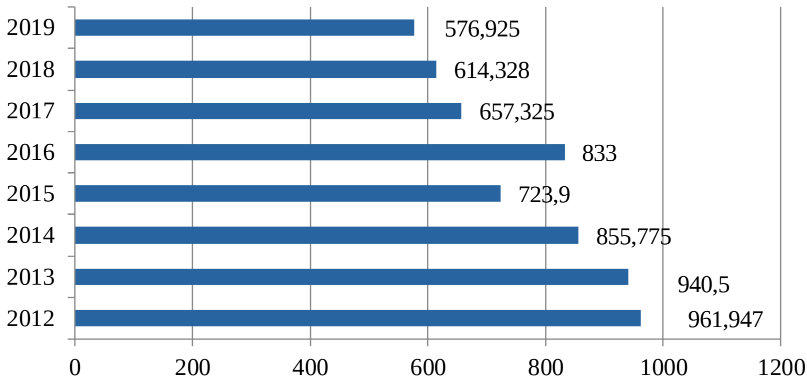
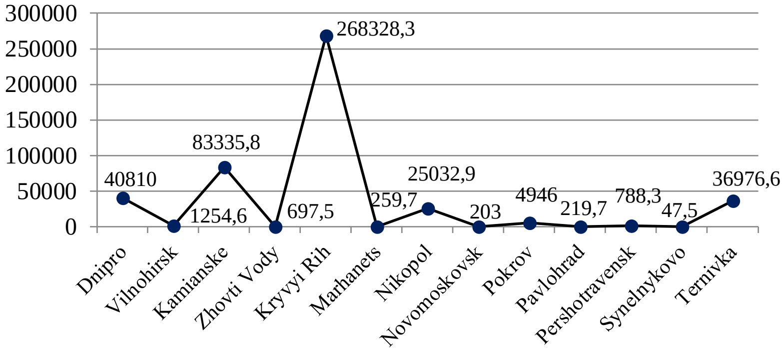


Figure 2

Pollutant emissions in the cities of Dnipropetrovsk region, tons, 2019 (compiled from EcopassDnipro, 2020)



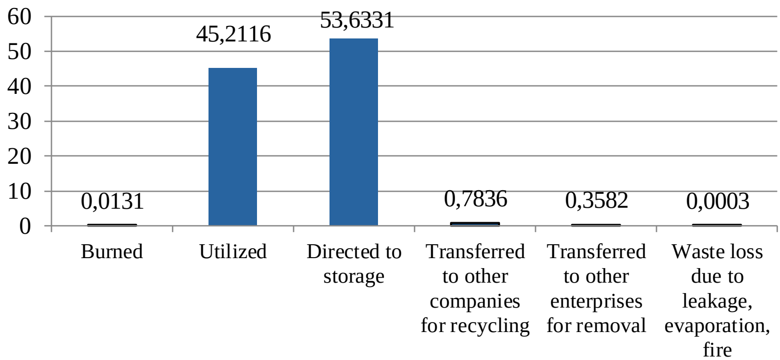
However, irrational use of energy resources leads to an increase in their losses and environmental pollution. In 2020-2021, during the COVID-19 pandemic, the demand for electricity from the population increased and far exceeded the decline in commercial and industrial enterprises, since these structures did not work at full capacity, and some were forced to stop their activities altogether.

4. Waste problem.

The issue of accumulation and disposal of industrial waste is of national importance, since most of the waste contains harmful substances for the environment. The solution to the problem of waste disposal is directly related to cleaning the environment from toxic substances and ballast and obtaining useful products and, as a result, an economic effect (Patnaik, 2018). In Figure 3, we will consider the main indicators of waste management in 2019 in the Dnipropetrovsk region. Figure 3 demonstrates that the largest part of waste is directed to storage (more 54%) and utilized (45%).

Figure 3

Key indicators of waste management, thousand tons, 2019 (compiled from EcopassDnipro, 2020)



5. The impact of the transport network on the on the environment.

Transport systems affect the environment, from noise and pollutant emissions to climate change. The cities of the Dnipropetrovsk region, such as: Kamianske, Kryvyi Rih, Pavlohrad, Synelnikovo and directly the city of Dnipro, are strategically important points in the transport and logistics chain of the infrastructure of Ukraine.

Transport and environmental issues are paradoxical, as transport provides significant socio-economic benefits, but at the same time, transport affects ecological systems. On the one hand, transport activities support the growing demands on the mobility of passengers and goods, and on the other hand, transport activities are associated with an environmental impact.

The complexity of the consequences has led to many controversies over environmental policy, the role of transport and mitigation strategies. This is compounded by the fact that the priorities between environmental and economic considerations change over time, which can influence public policy (Patnaik, 2018).

Conclusions. The United Nations, declaring in its policy documents the principle of the "green" economy as "economically profitable that which is environmentally safe" and summarizes: for the transition to a "green" economy, the world community needs to invest about 2% of world GDP in 10 key sectors by 2050: agriculture, forestry, housing and utilities, energy, industry, tourism, infrastructure, water resources management, waste disposal and recycling, especially at the regional level. The essence of "green regional policy" is to find the most economical solutions to reduce the impact of production growth on the use of resources, ensuring a more efficient resources use for the environment.

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JUSTIFICATION OF MEASURES TO REDUCE DUST EMISSIONS FROM OVERLOADING ROCK ON GRANITE QUARRY

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Introduction. Among the large number of environment pollutants the primary place has mining enterprises with an open pit mine development. On a typical quarry, basic technological processes are drilling and explosive operations, excavation, and transportation, warehousing and dumping (Buchavyi, 2013). All these processes have a negative impact on the environment components, mainly due to air pollution, since there are dangerous substances fall into soils and reservoirs with subsequent migration through trophic chains (Zberovskij, 1997).

In this regard, there is a need to substantiate both technologically simple and environmentally advisable measures to reduce dust and gas emissions from the main technological processes.

Presentation of the main research. Recently the special attention is given to reducing the environmental danger from drilling and explosive operations, in particular due to a decrease in the volumes of destroyed blocks with a simultaneous increase in the number of local explosions, the use of environmentally friendly explosives (Holodenko et al., 2013) and active suppressing agents of the dust-gas cloud (Kolesnyk et al., 2014). However, there is not enough attention to lowering the dust emissions when overloading a rock on granite quarries with conveyor equipment and crushing-sorting equipment of surface complexes.

As a result of the literary analysis and patent search, it was determined that to reduce the emissions of rock mass during its transportation and overloading with the help of the conveyor, it is most appropriate to use irrigation systems.

However, the main problem in irrigation systems operations is clogging of nozzles, and as a consequence of the suspension of water supply. Thus, for cleaning it is necessary to stop the system, and to disassemble the sprayer, clean and then put back.

For irrigation of the breed during transport, we propose to use a nozzle diagram with a speed Varispray cleaning system, which differs from analogues that the design of new sprayers allows you to exclude a simple one. The peculiarity is that the nozzle itself is made by moving and when clogging the drain channel, it is enough to turn the hole in the opposite side of motion of water. The general view of Varispray nozzles are shown in Figure below.

Figure 1

Varispray irrigation nozzles using for rock transporting by conveyors (compiled from specialisedroadingequipment.com, 2021)

Conclusion. The entire cleaning procedure takes a few seconds, and does not require the workflow stop. Sprayers are made of high-strength plastic that completely excludes corrosion. Simple threaded fastening with external thread 3/4".

Advantages of Varyspray irrigation nozzles using:

- Rotary valve for regulating water consumption and rapid cleaning of nozzles.
- Rigid fan-like sprayers, which provides uniform irrigation with water.
- Small dimensions (important advantage when installing on the lower sieve deck).

It should be noted that it is expedient to use water for irrigation, pumped out of the lower careers. Thus, a means of dust-ignition with irrigation nozzles are very convenient for reducing dust emissions when overloading a mountain mass.

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SECTION 4 ENERGY MANAGEMENT SYSTEMS

"We know we'll run out of dead dinosaurs to mine for fuel and have to use sustainable energy eventually, so why not go renewable now and avoid increasing risk of climate catastrophe? Betting that science is wrong and oil companies are right is the dumbest experiment in history by far".

Elon Musk,
Founder, Tesla

"We believe that the green energy industry has the potential to lift historically disenfranchised communities out of poverty, across the country, at massive historical scale".

Donnel Baird,
Founder, BlocPower

"We are at a critical juncture in human history. The decisions we make and actions we take today will have momentous consequences for future generations... Let us seize the moment to make this a decade of action, transformation and restoration to achieve the SDGs and make good on the Paris Climate Agreement."

Liu Zhenmin,
Under-Secretary-General for Economic and Social Affairs.
The Sustainable Development Goals Report, 2021

IDENTIFYING CORE OPPORTUNITIES AND CHALLENGES FOR GREEN TRANSFORMATION OF THE UKRAINIAN ENERGY MARKET

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Introduction. The article provides an overview and analysis of renewable energy promotion measures in the current Ukrainian energy market, including an examination of the impact of liberalisation programmes and other measures supporting green energy policy in Ukraine. To this end, we first analyse the adoption of relevant renewable energy legislation in Ukraine and then examine specific challenges in key areas of renewable energy.

Presentation of the main research. There are four global challenges that drive the need for renewable energy technology development in Ukraine: the new EU strategy on adaptation to climate change on 24 February 2021, the EU strategy for sustainable economic growth, objectives of SDG 12 to the consumption and production patterns, and the concept of the Circular Economy that is being promoted in the EU and globally.

As is known, climate change poses an immediate threat to the well-being and security of citizens for any country, including leading to an increase in natural disasters, food security, water shortage, etc. The main actions to resist and adapt to climate change are in one way or another related to the transformation of the energy sector and the acceleration of the transition to renewable energy sources.

The new strategy sets out how the European Union can adapt to the unavoidable impacts of climate change and become climate resilient by 2050. The strategy covers four main areas: making adaptation smarter, faster and systemic, and boosting international co-operation on climate change adaptation (EU Climate Strategy, 2021). Each of them also includes tasks to accelerate the greening of energy production and use processes.

Thus, the implementing regulation on the Governance of the Energy Union and Climate Action supports the implementation of the

National Energy and Climate Plans, as well as for areas crossing several borders with common climate risks. In particular, the Commission explore options to better integrate climate resilience considerations into the construction and renovation of buildings (for example, through strengthening the Green Public Procurement criteria for public buildings, introductions to the Digital Building Logbook, etc.). Corresponding changes to EU legislation are expected as a part of the process to revise the Energy Performance of Buildings Directive and the Construction Products Regulation. The Strategy states that the Commission will consider raising the energy efficiency requirements and energy mix, and will look at how to raise the requirements for energy-design and energy labelling, including for housing and buildings, and energy savings in agriculture and industrial plants.

In Ukraine, climate problems are regulated within environmental law of Ukraine as a part of legal protection of ambient air and the ozone layer. In the legal literature airspace, wind energy, solar radiation, radio frequency resource, etc. are defined as natural resources of a special kind – "intangible natural resources" (Malysheva, 2015). However, legal regulations for their use in Ukraine are mainly only in the process of their formation.

The legal literature emphasizes that climate state policy of Ukraine is conditionally divided into two areas: mitigating climate change (e.g., by reducing greenhouse gas emissions) and adapting to climate change impacts (Kopytsi, 2021). The fundamental strategic documents are the Strategy of the State Environmental Policy of Ukraine for the period up to 2030 (Environmental Strategy 2030) and the Concept on State Climate Policy Implementation until 2030 (State Climate Policy 2030).

The Environmental Strategy 2030 states that in order to strengthen response to the effects of climate change and to achieve the goals of sustainable low-carbon development in all sectors of the economy, Ukraine must ensure the implementation of international instruments on climate change and atmosphere quality.

The State Climate Policy 2030 is the first national strategic document aimed at improving State policy on climate change in order to achieve sustainable development and a gradual transition to low-carbon development.

Energy Strategy of Ukraine up to 2035 (ESU 2035) outlines strategic guidelines for the development of Ukraine's fuel and energy complex for the period up to 2035. It envisages the completion of energy sector reform by 2025 to allow its integration with the energy sector of EU. However, ESU has been criticized for its inconsistency and inability to meet the challenges of the present. Analysts, in particular, note that the ESU does not form the State's model of flexible support for renewable energy sources in Ukraine. Namely, the State buys all 'green' electricity, the price of coal and nuclear generation is distorted, and there is no competition on the energy market, etc. (Kopytsi, 2021).

It is important to emphasize that the design of implementation measures is crucial for achieving environmental and climate policy goals. The implementation of policy targets may in fact be 'consistent and synergetic' only if economic growth in absolute terms is decoupled from resource and energy consumption, and if the consumed energy will increasingly come from renewable sources (Teebken et al., 2022).

Renewable energy offers a range of benefits for comprehensive solutions to problems in the field of climate, ecology and energy shortages in the context of the 2030 Agenda for Sustainable Development (Vona & Nicolli, 2014).

Figure 1 below shows the main steps that the Ukrainian government has taken to converge with the EU renewable energy policy. A revision of the Ukrainian legislation on renewable energy implies, inter alia, the implementation of the RES Directive 2009/28/EC according to the provisions of the Decision D/2012/04/MC-EnC of the Ministerial Council of the Energy Community on the implementation of Directive 2009/28/EC and amending Article 20 of the Energy Community Treaty. Ukraine submitted its four Progress Reports on the implementation of the Renewable Energy Directive to the Secretariat.

Decentralized wind, hydropower, biogas and biomass, and solar electricity energy systems are the main renewable energy technologies promoted for energy supply within national programs.

