Smart strategies for the transition in coal intensive regions

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Research & Innovation strategy in the field of energy for Donetsk Region

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Executive summary

This report provides assessment of the state of investment climate and the prospects for attracting investment in science-intensive technologies for the development of power industry and the economy of the region as a whole. It is shown that despite the complexity of the economic situation, in implementing development strategy tasks, such as ensuring complementarity of national and EU R&I policy, avoiding duplication and strengthening cooperation, Ukraine's participation in European research programs and platforms, creating favourable innovation climate change in Ukraine, creating a balance between research and innovation, adopting a communication approach, ensuring coordination and cooperation between public, private and research structures will assist the transformation of the power industry in the Donetsk region. The main priorities in the changes of the region's energy are the wider use of renewable energy sources, such as biomass (assuming a significant agricultural production in the region), wind energy, solar energy (PV). These areas require attention both from the point of the investment policy of the state and from the international investment funds.

1 Introduction

According to the legislation of Ukraine, the priority directions of science and technology development are scientifically, economically and socially substantiated directions of scientific and technical long-term development, which receive the priority state support in the formation of the efficient research and development sector to provide production competitiveness, sustainable development, national security and improving the quality of life of the population.

Priority areas of innovation in Ukraine are scientifically and economically sound areas of innovation activity aimed at ensuring economic security, creating high-tech competitive environmentally friendly products, providing high-quality services and increasing the country's export potential with effective use of domestic and world scientific and technological achievements. For the period 2022-2026, the Government and the Ministry of Education and Science (MES) have decided to develop a single system of priority areas of science and innovation focused on achieving sustainable development goals (SDG).

At the present stage, the scientific search has been intensified for potential ways of innovative and scientific and technical development of Ukraine and the improvement of the research area in the context of European integration processes. Relevant research is conducted by scientists from leading research institutions of the National Academy of Sciences of Ukraine, as well as individual representatives of university science and experts. At the same time, it should be noted that Ukraine does not have a systematic approach to scientific development and the formation of a strategy for Ukraine's integration into the EU's research, education and innovation space. Meanwhile, none of the documents addresses the proposals for the own list of indicators and own assessment of the current level of research, educational and innovation space of European integration.

With the fast technological progress and alarming forecasts regarding climate and environmental degradation, requirements and approaches to technological forecasting are changing: on the one hand, the analysis of large scope of data on scientific and patent information allows us to assess scientific and innovative development priorities of the country; and, on the other hand, these areas of research should meet problems of the society and affect both the competitiveness of production and the achievement of the SDG by 2030.

Taking into account these tasks, guidelines have been developed and priority areas for the development of science and innovation in Ukraine for 2022-2026 have been identified, which are based on the technological forecast. The forecast is considered as one of the tools of the

unified system of public administration in the field of science, technology and innovation (STI), aimed at achieving strategic goals of the country's development by coordinating the goals and actions of all key stakeholders.

Due to the fact that in 2021-2022 the Laws of Ukraine "On Priority Areas of Science and Technology Development" and "On Priority Areas of Innovation Development" expire, the Plan of Priority Actions of the Government of Ukraine for 2021, approved by the Government Order of 24 March 2021, provides for the formation of a new system of priority areas for the development of science and innovation, focused on achieving the SDG. According to the Decree of the President of Ukraine dated 30.09.2019 № 722/2019 "On the Sustainable Development Goals of Ukraine for the period up to 2030" the tasks of the SDG must be taken into account in defining the priority areas of science and technology development.

The expert group established by the order of the Ministry of Education and Science to determine the priority areas of scientific, scientific-technical and innovative activities consists of seven sections by the number of priority areas. The Expert Group consists of leading specialists of the National Academy of Sciences of Ukraine, national industrial academies, leading research organizations, higher education institutions, and the representatives from business and government.

Sections of the Expert Group consider the proposed technologies/developments, form clusters from them, formulate their denominations and approve the projection of the prior scientific and technological directions. In the absence of consensus among the members of the section of the Expert Group, an additional survey is conducted. The Expert Group considers the thematic priorities selected by all sections, approves them and sends them to the Ministry of Education and Science for preparation of a draft government resolution.

Donetsk region is a complex industrial region that requires immediate transformation, but it also is one of the most conservative in Ukraine. The world was developing rapidly, while inertia of both the country as a whole and the region in particular left it with traditional industries and products. Moreover, the region has been severely affected from the side of the territories under temporary occupation. The so-called Kerch Bridge closed the entrance to the Sea of Azov for large PANAMAX-class vessels, and most insurance companies and major carriers migrated to other ports.

The transformation of the region cannot and will not be aimed at restoring everything as it was. But there is a basis for such a transformation in the regions: a strong, albeit broken infrastructure network, skilled and hard-working people, natural resources, fertile land and access to the sea. The strategy of economic development of Donetsk and Luhansk regions for the period up to 2030 envisages to account these strengths and ensure the construction of a modern economy based on them. The purpose of the Strategy is to ensure the restoration of economic power of the entire region to a decent living standard for people living in the region. The strategy envisages creating a clear and understandable framework for economic activity in the region, clearly defining the role of the state in this framework and ensuring a clear understanding of the main directions of community development.

The regional economy and labour market were mainly oriented on the Russian Federation, and large enterprises were not modernizing production due to the traditional market. Exports to the Russian Federation accounted for 19.7% of total exports. Exports of goods and services in the Donetsk region in 2019 compared to 2013 decreased by 71% and amounted to about 3,100 million US dollars, imports decreased by 74% and amounted to about 1,500 million US dollars. With the beginning of the armed aggression of the Russian Federation against Ukraine, many Ukrainian industrial enterprises in the temporarily occupied territories of Donetsk region terminated their activities, and large enterprises in the Donetsk region, where public authorities exercise their powers in full, lost their largest market and significantly reduced their profits [1].

Given the large-scale destruction of the Donetsk region's economy, significant human losses and the threat of the negative impact of armed aggression from the Russian Federation, resolving is needed to the following institutional and practical problems:

- lack of sustainable development of entrepreneurship and investment due to lack of strategic approach to support and development of business in the territories affected by the armed aggression of the Russian Federation against Ukraine, arranging quarantine and intensified anti-epidemic measures in connection with restrictive anti-epidemic acute respiratory disease COVID-19 caused by coronavirus SARS-CoV-2;
- leak of labour and intellectual potential due to labour and educational migration, high rates of depopulation and aging of the population of Donetsk region. A significant part of active, creative and self-sufficient citizens of working age left the territory of Donetsk region;
- outdated material and technical basement and structural imbalance of the industrial complex with the dominance of industries with weak innovation receptivity;
- disruption of infrastructural and logistical links caused by hostilities, which limits the movement of people, capital, products and information;
- depletion of natural resources and critical environmental situation;
- lack of modern financial, legal and insurance instruments in the investment market of Ukraine;
- factors that hinder the development of entrepreneurship and investment and are inherent in the entire territory of Ukraine: distrust of the judiciary, the complexity of administration, corruption;
- lack of interest of investors in investing in the development of Donetsk region and, as a consequence, lack of financial, investment and material and technical resources aimed at the development of this region;
- stagnation of interregional cooperation relations of large, medium and small businesses, underdeveloped interregional consolidation and focus of regions only on the problems of their own development.
- To address these issues and provide adequate and effective responses to challenges, the use of special instruments of economic, legal and organizational nature is envisaged after appropriate economic justification, in particular: in the strategic direction of improving institutional and financial instruments and regulatory policy:
- introduction of new investment protection instruments, in particular the opening of branches of international commercial arbitrations with the expansion of their jurisdictions to protect investments made within the territories of priority development of Donetsk region;
- ensuring effective coordination of attracting financial resources, including funds from international partners, to fulfil the tasks of Donetsk region development, introduction of project management at the community level, as well as implementation of social partnership agreements with business;
- creation of opportunities for start-ups financing in the territories of priority development of Donetsk region or application of other forms of support for new business projects;
- introduction of projects for joining high-tech European and world clusters;
- supporting the development of existing industrial enterprises, including state-owned ones, by attracting state investments;
- transformation of the Donetsk region's coal industry, which will help diversify the economy of mining monofunctional cities, and measures to mitigate the negative socio-economic consequences of closing coal mining and coal processing plants, in particular by creating energy industrial parks based on individual state coal mines;

