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DETERMINING KEY INDUSTRIAL SECTORS FOR GREENING OF UKRAINIAN ECONOMY

Different industries in terms of energy and resource efficiency, and their impact on the environment are analyzed in this article. The author proposes the criteria for determination of the key sectors crucial for transition to green economy.

Keywords: green economy; energy and resource efficiency; industry; modernization.

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ВИЗНАЧЕННЯ КЛЮЧОВИХ ГАЛУЗЕЙ ПРОМИСЛОВОСТІ ДЛЯ «ОЗЕЛЕНЕННЯ» УКРАЇНСЬКОЇ ЕКОНОМІКИ

У статті проведено аналіз розвитку різних секторів промисловості з точки зору енерго- та ресурсоефективності, а також їх впливу на навколишнє середовище. Запропоновано критерії для визначення ключових секторів промисловості, що мають вирішальне значення для «озеленення» економіки України.

Ключові слова: «зелена економіка»; енерго- та ресурсоефективність; промисловість; модернізація.

Рис. 1. Табл. 3. Літ. 20.

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ОПРЕДЕЛЕНИЕ КЛЮЧЕВЫХ ОТРАСЛЕЙ ПРОМЫШЛЕННОСТИ ДЛЯ «ОЗЕЛЕНЕНИЯ» УКРАИНСКОЙ ЭКОНОМИКИ

В статье проведен анализ развития разных секторов промышленности с точки зрения энерго- и ресурсоэффективности, а также их воздействия на окружающую среду. Предложены критерии для определения ключевых секторов промышленности, которые имеют решающее значение для перехода к «зеленой экономике».

Ключевые слова: «зеленая экономика»; энерго- и ресурсоэффективность; промышленность; модернизация.

Introduction. In Ukraine industry is very important for economic development, but at the same time industrial complexes are the key anthropogenic factors of the ecological crisis in Ukraine, being responsible for around 35% of Ukraine's energy use and over a quarter of primary resource extraction; industry also accounts for up to 58% of total air pollution. This dangerous situation requires increased attention to the problems of sustainable development at all levels and especially at the enterprises level. Industrial enterprises have to focus not only on achieving economic efficiency, but also consider their impact on the environment. Often companies put aside solving environmental challenges, thus increasing the negative anthropogenic impact even more. Therefore, it is vitally critical for Ukraine to change the existing industrial and environmental policies, in which the significant role should belong to "green modernization".

At present the implementation of sustainable development principles in Ukraine is provided by a range of legislation acts and national economic and social policy documents. They mainly relate to energy efficiency and environmental protection:

- Improvement of energy efficiency of the basic sectors of economy, modernization of the power industry as well as the housing and utilities sector are among the

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main priorities of the "National Economic Reform Program for 2010–2014 "Prosperous society, competitive economy, and efficient state" (2.06.2010.).

- "State target energy efficiency program for 2010–2016" (01.03.2010, # 243) provides 20% reduction in energy consumption as compared to 2008. Along with the planned objectives the program provides economic incentives for efficiency measures: since the end of September 2010 exemption from duty on energy efficient equipment has been in force.

- "State Programme of Development of domestic production in Ukraine for the period up to 2015" (12.09.2011, # 1130) includes strategic objectives and directions of greening and improving energy efficiency in order to protect the environment and create segments of "green" economy.

But the process of greening Ukraine's economy is proceeding very slowly. Despite some acceleration of technological greening industry still lags far behind economically developed countries and requires substantial government support. In Ukraine, the greening of industrial production is not integrated in reproduction cycles.

For Ukraine's rapid transition to green economy an appropriate regulatory framework should be implemented. Whether this subject will be rooted in Ukraine, and if so, how this will be achieved, substantially depends on the efficiency of strategies which alongside with recommendations on undertaking specific projects should also include appropriate funding. But in Ukraine a comprehensive approach on green economy development is not developed, neither are priorities and aims, directions of its implementation, target indicators of green economy development, there is no assessment of costs necessary for its implementation. Thus, to give a good start it is very important to identify the key industrial sectors crucial for green economy transition.