It should be reminded that the Ukrainian government has committed to increase renewables to 25 per cent of the energy mix by 2035. However, the implementation of the commitments was far behind schedule.

Figure 1

The adoption of relevant legislation on renewable energy in Ukraine

December 2020 Ukraine submitted its Forth Progress Report on promotion and use of energy from renewable sources under Article 22 of the Renewable Energy Directive

July 2020 The Law of Ukraine No. 810 was passed ensuring the improving the terms of support for production of electricity from renewable energy sources

January 2019 Ukraine submitted the third progress report on the promotion of renewable energy 2016-2017, outlining the progress and the challenges of renewable energy development during the reporting period

August 2018 Ukraine began to consider the revision of the existing support schemes based on feed-in tariffs and introducing auctions to grant support. Amendments to the Electricity Market Law and Alternative Sources Law are registered in the Ukrainian Parliament for public consultation

May 2018 The amendments to the Law on Alternative Fuels, covering the main biofuels principles of (Articles 17 to 21) Directive 2009/28/EC were submitted to the Parliament. Their adoption is still pending

In 2018, Ukraine reached only 7.1 per cent hare of energy from renewables, still below the trajectory of 9.1 per cent (Law of Ukraine, 2020). Given this weak growth and the sluggish Renewable Energy market, the Ukrainian Government has been taking a number of steps. Guaranteed access and gradual balance responsibility for large renewables producers in compliance with the acquis was introduced in the new Electricity Market Law No 2019-VIII, 2017. On 21 July 2020, the President of Ukraine has signed the long-awaited law of Ukraine No. 810 “On Amendments to Certain Laws of Ukraine related to Improvements of the Terms of Support for Production of Electricity from Renewable Energy Sources” (Law of Ukraine, 2020).

This Law is based on the Memorandum of Understanding for the Resolution of Problematic Issues in the Renewable Energy Industry of Ukraine signed between state authorities of Ukraine from the one side and European-Ukrainian Energy Agency, Ukrainian Wind Energy Association from the other side on 10 June 2020. In April 2020, the draft Law on amendments to legislative acts on the mandatory use of liquid biofuels (bio-components) in transport was registered in the Parliament – at the end of 2020, the share of renewable energy sources in transport is only 2.4 percent.

In order to stimulate the solar and wind industries, a feed-in tariffs (FiTs) have been established since 2009. Offtake of electricity under the FiT regime became an obligation for the state-owned Guaranteed Buyer, which subsequently began to suffer from liquidity problems. In the course of 2020 to 2021, the sources of funds to repay the indebtedness of the Guaranteed Buyer to RES producers were as follows: 1) State budget funds covering at least 20 per cent of the forecasted revenues of RES producers in the relevant year; 2) 35 per cent of funds received by the TSO from cross-border capacity allocation as of 1 July 2020; 3) Proceeds from placement of five-year term domestic state bonds. Nevertheless, the problem remained unsolved and had serious consequences for the prospects for a renewable energy market. According to the 2020 Report, in general, the implementation of the renewable energy program in Ukraine was moderately advanced (its implementation was assessed at only 52 percent).

In this regard, the Ukrainian Cabinet of Ministers has approved new Energy Strategy of Ukraine until 2050 (ESU 2050). Energy Strategy 2050 focuses on the development of nuclear and renewable power generation capacity and on the modernisation and automatisation of transmission and distribution systems, in order to achieve carbon neutrality in the energy sector.

Analysis of official reports showed that there are still several principal challenges related to adequately development of the renewable energy market (see Table 1).

This includes strengthening government control, incentives and lobbying to support energy efficiency and sustainable development RES, in particular:

Table 1

Specific challenges in renewable energy markets (compiled from Dreshpak &Paliekhova, 2021)

Solar energy market	High cost of panels (lack of government loans); Selection of the optimal location (large network losses); Land acquisition
Wind energy market	High cost of turbines (long payback time); The need for environ mental impact assessments; Land acquisition (the most prospective Azov and Crimean coasts are located in the conflict zone)
Hydro energy market	The need to restore abandoned stations; Land acquisition for hydraulic structures (dams); The need for environmental impact assessments
Biomass energy market	Insufficient number of agricultural bioenergy projects; biomass (in the form of wood pallets) is used for utilities, which contributes to the unfair consumption of forest resources

- solving the problem of balancing electricity in energy systems when using renewable energy sources;
- development of mechanisms to support the market for equipment and services for the RES industries;
- formation of comprehensive plans and programs for the development of territories, taking into account the placement of RES facilities; and strengthening state control over the targeted use of land;
- stimulating the process of energy management certification, especially in major polluting industries.

Conclusions. Research shows that a political-economic model of environmental policy, where both the power of government support and lobbying, and market competition are important is the most effective for Ukraine. The diffusion and adaptation of renewable energy technologies, and removing the obstacles to the entry of new actors in the renewable energy market plays a role that is at least as important as that played by other measures to curb climate change and prevent pollution.

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ENSURING SUSTAINABILITY OF ELECTRIC POWER SYSTEM WITH RENEWABLE ENERGY SOURCES

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Introduction. The statistical service of the European Union (Eurostat) estimates that Ukraine is potentially capable of producing at least 74% of the country's energy from renewable sources, while now this level is about 10% (as of October 2021). Renewable energy over the next 10 years will occupy up to 30% of the country's electricity generation market. However, due to volatile nature of electricity generation, it is necessary to provide for electric power regulators.

Presentation of the main research. In the second quarter of 2019, renewable energy facilities with a total capacity of 656 MW were put into operation in Ukraine. This is 6 times higher compared to the same period of the previous year (109.6 MW was introduced in the second quarter of 2018). Thus, at the end of the second quarter of 2019, the capacity of the Renewable energy sector (RES) in Ukraine reached above 3,600 MW. In general, in the first half of 2019, RES facilities with a total capacity of 1,517.1 MW were launched in Ukraine. Of these, 1,252.1 MW – solar power plants (SPP), 243.7 MW – wind farms (WF), 20.4 MW - biogas plants and 0.9 MW - small hydropower plants (SAEE, 2021).

According to the National Commission for Regulation of Energy and Utilities (NCREP, 2021), in the third quarter of 2019, the structure of electricity generation in Ukraine is as follows [2]: nuclear power plants (NPP) – 53.7%, thermal power plants (TPP) – 30.8%, combined heat and power plants (CHPP) – 6.8%, hydro power plants (HPP) and power storage power plants (PSPP) – 4.9%, RES -3.7%. In turn, among RES, wind farms and solar power plants accounted for about 90% of electricity generation, respectively 30% and 60%. The remaining 10% was produced by small hydropower plants (5%) and biogas / biomass generation (5%). Electricity generating systems based on RES are being implemented in Ukraine at a very high rate and occupy an increasing share of the market. Among them solar power plants dominate.

Significant daily and weekly uneven electricity consumption has a negative impact on the performance of the interconnected power system (IPS) that shows up in: 1) decrease duration of the installed capacity use; 2) increase in specific fuel consumption due to uneven mode of operation of the equipment; 3) acceleration of equipment wear4 4) reduction of district heating system efficiency due to direct reduction of superheated steam; 5) deterioration of electricity and heat supplied to consumers quality.

To increase the economic efficiency of the energy sector, the configuration of electrical load schedules is deliberately changed. This change (lowering the maximum and increasing the minimum load) is called adjustment (alignment) of load schedules. The most common method is use of electrical energy storage systems.

These systems include hydro-, pneumo-, electricity and hydrogen energy accumulating systems. They perform two functions: 1) they are involved in regulating workload schedules; 2) as generation sources, they cover load peaks.

Such systems are considered as a buffer between the mains and RES and are designed not only for long-term energy storage, but also for smoothing significant ripples associated with the unstable nature of RES.

Data on a day, a week and a month period power generation and consumption show that are time intervals at which over generation is observed. These time intervals can be used for storage of power, which later is used to cover consumption in time of peak intervals. There are two pumping storage plants (PSP) in Ukraine that are turned on, and they operate in the mode of energy storage – consumers. In addition, when the share of RES falls and consumption increases, they go into the mode of generation. It is necessary to have controlled shunting generation to balance the grid, which can produce about 13 GW power in less than in three hours of consumption growth.

In addition, every year the amount of the needed stored power increases. Experts noted that that in Ukraine, instead of over-stimulating the development of one type of generation, it is necessary to comply with the requirements of the National Action Plan for RES 2020 - to develop WF and SPP in a balanced way with the construction of shunting PSPs.

The existing structure of generating sources at the beginning of 2019 allows to integrate wind farms and power plants up to 4 GW in total without deterioration the balance reliability of the interconnected IPS system of Ukraine. At the same time, building further capacity of wind and solar power plants requires a change in the structure of generating sources limiting the capacity of base power plants.

The real situation on a Sundays in Autumn 2019 was that the difference between curves of power consumption and scheduled generation of "traditional" energy falls on the generation of RES. To balance the power system, the dispatchers took an unprecedented step launching the PSP in the afternoon for injection. And the situation is not standing still and according to the NCRECP by the end of 2021 is expected to significantly increase the generation of RES. That is, the curve of "traditional" generation is guaranteed to move even lower in the daytime next years.

Conclusions. Thus, the Ukrainian power system has a feature. During a flood, hydropower plants are operating at full capacity and can hardly manoeuvre. With such a regime and a high NPP base, there is not enough shunting generation left in the energy balance, which can provide the necessary reserves and effectively close the sharp evening increase in consumption (Ukrenergo, 2021). To overcome this situation, it is necessary to develop different types of generating capacities, taking into account increase in the share of generation from RES to 25%, as envisaged in the Development plan until 2035. Ukraine`s energy system needs to implement a storage systems based on energy accumulation. One of the effective ways for future development of power accumulating capacities is research and development hydrogen producing, accumulating, and generating complexes.

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IMPROVING THE EFFICIENCY OF THE POWER SUPPLY SYSTEM OF POLTAVA MINING AND PROCESSING PLANT BY CREATING A SOLAR POWER PLANT ON THE TERRITORY OF THE TAILINGS POND

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Introduction. In modern development of electricity in general and in Ukraine as a pan-European electricity network, there are a lot of problems that need to be resolved. Among them is important to use large amounts of renewable energy (Ukrenergo (2021).

The main purpose of this research is to propose a possible project for the use of renewable energy sources to solve the problem of industrial enterprises due to the lack of electricity for their own needs. The object of our research is the possibility of locating a floating solar power plant in non-standard industrial conditions. The subject of the study is the tailings pond of the Poltava Mining and Processing Combine, located in the town of Goryshny Plavni.

Presentation of the main research. Implementation of renewable energy sources in industrial enterprises, including mining and gas-processing plants, has three main barriers (Pouran, 2018):

- high cost of components (e.g., solar panels, inverters, generators for VES, etc.);
- unpreparedness of the general network to connect and receive a significant number of “green” watts of electricity;
- poor manoeuvrability of the power supply network (significant changes in consumption/delivery, depending on the season, the time of the day, and others).

However, an important problem today is that enterprises cannot effectively move to the use of any renewable energy (sun, wind, and biogas) without foreign investment, even including the benefits of the green tariff. The negative side of the green tariff is that the state now cannot provide it in an appropriate way through a number of economic, administrative and structural crises, once to satisfy the interests and wishes of investors in this area. It is important for foreign investments to find privatization in investing in Ukrainian energy projects. Even the green tariff is more of a negative factor than a positive one, if we consider the problems of its receipt and compliance with the obligations of the state on payments, as well as the low level of payment ability of the population.

However, in spite of these problems, an important argument for the development and implementation of projects on renewable energy sources is the expected indicators of the quality and quantity of additional electric power receipt, as well as their combined positive impact on the decentralization of energy supply sources.

Examining the potential of Ukraine in terms of increasing the use of renewable sources of energy, we can conclude that even taking into consideration today's military conflict there is a great number of territories that are suitable for the construction of CES. For the location of CES industrial purpose often allocated areas that are not suitable for agrarian processing, on which for over 4 years was not carried out farming works, land impregnated with various pollutants, which inhibit its fertility, abandoned areas.

The usual solar power plant, as a rule, is located on the surface of the earth and is mounted on special supports or trackers. An alternative project could be a floating solar power plant, which is a complex of solar panels secured on floating platforms. Such a station can be a drifting platform, or the usual floating mass on pontoons (Goswami, Sadhu, Goswami, Sadhu, 2019).

The main limitations for floating SECs are the state and type of water smoothness. Inland waters with minimal pressure during the year are the best for the construction of floating solar power plants. In our case, the particular advantage of pontoon construction of solar power plants is that they can be used in such areas as: flooded pits, tailings ponds of mining and enrichment facilities, areas that remained after the completion of extractive activities.

As we know, the area of the pits can be up to hundreds of hectares. Thus, their tailing pits can be considered as a nice backdrop for the construction of floating CES. After the end of exploitation the quarries often remain in private ownership, but there are cases when the quarries are transferred to state control and form protected areas in them. The state ownership is the main problem during the development of the CES project, because it is problematic and expensive to find compromises and get the opportunity to use the land for the capacity of the solar station. Also, a long time abandoned production land often converted to the area of residence or migrations of various species of flora and fauna, which limits the number of possible sites for the construction of CES.

According to the idea of the proposal, the solar power plant is planned to be built in non-standard industrial conditions, which is the area of the Poltava Mining and Processing Plant's tailings pond in the city of Goryshny Plavni.