- technical re-equipment and modernization of mines, in particular ventilation and degassing systems, to ensure the safety of mining workers;
- introduction of innovative solutions in the field of coal mining at prospective mines, the utilization of concomitant resources, including coal bed methane, mine waters, underground coal gasification technology;
- attracting investments for the introduction of alternative energy sources, in particular the construction of renewable energy facilities and facilities in the field of heat supply using alternative energy sources in the Donetsk region;
- promoting the introduction of a low-carbon economy and hydrogen energy;
- reduction of air pollution by mining and metallurgical enterprises and thermal power plants;
- formation in society the vision of ecological values and principles of sustainable consumption and production;
- development of regional automated environmental monitoring systems;
- increasing the share of alternative fuels in transport and industry (electric vehicles, biofuels, CNG, LNG) and developing new flexible infrastructure (electric vehicle charging stations, liquefaction, regasification, fuel storage systems, etc.);
- implementation of re-education and advanced training programs in accordance with the needs of the labour market on the basis of partnership between the state and business, in particular re-education and training of employees of city-forming enterprises in monofunctional cities;
- promoting confidence in the authorities throughout the country regarding the reintegration processes of Donetsk region;
- formation of an attractive investment image in Donetsk region for diversification of production of enterprises from foreign countries and initiation of public-private partnership projects in territories (according to the Law of Ukraine "On Public-Private Partnership"), which were negatively affected by armed aggression of the Russian Federation;
- expansion of mechanisms for the use of national instruments by small and medium enterprises to promote the domestic economic potential of the Donetsk region during international communication events.

The following indicators are planned to be achieved by 2030:

- growth of capital investments (percent to gross regional product) - 25%;
- growth of the share of goods with high added value in the sales of the processing industry - 17%;
- increase in the index of agricultural products - by 3%;
- average duration of power outages (System Average Interruption Duration Index) - 600 minutes;
- reduction of unemployment among the population aged 15-70 - 8%;
- increase in the employment rate of the population aged 15-70 - 56%.

At the same time, during the implementation of the operational plan, additional indicators in the field of environmental protection will be developed and identified, including the following indicators: forest area and forest cover; area of arable land (arable land) and their share in the total area; the area of agricultural lands of extensive use (hayfields and pastures) and their share in the total area; content of organic carbon (humus) in the soils of agricultural lands; area of restored lands and ecosystems, area of reclaimed lands and lands on which conservation measures are carried out; area of ecological network territories; the number of territories and

objects of the nature reserve fund, the area of lands of the territories and objects of the nature reserve fund and their share in the total area of the territory.

The Coordination Centre chaired by the Prime Minister of Ukraine is in charge of prioritizing the transformation of coal regions. The relevant document is being developed by the Ministry of Development of Communities and Territories of Ukraine (Ministry of Regional Development), in accordance with the model of EU member states "fair transformation", which according to preliminary estimates will last until 2030.

During the implementation of the Strategy, it is necessary to be guided by the principles in communication with other strategic documents of the state, namely:

- decarbonisation of regional economies (energy efficiency, development of renewable energy sources, development of circular economy and synchronization with the initiative "European Green Course");
- fair transformation of oblasts where the employment of the majority of the population is related to coal mining enterprises, mandatory provision of all social guarantees to employees of these enterprises;
- measures to reorient the economy of mining regions to other sectors of the economy (construction, processing, production of building materials, mechanical engineering, etc.);
- creation of new jobs and provision of jobs for the population released due to the liquidation of highly unprofitable coal mining enterprises.

It is necessary to assess the prospects of coal demand taking into account the projected share of heat generation and demand from other consumers, conduct financial and technological audits of mines, assess their prospects and classify them as subject to closure, privatization or modernization, and implement the chosen path for each mine. within the framework of a comprehensive transformation plan. Mitigation of social consequences (social reconversion) in projects for the transformation of coal monofunctional cities should be ensured by diversifying, if possible, the economies of mining cities or reviewing the optimal allocation of human and industrial resources in the territories. The set of measures to mitigate social consequences should be phased, based on broad social dialogue and include synchronization of mine closure with the opening of industrial parks or the launch of natural gas production in the Yuzovka area, development of coal bed methane production projects from potential coal deposits, where potentially the new jobs could be created for former miners. Some workplaces will remain in the mines, as they need to be maintained in an environmentally friendly condition.

2 Setting the context

2.1 Regional profile and specialisation

Industry provides the largest share of added value in the region (48% in the Donetsk region as of 2018). The area of agricultural land located in the Donetsk region, on which public authorities exercise their powers in full, is 1.4 million hectares or 73% of the total area of the region. After the seizure of territories and the curtailment of economic activity in the peaceful area of the region, the number of economic entities in the Donetsk region decreased by 55% from 2013 to 2019 and today amounts to only 3% of the total number of economic entities in Ukraine. The territory of Donetsk region has significant deposits of natural resources, which contributed to the emergence and rapid development of industry in the region. According to the survey, almost 49% of the reserves of minerals in Donetsk region are fuel and energy raw materials (coal, coal bed methane, free gas). The second place stands for non-metallic minerals used as raw materials, in particular in the construction, mining and chemical industries, and in

metallurgy. In the exports of Donetsk region, the vast majority are ferrous metals (75% of total exports in 2019), mineral products (7%), machinery and equipment (6%). In 2014-2015, capital investment in the region declined: in these years alone, the decline in the Donetsk region by 82%. By 2019, the capital investment in the assets of enterprises in real terms in the region has not yet risen to the level of 2013. In 2019, the region accounted for only 5.4% of all capital investments in Ukraine, while in 2013 this figure was 15.7%. With such a negative trend, companies provide investments financing at their own expense (81% in the Donetsk region in 2019). In addition, the crisis and armed aggression of the Russian Federation have also led to an increase in the role of the state in the development of enterprises: from 2013 to 2019, in Donetsk region the share of public funds in capital investment increased from 6 to 17%.

The natural growth of small businesses, turning it into medium and large requires additional public policy measures. The main purpose of creating an infrastructure to support entrepreneurship and the business environment (including business support centers) is to provide information, training in business, legal support and advice on government support programs, assistance in obtaining credit, including international, grant and investment resources, assistance in participation in public procurement and privatization; in exports, the creation of a permanent platform for interaction between local authorities and entrepreneurs, etc. (Table 1).

Table 1: Indicators of promoting the growth of small and medium businesses, investment and trade

Nomination of the indicator, unit of measurement	Basic (for 01.01.2021)	Intermediate (until 2025)	Target (until 2030)
Share of goods and services traded by micro-enterprises, small and medium-sized enterprises, percentage	35	37	40
Number of micro, small and medium enterprises per 1,000 population	43	36	40
The share of the employed population in micro, small and medium enterprises, percent	75	78	81

Scientific and educational sector. The main part of the scientific and educational potential of the economic region is concentrated in the number of scientific organizations and educational institutions of all levels. The key actors in the scientific sphere of the economic region are Scientific Institutions of the NAS of Ukraine, research, design and other organizations, including those subordinated to the ministries and departments of Ukraine, higher education institutions of III-IV levels of accreditation (universities, academies, institutes) and their structural subdivisions, public scientific organizations and associations, including analytical centers of state and non-state forms of ownership. For the period from 2007/2008 to 2013/2014 academic years, the number of students in secondary schools in Donetsk region was declining faster than the number of schools. In 2018/2019, the number of students in general secondary education institutions exceeded the 2014/2015 figure. This situation coincides with the general one in Ukraine and is related to the positive dynamics of the birth rate during 2008-2013. At the same time, the number of general secondary education institutions continues to decline steadily [2,3].