Resent research and publication analysis. Ecological and economic issues are widely discussed by foreign and domestic scientists. Significant contribution to the theory of sustainable development was made by foreign researchers: A. Pigou (2006), J. Forrester (1974), M. Mesarovic and E. Pestel (1974), V. Leontief and D. Ford (1972), D. Meadows et al. (1994). Various aspects of industrial development in the context of limited resources and environmental degradation have been studied by Ukrainian scientists – V. Vernadskyi (1978), V. Kukhar et al. (2007), O. Chmyr (2013), A. Polovyan (2012) and others. It is extremely important to continue research on the development of theoretical basis and practical recommendations for sustainable development of Ukraine.

The aim of the research is to identify the criteria for selection of key industrial sectors crucial for transition to green economy.

Key research findings.

Criteria for selecting the key sectors for greening of Ukrainian economy. Today Ukraine has the model of export-oriented industrial development, which is characterized by the predominance of poorly diversified low-technology manufacturing. There is the following proportion of sectors in the total volume of industrial products (goods and services): 11.4% – mining and quarrying; 61.8% – processing manufacturing; 26.8% – electricity, gas, steam and air-conditioning supply; water supply, sewerage, waste management and remediation (Volume of industrial products..., 2013).

Manufacturing activities take the lead in the industry. It is usually recognized that in terms of the volume of natural resources used and environmental pollution

such ratio is favorable for developing green economy as the share of national environmentally intensive primary sector is virtually 6 times less than that of processing (to compare, the same ratio in Russia is 1 to 3). If we analyze the structure of manufacturing activities, it is "brown" industries related to the ferrous and non-ferrous metallurgy, chemical industry, production of petroleum products and coke as well as paper industry, which take the lead. They account for over 37% of the total volume of industrial products in processing. For reference, the share of mechanical engineering (machines, equipment, electrical facilities, transportation means etc.) is governing modernization and diversification of economy, which is relatively neutral production with regard to its negative environmental impact, is as small as 8.7%. On the whole, the sectors with a considerable negative environmental impact (power engineering, mining, metallurgy, production and distribution of electrical energy and gas etc.) account for 62.5% of the industrial structure. A structural and technological shift in the industry is therefore the priority in transition from the "brown" raw material model of economy to green economy towards an increased share of technological, high value added industries with advanced processing of raw materials and small environmental impacts.

But it is impossible to modernize all industries in one moment. Ukraine should organize a stepwise process. For the selection of key industry sectors crucial for green economy such criteria can be used:

- importance of a sector for economic development of Ukraine (contribution to GDP and export, its share in national employment);
- high level of material intensity;
- low level of energy efficiency as compared to energy efficiency in the EU;
- high level of environmental influence;
- innovative activity and availability of projects (know-how, technological innovations etc.) encouraging green manufacturing;
- the possibility for a cumulative effect and the availability of economic potential for the development of "green economy";
- competition and concentration in the sector, motivation (interest) of owners to implement green innovations.

First of all, we have to bear in mind that a double benefit (i.e. economic efficiency and environmental performance) may not be gained concurrently in all sectors. In view of high capital intensity of mining and metallurgy, it is evident that implementation of mutually rewarding solutions for both environmental protection and resources saving in the short run is impossible. Drivers of ecologically friendly changes are therefore beyond the solutions with double benefits and voluntary approaches because they are ineffective when there is an obvious social priority but there is no business advantage to justify added costs.

Identification of important industrial sectors. To obtain a tangible environmental result and improve the efficiency of ecosystems and ecological quality of life on an economically sound long-term basis, it is necessary to exert influence on the essential sectors of national economy. We will fail to get a meaningful result by influencing a sector accounting for only 1% of the total GDP. The analysis proves that the most important industries for economic development of Ukraine are: metallurgy; machine-building; manufacturing of food products, beverages and tobacco; mining

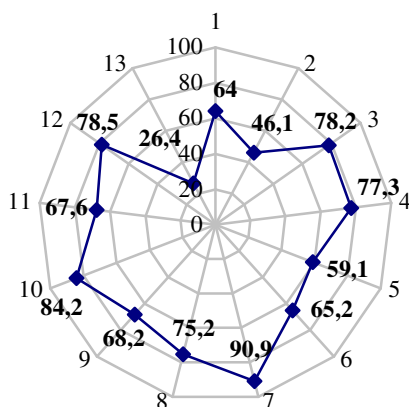
and quarrying; electricity, gas and steam. These industries make the greatest contribution to the output and exports volumes, volume of sold industrial products, also providing the highest employment rates. The metallurgical industry has the major share in the structure of exports and output. Machine-building has the largest number of listed employees and ranks second in total export. The above does not however mean that other sectors should not engage in greening of their technological processes. Greening actions have to be consistently introduced in all fields of activity. But efforts of state and non-governmental organizations as well as financial support have to be primarily focused on greening of the priority sectors. Well-known Pareto's law says that 20% of efforts yield 80% of results. A correct selection of the minimum of the most important actions allows quickly obtaining a considerable share of the anticipated result.