The Poltava Mining and Processing Combine (Poltava GOK) is part of the "Ferrexpo" group of companies located in Goryshny Plavni, Poltava region. Goryshny Plavni, Poltava region. The company is the largest Ukrainian exporter of iron ore pellets, the main products are delivered to Europe (Poltava GOK, 2021).

The capacity of the tailings ponds of the Poltava GOK is 510 million cubic meters; the dam has the following parameters: maximum height 100 meters, length 4 km (see Figure 1).

Figure 1

General view of the tailings ponds of the Poltava GOK (Poltava GOK, 2021)

This means that the CES needs to be positioned so that it is within the GZK facility itself and becomes part of its technological process and sanitary area. For this reason, the best option is to locate the floating CES in the Poltava GZK tailings pond and integrate it into a single process line of the facility (see Figure 2).

Figure 2

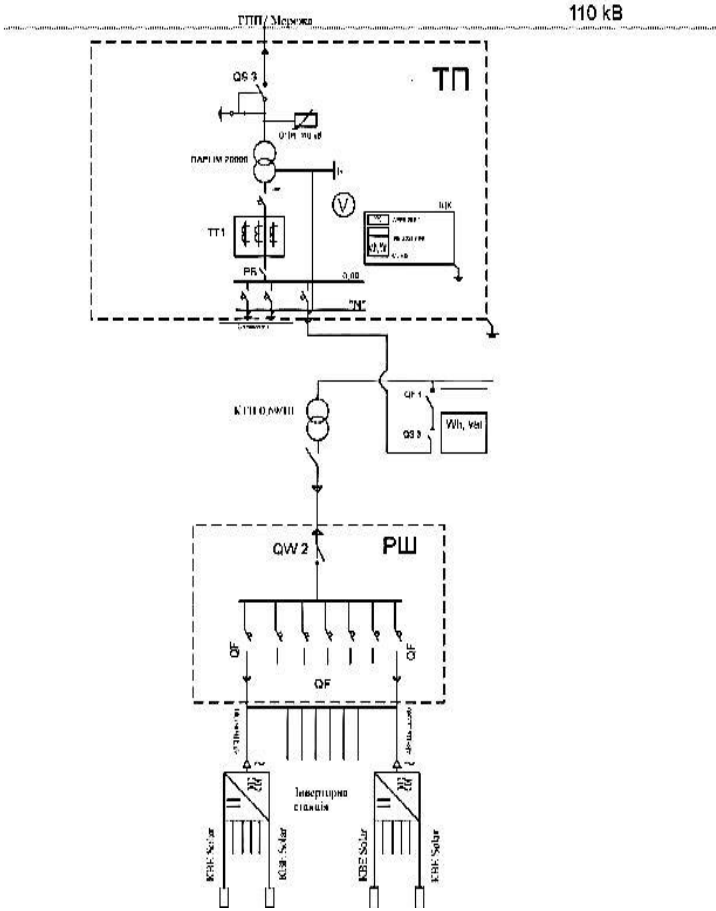
Schematics of the Tailings Facility for Planning the Cascade of Solar Panels at the Poltava GOK

In our view, for this enterprise the project does not have an adequate alternative location.The total area for the construction of SES will be 2,938 square kilometers. As a result of the calculations the electrical scheme of the plant was determined (see Figure 3) and the equipment was selected. The payback period of the project is expected to be 3.5 years.

Thus, the importance and actuality of the project consists in using non-specified industrial areas of Ukraine as a potential for renewable energy, first of all, solar energy, reducing the construction of new solar power plants in non-standard conditions, particularly, floating CES.

Figure 3

Scheme of the hybrid connection to the main step-down substation in mountain concentrating combine



Also, the analysis showed the following: local territories, which are limited by certain geographical, physical and industrial objects, are promising for the creation of effective autonomous systems of energy supply with the use of electric photomodules, which produce electricity from the solar shining. In the future, these projects will not only increase the production of electricity, but also improve its quality through the introduction of ecologically safe technologies, to influence the effect of decentralization in the energy sector.

Conclusions. Therefore, the use of floating CES at industrial facilities is useful for increasing the share of energy generation from renewable sources, both local and global positive impact on the environmental and social situation in the region and the country as a whole. In our situation, the proposal to use floating CES at industrial facilities allows to solve the problem of entering into the exploitation of large capacities with already installed capacities at large mining and gas extraction complexes. However, the project causes certain conditions, including the requirement to modernize the existing equipment and technological processes.

In summary, we consider that the use of similar projects, of course, leads to improvement of the system of energy supply, at least locally; also we can assume a positive impact of the "green" source of energy for “greening” of the poor sectors of industry, which are mining activities.

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ENERGY MANAGEMENT SYSTEMS IN THE INDUSTRIAL SECTOR

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Introduction. Problems of energy efficiency, along with increasing the environmental safety of production and strengthening social responsibility, are becoming a central object of study of modern theory and practice of industrial enterprise management (Di Franco&Jorizzo, 2020). In this regard, the need for more rational use of energy resources by industrial enterprises comes to the fore. After all, they are the largest consumers of fuel and energy resources. Improving energy efficiency is a priority factor in reducing production costs, which has a positive effect on the profits of manufacturing companies.

The number of people in the world is growing steadily. Every day people require more energy to meet their needs and this process is progressing. The development of the industrial sector using traditional sources of energy (coal, oil, gas) is accompanied by the depletion of natural resources, causing greenhouse gases emissions, because of which the climate on the planet is changing.

The industrial sector accounts for around 38% of global final energy consumption. They are responsible for 24% of the total CO_2 emissions. The environmental consequences of wasteful energy use make us hesitate to consider how efficiently and safely we use energy resources (Dreshpak,&Paliekhova, 2021).

The article presents the problem of efficient electricity consumption in Ukrainian industry. The key reasons for the low efficiency of energy use in industry are explained. The structure of electricity consumption during 2019-2020 is analysed. The main problem for developing mining and metallurgical complex in Ukraine is determined. The ways to increase energy efficiency in industrial enterprises are proposed. The article presents review of energy management systems at Ukrainian industrial enterprises. The model of energy management basing on ISO 50001 is analyzed.

Presentation of the main research. One of the key reasons for the low efficiency of energy use experts calls the still existing stereotype of thinking about the insignificance of the share of energy consumption in the cost of finished products, as well as the idea of affordability and relatively low cost of energy. However, in some industries, they account for 15% to 40% of the cost of the finished product (excluding the cost of purchasing raw materials). The constant increase in the cost of energy and the outdated approach to the use of energy resources harm the competitiveness of manufactured goods.

In turn, this provokes a forced reduction in output and leads to an additional increase in the energy component in the price of the final product, which is associated with falling load and irrational use of production capacity.

As we know, the industry consumes about 40% of all energy resources in the country, so it is very important to pay attention to this topic. Ukraine urgently needs to increase the energy efficiency of its industry. But government measures should be divided into two categories: energy efficiency and energy saving for large enterprises and others. This is done all over the world. Large energy-intensive enterprises such as the fuel and energy complex, metallurgy, chemistry, the pulp and paper industry, and the cement industry, incur very high costs. Small projects such as replacing lamps with energy-efficient ones are quietly implemented by everyone. But for large-scale eco-modernization, large enterprises need state assistance.

The main problems of energy efficiency in industrial enterprises are as follows:

- use of obsolete equipment that does not meet energy efficiency requirements;
- application of out-dated technologies in the production cycle;
- old stock and old utilities, which result in significant heat loss;
- the problem of using modern ventilation systems (with recuperation) in buildings under construction and reconstruction is not solved (old and non-working systems lead to additional heat loss and deterioration of the microclimate in the room);

- the use of cheap building materials in mass construction, despite the well-established production of energy-saving solutions (production of heat-reflecting glass, translucent structures, photovoltaic panels, thermal insulation materials);
- weak use of alternative energy sources (solar collectors and batteries, heat pumps, wind generators); developed legislation in the field of energy saving; etc.

The main problem for the development of the mining and metallurgical complex of Ukraine is the high degree of depreciation of fixed assets, as well as the technical and technological lag of the metallurgical industry compared to the best world achievements. The energy costs of Ukrainian metallurgical enterprises significantly exceed the energy costs of foreign producers (Ukrenergo, 2021).

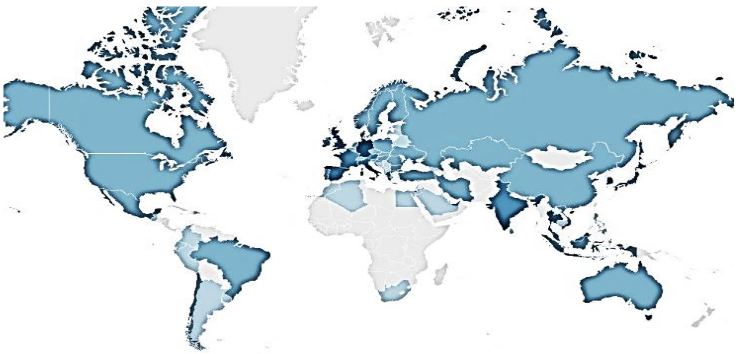
The problem of high energy intensity of gross domestic product of the country is caused not only by energy-intensive equipment and outdated technologies but also to the lack of systemic understanding and management of processes of use and consumption of energy resources. A common way to solve these problems is the implementation of energy management systems (EnMS), which comply with the international standard ISO 50001. According to ISO 50001:2018, the term "energy management system (EnMS)" (is a management system is the way in which an organization manages the interrelated parts of its business in order to achieve its objectives.

The objectives on management systems can relate to several different topics, including product or service quality, operational efficiency, environmental performance, health and safety in the workplace, and etc. EnMS allow to analyze the state of energy security and energy use, to organize efficient monitoring and control over the state of consumption of all types of fuel and energy resources, assess the energy efficiency of industrial technologies, identify the reserves of energy-saving and suggest comprehensive energy-saving measures for efficient use of energy resources. Practical experience shows that enterprises that implement EnMS, with minimum capital investments during the first years, obtain an increase of energy efficiency by 10-20%.

Thousands of companies in Europe are now using energy management systems in their companies. In the industrial sector, the largest number of ISO 50001 certifications in the period 2018-2019 was obtained by enterprises of the metal, food, and chemical industries. According to official ISO reviews, the following number of ISO 50001 EnMS implementation certificates was verified worldwide: in 2016 - 20216; in 2017-22870; in 2018-18059: in 2019 - 18227 (see Fig.1). The leaders in ISO 50001 implementation are Germany (6,243 in 2018), the UK (1,153), and (in recent years) China (2,364). In Ukraine (according to official ISO reviews), the following number of certificates was granted: in 2016 - 21; in 2017-189; in 2018-21; in 2019-12.

Figure 1

Worldwide issued ISO 50001 certificates (OECD/IEA, 2017)



According to ISO 50001:2018, the EnMS cycle of operation is based on the methodology known as the Plan-Do-Check-Act (PDCA) continuous improvement cycle or Deming cycle, which can be represented as follows:

Plan: Planning of its activities for the reporting period by setting goals and objectives, as well as work plans, resources necessary to achieve the results per the requirements of the energy policy of the organization, and identification of risks associated with the activities of EnMS.

Do: Implementation and execution of planned activities (measures) aimed at achieving the policy, goals, and objectives and the implementation of the ISO 50001 requirements that the standard regulates, and which have been specified both for the current period and in the framework of continuous improvement.

Check: Continuous monitoring of EnMS performance and energy use indicators in combination with all non-energy factors affecting them. All this is done in conjunction with a continuous review of the fulfillment of the goals, objectives, and work plans, as well as the requirements of the other EnMS documentation during the operational activities of the organization.

Act: Implementation of actions for continuous improvement of the energy management process and standard requirements with the mandatory participation of the top management.

Conclusions. Thus, energy management is a set of continuous processes and tools that are combined with the business processes of any organization. It encourages it to constantly manage energy consumption and find ways to improve its energy efficiency. These processes and tools cover not only procedures, equipment, and technologies, but also people. Any system (even fully automated) depends on the behavior of the people who created, maintain, and improve it.

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OVERVIEW OF THE WIND ENERGY MARKET IN UKRAINE

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Introduction. The growing interest in energy resources is associated with global warming and the consequences of the greenhouse effect. Today people understand that the reserves of fossil fuels are limited and the use of such fuels leads to environmental pollution (Bezgina, Strelina, 2013). The purpose of this study is to analyze the wind energy market in Ukraine.

Presentation of the main research. In the transition to sustainable energy, one of the main factors is the reduction of greenhouse gas emissions. Specific greenhouse gas emissions from alternative energy sources are hundreds of times lower than traditional ones (WEO, 2021). Greenhouse gas emissions from energy production, taking into account emissions from the manufacture of equipment at wind power plants, are 4 times lower than at solar power plants and dozens of times lower than at processing coal and oil gas.

To achieve the goal of reducing greenhouse gas emissions, it is necessary to increase the share of renewable energy sources. Solar, wind and biomass energy can meet local energy needs and help improve the environment. Wind energy has one of the largest increases in installed capacity over the past 20 years (IRENA, 2021). Wind energy is the cheapest renewable source. In places with good wind conditions, it competes successfully with traditional fuel and nuclear power plants. The development of wind energy in Ukraine is promising for the following reasons: there are many territories with high wind energy potential; Ukraine is the only one country of the former USSR and Eastern Europe that produces wind power equipment; more than 10 years of experience in the design, construction and operation of industrial wind farms; there is legislative support for the use of renewable energy sources (Konechenkov, 2017).