Back in the mid-1990s, there were 142 vocational schools in the Donetsk region. During 18 years, 31 such institutions ceased to operate in the region. According to the data of 2018, 44 vocational education institutions accept students in the region. Thus, the rest remained in the territory temporarily out of the control of Ukraine. The number of students in vocational (technical) education institutions decreased by 23%, despite the economically justified need of the market for qualified specialists in working professions. As a result, the number of vacancies at industrial enterprises of Donetsk region is 32% and is the highest among other types of

economic activity (in Ukraine as a whole – almost 30%) [4], and the need for skilled workers is not met, even in the presence of high wages.

Until the 2014/2015 academic year, the Donetsk region was second only to the city of Kyiv in the number of higher education institutions. More than 100,000 students studied in 73 educational institutions (colleges, technical schools, colleges, universities, academies, institutes). With the start of hostilities, many higher education institutions have moved to new locations. For example, Vasyl Stus Donetsk National University currently accepts students in Vinnytsia (Vinnytsia region), and a branch has been opened in Kostiantynivka, Donetsk region. In the 2018/2019 academic year, there were 27 higher education institutions in the Donetsk region, which accepted almost 33,000 students. It should be noted that over the past five years, the number of institutions has increased by 11 units, which can be explained by their gradual relocation from uncontrolled territory.

According to research in the Donetsk region, a disproportionate number of graduates graduate with the level of junior specialist, which correlates with a large supply of jobs with low qualification requirements [5].

Institutions of the National Academy of Sciences of Ukraine. Until 2014, there were 11 institutions of the National Academy of Sciences of Ukraine in the Donetsk region, which were moved to the territory controlled by the Government of Ukraine: Donetsk Institute for Physics and Engineering named O.O. Galkin (now in Kyiv), Institute for Physics of Mining Processes (Dnipro), Scientific center of mining, geology geoecology and infrastructure development (Dnipropetrovsk region, Pavlohrad), L.M. Litvinenko Institute of Physical-Organic Chemistry and Coal Chemistry (Kyiv), Donetsk Botanical Garden (Donetsk region, Kostiantynivka), Donetsk Research Center (Donetsk region, Pokrovsk), Institute of Artificial Intelligence (Kyiv), V. Mamutov Institute of Economic and Legal Research (Kyiv), Institute of Industrial Economics (Kyiv), Ukrainian Steppe Nature Reserve (Zaporizhzhia region, Kamianka town), Institute of Applied Mathematics and Mechanics (Donetsk region, Sloviansk).

General characteristics of the economy of Donetsk region are given in Table 2.

Innovative ecosystems are created and developed in a localized space, where material, production, information and labour resources are already concentrated, which allow to develop and use innovative solutions. Each branch of the economy has the characteristic features of economic activity and types of innovation activity [6].

Table 2: The place of Donetsk region among the regions of Ukraine in some social, economic and environmental indicators (2017)

Indicator	In general / on average in Ukraine	Industrialised regions							Maximum value of the indicator by region / region	Minimum value of the indicator by region / region
		Dnipropetrovsk	Donetsk	Zaporizhzhia	Kyiv	Luhansk	Poltava	Kharkiv		
GRP per capita,%.	100.0	138.3	56.1	107.2	128.2	19.8	151.3	98.9	151.3 Poltava	19.8 Luhansk
The share of the region in the total amount of Gross Value	100	10.5	5.6	4.1	5.3	1.0	5,1	6.3	10.5 Dnipro-petrovsk	1.0 Luhansk

Added (GVA) of Ukraine, %										
The share of sold industrial products in total sales, %	31.0	46.5	64.3	64.9	25.3	54.4	69.1	47.8	69.1 Poltava	17.6 Voyn
The share of sold products of high- and medium-high-tech industries, in the total volume of sold industrial products in the region, %	8.5	7.4	4.8	15.1	11.4	25.2	6.8	12.8	35.7 Ivano-Frankivsk	4.8 Donetsk
Fixed capital investment of total, %;	100	9.8	3.8	3.7	7.5	0.7	3.7	4.4	30.1 Kyiv City	0.7 Chernivtsi
Share of regional investments in high- and medium-high-tech industries of total investments in industry, %	9.7	2.9	5.4	25.3	4.0	13.4	6.0	27.5	43,1 Zakarpattia	2,0 Chernivtsi
Share of regional employees in high- and medium-high-tech industries of the total number of employees in industry in 2016, %	21.2	12.1	12.7	12.7	13.9	20.9	26.4	33.4	47.2 Sumy	11,0 Vinnytsia
The share of innovative enterprises in the total number of industrial enterprises, %	16.2	11	11.5	19.1	11.0	10.0	10.4	28.1	28,1 Kharkiv	5,7 Khmelnytskyi
Regional expenditures on internal research and development of the total expenditures	21.3	15.1	28,4	9.9	2.0	38.3	37.1	33.0	82.2 Mykolaiv	0.5 Ivano-Frankivsk

on innovation, %										
Depreciation rate of fixed assets in industry (according to the latest officially published data in 2010), %	63.0	66,1	69,8	72,5	49,3	44,8	71,2	65,0	73,8 Chernihiv	16,4 Chenivtsi
Unemployed population in aged 15-70 years, %	9.5	8.5	14.6	10.7	6.5	16.6	12.0	6.1	16.6 Luhansk	6.1 Kharkiv
Emissions of harmful substances into the atmosphere from stationary sources, kg per capita	61.0	203.,4	186.8	105.0	27.5	34.6	39.5	16.7	203.4 Dnipro-petrovsk	2.5 Zakarpattia

The industries can be divided into four types by dominant sources of innovation (scientific, engineering, consumer and efficient), as well as by types of innovation activity (technological and non-technological innovation) – Table *3*.

Table 3: The ratio of the share of innovative enterprises in the total number of enterprises by type of innovation and economic activity

	Innovatively active enterprises, units	of them				
		enterprises with technological (product and/or process) innovations	of them			enterprises only with non-technological (marketing and/or organizational) innovations
			enterprises with product innovations	enterprises with process innovations	enterprises with product and process innovations	
Total	1.00	1.00	1,00	1,00	1,00	1,00
Industry	1.05	1.43	1.51	1.33	1.33	0.84
The mining industry	0.78	0.75	0.31	1.09	1.,09	0.80
Manufacturing industry	1.13	1.56	1.75	1.26	1.26	0.90
Supply of electricity, gas, steam and air conditioning	0.71	0.89	0.37	2.00	2.00	0.61

Water supply; sewerage, waste management	0.56	0.81	0.42	1.71	1.71	0.42
Wholesale	1.07	0.46	0.42	0.57	0.57	1.42
Transport	0.55	0.39	0.21	0.67	0.67	0.65
Information and telecommunications	1.12	0.99	1.01	0.90	0.90	1.20
Financial and insurance activities	1.36	1.15	0.53	1.79	1.79	1.49
Activities in the fields of architecture and engineering	0.78	0.75	0.89	0.49	0.49	0.80
Research and development	1.33	2.83	2.62	1.75	1.75	0.49
Advertising activities	1.21	0.79	0.,84	0.81	0,81	1.45

The activities in which the share of enterprises with technological and product innovations is the largest are highlighted in grey. [4]

2.2 Donetsk Region energy and environment outlook

Power production in the Donetsk region is associated with the operation of large thermal power plants on its territory, the design fuel for which is the coal of the Donetsk coal basin. According to the Energy Strategy of Ukraine until 2035, coal will remain a significant source of energy in Ukraine, until 2030 in the amount of 12 million tons of oil equivalent annually. Capacities of the Ukraine's coal-fired power plants provide the power system control, which are required for sustainable operation in the total amount of 10-12 GW of electric power. There are 3 large thermal power plants operating in the Donetsk region controlled by the government of Ukraine, which consume more than 6 million tons of coal year. Kurakhivska TPP and Uglehirska TPP operate with gas coal, which comes from the mines of Dnipropetrovsk region and the western part of Donetsk region. Slovyanskaya TPP, which is designed to burn Donetsk anthracite, which deposits are located in areas not controlled by the government, is forced to burn coal mixtures from foreign low-reactive and Ukrainian high-reactive coal. To reduce the negative impact on the environment of coal combustion at thermal power plants the dust cleaning plants are used at power stations. New electrostatic precipitators were installed at 4 power units out of 12 operating at the TPP of Donetsk region, providing the outlet dust concentration of no more than 50 mg/m^3. Flue gas cleaning plants from sulfur dioxide and nitrogen oxides are not yet available.

