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**VECTORS OF BALANCED INNOVATIVE DEVELOPMENT OF
METALLURGICAL ENTERPRISES
UNDER THE CONDITIONS OF NEOINDUSTRIALIZATION OF THE
ECONOMY**

The article states that metallurgy is generally recognized as one of the most important branches of industry since its products remain the basis for the development of many metal-consuming industries. However, in recent years its growth rates have significantly been lagging behind those of other types of economic activity. The reasons for the negative changes in the metallurgical industry are determined. The need to define the vectors of balanced innovative development of the metallurgical industry under the neoindustrialization of the economy is emphasized. The content component of the concept of "neoindustrialization of the economy" is considered. The Program of modernization of production of spongy titanium of aerospace quality by Zaporozhye Titanium & Magnesium Combine Ltd. was studied. The main vectors of balanced innovative development of metallurgical enterprises under the neoindustrialization of the economy are determined taking into account AA1000SES and ISO 26000: 2010 international standards ratified by Ukraine.

Keywords: technical modernization, investment, innovative project, innovative development, neoindustrialization of the economy

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Introduction.

Metallurgy is generally recognized as one of the most important industries since its products remain the basis for the development of many metal-consuming

industries. However, its growth rate in recent years have significantly been lagging behind those of other types of economic activity due to a number of reasons:

The first reason is the unprecedented increase of metal production volume in the world and the intensification of competition on the world market of steel products owing to the accelerated development of steel production in many countries on the basis of more modern technologies [1, p.142]. Thus, from 1970 to 2015, the amount of steel smelting increased by 2.7 times - from 595 to 1623 mln tons. At the same time, according to the World Steel Association (WSA), 99% of pig iron in the world is produced by 39 countries, 98 % of steel is produced by 68 countries, 10 out of them are major producers (China, Japan, USA, India, South Korea, Russia, Germany, Turkey, Brazil, Ukraine) that provided 80% of the total steel output in 2015 [1, c. 138];

The second reason is radical changes in the geographical structure of production and consumption of metal products. China is the leader in this process. Since 2005 (when this country became the main net exporter of steel) China has increased steel smelting by more than 2.3 times, and in 2015 it accounted for almost half the total volumes of metal production and consumption of finished metal products. The positions of India and Turkey as main metal producers have also considerably strengthened, which has finally made Asia the main steelmaking region. The influence of Brazil, which in 2010 entered the TOP-10 steel producers and has been increasing its growth rates, has also become stronger. The positions of Ukraine and Germany (as well as Europe and the CIS on the whole), on the contrary, have significantly decreased [1, p.140];

The third reason is the aggravation of marketing problems as a result of metal surplus on the world market of metal products. Thus, according to the WSA data, during the ten-year period from 2005 to 2014, the average annual growth rate of steel production and consumption of finished metal products was 104.8%, while the average growth rate of metal surplus in the world (excess of production over consumption) over the same period was 106.3%; the share of the surplus in the total volume of metal production on average amounted to 8.1%, or 112.8 mln tons [1, p.143];

The fourth reason is the aggravation of resource problems.

The fifth reason is the aggravation of environmental problems in the world metallurgy. According to the WSA and the International Energy Agency, ferrous metallurgy accounts for 6.7% of the world's total carbon dioxide (CO₂) emissions. This

equals to 1.8 tons of CO₂ per a ton of smelted steel. And, as experts from these organizations point out, in the future, reducing emissions of carbon dioxide and other harmful substances is possible only with the development and implementation of entirely new steelmaking technologies [3].

Therefore, the abovementioned trends necessitate a more detailed study of the vectors of balanced innovative development of metallurgical enterprises.

Analysis of recent studies and publications shows that the transformational processes that are currently being observed in the economy encourage scientists to study the vectors of innovative development of domestic metallurgical enterprises, since the innovation component reflects the efficiency of the industry in general and determines the volume of investment for the implementation of innovative projects. The issues of innovative development of metallurgical enterprises have been studied by many scientists, e.g. O.I. Amosha, L.L. Antonyuk, V.M. Heyets, M.Z. Zgurovsky, A.V. Peretyatko, K.V. Sirenko, A.M. Tkachenko. The scientists confidently argue that the development of the metallurgical industry is possible only under the new state policy of neoindustrialization. However, the issue of the transition of metallurgy to a balanced innovative development is still controversial. Therefore, the need for further scientific study of neoindustrial development of metallurgy of Ukraine has necessitated the research to identify the vectors of balanced innovative development of the industry.