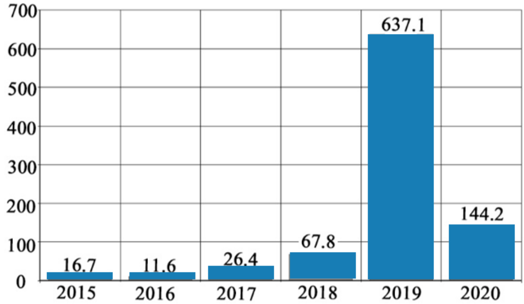
Since 1997, when the Comprehensive WPP Construction Program was adopted, wind energy in Ukraine has received state support in the form of a surcharge on electricity tariffs and direct financing. In 2008, the Verkhovna Rada introduced a “green” tariff for electricity obtained from alternative sources. The document stipulated that Energorynok should buy such electricity twice as much as that obtained from traditional sources. In this way, the government planned to attract foreign investors and stimulate industrial electricity production through wind turbines. Significant growth in the construction of wind farms has been observed since 2009, after the introduction of the “green” tariff by the Government of Ukraine. International and national investors continue to be interested in investing in wind energy projects and developing Ukraine's investment attractiveness and business climate. In 2020, the volume of investments in the wind energy sector amounted to 154 million Euros, which is more than 6 times less than in 2019 (UWEA, 2020) However, it can be stated that the general trend of investing in new wind energy projects remains. In the last 5 years, a total of about 2 billion euros has been invested in the wind energy industry.

At the end of 2020, the installed wind power capacity in Ukraine reached 1,314.1 MW. Wind power plants delivered 3,251.6 mln kWh of “green” electricity to the Integrated Power System of Ukraine in 2020, or 2.2 % of the total annual electricity generation in Ukraine. Compared to 2019, in 2020 the national wind energy sector was enriched by a much smaller number of new capacities (see Figure 1). In 2020, only 144.2 MW of new wind power capacity was put into operation in four regions of Ukraine, and the total capacity of the wind energy sector of Ukraine reached 1,314.1 MW. At the newly built wind farms, 36 megawatt-class wind turbines began to generate clean electricity. The average unit capacity of new wind turbines is 4 MW.

National Renewable Energy Action Plan, which provided for the achievement in 2020 of 11% share of RES (including high-capacity hydropower) in the national electricity generation. The National Renewable Energy Action Plan until 2020 has a clear annual plan for the development of each renewable energy source. In particular, by the end of 2020 it was planned to put into operation 2,280 MW of wind capacity in the country.

Figure 1

Annual wind power additions, 2015 – 2020, MW (compiled from data of UWEA, 2020)



However, a t the end of 2020, only 1,314.1 MW of wind power capacity was installed in the country, including 138 MW of wind power capacity located in the temporarily occupied territories of Ukraine (certain districts of Donetsk and Luhansk regions), which currently do not supply electricity to the Integrated Power System of Ukraine. That is, the goals for the installation of wind energy capacity have been met by only 57%. In the first half of 2021, the trend towards a gradual increase in the unit capacity of wind turbines continues. The average unit capacity of new wind turbines put into operation in the first half of 2021 is 3.8 MW, while the average unit capacity of wind turbines installed in Ukraine since 2011 is 3.4 MW. The participation of wind power equipment manufacturers in the wind energy market of Ukraine also remains stable. Thus, at the end of June, the three leading manufacturers of wind power equipment, whose turbines are installed in the country, include the Danish company Vestas, the American company General Electric, and the Ukrainian company "Wind Parks of Ukraine" (UWEA, 2020).

Wind energy opens such opportunities for Ukraine as:

- step towards integration into the world energy system;
- the ability to improve the environment by reducing the impact of anthropogenic factors on the environment, which leads to the disruption of natural ecosystems;

- given the constant rise in energy prices - the possibility of reducing the negative socio-economic consequences of this process through the development of socially available energy sources, and as a result, improving living standards;
- the possibility of introducing new scientific, strategically important state, as well as commercial infrastructure projects and the development of the energy structure in general;
- strengthening and improving the energy system of the state;
- diversification of alternative energy resources (wind energy in particular) increases the economic potential of the country.

Conclusions. Without effective world and European experience, attracting foreign investment and modern technologies, the national economy and territorial communities of Ukraine are unlikely to be able to implement the energy priority of sustainable development, harmonization of current livelihoods, industries and environment. Incentives for the development of wind energy projects may be provided by law for medium-term tax and customs preferences, exemption from land tax and income tax of energy suppliers that have been produced by wind equipment.

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CERTIFICATION OF BIOMASS SUSTAINABILITY FOR BIOFUEL PRODUCTION

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Introduction. The article presents review of Roundtable on Sustainable Biomaterials (RSB) Standard in Ukraine. The effectiveness of RSB Standard for Ukraine is substantiated. The purpose, principles and major elements of the Roundtable Standard are explained. Statistics on applying RSB Standard around the world is analysed.

As a result of the EU renewable energy policy (EU Directive 2009/28/EC of 23 April 2009, Renewable Energy Directive - EU RED), EU Member States are going to increase the consumption of vegetable oil for energy production in order to meet the EU renewable energy targets. Under EU RED, member states must have 20% of their overall energy consumption and 10% of the fuel in the transport sector coming from renewable sources by 2020 (CMU, 2013). Currently, only 50% of the vegetable oil used in the EU is grown on EU fields. For net exporters of agricultural commodities, such as the Ukraine, the EU biofuel market will offer attractive prices. The demand will be of particular relevance for rapeseed from Ukraine.

Presentation of the main research. However, producers will have to show compliance with EU RED sustainability criteria, otherwise they cannot enter the EU RED regulated market. Compliance will be possible by using recognized biomass certification schemes. The EU RED criteria contain life cycle greenhouse gas emissions (reduction of emissions by 35%, later 50%, compared to fossil fuels), protection of carbon rich areas (wetlands, continuously forested areas), protection of land with high biodiversity value (primary forests, nature reserves, highly biodiverse grassland), and the protection of peat land.

On the other hand, in order to fulfill its responsibilities for national sustainable development, the new version of the Energy Strategy of Ukraine (ESU) envisages a gradual increase in the production and use of motor biofuels in Ukraine until 2030. Thus, from 2020 to 2030, it is planned to spread biodiesel as a motor fuel, bringing the share of biodiesel in diesel fuel to 7% by 2025.

The problem in Ukraine are:

- increasing the production of vegetable oil for energy production in order to meet the renewable energy targets for Ukraine (see Table 1);
- implementation of the EU Directive 2009/28/EC (Renewable Energy Directive - EU) under the Association Agreement between the European Union and Ukraine (2014);
- the importance of the vegetable oil for biofuel production as one of the main export commodities (see Figure 1).

Figure 1

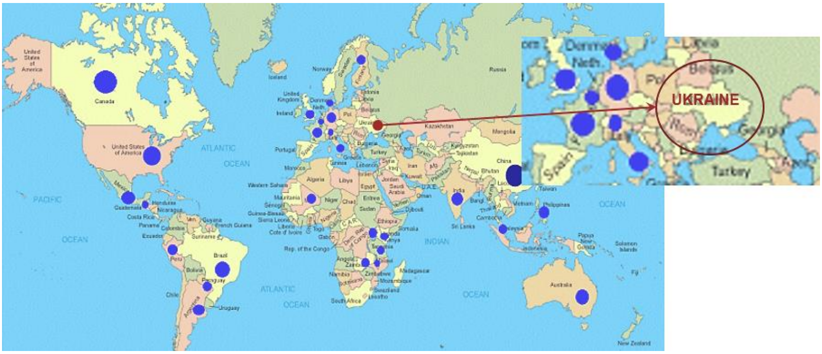
Main exporters of the vegetable oil for biofuel production (RBSA, 2021)

According to experts, the implementation of the planned actions in full will:

- to increase the level of energy independence of Ukraine;
- to increase the share of energy from renewable energy sources in the overall fuel and energy balance of Ukraine;
- to improve the environmental situation in Ukraine by reducing emissions of harmful substances and increasing the level of development of energy production from renewable energy sources to the level of the European Union.

Figure 2

Main importing countries of Ukrainian rapeseed (RBSA, 2021)



The RSB Standard has components designed to ensure the whole system works smoothly and effectively. The main components are shown in Table 1. New laws relating to energy, such as the renewable energy directive in the EU, provide a broad perspective on biofuels worldwide.

Table 1

The major elements of the RSB standard (RBSA, 2021)

Legal	The RSB Standard ensures legal compliance, including traditional land and water rights.
Social	The RSB Standard ensures human and labour rights, rural and social development in regions of poverty, and local food security.
Environmental	The RSB Standard ensures the preservation of conservation values, soil health, water quality and availability, mitigation of climate change, as well as control of air pollution.
Management	The RSB Standard ensures the reduction of risks and continuous improvement through an effective management approach.

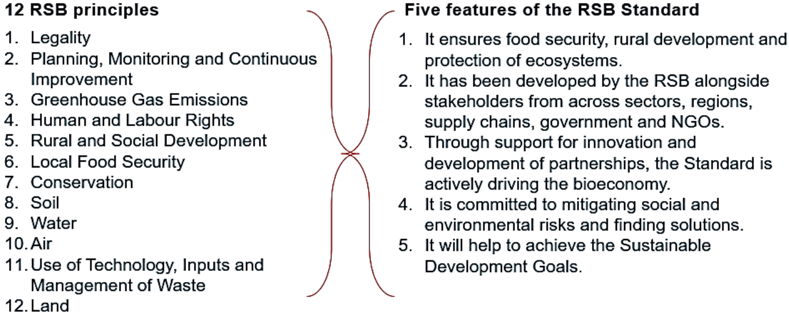
Six biomass certification schemes for biofuels can be used in Ukraine. Composed of a variety of different standards, the RSB Standard has been designed and continuously developed to support certification in all circumstances, anywhere in the world. In Ukraine, since 2010, only 20 companies have passed the certification of biomass production, a total of 30 ISCC certificates (today, 10 of them are valid), as well as 2 RBSA certificates, have been issued.

Why is the RSB Standard an effective standard for Ukraine? Certification to the RSB Standard covers the production of any bio-based feedstock, biomass-derived material and any advanced fuel, as well as complete supply-chains and novel technologies. The RSB Standard has five features that provide with a foundation for sustainable production:

- It ensures food security, rural development and protection of ecosystems.
- It has been developed by the RSB alongside stakeholders from across sectors, regions, supply chains, government and NGOs.
- Through support for innovation and development of partnerships, the Standard is actively driving the bioeconomy.
- It is committed to mitigating social and environmental risks and finding solutions.

Figure 3

RSB Standard is an effective standard for Ukraine (RBSA, 2021)



Conclusions. Roundtable on Sustainable Biomaterials (RSB) is an independent, global coalition of a wide range of stakeholders working to promote stability of biomaterials (Palekhova, 2016). Roundtable on Sustainable Biomaterials includes more than 120 organizations. And 30 non-governmental organizations are known as RSB members, for example, World Wildlife Fund, International Union Conservation of Nature and Natural Resources Defense Council. Application of the RSB Standard showcases a company's commitment to sustainability and the realization of the UN Sustainable Development Goals.

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STUDY OF THE EFFICIENCY OF A CHARGING STATION FOR ELECTRIC VEHICLES USING AN ACTIVE RECTIFIER IN A MICRO-GRID SYSTEM

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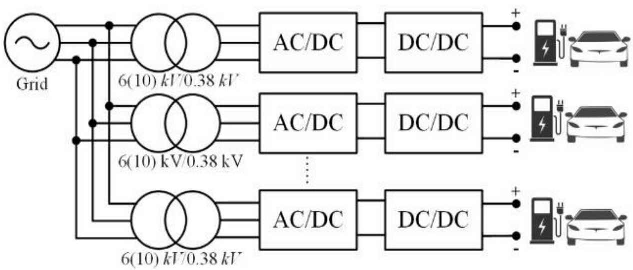
Introduction. Every year, electric vehicles become more attractive compared to vehicles with internal combustion engines (ICE). The development of electric vehicles (EVs) has received significant attention from governments, manufacturers and researchers. In this case, an important issue is the creation of energy-efficient charging stations with the highest power efficiency parameters. Another quite important parameter is the charging time of electric vehicle batteries. In this regard, topologies of external charging stations with fast charging mode (DC, Mode 4) are quite promising. In addition, one of the requirements for charging stations is the ability to provide bidirectional energy transfer, which corresponds to the vehicle-to-grid (V2G) concept (Deilami et al., 2011).

Traditional fast charging stations typically contain two conversion stages, namely an AC/DC input rectifier and an output DC/DC converter (see Figure 1).

Figure 1

Schemes of fast charging stations based on AC/DC-DC/DC



In this topology, the DC/DC converter provides regulation of the output voltage and current of the charging station over a wide range. The DC/DC converter is also used to provide galvanic isolation of the electric vehicle from the network. At the same time, two-stage conversion of electricity leads to additional losses and a decrease in the efficiency of the charging station power.