When selecting priorities, it is also necessary to identify crucial sectors which would ensure improved competitiveness of the national economy in the long term. Keeping in mind intricate economic situation of Ukraine though, at the initial stage it is essential to select those branches the greening of which will not result in great unemployment and/or create additional jobs in other branches.

Analysis of material intensity by sectors. Development of domestic production is carried out on the extensive basis, accompanied by the consumption of a large amount of material and energy resources which is quite expensive. As of year-end 2012, the intermediate consumption rate in mining and quarrying industry in the structure of production was 43.7%, in manufacturing – 81.1% and on average in industries – 75.2% (National Accounts of Ukraine, 2013). Taking into consideration the technological backwardness of Ukrainian industry, together there are two factors that reduce the competitiveness of industrial products.

In 2012 material intensity of Ukrainian GDP amounted 0.42 kg/UAH, which is 1.5–3.3 times higher than in many European countries (Draft of the Concept of the State Policy of green economy..., 2013). The analysis of the cost structure of sold industrial products makes it clear that the share of material costs in the total operating costs in mining amounts to 46.1%, in processing industry it is 78.2% (Figure 1). Material costs have the highest share in the operating costs of companies producing coke and oil products (90.9%), metallurgy – 84.2%; food products (77.3%) as well as chemical and petrochemical products (75.5%). Those branches are the major materials-intensive subsectors in Ukraine.

The selection process of priority sectors should focus on those industries where the level of material intensity is very high. But we must consider not only the level of material intensity of enterprises in a particular sector, but also the type of material resources. The cement industry drives large material flows, but of relatively non-scarce resources such as limestone and clay. Iron ore and bauxite are not particularly scarce, and near substitutes are available. Paper and pulp, natural fibre-based textile industry use renewable resources, the challenge here is to avoid using them beyond the maximum sustainable yield. Challenges for electrical and electronic industries may be more fundamental. High grade (> 1%) and easy-to-refine copper ores are becoming scarcer and low-grade ores need more energy for extraction and refining. Rarer metals such as silver, indium and tellurium are mostly extracted from other metallurgical wastes.



1 – Industry. 2 – Mining. 3 – Manufacturing. 4 – Food products, beverages and tobacco. 5 – Textiles, apparel, leather and related products. 6 – Wood and paper products, and printing. 7 – Manufacture of coke, and refined petroleum products. 8 – Chemicals and chemical products. 9 – Manufacture of non-metallic mineral products. 10 – Manufacture of basic metals and fabricated metal products. 11 – Machine-building. 12 – Other manufacture, repair and installation of machinery. 13 – Electricity, gas, steam and air-conditioning supply.

Figure 1. Share of material costs in total operating costs of sold industrial products, 2011, calculated by the author basing on the statistics from (Industry of Ukraine, www.ukrstat.gov.ua)

Why is it important in the selection process to take into account the level of material intensity? Decreasing material intensity will promote decoupling economic growth from resource consumption. For achieving economic benefits from greening special importance belongs to life-cycle approaches, green innovations that enable dematerialisation and expanded service systems. This relates to the problem solution of excessively rapid depletion of natural resources, which could adversely affect future economic growth. Both at the country and industrial sector levels, improved resource efficiency and decoupling offers competitive advantages and sustainable future prospects. These, together with other measures, can become the powerful drivers encouraging manufacturing become more efficient in the use of natural resources and energy.

Analysis of energy intensity by sectors. Energy component in the cost of some industrial products is still high. However, own energy supply is less than 50%, which makes energy efficiency the key issue in national economic security. Consumption of primary fuel and energy resources per GDP unit in Ukraine is much higher than in developed countries. The energy intensity of GDP in 2010 amounted to 0.47 kg of oil equivalent per 1 USD, which is 1.3 times higher than in Russia, 3.1 times higher than in Poland and 2.6 times higher than the worldwide average (Key World Energy Statistics, 2012).