Purpose and presentation of the main material.

From the economic point of view, "neoindustrialization" is a process that contributes to the new development of productive forces on the basis of high-tech and knowledge-intensive production processes based on the institutional environment.

Realizing the need for entirely new steelmaking technologies and, in particular, for the production of spongy titanium of aerospace quality, Zaporizhzhia Titanium Magnesium Combine Ltd. (hereinafter referred to as ZTMC Ltd.), as one of the leading metallurgical enterprises in Ukraine, adopted the Strategy for the Development and Modernization of Production of Spongy titanium. On the basis of this Strategy, they developed the Program for modernization of production, namely:

- acquisition of three ore-smelting furnaces with the production capacity of spongy titanium of up to 50 thousand tons / year, each with a downgrade transformer with the capacity of up to 21 MW	USD 21,0 mln
- modernization of the existing salt chlorinators with increased productivity of up to 170 tons / day	USD 7,5 mln
- construction of a new workshop for the purification of titanium tetrachloride with the capacity of 80,000 tons / year	USD 16,0 mln
- design work in order to create capacities	USD 9,5 mln
- modernization of the railway facilities and highways	USD 9,5 mln

Currently, the process of spongy titanium production is carried out on a periodic basis, which leads to additional energy losses for heating the material, and, consequently, to significant amounts of CO₂ emissions into the atmosphere. With such a technology, the production is characterized by a high level of raw material and labor costs per unit of output, which, accordingly, has a negative impact on the performance of the enterprise and the competitiveness of its products.

According to the Program for the modernization of spongy titanium production, innovative technologies are to be introduced with the acquisition of three ore thermal furnaces with the production capacity of spongy titanium of up to 50 thousand tons / year each with a lowering transformer with the capacity of up to 21 MW operating on alternating current. The total amount of investment under the Program for the modernization of production of ZTMC Ltd. is given in Table 1:

Table 1

Total amount of investment under the Program for the modernization of production of ZTMC Ltd., USD, mln [3]

Indicators	Amount of investment
Total amount of investment for the implementation of the Program for the modernization of production	110,0

The modernization program makes provisions for	
- construction of a new production of titanium slag with the capacity of 150 thousand tons / year using three new ore thermal furnaces, with the capacity of 21 MW each	63,5
- modernization of the CX-1 salt chlorinator with the capacity of 170 tons / day (with realization of automated system of control of production process)	12,0
- construction of a new purification section for titanium tetrachloride with the capacity of 80,000 tons / year	16,0
- organization of production of spongy titanium with the capacity of 20,000 tons / year and magnesium reducing agent for the production of spongy titanium	9,0
- modernization of railway facilities and highways	9,5

Nowadays, purchase of ore-thermal furnaces can give the opportunity to clear the gases, which were formed in the production process, to the level required by the international standards.

The graph showing the use of investment under the Program for the modernization of production of ZTMC Ltd. is given in Table 2:

Table 2

Schedule of investment use according to the Program for the modernization of production of ZTMC Ltd., USD, mln [3]

№ п/п	Description	Expenses during the 1 st stage of moderniz ation, USD, mln	2013	2014					2015
			IV quarter	I quarter	II quarter	III quarter	IV quarter	I quarter	
1	Production of titanium slag	63,50	1,10	5,15	17,25	15,00	18,00	7,00	
1.1	Design works (capacity of 150 thousand tons/year)	5,75	1,00	1,50	1,75	1,50	-	-	
1.2	Purchase of equipment	32,50	-	3,50	12,50	5,50	11,00	-	
1.3	Construction and assembly works	25,25	0,10	0,15	3,00	8,00	7,00	7,00	
2	Modernization of CX-1 salt chlorate with the capacity of 170 tons /day (with realization of automated system of control of production process)	12,00	-	0,25	0,25	3,00	4,00	4,50	