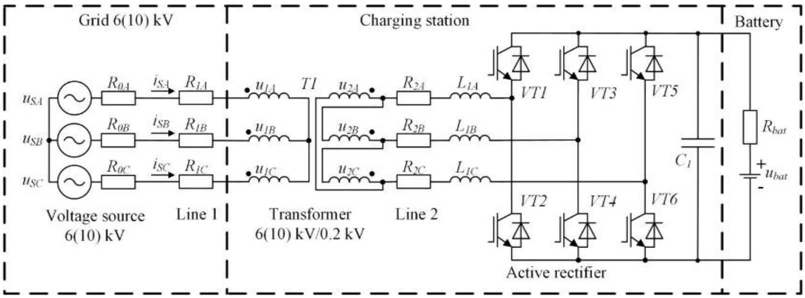
Presentation of the main research. This paper proposes a topology concept for an external DC charging station based on an active three-phase rectifier (AB) with power factor correction (see Figure 2). In this case, the active rectifier performs the function of regulating the output voltage and charging current, and the galvanic isolation is provided by the input transformer. The advantages of the proposed charging station with AV include: high power factor close to unity, low harmonic distortion of the consumed current (THD < 5 per cent), higher efficiency relative to two-stage charging stations of the AC/DC-DC/DC type, as well as the ability to provide bidirectional energy transfer (Sortomme, 2010).

Parameters of the system under consideration. The characteristics of the supply network are determined by the parameters of the three-phase transformer of the supply substation type TMN4000/35/6, for which the phase resistance R0A = 1.4 Ohm (Perelmuter, 2020). The parameters of line 1 are determined by the distance between the traction substation and the converter transformer, which we take equal to 1 km. The aluminum three-core cable used in line 1 has a phase resistance value of R1A equal to 0.8 Ohm/km, and its cross-section is selected according to the current and is equal to 35 mm2. The SPZ-1000/10U3 series 6(10)/0.2 kV converter transformer has a rated power of 0.878 MW and a short circuit loss of 8 kW. The total equivalent resistance of its RTV phase for it will be equal to 1.73 mOhm. The parameters of line 2 are determined by the distance between the converter transformer T1 and the active rectifier, which is assumed to be 50 m. In this case, the cross-section of the copper cable will be equal to 350 mm2, the value of the R_{2A} phase resistance will be 2.5 mOhm. The inductance value of the active rectifier input chokes is 0.2 mH. CM600DX-13T switches from the manufacturer Mitsubishi Electric with parameters of collector current I_c 600 A and collector-emitter voltage U_{CE} 650 V, output capacitor capacity equal to 20 mF were selected as switches for active rectifiers.

The system for automatically regulating the current and voltage of battery charging is implemented on the basis of an integral regulator with further PWM formation of the input current shape (Sokol et al., 2018). The automatic control system is described in more detail below by modeling the system (see Figure 2).

Figure 2

Diagram of a Micro grid charging station for electric vehicles with single-stage energy conversion



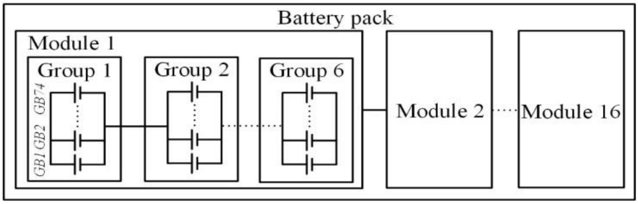
Equivalent EV battery model. The work examined the charge of an equivalent model of the battery compartment of the Tesla S electric car, which contains 7104 Panasonic NCR-18650 batteries with a total capacity of 85 kWh (Nerubatsky et al., 2019). The battery connection diagram in the Tesla Model S electric car is shown in Figure 3.

In the battery compartment, individual NCR-18650b batteries are connected in parallel into groups of 74 pcs. With a parallel connection, the voltage of the group is equal to the voltage of each of the elements (4.2 V), and the capacity of the group is equal to the sum of the capacities of the elements (250 A•h). Next, six groups are connected in series to form a module.

In this case, the module voltage is summed up from the group voltages and equals 25.2 V. Next, the modules are connected in series to form a battery. In total, the battery contains 16 modules (total 96 groups). The voltage of all modules is summed up and amounts to 400 V.

Figure 3

Battery connection diagram in the Tesla Model S electric car

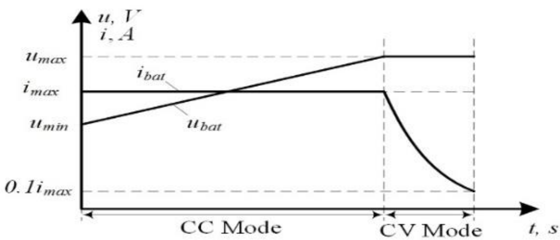


The equivalent resistance of the battery pack is also calculated. Based on the fact that the average resistance of one R_{NCR} battery is 37 mOhm, the equivalent resistance of the R_{bat} battery is 27 mOhm. Battery charging algorithm. When implementing fast battery charging, the method (algorithm) that will be used to charge the battery plays a significant role. The most popular battery charging method is the Constant Current - Constant Voltage (CC-CV) method (see Figure 4).

The basic idea of the method is that the battery is charged with a constant maximum current (imax), which is determined by the battery manufacturer up to a certain cutoff voltage (umax), and then charged at this voltage until the current consumption decreases to approximately 0.1C or less, providing a full charge (Nerubatsky et al., 2019). It should be noted that when switching from CC mode to CV mode (this occurs at approximately 80 per cent of the battery charge), the charging speed is significantly reduced.

Figure 4

Charge mode using the CC-CV method



The work assessed the efficiency of the proposed charging station, shown in Figure 2. The efficiency was estimated based on the total energy losses and useful energy received by the battery during the full charging interval (Tugay et al. (2019). The formula was used to calculate the efficiency:

$$\eta = \frac{E_{Load}}{E_{Load} + \Delta E_{\Sigma}}, \qquad (1)$$

where E_{Load} – is the useful energy transferred to the battery during charging; ΔE_{Σ} - is the total energy loss in the micro-grid system under consideration.

$$\Delta E_{\Sigma} = E_S + E_{L1} + E_{TV} + E_{L2} + E_L + E_{AR} + E_{bat}, \qquad (2)$$

where E_S – is the energy of losses in the source 6(10) kV; E_{L1} – loss energy in line 1; E_{TV} – energy losses in the transformer; E_{L2} – loss energy in line 2; E_{AR} – loss energy in active rectifier switches; E_{bat} – is the energy loss in the battery.

Useful energy transferred to the load:

$$E_{Load} = \int_0^{T_з} (u_{Load} \cdot i_{Load}) \cdot dt, \qquad (3)$$

where $T_з$ – time to fully charge the EV battery; u_{load} – instantaneous value of the output voltage supplied to the battery compartment of lithium-ion batteries (when charging, the range is from 340 to 420 V); i_{load} - is the instantaneous value of the load current (battery charge), which during the charging process varies from 15 to 400 A.

Losses in the 6(10) kV source, in line 1, in transformer T1, in line 2 and in the battery are calculated using the formula:

$$E = \int_0^{T_з} (i^2 \cdot R) \cdot dt, \qquad (4)$$

where i and R – are the instantaneous current value and resistance in the calculated section of the circuit.

An IGBT module of type CM600DX-13T was selected as AB keys. The total losses in the IGBT module consist of dynamic and static losses in the IGBT transistor and reverse diode (Zhemerov et al., 020) calculated:

$$E_{loss.IGBT} = E_{loss.VT} + E_{loss.VD} \; ; \quad (5)$$

$$E_{lossVT} = E_{VT.DC} + E_{VT.SW} \; ; \quad (6)$$

$$E_{lossVD} = E_{VD.DC} + E_{VD.SW} \; , \quad (7)$$

where $E_{VT.DC}$ – is the energy of static waste in IGBT transistors; $E_{VT.SW}$ – energy of dynamic losses in IGBT transistors; $E_{VD.DC}$ – energy of static losses in parallel diodes; $E_{VD.SW}$ – energy of dynamic losses in parallel diodes.

$$E_{VT.DC} = \int_0^{T_з} (i_c \cdot u_{ce}) dt \; , \quad (8)$$

where i_c – collector strum; $u_{ce}(i_c)$ – the voltage between the collector and the emitter, which lies below the value of the collector flow.

Dynamic losses in IGBT transistors are calculated according to the following formula:

$$E_{VT.SW} = \int_0^{T_з} \left[E_{on}(I_c) + E_{off}(I_c) \right] \cdot dt \; , \quad (9)$$

where $E_{on}(I_c)$ and $E_{off}(I_c)$ – are the energy that is dissipated in the transistor when it is energized and ignited, which is stored in the volume of the collector stream.

Static losses in freewheeling diodes:

$$E_{VD.DC} = \int_0^{T_з} (u_{fwd} \cdot i_{vd}) \cdot dt \; , \quad (10)$$

where u_{fwd} – is the voltage drop across the reverse diode; i_{vd} – reverse diode current.

Dynamic losses in freewheeling diodes:

$$E_{VD.SW} = \int_0^{T_з} E_{rec}(i_{vd}) \cdot dt \quad (11)$$

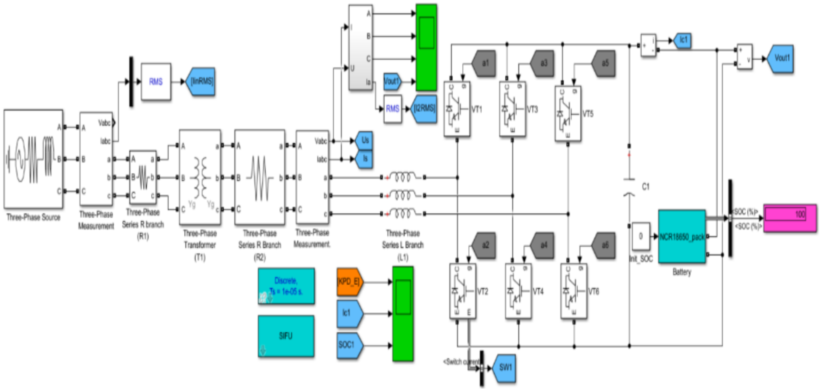
where E_{rec} – is the recovery energy of the reverse diode.

Data $E_{on}(i_c)$, $E_{off}(i_c)$ и $E_{rec}(i_c)$, $u_{ce}(i_c)$, $u_{fwd}(i_{vd})$ were taken from the datasheet for the CM600DX-13T module.

Simulation of charging station operation. To experimentally test the theoretical assumptions, a Matlab model of the proposed charging station was developed (see Figure 5).

Figure 5

Matlab model of Micro-grid charging station system for electric vehicles



The automatic control system (ACS) for an active rectifier is built on the basis of an integral regulator with further pulse-width modulation (Tomashevskyi et al., 2014). The developed ACS provides the specified dynamics of changes in voltage and charge current in CC-CV modes.

Conclusions. The article presents the results of a study of the energy efficiency parameters of an external DC EV charging station using an active rectifier.

The parameters of the proposed structure of the ES are described, the parameters of the equivalent circuit of the battery compartment of the Tesla model S electric car are presented, which are reduced to one equivalent battery. A method for quickly charging a CC-CV battery is described, which provides a greater number of charge-discharge cycles. Formulas are given for calculating the components of losses and efficiency during the interval of full battery charge. A Matlab model of the charging station system and simulation results are presented. The studies have shown that the maximum efficiency of the system power is achieved in the minimum charge current mode. At the same time, a decrease in the charge current leads to an increase in the charging process time, as well as a slight deterioration in power quality parameters.

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SECTION 5 MANAGEMENT AND MARKETING FOR SUSTAINABLE DEVELOPMENT

"We are determined to take the bold and transformative steps which are urgently needed to shift the world on to a sustainable and resilient path. As we embark on this collective journey, we pledge that no one will be left behind."

Transforming our world: the 2030 Agenda for Sustainable Development, 25 September 2015

"Today, we have a historic window of opportunity to design a transformative COVID-19 recovery strategy to build sustainable and resilient economies and societies. It is time to fully embrace the decoupling of economic growth from environmental degradation, a reduction in carbon emissions, improvements in resource efficiency, and the promotion of sustainable lifestyles."

The Sustainable Development Goals Report 2021

"The Green Deal ... is a comprehensive plan to make our economy and society ready for a climate neutral future. A future where we live in harmony with our natural environment. It applies to every sector and every region and appeals to everyone to grasp the opportunities inherent to the transition."

Frans Timmermans, European Commission Executive Vice-President for the European Green Deal. Speech at the World Sustainable Development Summit, 12 February 2021

GREEN JOBS INITIATIVE: CHALLENGES FOR UKRAINE

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Ludmila Paliekhova, Prof. PhD-Econ.
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Introduction. In the past two decades, the topic of "green jobs" as a condition of "decent work" has drawn particular attention all over the world. However, in Ukraine, scientific interest in this area has so far been weak, resulting in a lack of diversity and a relatively small number of articles by Ukrainian authors on environmental aspects in labour organization (according to Google Scholar, less than 0.4% of all publications).

The relevance of the topic in the context of post-war recovery of the Ukrainian economy on the principles of sustainable development is a determining factor for the expansion of knowledge in this area. The present research focuses on analyzing key official documents and reports on the topic of "green jobs" with the aim to identify definitions and meanings associated with the broader concept of "decent work". The article specifies connected terms, areas of research interest and the main theoretical and practical results, important for the realities of Ukraine.

Presentation of the main research. At the United Nations Conference on Environment and Development in 1992, the international community endorsed the concept of sustainable development. The main idea of the concept of sustainable development is that human societies must live and meet their needs without compromising the ability of future generations to meet their own needs. In 2015, the United Nations General Assembly adopted the Sustainable Development Goals (SDGs) as the blueprint for a global partnership for peace, development, and human rights for the period 2016 to 2030. SDGs recognize that economic growth must go hand-in-hand with strategies that address a range of social needs including social protection, and job opportunities, while tackling climate change and environmental protection.