Ukraine, as a party to the Energy Community Treaty, has committed itself to bringing its environmental performance in the thermal power industry to European levels. To this end, the National Emissions Reduction Plan for Pollutants from Large Combustion Plants has been developed and approved by the order of the Cabinet of Ministers of Ukraine. It provides for the gradual achievement of compliance with the requirements of Directive 2010/75/EC on industrial emissions by the end of 2028 for emissions of sulfur dioxide and dust, and by the end of 2033 on emissions of nitrogen oxides through the construction of new flue gas cleaning plants with annual reductions of pollutants. It is planned that the gross emissions of sulfur dioxide after implementation of the NERP, compared to the level of 2012, will be reduced by

19.5 times, nitrogen oxides by 3.6 times, and dust by 40 times. Therefore, the successful implementation of the plan in 2030 in the Donetsk region will significantly improve the environmental situation. To date, the implementation of the NERP in terms of gross emissions levels is ensured only by significant reduction of production and consumption of electricity after 2014. The construction of any new sulfur and nitrogen treatment plant is not planned or financed.

Almost in 2025, Ukraine's TPPs will be forced to shut down power units due to non-compliance with environmental requirements with the prospect of complete shutdown of all TPPs in 2027. Since the specific carbon dioxide emissions when burning coal at power units in flexible modes amounts to 1000-1100 g/kWh, one should not expect the reduction of greenhouse gas emissions in the thermal power sector without solving the problem of power system capacity control in Ukraine. Biomass in the Donetsk region should be considered as a local fuel due to its small amount in the urbanized and industrialized region, which is located in the steppe zone of Ukraine. Biomass should be used in municipal and industrial boilers for co-incineration with waste to provide hot water and heating.

Modeling of future energy development was performed by Ukrenergo. The analysis was carried out in two scenarios. The “Neutral climate economy” scenario (SCNE), which provides for timely implementation of legislation, as well as additional climatic policies, and the reference scenario (RS), which was created to obtain a model assessment of timely and full implementation of the entire current legislation adopted until 01.09.2019, as well as draft normative legal acts developed and presented as of this date. With the reference energy development scenario, the average capacity of coal power units in Ukraine will decrease from 18.4 GW in 2021 to 16.1 GW in 2030, including 9.53 GW of new maneuvering capacities (2 GW high-maneuvering capacities with a fast start). When implementing the SCNE scenario, the average capacity of coal power units in Ukraine will decrease from 18.4 GW in 2021 to 2.5 GW in 2030, without commissioning of new coal power units.

At the moment, approximately 230 million cubic meters of natural gas are used in the Donetsk region per month in private households. The share of heating boilers that will work on natural gas is expected to increase until 2030. This will reduce the emissions of ash, nitrogen oxides and sulfur dioxide into the atmosphere, as well as carbon dioxide emissions.

In the first nationally determined contribution (NDC) submitted in 2016, Ukraine defined independently its goal of limiting GHG emissions – in 2030 it will not exceed 60% of the 1990 level. This level of GHG emissions reduction is not ambitious in the context of the Paris Agreement, as it envisages an increase in national GHG emissions by 75% by 2030 relative to 2017.

It is envisaged to constantly expand the use of all types of renewable energy, which will become one of the tools to ensure the energy security of the state. In the short and medium-term (until 2025), the share of renewable energies in Ukraine is projected to increase to 12% of primary energy and to at least 25% by 2035 (including all hydropower and thermal energy).

The state policy should be aimed at mobilizing investments to ensure a "green" transition through the creation of favourable conditions for private investors and the introduction of appropriate state support mechanisms, in compliance with the requirements and standards of such support introduced in the EU countries without violating the rules of state aid. The state contribution will require the revision of existing budget programs in the field of energy and climate, as well as developing new financial instruments (for example, to implement a fair transition, innovation support, investment promotion in the priority areas of the green economy), including state and municipal co-financing Projects.

In the electric power, parallel processes of modernization, greenhouse gas emission reductions and gradual reduction of coal generation should be taken. This should take place

through the development of the latest technologies that involves compulsion and / or incentives for the introduction of advanced technologies for TPPs that use non-renewable energy sources (primarily coal). Compulsion assumes that all or a certain part of power plants on coal will use a certain technology, in particular IGCC, CCS. Incentives include direct subsidies and / or assistance in attracting funding to implement the latest technologies and / or long-term procurement of TPP products or services.

According to Ukrenergo, which is an operator of the transfer system of Ukraine with the functions of operational and technological management of the united power system of Ukraine, with an optimistic energy development scenario, the average used capacity of coal power units in Ukraine will decrease from 18.4 GW in 2021 to 14.0 GW in 2050, including 12 GW of new maneuvering capacities, from which 2 GW high-maneuvering capacities with a fast start. When implementing a pessimistic scenario without commissioning of new coal power units, coal generation will cease to operate in Ukraine. These scenarios can be transferred to the Donetsk region in the corresponding portions of coal capacities.

Ukraine has a significant natural potential for the implementation of "green" transition in all sectors of the economy. Taking into account the possibilities and availability of modern renewable energy technologies, as well as their rapid development, Ukraine is entirely powerful and economically capable to reach 70% of the share of electricity by RES in the electricity production. Moreover, a significant part (up to 15%) could come from the production of electricity from the solar power plants in the roofs of households and businesses.

2.3 Donetsk Region current energy-related R&I landscape

Donetsk region ranks second among other regions in terms of industrial output, has the strongest chains of "raw materials-production-sales" in the metallurgical and energy sectors, and provides a significant share of national production of rock salt (almost 99%); stone, sand and clay (40%), coal (35%); machinery and equipment for metallurgy (87%); cast iron (40%); steel (37%); ready-made rental (35%); coke (46%); decorative ceramic products (47%), refractory products (33%), etc. [7].

The most favorable impact on this strength will be the cessation of military conflict (and thus - the return to Ukrainian control of a significant part of industrial potential, restoration of broken economic ties), the implementation of projects of international organizations to support certain economic activities, possibilities of entering new markets through the implementation of the Association Agreement with the European Union and other countries - important trading partners (including by adapting to new standards and technical regulations for products in accordance with the requirements of the European Union).

From the point of view of staffing of industrial and energy production, it will be important to strengthen the interaction between educational institutions and business entities, the development of mechanisms of dual education. This will help increase the level of professional training in accordance with the needs of the economy.

The key structural problems of the Donetsk region's economy are the predominant specialization of the industrial complex in the production of intermediate products with a low degree of raw material processing (about 90% of industrial production is metallurgy, mining, electricity supply and coke production), significant energy intensity (Donetsk area is second among other regions by the scope of consumption of heat and electricity), significant dependence on foreign trade (the share of exports in gross regional product is 75%), low role of small and medium enterprises, as well as the mismatch of the degree of economic activity in the region of demand (taking into account the available raw material base).

The challenge of restructuring the regional economy is one of the most pressing in terms of strategic focus. To address this issue, the effectiveness of nationwide reforms to create

favorable conditions for business development and investment, energy sector reform, further industrial modernization and infrastructure development will be important. Equally important are the activities of international organizations and other international partners aimed at developing small and medium-sized businesses, as well as supporting those economic activities that have the greatest prospects for integration into the global added value chain.

Indirect incentives for modernization and renewal of production facilities will provide an opportunity to enter new markets through the implementation of the Association Agreement with the European Union and, accordingly, the need to adapt products to global standards and technical regulations, the requirements of the European Union.

In terms of increasing the share of high value-added industries in the regional economy, the trend of digital economy and information technology is considered favorable, in terms of improving the investment climate - the possibility of ending the military conflict in the region.