Thus, during 2010–2012 in the structure of final energy consumption industry occupies a significant position – its share ranges from 35.1% in 2010 to 34% in 2012 (Table 1).

Metallurgy is the most energy-intensive industry due to the technological characteristics of this sector. In 2011 the share of metallurgy in the total consumption of

energy resources by industry was 2.5 times higher in Ukraine than the EU average (Energy efficiency rating for Ukrainian regions in 2011, 2012 and 2013). Allowing for a considerable gap between industrial sectors of Ukraine and the EU countries, Ukraine has therefore a great energy-saving potential. Improvement of energy efficiency to meet the European level will enable reducing the final consumption of fuel and power resources in agriculture, industry, construction, services and housing by 45.8%. The energy saving potential of Ukraine in 2011 was 26.5 mln tons of oil equivalent, which approximates to 29.3 bln m³ of natural gas. Potential saving in money terms comes to 2010 11.4 bln UAH (Energy efficiency rating for Ukrainian regions in 2011, 2012 and 2013).

Table 1. **Consumption of energy resources, 2010–2012**, calculated by the author using ("Energy balance of Ukraine", 2012)

Industrial sectors	2010		2012	
	ths tons o.e. ¹⁾	% to the total	ths tons o.e.	% to the total
Total consumption	73778	100	73107	100
Industry	25923	35.1	24845	34.0
ferrous metal industry	14026	19.0	13312	18.2
manufacture of chemicals chemical and petroleum products	2075	2.8	2420	3.3
manufacture of other non-metallic mineral products	1771	2.4	1573	2.2
machine-building	767	1.0	816	1.1
mining (except fuel)	2097	2.8	1620	2.2
food products, beverages and tobacco	1887	2.6	1921	2.6
other manufacturing	1306	1.8	1307	1.8

¹⁾ oil equivalent.

The analysis of environmental impact sectors. The basic contradiction between economic and ecological development lies in the two aspects. On the one hand, economy should grow, on the other, this development gives a rise to adverse environmental effects. Most of manufacturing processes cause varying degrees of air, water and soil pollution. That's why the growth of industrial production is always accompanied by increasing pressure on the environment. Industry is responsible for over a fifth of CO₂ emissions.

One of the most pressing ecological and social problems in Ukraine is air pollution. Table 2 shows that the strongest polluters are steel-makers as well as mining companies and electricity producers accounting in total for 87.2% of all polluting emissions (from stationary sources) in 2012. Processing industry is the second biggest producer of emissions in Ukraine, moreover, they produce especially dangerous substances for the environment and for human health.

The analysis of the emissions dynamics from industrial enterprises demonstrates a negative tendency reflected in a discrepancy between the volume of industrial production and the emissions volume. In 2012 emissions were increasing despite a slowdown in industrial production in most branches.

Other significant environmental externalities of industrial production include the impacts associated with hazardous substances and wastes. The waste sector produces pressure on the environment through releases from landfills, domestic and

commercial waste-water treatment, industrial wastewaters. According to the analysis (Table 3), the highest volume of sewage waters comes from the energy industry, metallurgy and coal industry.

Table 2. Emissions of harmful pollutants and carbon dioxide to the atmospheric air from stationary pollution sources
(Report "Environment of Ukraine", www.ukrstat.gov.ua, 2012)

Sectors	Emissions of harmful pollutants			Emissions of carbon dioxide	
	2010	2012	% to	2010	2012
	ths tons		the total	ths tons	
All economic sectors	4131.6	4335.3	100	165041.8	198175
1. Mining and quarrying	851.7	882.4	20.4	2421.6	4296.8
2. Manufacturing	1347.5	1272.5	29.4	59130.8	81908
Including:					
chemicals and chemical products	63.7	61.4	1.4	5777.5	6760.6
basic metals and metal products	1076.8	1015.8	23.4	39234.8	59188.1
3. Electricity, gas, steam and air-conditioning supply	1601.9	1882.7	43.4	95778.9	105752.9

Table 3. Wastewater discharges by the main sectors of economy
(Report "Environment of Ukraine", www.ukrstat.gov.ua, 2012)