2.1	Realization of automated system of control of CX-1 production process	0,50	-	0,25	0,25	-	-	-
2.2	Construction and assembly works	2,00	-	-	-	-	1,00	1,00
2.3	Purchase of equipment	9,50	-	-	-	3,00	3,00	3,50
3	Construction of a new site for the purification of titanium tetrachloride with the capacity of 80 000 tons / year	16,00	0,50	3,00	2,50	4,00	4,00	2,00
3.1	Design works	2,00	0,50	1,00	0,50	-	-	-
3.2	Construction and assembly works	6,00	-	-	-	2,00	2,00	2,00
3.3	Purchase of equipment	8,00	-	2,00	2,00	2,00	2,00	-
4	Feasibility study, project design, modernization operational performance documents for 20 000 tons /year for the production of spongy titanium and magnesium reducing agent (for the production of spongy titanium)	9,00		2,00	2,00	2,00	2,00	1,00
5	Modernization of the railway facilities and highways (feasibility study, project design, operational performance documents)	9,50	0,10	1,10	2,65	2,15	2,00	1,50
5.1	Implementation of the project and the operational performance documents	0,50	0,10	0,10	0,15	0,15	-	-
5.2	Purchase of equipment	6,00	-	1,00	2,00	1,00	1,00	1,00
5.3	Construction and assembly works and modernization of the existing facilities	3,00	-	-	0,50	1,00	1,00	0,50
	Total:	110,00	1,70	11,5	24,65	26,15	30,0	16,0

The financial profile of the Program for the modernization of production of ZTMC Ltd. is as follows (Table 3).

The data in Table 3 shows that, if titanium slag and pig iron are sold at the planned prices according to the program, at the end of 2020, the NPV will be USD 3594,000. At the same time, the level of IRR will reach 19.6%, and, therefore,

according to the Program, 1/5 of the profit per each monetary unit of invested capital is expected. If the expected NPV level is reached, the payback period of the Program will be 4 years and 8 months after the development of the project documentation and 2 years and 11 months after the implementation of the program.

Table 3

Financial profile of the Program for the modernization of production of ZTMC Ltd. [3]

Baseline			Main economic indicators of the program						
Product name	Price, USD per 1 ton		Investment, USD, mln	Payback period (PP), years	Payback period since the implementation of the program (PP),	Discount payback period of the program, years	NPV according to the program by the end of 2020, USD, thousands	IRR according to the program	PI according to the program in 2020
Titanium slag	800	682,8	110	4 years and 8 months	2 years and 11 months	6 years and 10 months	3 594	19,6	1,45
Pig iron	400	150							
OTT	1 200	839,9							

Thus, the NPV schedule of the Program for the modernization of production of ZTMC Ltd. looks like follows (Fig. 1):