SWOT-analysis of the energy sector of Donetsk region

Strengths

S1 High concentration of natural mineral deposits

S2 Powerful industrial and energy complexes with chains "raw materials-production-sales", as well as leadership positions in certain areas of production

S3 Significant resource base for the development of agro-industrial production

S4 Availability of logistically attractive industrial sites for the creation of industrial and technology parks

S5 High educational level and intellectual potential of the population

S6 Active youth who are ready to implement ideas for change

Weak sides

W1 Temporary occupation of part of the region

W2 Negative demographic trends with deepening gender imbalance

W3 High unemployment due to imbalances between labour proposition and demand

W4 Lack of qualified staff in the most popular industries and areas

W5 Complexity of transport and logistics connections

W6 Structural deformations of the existing economic system

W7 Mismatch of existing scientific, innovation and business infrastructure to modern development needs

W8 Negative image of the region at the national and international levels

W9 Informational isolation and low level of public awareness (especially along the demarcation line)

W10 Significant pollution of the environment, including due to significant man-made load on it

Opportunities

O1 End of military conflict

O2 Implementation of projects of international organizations, involvement of international technical assistance

O3 Diversification of markets through the implementation of the provisions of the Association Agreement with the European Union

O4 Development of a unique regional innovation security system

O5 Operation of an automated environmental monitoring system

O6 Development of a systematic approach to waste management in the region [10]

Threats

T1 Escalation of hostilities / "freezing" of the military conflict / preservation of the current situation

T2 Further decline in the region's investment attractiveness

T3 Loss of competitiveness of leading sectors of the economy

T4 Reduction of foreign financial support for infrastructure rehabilitation measures in the region

T5 Underfunding of investment projects and regional development projects at the expense of budget funds

T6 Unfair distribution of environmental tax funds between state and local levels

T7 Increase in the number of accidents at infrastructure facilities due to increased depreciation of fixed assets and hostilities

3 R&I in Energy and Environment: Vision for 2030 & 2050

3.1 Objectives and outcomes

The reorientation of Ukraine's science and technology system to higher efficiency and innovation, as well as the radical reforms, require strong leadership, control and monitoring by an independent commission, which considers itself responsible for defining a complex reform agenda in consultation with key stakeholders. Substantial implementation of political statements has been a major shortcoming in STI in Ukraine for many years. In particular, the country faces a difficult task - to demand adequate political interventions and actions from all stakeholders, including the Ministry of Education and Science (MES) and the National Academy of Sciences of Ukraine (NASU).

Increasing the share of renewable energy in Ukraine makes sense by environmental reasons and following international agreements. The recommended method of development is through the providing of non-monetary preferences to support production of electricity from renewable energy sources, including that in Donetsk region, by offering annual support quotas. Ukraine has abandoned further support for new renewable energy projects on a fixed tariff basis and is moving to market-based pricing mechanisms based on auctions in which the state places lots within a certain annually supported quota. At the same time, to ensure further development of renewable energy sources with an unpredictable schedule of electricity production, it is necessary to implement measures to increase the flexibility of the energy system.

One of the solutions is the construction of new highly maneuvering capacities, including through the use of competitive procedures. It is necessary to consider the possibility of building such facilities in the Donetsk region, taking into account the economic feasibility and technical capacity of the entire integrated energy system of Ukraine. Also, the implementation of the task will contribute to: the installation of renewable energy sources for additional or backup power supply at the state-owned facilities; installation of lighting or electrical facilities that use renewable energy sources in the places located along the demarcation line and have problems with electricity supply.

3.2 Key guiding principles

The main guidelines for R&I in energy and environment are based on the Energy Strategy of Ukraine until 2035 and the provisions of the Association Agreement between Ukraine and the EU in 2014. This, in particular, include

- Ensuring complementarity between national and EU R&I policies
- Avoid duplication and strengthen cooperation
- Ukraine's participation in European research programs and platforms
- Creating a favourable innovation climate in Ukraine
- Balancing research and innovation
- Adopt a communication approach
- Ensuring coordination and cooperation between public, private and research structures.

The need for investment in Ukraine's electricity sector opens up a window of opportunity for decarbonising the energy sector, stimulating economic growth and creating new jobs.

1. Intensification of climate research

It makes sense to develop Ukrainian climate research in the context of participation in international research (integration into current research projects, consortia) conducted under the auspices of economically developed countries (e.g. EU Horizon 2020, US, Japan programs, etc.), interstate projects, etc. It is necessary to ensure the interaction of Ukrainian scientists with the world's leading scientific institutions. Research aimed at finding ways to combat and adapt to climate change will be a priority and will receive adequate support from the state.

2. Comprehensive support for innovations, startups, pilot projects

Innovations, startups and pilot projects should be funded from both private and public budgets to support projects / startups at different stages (with different levels of risk). State support for innovation and startups should be aimed at creating jobs in the "green" circular economy of Ukraine, ensuring a balanced regional distribution. Public funding for research and innovation should be competitive, and support should increase to reach at least 3% of GDP as soon as possible. For this purpose, special programs of the Ukrainian Startup Fund and a target national fund to support research projects with an independent supervisory body will be established. Special priority will be given to young researchers and scientists.

3. Strengthening and intensifying cooperation between science and business

According to European best practices, the transition to a climate-neutral economy will require the systematic integration of education, science and business. Such integration is crucial to ensure the sustainable availability, financing and technological support of innovation in the power sector and energy, and will lead to the emergence of innovation and production clusters and increase employment, especially among young people. Cooperation between business and research institutes will be stimulated both by changing the mechanisms of public-private partnership and by continuing the reform of higher education, as universities will become the main research centres.

Most investments will be made by private players, especially network operators. This will require a change in the approach to setting tariffs from cost-plus pricing to investment incentives.

Pricing policy should not provide for ultimate price regulation but should include framework conditions for all, including the expansion of the environmental tax base, the taxation of fossil fuel externalities, and the emissions trading system (including the secondary market). Renewable energy support schemes will determine the cost of electricity / heat / cold

production on a competitive basis and will help replace cash support (preferential prices, preferential tariffs) with other forms of support (preferential grid connection, priority grid access, etc.).

The Energy Efficiency Fund will strive to improve its warm loans and products to simplify and differentiate them to expand the scope of the thermal renovation of apartment buildings and single-family homes.

Any support provided by the Government should not conflict with the Energy Community Treaty and the Association Agreement concluded between Ukraine, on the one hand, and the European Union, the European Atomic Energy Community and their Member States, on the other hand, i.e. should not distort market competition.

State support for fossil fuels is allowed only for decarbonisation measures and / or measures aimed at achieving Ukraine's strategic goals of strengthening energy security and achieving energy independence, including mandatory assessment of support for its compliance with Ukrainian legislation and EU Principles. An appropriate approach to state support for fossil fuels should be developed in the medium term, in particular by defining the applicable criteria by the Cabinet of Ministers of Ukraine.

Priority areas for state support through direct subsidies and fiscal incentives include energy efficiency of the buildings (including residential buildings), clean transport, research and development, export of services and others. Some funds and programs will be used to co-finance municipal energy transition initiatives, such as the Covenant of Mayors and 100% Renewable Energy. All projects and programs supported by the government must have clear KPI (Key Performance Indicator) and independent verification of results.