	Wastewater discharges			Polluted wastewaters		
	2010	2012	% to	2010	2012	% to
	mln m ³		total	mln m ³		total
All economic sectors	8141	7788	100	1744	1521	100
Including:						
Electrical energy industry	2511	2839	36.5	24	21	1.4
Coal industry	491	452	5.8	311	295	19.5
Metallurgy	1389	1210	15.5	529	505	33.4
Chemicals and chemical products	139	107	1.4	27	26	1.7
Machine-building	42	41	0.5	21	22	1.5
Oil and gas	12	4	0.1	5	4	0.3
Food industry	55	26	0.3	7	3	0.2

Another pressing ecological problems in Ukraine is environmental pollution caused by production wastes. In 2012 64.5% of the total waste volume accounted for primary mining and enriching production cycles – excavated and spoil materials, sludge and other mining products deposited for a long time. The sites for the storage of these waste occupy 160–165 ths ha. In mining and steel-making alone the annual waste production amounts 100–120 mln tons. The second place in waste generation belongs to metallurgy (58.9 mln tons – 13.1% of the total volume). Emissions from metallurgy, cement and chemical industries account the most, while industries such as textiles and leather (due to dyeing and tanning process), paper and pulp (due to bleaching and water emissions) can generate significant negative externalities if their effluents are not handled properly. It should be noted that pulp and paper industry as well as textiles and leather have direct impact on biodiversity.

When selecting the key sectors for greening of Ukrainian economy it is necessary to take into account which sectors have untapped opportunities for resource and

energy saving, environment protection. Therefore, for the selection of priority sectors cooperation between representatives of academia and government agencies should be organized. It is very important to analyze the availability of projects aimed at greening of different processes to facilitate the technologies transfer.

Conclusions. The development dynamics of Ukrainian industries faces a number of system problems which necessitate prompt solutions and overcoming risks for further economic growth. Primarily, these are the significant export focus of production, its high resource and energy intensity, a critical state of fixed assets in the country overall low technological level and inadequate innovation capacity of the economy. The above limitations during the recession period demonstrated the necessity for radical reforms in the industrial sector by developing high-tech production on the basis of green economy which is capable of securing economic growth. It can be achieved through development and implementation of a comprehensive concept of green modernization of Ukrainian industrial complex.

When selecting the key sectors for greening of Ukraine's economy it is necessary to consider the possibility of these sectors on: reducing negative environment impact; reducing the use or restoration of natural resources and ecosystems; availability of economic benefits for business; social benefits for population.

From the viewpoint of the importance of the industrial sector for economic development of Ukraine (contribution to GDP and exports volume) metallurgy took the first place. At the same time this sector has rather low levels of value added and profitability, and also considerable negative environmental impact. Metallurgy is highly dependent on global trends at metal markets, this sector has high degree of fixed assets depreciation, low technological level and energy efficiency. This creates serious problems for future development of this industry. Structural and technological shift in the industry is therefore the priority for modernization of economy.

Machine-building ranks the second by importance for economic development of Ukraine. But this sector has low competitiveness. Priorities for machine-building sector development in Ukraine should include: changing the structure of this sector with the emphasis on increasing high-tech industries; expansion of production for domestic market while increasing the quality and reducing the range of imported products; development of new markets, investing in technological renovation of production processes.

Food industry ranks the third by importance for economic development of Ukraine. Structure, technical-economic indicators and infrastructure development of food industry in Ukraine significantly lags behind developed countries, particularly when it comes to processing of raw materials, mechanization and automation of manufacturing processes, packaging of products etc. To stabilize the situation in food industry green modernization of this sector is needed. This implies renewal of material and technical basis, modernization of production cycles by means of innovative technologies implementation.

State regulation could be of paramount importance in promoting green business. However, this should not lead to even heavier tax burden on some sectors, for example, mining and metallurgy, due to their export orientation and significant role in foreign currency earnings of the country, though such steps could bring about positive long-term changes. For example, more stringent ecological standards in Europe,

which are focused, inter alia, on green business promotion, encouraged the development of new competitive advantages of European companies which are now taking the lead in offering resource and energy saving technologies. Governments are challenged to find flexible policies and regulatory mechanisms that best suit national interests. Environment-related levies, including carbon taxes, will be required to ensure producers include the cost of externalities into their pricing calculations. For Ukraine it is very important to increase the incentives behind pollution charges.

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