Goal 8 provides “promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all” (UNGA, 2015, 19). It is determined here that decent work means opportunities for everyone to get work that is productive and delivers a fair income, security in the workplace and social protection for families, better prospects for personal development and social integration. In this respect, the target on decent work at least aimed to achieve this human right rather. Specific targets and indicators for decent work also have some features, including links to the International Labor Organization (ILO) monitoring mechanisms. The ILO defines decent work as “productive work for women and men in conditions of freedom, equity, security and human dignity” (ILO, 2017).

The Green Jobs Initiative emerged as a result of a partnership between the United Nations Environment Program (UNEP), the International Trade Union Confederation (ITUC), the International Organization of Employers (IOE) and the International Labor Organization (ILO). The main goal of this partnership is the promotion of opportunities, equity, and a fair transition to green sustainable development. It should be emphasized that ILO clearly distinguishes between the concepts of “decent work” and “green jobs”, which are closely related, but do not coincide. The idea of green jobs concept is that reducing the negative impact on the environment and sustainable development should start from the workplace.

Green jobs are characterized by the inclusion of sustainable development principles in the processes of labor organization as part of the policy of green economy and social integration. Green jobs are defined as “decent work that contributes to preserve or restore the environment and human health”. Moreover, ILO argues that green jobs are an integral part of the concept of decent work, because this practice is a valuable source of growth and productive employment creation, overcoming poverty and inequality (ILO, 2017).

Figure 1 illustrates the differences between the spheres of “decent work”, “green jobs” and “green economy”.

It can be argued that a continued lack of decent work opportunities, insufficient investments in green jobs lead to an erosion of the global social contract underlying Sustainable Development Goals: that all must share in progress of sustainable development and green economy (UNEP, 2008).

Figure 1

Green Jobs as an element of the Green Economy (ILO, 2017)

The Green Jobs Initiative can help advance progress in reducing the environmental impact of economic activity and improving living standards. First of all, green jobs are associated with the development of new innovative areas, such as renewable energy and circular use of resources, increasing the number of green generation facilities and creating new jobs (UNdocs, 2015).

A critical analysis of scientific articles (Janser, 2018; Liu et al., 2022; Bowen et al., 2018) showed that to assess the impact of green jobs development, achievements in different areas have been proposed, in particular:

- increasing the energy efficiency and raw material efficiency;
- limiting greenhouse gas emissions;
- minimising waste and pollution;
- protecting and restoring the ecosystem;
- supporting adaptation to climate change impacts.

Conceptual link of Green Jobs with other elements of sustainable development is shown in Figure 2.

Figure 2

Conceptual link of Green Jobs with other elements of sustainable development (Paliekhova, 2020)

At the same time, the implementation of the concept of green jobs requires a just transition that will allow timely use new opportunities and overcome possible problems associated with the process of integration of greening elements, social development and achievement of decent work (Paliekhova, 2020).

Indeed, UN reports confirm that globally, labour productivity has increased and unemployment rates have fallen significantly. However, more progress is needed to massively increase green jobs, which involves the development of green industries with the creation of decent work conditions. It is clear that the green transition will require wholesale reforms to overcome economic uncertainty and interaction of key green economy programmes, including development of circularity, environmental management, certification and standardisation, etc. In this format, the European Environmental Policy 2020 and the vision of where to be by 2050 regarding the green transition, as well as the adoption of the Green Deal in 2019, were recognised as global drivers for change.

It can be argued, however, that from practical implementation perspective the goal is a challenge for Ukraine, whether in traditional sectors such as manufacturing and construction, or in new, emerging green sectors such as renewable energy and energy efficiency.

The issue of green jobs is acute for traditional industries that have the greatest negative impact on the environment, global warming, and public health. In particular, these are mining activity, ferrous and nonferrous metal industry, power industry, cement industry, transport services, construction industry, waste management, and agriculture. These industries are mainly concentrated workers with inadequate wages, who have difficult and dangerous working conditions. In addition, low-competitive companies do not have the funds to reorganize production and jobs. That is, there will be a need for measures that promote a fair and painless transition to an environmentally sustainable economy, where more jobs will be created than lost (ILO, 2017a).

Before the start of the war in 2022, environmental issues were not a priority of the Ukrainian government, so the implementation of green models was extremely slow. Ukraine remained one of the most energy-intensive countries in Europe (Enerdata, 2021). Alternative energy has just begun to develop, the market for ecological products was extremely uncompetitive, and accordingly, the number of Green Jobs was small in the country.

Another area that has a significant potential for «green growth» is agriculture, in particular organic farming, the cultivation of energy crops (rapeseed, willow, corn), and the use of straw for energy purposes. Ukraine is one of the world's top agricultural producers and exporters and plays a critical role in supplying oilseeds and grains to the global market. The USDA sees the rapeseed production in Ukraine in 2023/24 MY at a record 4 mln tonnes, which is 14% higher than last year's crop[2].

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[2]See: Ukraine on the way to record rapeseed exports, but at what cost? –https://www.apk-inform.com/en/exclusive/opinion/1535791

These are the existing and potential increase in rural unemployment, stable demand for various types of biofuels in the EU, constant increase in prices for traditional energy sources, existing experience in organic farming and demand for its products (Martynyuk, Okharenko, 2021).

Conclusions. The effective post-war reconstruction of Ukraine based on a green sustainable growth strategy requires, among other things, a focus on the Green Jobs Initiative which aims to create decent jobs decoupled from the extensive use of resources, and leading to an increase in the quality of life of the individual while reducing the negative impact on the environment. It was found that in the literature, there is currently no universally accepted definition of "green job". It seems that most authors choose to address the issue of green jobs, используя the definition given by the Program United Nations Environment Program (UNEP), the International Trade Union Confederation (ITUC), the International Organization of Employers (IOE) and the International Labor Organization (ILO).

However, the review of the literature reveals that clarification of the concept of "green jobs" is also linked to the desire to highlight the importance of green jobs in achieving the minimization of the use of natural resources and the introduction of new production technologies that will provide decent working conditions for workers.

Although in EU policy progress has been made in the broader practical use of the green jobs concept, in Ukraine the lack of such an initiative may raise problems with restoring the national economy on the principles of sustainable green growth. The study found that today it is difficult to assess the potential of green jobs in Ukraine due to the lack of special studies and relevant statistical reporting. It can be noted that this process is not happening as fast as it seems at first sight. A large-scale transition to responsible models of production and consumption, a change in approaches to organizing jobs, etc. is required. However, there is already successful experience of European countries that needs to be studied, adapted, and implemented in order to speed up the green transition.

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MANAGEMENT ASPECTS OF ADAPTATION OF THE HIGH-TECH SECTOR OF THE UKRAINIAN INDUSTRY TO THE REQUIREMENTS OF THE GLOBAL ECONOMY

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Introduction. National economies focused on global integration are developing much faster than economies that are focused only on the domestic market. The constant interaction of the subjects of integration necessitates a progressive movement towards to the market reproduction system. The main mechanism of this movement is competition. To function successfully in a competitive environment, most companies are forced to continuously improve and expand the innovative focus of the means of production, which used in manufacturing process. At the same time, the incremental level of demand increases the need to enlarge production and consumption, which leads to a new rise in manufacturing.

The research is based on methods of dialectics, which allow identifying the trends in the development of the machine-building complex of Ukraine in the direction of increasing the competitiveness of products in the international market in the context of scientific, technical integration and requirements for the sustainable development in industry. The goal of the study is to substantiate the theoretical and applied points for increasing the competitiveness of products on the international market in the context of scientific and technical integration based on the reorientation of high-tech engineering. The objectives of the study are: substantiation of the meaningful characteristics of the competitiveness of high-tech domestic products in the world market; analysis of the problems of domestic mechanical engineering that slow down its development; argumentation of the need to develop a comprehensive concept for the development of high-tech industries in Ukraine, based on the factors of ensuring sustainable development.

Presentation of the main research. The determining factor of modern economic development is the need for constant implementation at all stages of social reproduction of the achievements of scientific and technological progress. The unprecedented growth of the impact of science and new technologies on socio-economic results has led to the formation of a new economy based on knowledge and large-scale reorientation of economic entities from resource-intensive to knowledge-intensive activities.

With the development and deepening of the processes of internationalization of the scientific and technical sphere in the world economy, the main role in increasing the effectiveness of the implementation of the strategy of innovative development of Ukraine is acquiring the use of the advantages of international scientific and technical integration. The innovative dynamics of the development of the world economy at the present stage requires from the government to choose certain models of economic growth. Consequently, the economy of our country faces a priority task – the transition to an innovative development path based on the introduction of the achievements of science, technology in all spheres of the economy, especially in the machine-building industry.

The machine-building industry is one of the science-intensive industries that have a high scientific and technological development potential in the structure of the national production of Ukraine. Due to the tendencies of globalization and sustainability of the world economy, the machine-building industry of Ukraine has worsened its performance indicators, which resulted in a significant decrease in competitiveness indicators in world markets. In general, domestic mechanical engineering has a number of problems:

1 Using of outdated equipment and technologies in the industry which leads to high maintenance costs.

2 Presence of interacting service systems of the industry, which are characterized by a high degree of obsolescence.

3 Low investment attractiveness of Ukrainian machine-building enterprises, which leads to problems with financing, what creates difficulties for restructuring and developing programs to transform the development strategy.

4 Achievement of low indicators in the direction of production cooperation in the context of globalization of economic processes.

5 Lack of qualified personnel.

Despite the negative trends, the industry remains complex and multifaceted with a proportional allocation of production facilities within the country (Pihul'&Pihul', 2018). The adaptation of the branches of the high-tech sector of the Ukrainian industry to market conditions is the most important task of the national economy. This adaptation involves the arrangement of industrial complexes to the market environment and ensuring sustainable development. At the present stage of development, the machine-building industry, as the most science-intensive direction, is characterized by the absence of stable development trends and significant disproportionality. The global market for engineering products continues to be sustainable and is constantly expanding across all sectors. In the interstate market of equipment and technology, due to the growing number of exporting countries, the competition between them is intensifying.

However, on the other hand, international technological cooperation is intensively developing in the machine-building industry. Expensive scientific and technical developments and the organization of a full production cycle lead to the specialization of science and industry in countries with this sector of the economy.

Based on the different levels of development of machine-building enterprises, there are various mechanisms for changing the structure of the industry in the direction of increasing the competitiveness of machine-building products in the world market. For highly competitive machine-building industries on the international markets, it is necessary to strengthen their competitive advantage based on science-intensive products. For subjects of machine-building enterprises that are competitive in the national market, foreign experience should be attracted in creating a unique domestic product. For potentially competitive enterprises of the machine-building complex, it is necessary to conduct research on the possibility of building production facilities on the territory of Ukraine.

The national policy of industrial integration in the machine-building industry cannot yet be recognized as optimal (Korotkyj, 2015). As a rule, the economic and organizational measures taken are not based on scientific forecast and pursue the private interests of state institutions and companies. The currently used mechanism for restructuring domestic enterprises of the machine-building complex is not systemic and does not reflect industry specific features. In this connection, it is extremely necessary to develop a comprehensive concept for the development of science-intensive industries in Ukraine, based on taking into account all the main factors of ensuring national security and national development in the near future.

One of the most effective methods of competition in the world market for machine-building products is the implementation of integration processes to strengthen the economic stability of enterprises and increase their scientific and technical potential. The strengthening of these processes in the world economy is evidenced by the emergence of transnational integrated structures. The 5-7 of the largest transnational structures account for more than 50% of the world production of high technology products. Our state should strive to actively participate in global organizations that regulate the world economy, increasing its authority in the world community. For this, it is necessary to allocate funds for scientific research in engineering at the level up to 2-3% of GDP, as it is done in developed countries.

Conclusions. The Ukrainian machine-building complex has a number of problems that hinder its development. The industry operates in difficult socio-economic conditions associated with a lack of demand for domestic products and funding sources; the presence of an outdated base of fixed assets; lack of skilled labor; lack of implemented innovations, modernization, reconstruction and compliance with the international quality system. Further activity of the machine-building complex of Ukraine in such conditions will lead to bankruptcy. Today, the situation requires a revision of the state strategy for the development of both the industry of Ukraine in general, and the machine-building industry in particular, as one of the most important and promising areas of the economy.

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DECENT WORK: ECONOMIC AND SOCIAL ASPECTS IN UKRAINE

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Introduction. In this article, we will discuss some of the issues related to the implementation of the Decent Work program. Labor as a basic of human life is the source of all benefits and a form of realization of the intellectual and physical abilities of an individual, the development of human potential, which in modern conditions is a determining factor in socio-economic progress. Decent work is understood as the existence of employment on the principles of freedom, equality, security and human dignity. Labor should be economically expedient for society and provide the employee with earnings sufficient for his material well-being, and contribute to the development of his professional qualities and personality (Paliekhova, 2020).

Presentation of the main research. In 2013, the International Labor Organization (ILO) adopted the Guidelines for a Fair Transition to an Environmentally Sustainable Economy and Society for All, which defines policy frameworks for decent work, such as inclusiveness, freedom, fairness, equality, security, representation and dialogue, i.e. activities of subjects of social dialogue in the prevention of social conflicts in the field of labour organization. With the support of the International Labour Organization, the Decent Work Program of Ukraine was developed for the period 2020-2024. This program is closely related to other social goals, namely: goal 1 - overcoming poverty, 3 - health, 4 - the necessary level of education, goals 5 and 6 - gender equality and reduction of any inequality (see Table).

The main one is employment. According to data for 2019, before the emergency situation with COVID-19, the employment of the working-age population in Ukraine is relatively low compared to EU countries. In the structure of employment by professional groups, there is a fairly high level of unemployment of “professionals” and “specialists”, as well as the problem of youth employment.