4 Support framework for R&I in Energy and Environment

4.1 Multi-level governance structure for R&I policies in Donetsk Region

The actors of the regional innovation ecosystem are organisations that embedded in the institutional structure of the region, represented by a set of institutions (laws, norms, rules, inherited social habits, traditions, values) that determine the institutional environment of organisations, affect relations between people in organisations, between organisations, between organisations and the external environment [11]. Thus, the regional innovation ecosystem is a ratio of structural elements (actors) grouped into six sectors:

1) the business sector, which creates innovations and forms the main demand for innovations, in the form of enterprises of all spheres of economic activity, forms of ownership and size, Ukrainian and foreign, in particular young (startups);

2) the public sector that promotes (supports) or blocks innovation, consisting of public authorities and regional government, which determine and implement state and regional innovation policy; other power structures, which by their management decisions influence the course of innovation processes;

3) the financial security sector, which finances innovations throughout the innovation cycle, which includes state funds and institutions; Ukrainian venture funds; banks; international participants, in particular, foreign venture capital organizations, companies that enter into contracts with research institutions for commercial research and development; foreign programs and funds, etc.;

4) the sector of infrastructural support, which unites actors in one location, carries out incubation, testing, approbation, promotion on the market, represented by the subjects of innovation infrastructure, which:

a) help to start an innovative business by providing office space, specialized services and advice on setting up a business, attracting investment, protecting intellectual property (business incubators and accelerators);
b) promote innovative developments of research institutions and universities in business (technology transfer centres); provide access to specialized equipment and production areas to create a minimally viable product and test it for viability and demand by the end-user with subsequent changes (if necessary) to its configuration and marketing (technological, scientific and industrial parks) and others that help turn creative ideas and developments into real innovative business;

5) the sector of public associations, which provides and disseminates information, unites actors in solving common goals, which includes non-governmental non-profit self-governing organizations, unions, associations, whose activities affect the development of the innovation ecosystem.

According to this classification of actors of innovative development at the meso-economic level of the Donetsk region, the following groups can be distinguished.

1. Business sector. In the region there are enterprises of almost all types of industrial activity, clearly expressed mining and metallurgical, machine-building and electric power orientation, there is a developed agro-industrial sector. Most enterprises in the economic region, as in Ukraine as a whole, are small and medium in size. Small and medium-sized enterprises have less innovative activity than large enterprises, which is typical not only for Ukraine but also for the world as a whole. According to I. Pidorycheva [11], the enterprises of mining and metallurgical industries have low knowledge intensity, their technologies are relatively stable, and products are of the same type and variety. But in Soviet times, a powerful source of innovative development at the regional level was the so-called "factory science". Corresponding Member of the NAS of Ukraine V. Shevchenko called the then union of science-industry-government a system of "equal triangle" [12] – the history of the Donetsk Research Center preserves the memory of resolutions made by directors of institutes and leading industrial enterprises, leaders of party-Soviet bodies, received directive force, guaranteed implementation and gave a significant economic effect.

Unlike heavy industry enterprises, food industry enterprises and mechanical engineering enterprises are more receptive to innovations and to a greater extent require the development of innovation-market management mechanisms [1]. The fastest factor in innovative development is startups - organizations under the age of five to create, implement and disseminate an innovative product. According to the Startup Ranking service, out of 192 countries, Ukraine ranks 42nd in the number of startups (266 units) [13]. The most progressive Ukrainian startup sector is the technology sector: in 2019, a record $ 544 million was attracted to this sector. US venture capital investment, a total of USD 1,400 billion was invested in Ukrainian technology companies in 2014-2019 [14], which makes Ukraine one of the most attractive countries for investment in Central and Eastern Europe. The distribution of startups by region is heterogeneous: the largest number of them is recorded in Kyiv region (almost 58% or 154 units). 1 startup (Wattagio) is registered in Donetsk region, two in Dnipropetrovsk region (OWOX BI, molfar.io, Flyy.io); in Zaporizhzhia region and Kirovohrad region – one each (Callfound and Delibroom), respectively.

2. Public sector. Public sector actors include:

1) bodies of state power and regional administration, which determine and implement the state innovation policy. In particular, these are the President of Ukraine; representative bodies of power: the Verkhovna Rada of Ukraine, etc .; executive bodies: the Cabinet of Ministers of Ukraine (CMU), regional, district state administrations and other central executive bodies (CEBs) – the Ministry of Economic Development of Ukraine, the Ministry of Education and

Science (MES) of Ukraine, the Ministry of Finance of Ukraine and others concerns the issues of innovative development of the country, as well as advisory bodies under the Cabinet of Ministers (Council for Innovation Development, National Council of Ukraine for Science and Technology Development),

2) other state organizations and agencies: National Intellectual Property Office (NIPO), NIPO Technology and Innovation Support Centers, which may be initiated by any interested organizations – there are 11 such centres in Ukraine; regional development agencies.

The system of public administration for innovation development of Ukraine is extensive and sufficient to implement its functions, but according to experts on innovation development, the problem is that the main focus of regional authorities is on ensuring the functioning of the economic complex, while regional innovation policy is usually, is indistinct and is carried out unsystematically [11]. According to the Law of Ukraine "On Priority Areas of Innovation in Ukraine", regions through the formation and implementation of regional and local innovation programs and individual innovation projects participate in the implementation of medium-term priority areas at the regional level. Currently, the regional program of innovative development is implemented only in Dnipropetrovsk region. The state is the guarantor of innovative development of the country and regions, because the innovation ecosystem cannot be based on the interests of business. The goal of the business is to maximize profits in the short term with the least risk, which is incompatible with innovation, unless, of course, it is not limited to the purchase of ready-made technological solutions. The role of the state is not only to create a favourable tax, customs and monetary and financial climate for innovation, but also to support inclusive and block extractive institutions, create conditions for cooperation and consolidation of interests of all stakeholders in the innovation process. Under the Strategic Plan of the Ministry of Education and Science of Ukraine until 2024 [15], Ukraine provides for appropriate measures to create and operate an online platform for communication between participants in the innovation process; standardization at the legislative level of the creation and operation of technological platforms.

3. Financial support sector. The issue of funding is one of the most problematic for regional science. Following Article 7 of the Law of Ukraine "On Innovation", regional and district councils approve regional innovation programs credited from regional and district budgets; determine the funds of regional and district budgets for financial support of such programs. However, the Budget Code of Ukraine (BCU) does not provide local budgets for the direction of expenditures for financing innovation. The budget for the development of local budgets (Article 71 of the BCU), which should be used to finance innovation activities at the regional (local) level, is directed to various purposes not related to innovation - repayment of local debt; capital expenditures, including capital transfers to other budgets; development of urban planning documentation and other similar areas. This does not provide for the obligatory allocation of funds for innovation development of oblasts and requires a revision of the directions of expenditures of the local budget development budget and fixing in it the source of funds for financing innovation programs. As the main innovators in the ecosystem are enterprises and entrepreneurs, it is advisable to consider how affordable they are to develop innovation. Ukrainian enterprises are significantly limited in their ability to innovate. The main source of funding for innovation in the industry is the own funds of enterprises. The state innovative financial and credit institution together with the newly created Invention Support Fund of the Ministry of Economic Development and the Ukrainian Startup Fund do not affect the level of innovative activity of business [11]. Despite the goal of the last tax reform (2017), which was to improve the investment climate and promote economic development, specific tools and incentives to attract investment in innovation were not provided by law, including the new version of the Tax Code of Ukraine.

Banks are generally reluctant to lend to innovative projects because of their high risk and the inability of small and medium-sized enterprises to provide reliable guarantees of loan repayment. In developed countries, the lack of funds for innovation purposes of enterprises and entrepreneurs, especially in the early stages of the innovation project, is compensated by the funds of venture capitalists. For companies developing fundamentally new technologies,

venture capital is often the only available source of funding. In Ukraine, venture capital accounts for only 0.08% of the GDP; on average in the EU – 0.68% of the GDP. Venture funds are key players in innovation ecosystems in many developed countries. In Ukraine, as of the third quarter. In 2019, there were 1,163 venture funds. Asset management funds are managed by an asset management company (AMC). The main share of them is concentrated in Kyiv and Kyiv region, there are a small number of them in the regions. The main difficulty is that venture funds in Ukraine direct investments mainly in real estate construction, agro-industrial sector, wholesale and retail trade. The reason is the ineffective legal regulation of venture funds by the basic Law of Ukraine "On Joint Investment Institutions", as well as numerous provisions that regulate the activities of AMC. In addition, venture capitalists need an adequate level of protection of intellectual property rights in the implementation of innovative projects, which is also a big problem in Ukraine [16, 17].