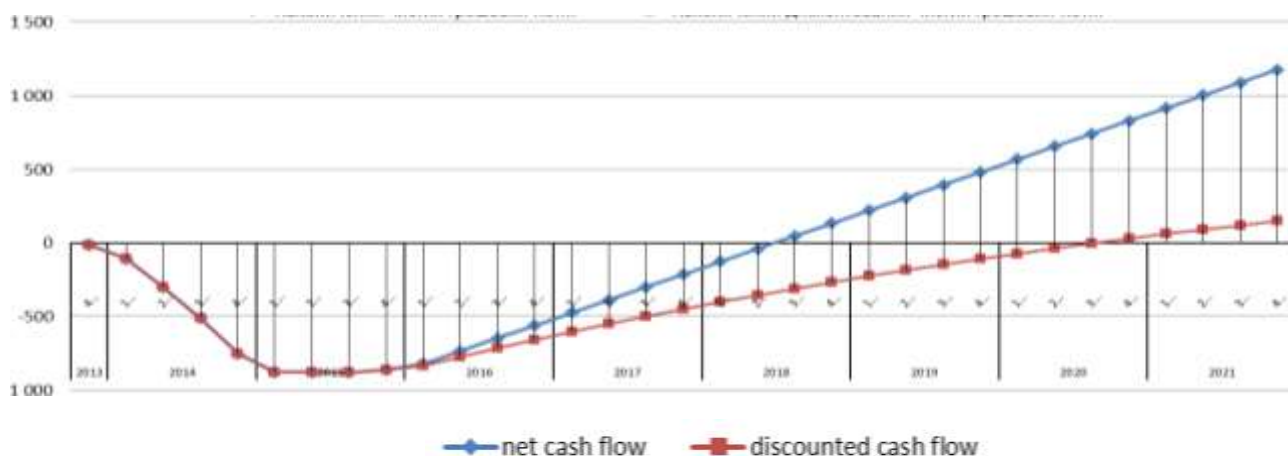


Fig. 1. NPV graph of the Program for the modernization of production of ZTMC Ltd.

Source: [3]

According to the results of the first years of the Program implementation, ZTMC Ltd. has actually achieved an increase in the production of spongy titanium of aerospace quality, its dynamics is shown in Fig. 2:

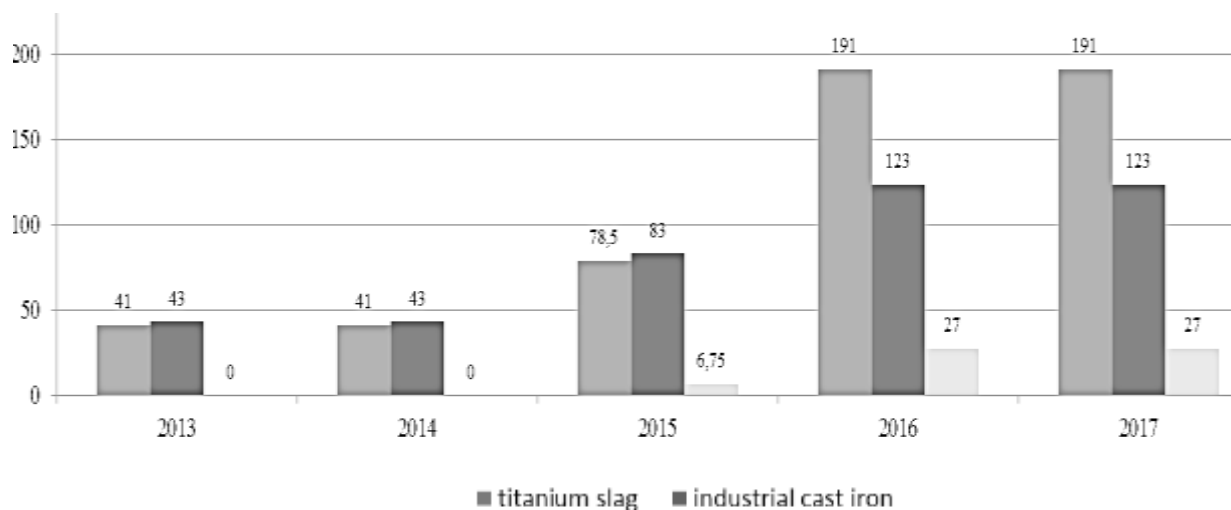


Fig. 2. Dynamics of changes of main production indicators of ZTMC Ltd. during 2013-2017

Source: [3]

Consequently, we conclude that the Program for the modernization of production of ZTMC Ltd. takes into account both the economic benefits and international standards ratified by Ukraine. In particular, these are AA1000SES [2] and ISO 26000: 2010 [4] standards, which stipulate the enterprises which have social responsibility to future generations. It is proved by meeting the requirements of stakeholders via:

- the increase in the production volume of spongy titanium of aerospace quality;
- double increase in the service life of furnaces lining;
- reduction of expenses for raw materials and energy resources;
- reduction of CO₂ emissions into the atmosphere.

Conclusions. Therefore, the main vectors of balanced innovative development of metallurgical enterprises in the conditions of neoindustrialization of the economy should be:

- efficient technology transfer;
- ensuring the energy efficiency of modernization of production technologies;

- overcoming the contradiction between the level of innovative potential and the complexity and high cost of innovative projects;
- change of investment support from the investment innovation model to the innovation and investment one;
- ensuring the requirements of stakeholders in accordance with AA1000SES and ISO 26000: 2010 international standards of relationship with stakeholders.

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