Table 1

Decent Work Program of Ukraine for 2020-2024 (ILO, 2021)

Priority	Final results
1. Improved social dialogue	1.1. Reformed National and Territorial Socio-Economic Councils as effective platforms for dialogue 1.2. Strong social partners 1.3. Improved collective bargaining at the sectoral level
2. Inclusive and productive employment	2.1. Modern and efficient employment services 2.2. The mismatch of qualifications to the needs of the labor market among young people has been reduced 2.3. Improved business skills
3. Improved working conditions and social protection	3.1. Improved compliance with international labour standards of legislation and law enforcement mechanisms on occupational safety and health and the transition to a formal economy 3.2. Improved protection, level and equality of wages 3.3. Improved coverage and sustainability of social protection 3.4. Overcoming violence and harassment in the workplace

In a relatively prosperous 2019 in Ukraine, the unemployment rate among people aged 40 to 49 was 8.1%, and among young people –15.4%, that is, almost twice as high. Today the youth unemployment rate is 20.7%. There are many factors causing this condition, however, let us consider first of all the quality of education, it concerns the correspondence of training at universities to the needs of employers. In our country, about 52% of the active population has received higher education - in OECD countries only 36% (Repko, Ruda, 2017).

We have many universities, 1 million more people than in Great Britain and even in Germany. However, none of the polytechnic universities rose above the 400th line in the world ranking (Palekhov, Palekhova, Schmidt, Hansmann, 2019). Even the best of them are not tuned in to reputation with employers.

Let us consider the international programs of our university, which are opened to students and teachers. Dnipro Polytechnic cooperates with more than 50 universities around the world. Of these, the Brandenburg University of Technology is the most powerful partner we have been working with since 1999. Since 2013, a Memorandum has been in effect, according to which more than 40 joint educational and scientific programs have been opened today. That is, students of our university have great opportunities for the development and mastery of knowledge on sustainable development at the European level (Pivnyak, Shvets, Palekhova, 2017).

Pay is the second cornerstone of decent work. According to EU criteria, the minimum wage should be at least twice the subsistence minimum, and the average wage should be from one and a half to two times higher than the minimum. Today, the level of wages in Ukraine provides no more than 21% of the reproduction of the labour force, which does not even compensate for direct labour costs, does not stimulate interest in reorienting the labour force to priority spheres of activity. As a result, wages do not fulfil their main functions - reproductive, motivational, regulatory, social. The current problem in the workplace today is unfair savings on wages. Ukrainian employers act according to the old, extensive principles. The main violations of workers' legal rights to decent work are shadow wages, reaching UAH 500 billion a year, increasing vacancies and increasing workload, part-time work and compulsory vacations at their own expense.

Decent work includes providing safe and secure working conditions for all workers. The occupational injury rate in Ukraine is one of the highest in Europe. On average, there are 9.3 accidents per 100 thousand workers. For comparison, in the EU countries this index is 1.7. Main causes of accidents, including fatal accidents, are predominantly organizational - failure to fulfil official duties and disruption of the technological process.

Conclusions. The study found that to implement the concept of decent work in Ukraine, it is necessary to develop a set of measures at the national, sectoral and regional levels and at the level of enterprises and institutions. So, at the national level, the most relevant is the phased introduction of state guarantees in the field of wages, which will ensure an expanded reproduction of labor potential at a higher quality level. At the sectoral and regional levels such measures have to be taken: assistance in the implementation of international standards of social responsibility of business, principles of corporate governance and social packages for employees at enterprises; counteraction to attempts by employers to improperly formalize labor relations. At the enterprise level, the most pressing problems are the increase in the share of wages in the cost of goods, works, services; conclusion of collective agreements; ensuring the professional development of employees, etc. An increase in the qualifications of workers and decent wages for their labor will contribute to an increase in the level of competitiveness of the national economy.

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BUILDING SUSTAINABLE AND FAIR MARKETS: GERMAN EXPERIENCE

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Introduction. Modern trends in the development of global and national economies have been largely formed due to the awareness of mankind of the need to use available resources wisely and to care for the environment. Thus, a specific type of managerial scientific and practical activity has emerged - sustainable development management. The creation of values in the sustainable development management system involves compliance with relevant principles not only within individual companies, but along the entire value chain and considering global and national sustainable development goals. Depending on the size of the organization and its market goals, the Sustainable Development Management Program of companies may provide different degrees of responsibility for sustainable development, due to factors such as company size, industry affiliation, activities, and market goals, etc.

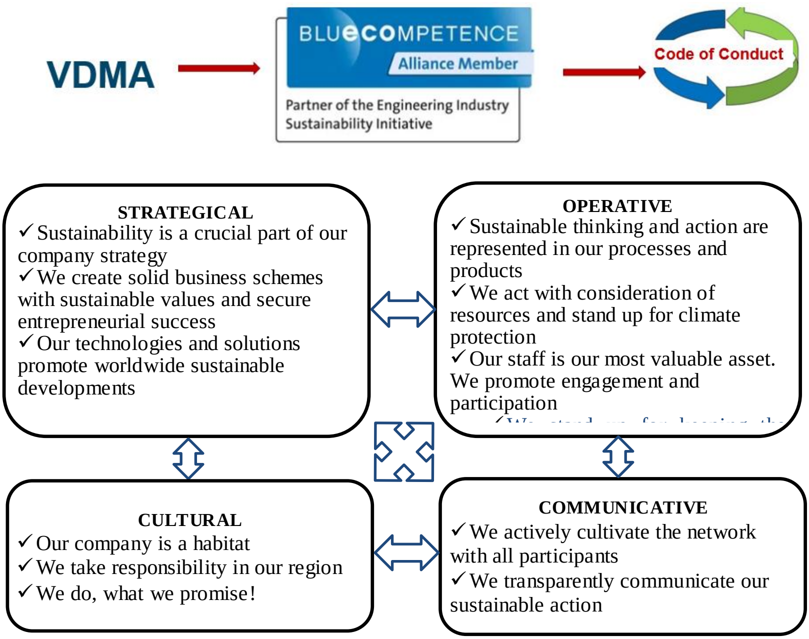
Presentation of the main research. One of the active participants in the global movement for sustainable development is the German Union of Machine Builders (German: Verband Deutscher Maschinen und Anlagenbau – VDMA), that also stands for free and fair competition. The Union has developed and is implementing many programs for sustainable development management in mechanical engineering and equipment production (VDMA, 2021), that are also directed to popularizing of sustainable decision in the sector. As part of the partnership, the participants recognize and adhere to the twelve principles of sustainable development of mechanical engineering and industrial production set out in Sustainability Initiative Blue Competence (see Figure 1).

Initiative Blue Competence helps individual companies to find optimal solutions and products, as well as to ensure compliance with the values of sustainability in global chains with the involvement of all participants in such chains using common transparent criteria and standards of sustainable development.

By VDMA a Code of Conduct has also been formulated, the provisions of which are assumed by all participating companies «Blue Competence». Such provisions are: respect for human rights and the rule of law; prevention of discrimination in all its manifestations; prevention of the use of child labor, forced labor and punishment of employees; prevention of corruption; ensuring the freedom of self-determination of employees, decent pay for their work and compliance with labor laws; creating safe working conditions and caring for the health of employees; ensuring the protection of the environment through compliance with current requirements and the prudent use of natural resources.

Figure 1

The principles of Sustainability Initiative Blue Competence (compiled on the basis of VDMA, 2021).



As part of the Initiative Blue Competence, Kärcher Group has identified its mission as “a market leader in sustainable development that guarantees customers a high level of customer satisfaction” and has developed the Sustainability Management Program “Perfect Sustainability” (Kärcher, 2021). This program covers six areas of responsibility: for the environment; for products; for supply chains; for the development of the organization; corporate social responsibility; responsibility for the company's employees.

Figure 2

Sustainability management program: German experience Kärcher (Kärcher, 2021)

Zertifikat seit 2013 audit berufundfamilie

- Environmental responsibility
- Product responsibility
- Responsibility in supply chains
- Responsibility for the development of the organization
- Corporate social responsibility
- Responsibility for the company's employees
- Accountability to society for sustainable development

Sustainable development management is designed to ensure the usage of effective actions for environmentally and socially balanced economic development of the company, which would contribute to the implementation of strategies for sustainable development of the industry, region, and country. The implementation of sustainable development tasks involves the use of various management tools at the level of the company as whole and individual departments that perform specific management functions.

Such tasks may include the introduction of circular models of resources utilization. Considering the need for constant adaptation of the company to changing and unpredictable operating conditions, the establishment of partnerships with stakeholders along the value chains deserves special attention. Adaptive management displayed as a cycle with double-loop learning. A deliberative phase includes problem assessment, design of the decision architecture and implementation. An iterative phase includes monitoring, evaluation of monitoring results and adjustment of management strategy (Williams, Brown, 2014).

Conclusions. Thus, a balanced and effective activity of the company in the long run can be ensured through the accumulation of knowledge about external factors, learning from experience and predicting the results of mutual influences of the environment and human activities. The use of adaptive management provides opportunities for gradual implementation of the principles of sustainable development, which is especially important in the primary sectors of the economy, which activities significantly affect environmental, social and other systems, and to adopt adequate strategic solutions lack the necessary knowledge or experience.

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CLUSTERING IN SPATIAL PLANNING FOR SUSTAINABLE DEVELOPMENT

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Introduction. It is important to choose integration models of doing business aimed at increasing their competitiveness in the context of globalization processes which covers not only the economy of states but also the economy of regions. One of these types of modern innovation structures are cluster models of organization of economic activity as a type of network structures that have proven their high efficiency in different countries.

International experience proves the expediency of using cluster structures in increasing the sustainability of the economy and especially in increasing the sustainable development of regions. Clusters should be an effective tool in overcoming the negative factors that hinder the development of the regions of Ukraine and the country as a whole (Industry4Ukraine, 2021).

Presentation of the main research. There are a significant number of definitions of the term "cluster" in both foreign and domestic publications, which in some way reflect the theory and practice of clustering processes. The first theoretical views on clusters were based on industry combinations, and today clusters are considered as innovation-territorial associations that are better coordinated with the sources of competitive advantage, cover foreign economic relations, relations between industries, technology, information, marketing etc.

The research allows to formulate the following author's interpretation of this definition: Cluster is a territorial-industrial form of optimization of the region's economy, which is based on a poly-structural model of integration of economic entities in order to synergistically use the potential of a single resource, material and technical base to increase production and expand economic activities to ensure sustainable regional development (Sarana, Lutsenko, 2018). Thus, the usage of a cluster approach of forming an effective strategy for sustainable development of the regions aims to solve an increasingly wide range of tasks, in particular:

- analysis of the region's competitiveness;
- development of regional development programs;
- stimulation of innovative activity in the region;
- ensuring the interaction of large and small businesses, etc.

Cluster structures represent a territorial and spatial form of production organization and optimization of the region's economy, focused on innovative development in both scientific and industrial activities. The authors proposed the concept of “autonomous specialized poly-structural cluster”, which, in contrast to the existing ones, involves a combination of economic entities not on the basis of belonging to one industry through the manufacture of relevant products and services, but also on the basis of belonging to a single resource center cluster, which provides an opportunity to use a set of resources of natural and man-made origin for the manufacture of products and services of various industries.

The autonomy of such a cluster is self-sufficiency of the most important resources (energy, water and land), their location directly on the cluster and the possibility of their integrated use in case of any need for maximum efficiency. The specialization of the above cluster is the availability of resource potential of the region belonging to a particular industry. The poly-structure of such a cluster is the use of specialized mining resource potential for production and provision of services of various industries.

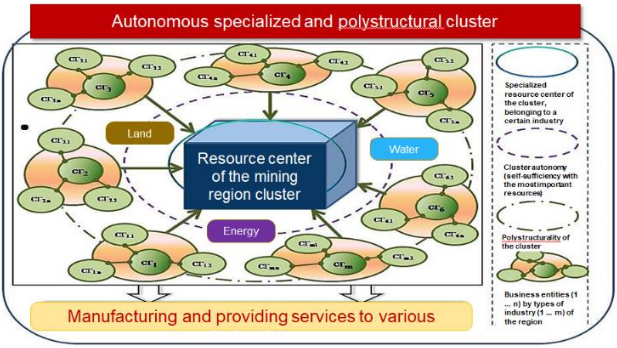
A graphical interpretation of the above concept on the example of a mining region is given in Figure below.

Conclusions. Today, the issues of studying the nature of the association of the subjects of the regional cluster, the principles of formation and interaction, its basis are very important. Usually a regional territorial production cluster is formed as a mono-structural model, which is based on a single production area, a single production chain, process, a single innovative technology and so on.

According to the authors, according to the above definition of “cluster”, the most effective should be a parallel, ie, poly-structural approach to grouping enterprises. In such a cluster, enterprises are united not on the principle of belonging to one production chain, but on the principle of belonging to a single material and technical base, on which the production of several types of products or services can be carried out at once.

Figure 1

Graphic interpretation of an autonomous specialized poly-structural cluster on the example of a mining region



This will allow a more rational and full use of the “basis” of the cluster, to form a several times expanded range of business projects and effectively implement them, which will stimulate the regional economy and ensure sustainable development of regions.