4. Infrastructure support sector. There is no single information resource in Ukraine that would provide up-to-date information on the number, types of innovation infrastructure entities and their condition, including by regions, where they would be registered and publish current news on the creation and development of such structures. Currently, the Ministry of Education and Science of Ukraine and the Ministry of Economic Development of Ukraine, under their powers in the field of innovation, provide information only on such subjects of innovation infrastructure as technology parks, science parks and industrial parks. While an important form of development of regional innovation ecosystems are clusters – a group of interconnected enterprises, as well as other organizations and firms involved in the value chain, which cooperate and compete with each other in one or related sectors of the economy to increase competitiveness. own products / services, establishing their exports and promoting economic development of the region. In the EU, clusters are seen as strategic instruments of economic policy that promote the development of innovation and smart specialization of regions. Economic activity in EU clusters accounts for about 39% of European jobs and 55% of European wages [18, 19].

The following cluster practices have developed in the EU: the main cluster is the collaboration of a wide range of economic players in the sector – large, small and medium-sized enterprises, startups, universities, research institutions, etc. Clusters are an integral part of the regional economy, cluster members interact not only with each other but also with other economic players in a particular sector operating in the region. Cluster development is supported by cluster policies and development programs, which provide for the creation of cluster infrastructure, services for their members, allowing them to better respond to common challenges. Clusters of high-tech sectors tend to develop research, development and innovation, but this depends primarily on the conditions of their activities; clusters move to a higher level - international, cross-border and interstate clusters are formed, business, scientific, innovative and cultural collaboration between clusters is intensified, which leads to increased competitiveness of clusters, their members and territories of their location.

4.2 Funding opportunities

Compilation and analysis of the rating of economic activities of the Donetsk region on the intensity and effectiveness of development result us to conclude that the most efficient industries are focused on efficiency (metallurgical industry). The innovation in production processes and supply systems reduce the costs while maintaining and improving the quality and environmental friendliness of products, and the cost of innovation is carried out in the direction of purchasing new technologies, machinery and equipment. The activities in which innovation is determined by engineering and research, and enterprises develop and implement the technological product innovations (mechanical engineering and professional scientific research) are at the bottom of the ranking of industries in intensity and efficiency. To intensify the development of such activities, the innovation ecosystem must provide conditions for research and development, formation and development of networks that concentrate research centres and science-intensive industrial production; training of professional staff; reliable

protection of intellectual property; developed industrial clusters; gaining wide access to global sources of technology, knowledge and highly qualified engineering and technical personnel.

According to research [20], the efficiency-oriented innovations are inherent in capital-intensive and labour-intensive industries, such as mining, chemicals, oil and gas, woodworking, textiles, metallurgy and agriculture, where the investment in infrastructure, production and equipment accounts is about a third of revenue by the low level of marketing costs. The innovation process for this type is determined by the depth of understanding of production processes and products, able to reduce costs while maintaining or improving quality.

Innovations determined by engineering developments involve the design and creation of new products through the integration of technology with supply chain partners. The areas of engineering archetype include, for example, mechanical engineering, power engineering and construction. The level of R&D expenditures in these industries ranges from 3% to 10% of revenue, and the product life cycle is 5-10 years.

Consumer-oriented innovations meet their needs and demands by providing offers of new products, services and creating alternative business models. Examples of industries of this type - telecommunications, banking, trade, IT, transport, education, entertainment, food and textile industry. These industries are characterized by high marketing costs, from 3% to 7% of revenue, and a relatively short period of product development.

Research-driven innovation involves the development of new products based on the commercialization of basic research. Some industries, such as pharmaceuticals or petrochemicals, can spend between 15% and 30% of their revenue on the R&D. The process of developing and implementing innovations in these areas includes basic research and is characterized by a long cycle: from initial research to commercialization can take from 10 to 20 years. Innovations of this type involve close cooperation between business, science and education at the national and international levels.

The principle of defining industries by a scientific source of innovation is quite close by analogy to the competence of research intensity used by OECD experts. An indicator of the technological level of the industry (type of activity), according to the concept of research intensity, is the ratio between the cost of research and development and sales or gross value added. Ukrainian science uses the criterion of innovation intensity, which takes into account the level of total expenditures on innovation per unit of sales, caused by differences in economic and technological levels of domestic industry and industry of developed countries. Developed countries, with a high level of efficiency, prosperity and technological development, focus on stimulating research and development. Ukraine, implementing the model of catching-up development, uses the vast majority of its innovative resources to acquire new technologies, machinery, equipment, installations and other fixed assets on the terms of transfer from developed countries. Therefore, the technological level of industries (activities) of Ukrainian industry is functionally much more related to the total cost of innovation than the cost of research and development

The development of Donetsk region was determined by the historically formed orientation of the country's economy to expand the extensive exploitation of natural resources. As a result, the industry remains the main structure of the region's economy. Until 1990, the structure of an industry in the Donetsk region was dominated by ferrous metallurgy (34.5%), the share of mechanical engineering and metalworking was 17.2%, the fuel industry was 12.2%, the food industry - 8.9%, the light industry – 7.2%, power industry – 5.2%, chemical and petrochemical industry - 4.8%, non-ferrous metallurgy – 3.1% [8]. Enterprises related to these industries were subordinated to the USSR and produced products of all-Union specialization, i.e. in the region developed industries that were focused mainly on the export of products produced outside the Donetsk region.

Today, the Donetsk region remains a region with a predominant share of mining and metallurgical production, i.e. raw materials orientation. The dominant industries in terms of share of production are mining and metallurgy (18.6% and 43.8%, respectively). The production structure of the region determines the commodity structure of exports – 81.6% is accounted for by ferrous metals, the share of goods with higher added value remains low.

The main role in the region's economy belongs to **the industries that are capital-intensive and capital-intensive**. The degree of depreciation of fixed assets of the region's economy in 2010 amounted to 64.5%, which is almost 14.0% lower than in Ukraine as a whole. However, in the industry the degree of depreciation of fixed assets is 10.0% higher than in Ukraine and is 55.8% in mining (47.8% in Ukraine), 73.4% in manufacturing (66% in Ukraine), 8%), production and distribution of electricity, gas and water - 67.0% (in Ukraine as a whole – 60.7%). (Fig. 1).

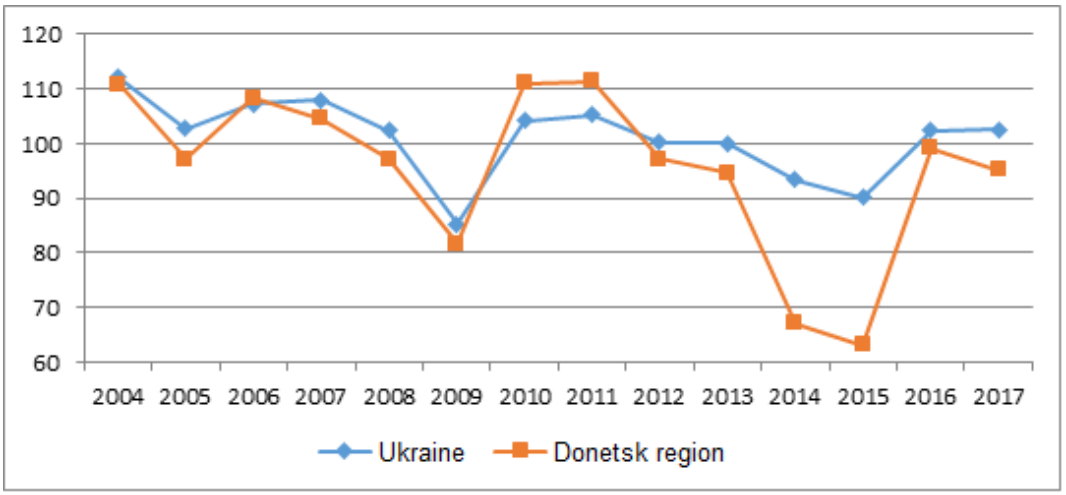

Figure 1: Index of physical volume of GRP (in previous year's prices)

The region is characterized by a greater amplitude of fluctuations in the gross regional product (GRP) than Ukraine as a whole. This indicates its instability to the negative effects of world market conditions due to reduced demand on world markets for metallurgical products. Since 2014, the region's sharp decline in GRP has destroyed not only the region's economy and normal life, but also Donbas's economic ties and relations with other regions and the state. The gradual increase was against the background of its critically low performance in previous years. In general, since 2014, the GRP of Donetsk region has decreased by 60.0%.

Innovation activity in Donetsk region shows rather ambiguous, mostly passive steps. The share of enterprises engaged in innovation has significantly decreased compared to 2000 and has remained almost unchanged over the last four years (Fig. 2). At the same time, the share of sold innovative products in 2017 did not exceed 1.3% (in 2000 this figure was 21.5%) and was a record low for the years of the study period. The total expenditure of industrial enterprises on innovation does not have a clear trend, but it can be stated that although the share of expenditures on domestic research and development in total expenditures on innovation increased significantly in 2010, 2013 and 2017, the cost of acquiring research and development, machinery, equipment and software, other external knowledge continues to occupy more than 60.0% [9], which leads to the degradation of innovation potential and threatens the innovative development of the region's economy.

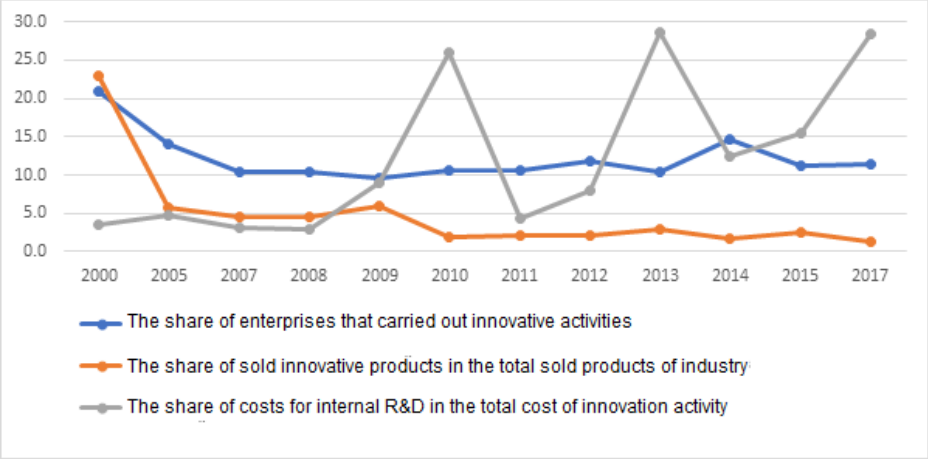

Figure 2: Indicators of innovation activity of enterprises of Donetsk region [9]

Despite the difficult economic situation, the Donetsk region remains relatively attractive for **foreign investments**. However, most of the investments are Ukrainian capital coming from offshore countries. In the structure of foreign direct investment (FDI) from the world economy in Ukraine more than 50.0% are from Cyprus and the Netherlands. The OECD Investment Policy Reviews for Ukraine 2016 (OECD Investment Policy Reviews: Ukraine 2016) noted the wide scale of the phenomenon of pseudo-foreign investment (FDI round-tripping) in Ukraine [8], which falsifies FDI statistics by overestimating their real revenues. Significant flows of FDI are formed as a result of the repatriation of domestic capital from offshore jurisdictions. The region among the regions of Ukraine is traditionally the main source of direct investment – its share in the total amount of direct investment from the regions of Ukraine in the economies of the world in 2016 amounted to 93.6%.

In the structure of investment are dominated the low-tech industries and industries with a low degree of technological processing (the share of investment in high-tech and medium-tech industries is only 5.4% against 9.7% in Ukraine as a whole), but which are in demand domestically and foreign markets. Relatively stable were investments in the production of those internally oriented industries that meet the vital needs of the population in basic foodstuffs (including alcohol and tobacco, which is not in favour of a decent level of society culture), and the pharmaceutical industry.

4.3 Priority areas for Research and Innovation

According to the Law of Ukraine of September 8, 2011, № 3715-VI "On Priority Areas of Innovation in Ukraine": priority areas of innovation in Ukraine (hereinafter - priority areas) are scientifically and economically justified and defined following the Law the areas of innovation aimed at ensuring the economic security of the state, creating high-tech competitive environmentally friendly products, providing high-quality services and increasing the export potential of the state with the effective use of domestic and world scientific and technological achievements. Of the 7 strategic priorities in the field of R&I in the energy and environment defined by the Law, the following are relevant:

- development of new technologies of energy transportation, the introduction of energy-efficient, resource-saving technologies, development of alternative energy sources;
- wide application of technologies of cleaner production and protection of the environment.

In Ukraine, the cooperation of industrial enterprises in production and innovation stays at a low level. The most pressing issues are the low level of cooperation of innovative industrial enterprises with the science sector; insufficient level of integration of small and medium enterprises (SMEs) into added value chains; low level of internationalization of value chains; insufficient use of digital technologies by industrial enterprises.

The solution to these problems will be facilitated by the use of public policy tools devised by the developed countries aimed at building cross-sectoral cooperation. At the local level, attracting the potential of the scientific and educational sector to the commercialization of innovations is due to the introduction of the concept of entrepreneurial universities, which activates the university's own business initiatives, projects with external investors, development of cooperation with business and other organizations. The development of cooperation within innovation ecosystems is stimulated through the introduction of the concept of open innovation platforms, which expands the possibilities of partnership based on research projects, stimulates the attraction of investors and accelerates the commercialization of scientific developments.

At the regional and national / supranational levels, ensuring the inclusiveness of economic development is due to the concept of smart specialization, which allows realizing the unique potential of economic development of regions and countries based on specific competitive advantages. An important component of the concept of smart specialization is the concept of cluster development, the focus of which is to create world-class clusters with the active involvement of SMEs.

Ukraine's steps towards implementing these concepts in state economic policy include integrating their principles into strategic documents - the Concept of Digital Economy and Society of Ukraine for 2018-2020, the Strategy of Ukraine's Industrial Complex until 2025, the Government's Medium-Term Priority Action Plan until 2020 and Government Priority Action Plan for 2018; entry of certain regions of Ukraine into the EU Smart Specialization Platform; implementation of pilot projects of smart specialization of industry in the regions.

4.4 Evaluation and Monitoring

There is an urgent need to develop environmental monitoring systems to provide informational support for management decisions on environmental quality management and environmental safety in the region. The development of environmental monitoring systems is carried out to comply with Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe and Directive 2004/107/EC of the European Parliament and of 15 December 2008 2004 "On arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air", Directive 2000/60 EC of the European Parliament and of the Council of 23 October 2000 on the approval of the limits of Community action in the field of water policy, etc.

Development of environmental monitoring systems will contribute to: improving environmental quality management at the regional level through information support for management decisions; strengthening control of environmental pollution; improving air quality in the zones and agglomerations of Donetsk and Luhansk regions, surface and groundwater, soil condition, biodiversity indicators, etc.; reducing the negative impact on health and improving the quality of life of the population of Donetsk and Luhansk regions. Environmental monitoring and development of environmental monitoring systems are provided by local governments and by paragraph 4 of the Regulations on the state environmental monitoring system approved by the Cabinet of Ministers of Ukraine of March 30, 1998, № 39 (Official Gazette of Ukraine, 1998, № 13, Art. 495), 145 Ministry of Agrarian Policy, Ministry of Environment, State Environmental Protection Agency, State Geodesy, Ministry of Regional Development, State Tax Administration, State Emergency Service, State Forestry Agency, State Water Agency, State Geocadastre and their territorial bodies, enterprises, institutions and organizations belonging to the sphere of their management of the Autonomous Republic of Crimea on environmental protection. Expenditures are financed from the state and regional funds for environmental protection.

5 Concluding note

Implementation of the Research and Innovation Development Strategy requires joint work of commissions under the Cabinet of Ministers of Ukraine, Donetsk Regional State Administration, as well as local private companies and local residents. Given the complexity of the situation in the region, it requires preferences for business development, especially in innovation. At the same time, it is necessary to create structures to monitor the implementation and correction of the Donetsk Region Development Strategy. With significant investments, the region has good prospects for further development and transformation of the coal industry.

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