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THE MANAGEMENT MODELING OF ECOLOGICAL AND ECONOMIC SYSTEM

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Introduction. Entrepreneurs play an important role in the socio-economic development of the country, providing employment and saturation of the market with a variety of goods and services to meet social needs. However, the growth of industrial production increases the man-made load on the environment, contributes to the emergence of environmental problems that threaten the living conditions of the population, forming humanitarian problems. Therefore, the successful management of business entities requires the coordination of their economic performance, environmental safety and social responsibility, ie the balance of economic, environmental and social spheres, which corresponds to the principles of sustainable development.

Presentation of the main research. Ensuring the balance of economic, social and environmental dimensions of sustainable development of the regions and Ukraine as a whole requires the broad participation of all stakeholders. Entrepreneurial structures must take real steps towards sustainable development. The goals of sustainable development serve as guidelines for long-term planning of business structures. Thus, control of business processes can be carried out based on the use of modern information technologies.

Scientists actively use the system-situational approach in the study of production and economic processes, economic and environmental phenomena, management problems at the level of independent business entities. Thus, exploring the definition of the word “sustainable” in the concept of "sustainable development" Zagorsky V. S. notes its ‘double load’: on the one hand, economic development provides a stable state of the environment, and on the other – sustainable economic growth. Given this, the environment and the economy must be considered in one system and properly manage this system (Zagorsky, 2018).

Rozum R. I. distinguishing two interconnected subsystems in the ecological and economic system: ecological and economic, emphasize that the unifying section between them is the sphere of nature management (Rozum et al., 2018).

Scientists in determining the initial conditions for sustainable development of the ecological and economic system emphasize the need for transition from spontaneity to manageability. And this involves the following steps: to assess the state of the system (the system of indicators is provided for this, its development is a separate task), to forecast (predict) the development of the situation, to determine the necessary indicators that need to be achieved and to establish the necessary management influences which will ensure the achievement of these indicators over a period of time or ensure the stable existence of the system. Solving these problems makes it possible to increase the validity of management decisions and requires appropriate information and analytical support. This determines the feasibility of applying mathematical modeling during the study of such systems.

Ecological and economic systems are a set of objects of human and nature production activities and their interaction. Such systems are characterized by a large number of elements, the interaction between which is difficult to describe in the form of analytical functions.

The relationships between the factors that describe the functioning of the system may be implicit, the influence of one factor on another is not always known and can sometimes be detected only in the process of research. Thus, such systems are poorly structured, so to study scenarios of its development, taking into account possible situations, as well as to determine ways to achieve the desired state of the system through targeted management influences, it is advisable to use cognitive analysis, what focuses on the study of poorly structured systems.

It involves the representation of the system in the form of a cognitive map and its further study using the theory of impulse processes. The authors conducted a study of the ecological and economic system on the example of the company of the fuel and energy complex as the activities of such enterprises have a significant impact on the environment and therefore require special attention (Tymoshenko et al., 2020).

To study the production and economic activities of the company as an ecological and economic system, the following main indicators (factors) were identified, which were taken as the tops of the cognitive map:

1 investments in environmental protection, million UAH;

2 net cash flow, million UAH;

3 coal production, thousand tons;

4 electricity generation, million kWh;

5 specific emissions into the atmosphere, t / t;

6 specific discharges of wastewater, cubic. m / kWh.

The characteristics of emissions into the atmosphere were taken in this form, as emissions into the environment depend not only on the treatment technology used, but also on production volumes. The use of specific emissions into the atmosphere makes it possible to assess the effectiveness of the company's environmental activities, as they reflect how many tons of emissions per ton of coal produced.

The influence of one factor on another was assessed on the basis of expert assessments and methods of statistical analysis. Based on the constructed cognitive model, three problems were solved:

- forecasting the company's development and its impact on the environment under conditions of sustainable production growth;
- determination of the necessary management influences to achieve the desired state of the company after a certain period of time;
- definition of management influences to achieve the desired ratio between the indicators that describe the company's activities.

The study of the constructed model showed that in the presence of an increase in production we have a tendency to reduce harmful emissions into the atmosphere and wastewater pollution due to the steady increase in investment in environmental activities.

Subject to the submission of control effects, the set environmental and economic indicators can be achieved in a much shorter time (all results are achieved in 4 years, if control effects are not applied – the results are not achieved within 5 years). At the same time, the main investments in the company's environmental activities should be made in the initial period, namely in the first two years, then they are used as corrective actions.

Conclusions. Thus, the methodological approach to justify management decisions on the functioning and development of the business structure as an ecological and economic system to ensure the solution of sustainable development based on the application of cognitive modeling was improved by the authors. It is established that business structures that carry out production and economic activities and actively use natural resources, are poorly structured systems on the basis of the fact that not sufficiently defined both the system of factors and the relationships between them, so it is advisable to apply cognitive analysis for these structures.

The cognitive model of activity of a fuel and energy complex company taking into account ecological and economic aspects is constructed. On the basis of the constructed cognitive model, the forecast of a condition of business structure for 5 years is carried out and the managing influences which provide achievement of desirable ecological and economic indicators of the company activity for a certain period of time and / or the set ratio between indicators are defined. It is proved that cognitive modeling should be used to increase the validity of management decisions in developing a scenario to achieve the desired state of the business structure, taking into account a certain level of environmental protection. If necessary, it is possible test on the model several alternatives to assess new opportunities for system development.

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BASIC APPROACHES TO RISK ASSESSMENT OF THE BUSINESS PLAN FOR THE SUSTAINABLE DEVELOPMENT

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Introduction. When developing plans and programs for sustainable development, business plan is often not used or used incompletely. In accordance with the theory and practice of project management, the business plan should contain sections corresponding to the areas of knowledge in project management, in particular the main areas include the four: content, timing, cost, quality - which are used to assess the project status (Mashina, 2017).

Despite such a wide range of tasks that are solved in the process of business planning for sustainable development tasks, in domestic practice this term is often reduced to the procedures for writing standard sections of a business plan and/or financial and economic justification of a project.

The structure of the document may vary but it should clearly and fully describe the project objectives, and the conditions for achieving them, linking many indicators, criteria, objective and subjective factors, as well as mechanisms for responding to changing conditions of the external and internal environment into a single system. In this regard, the task of using business planning for sustainable development not only as a search and project research tool for investment analysis, but also as a tool for managing the course of project implementation becomes an urgent problem of project management.

Presentation of the main research. Business planning is an effective management tool widely used in modern economic practice, regardless of the scale, scope and form of ownership of individual enterprises and organisations. A business plan is a working tool for both newly established and existing companies and is a brief, accessible and understandable description of the business, while being the most important mechanism for considering a wide range of potentially possible situations.

Business planning allows you to identify promising project solutions, identify and calculate the funds to achieve them. In this regard, the role of the business planning process in project management is growing, as the development of a business plan is one of the most important and popular stages of the life cycle of any investment project.

In project management, a business plan can be viewed as a comprehensive project management tool that helps an enterprise solve its development problems (Klymenko et al., 2017), in particular in order to: developing financial and feasibility studies for projects and programmes; summarising and reassessing current operations; development of the company's investment strategy; innovative development of the enterprise; risk assessments; public relations and coverage of the results and plans of the enterprise, as well as the activities of partners and competitors in value chains.

The target diversity of business planning allows us to consider this process not only in the context of attracting certain investments in a project, but also as one of the key management tools for sustainable development. This can be used to implement projects and programs of production, development, mergers with other companies, in solving problems of increasing the efficiency of the company's activities, reducing decision-making cycles and relevant bureaucratic procedures, etc.

In this regard, it is advisable to consider a business plan not as a single document, the structure of which is unchanged, but as a toolkit that can change depending on the current tasks and problems of a company or project, and changes in the conditions for their implementation.

The problem of identifying, assessing and neutralising the risks of the planned activities is becoming especially important in the current unstable economic and financial situation in the global and domestic markets and should be addressed at all stages of the project life cycle - both at the stage of identifying and assessing potential risks during the preparation of the Risks and Guarantees section of the business plan and at the stage of project implementation during monitoring and control functions.

In general, the project risk management system includes (Starostina, 2019):

1) risk identification, which involves identifying various types of potential project risks and classifying them according to selected criteria;

2) quantitative and qualitative risk assessment, which includes the selection of risk quantification methods and the correct interpretation of the assessment results, as well as determining the impact of a particular risk on the project efficiency and implementation of the company's overall business strategy;

3) systematic monitoring, expert assessment and risk control within the framework of strategic and operational management of project implementation in order to limit risky decisions and neutralise their consequences.

It should be noted that risk identification is not a one-time procedure and should be repeated regularly as the situation changes during project monitoring.

In order to make the risk identification process systematic, special forms of documents are used that reflect the sources of risks, the project environment, the characteristics of the project's output products, the technologies used, and the experience of the project team.

In modern risk management practice, the following risk identification methods are used (Vitlinskyi, 2016):

- comparison with the full list of risk categories, including: cultural risks; risks related to the quality of project work; risks related to project stakeholder satisfaction, contractual risks, etc;
- analysing the risks of previous projects by examining records related to previous projects;
- use of the brainstorming technique, which aims to identify as many possible risks as possible in the shortest possible time.

The result of the risk identification stage is a list of risk sources and potential risk events, which are included in the Risks and Assurances section of the project business plan.

An important stage of risk management is the quantitative assessment and analysis of risks, which is a procedure for identifying risk factors and assessing their significance and analysing the likelihood that certain undesirable events will occur and adversely affect the achievement of project objectives.

At this stage, it is important to distinguish between qualitative and quantitative risk assessment. Qualitative assessment can be relatively simple its main task is to identify possible types of risks, as well as factors that affect the level of risks in a particular type of activity. Quantitative risk assessment is determined by the probability that the result obtained will be less than the required value (planned or forecasted), as well as by multiplying the expected loss by the probability that this loss will occur.

In the course of monitoring the business plan, the project is subject to control and regulation procedures, which in general represent a classic feedback management scheme. The technology for monitoring the cost and time of work involves creating a plan for the frequency of collecting information on the project's work and using a number of modern methods for determining the amount of work performed, such as the percentage of work performed method, the fixed formula method, the method of weighted milestones, control points and diagrams, etc.

The global practice of project management convincingly shows that the main method of controlling the efficiency and risks of project implementation is currently the EVM (Earned Value Management) method, which is based on the use of a number of numerical indices calculated during the phased implementation of the project. This method can be successfully used not only as part of the methodology for financial management of individual projects, but also in the course of general controlling of large project-oriented organisations. However, in domestic practice, the use of this method is complicated because among project managers it is generally accepted that the mastered volume method is very complex and highly mathematical.

In our opinion, the unpopularity among managers of this quite effective and rather simple analytical tool for project management is associated with insufficient training and low qualification of specialists in the field of project analysis, and the lack of training programmes for risk managers and project managers in many universities. In this regard, currently in the domestic practice of project management, quite simple visualisation tools, such as the percentage of work completed and a control point chart, are used to monitor the project status in the vast majority of cases.

However, in this case, the monitoring algorithm is tied not so much to the hierarchical structure of work (HSW) as to the criteria for the supply of equipment and materials, and the production of the project product. Recently, a more complex monitoring option has been used in modern practice – a traffic light diagram, when at a certain date of project control, it is recorded which ISR activities, in accordance with the basic business plan, should be completed, which should be in progress, and which may not even be started.

The next step is to record the actual performance of these activities (“completed”, “in progress”, “not started”), and the project manager gives a subjective assessment of the status of each activity (“all is well - green signal”, “keep under control - yellow signal”, “intervene immediately - red signal”).

These tools are easy to use, but can only be used in cases where the IMS is simple or the project does not involve strict control over the use of time and financial resources, which is very rare in practice. Compared to the tools described above, the completed scope method is a serious analytical methodology that allows assessing the performance of project work in three main areas: content, timing, and cost. An auxiliary tool for monitoring the project status is the Gantt chart.

The ideology of EVA (the Exploited Value Analysis) is based on the calculation and comparison of three project cost characteristics at a certain control date:

- planned volume (planned value of planned work - PlannedValue, PV) - the budgeted value of the work that, according to the business plan, should be performed as a result of an operation or an IMR element by a certain deadline;
- volume completed (planned value of work performed - EarnedValue, EV) is the amount of work specified in the budget that was actually performed as a result of a planned operation or IMR element over a certain period of time;
- Actual Cost (AC) - the total cost of performing work as a result of a planned operation or ISR element over a certain period of time (Shepilova, Kiriyenko, 2019).

The information support of this method also includes the use of accounting and management accounting data to determine the planned project budget (BAC - Budget at Completion) and build a cumulative planned project cost schedule (S - curve), which shows the dependence of planned total project costs on time.

At the same time, the principles of the mastered volume method can be applied to any project and in any industry. It is well known that the degree of volatility of a process is an important risk assessment indicator. Therefore, in addition to its traditional use in determining whether a project is within the planned budget and whether it will be completed on time, the completed volume method should be actively implemented in the practice of project risk management and become an effective tool for monitoring business planning.

Conclusions. Monitoring a project's business plan is an extremely difficult task, as in real life, risky situations often arise that impede the implementation of plans, such as untimely deliveries of equipment and materials, unforeseen delays in work for various objective and subjective reasons, delays in the timing of various necessary approvals, etc. The analysis of the above indicators allows the project manager and the project team to monitor the volatility of the project, i.e. the deviation of the volume and cost of work actually performed to this point in time from the volume and cost that were planned.

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Наукове видання

СТАЛЕ ВИРОБНИЦТВО ТА СПОЖИВАННЯ В ПРОМИСЛОВОСТІ: ВИКЛИКИ ТА МОЖЛИВОСТІ

Збірник наукових статей

За заг. ред. Павличенко А.В., Палєхової Л.Л.

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