

# Assessment of the Economic Security of Carbon-Intensive Industries in the Oil and Gas Sector of the Economy

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## ABSTRACT

**The relevance** of the article is related to the analysis of the business model of the leading carbon-intensive industries included in the holding of the petrochemical market. **The objective** of the study to improve the value formation model for petrochemical production. **The results** of evaluation demonstrate the obsolescence of the profit generation model, which confirms the statement that it is necessary to improve value creation models during the transition to a new level of technological development and a change in the economic development model. In addition, shifting consumer interests dictate the need to transform familiar business processes in order to create value for consumers and suppliers. **Research results.** According to the authors, in the context of the transition to carbon neutrality, the relevant models that form value are models of responsible consumption and transfer of responsibility based on the principles of K. Christensen. The uniqueness of both models lies in the formation of profits due to reproducible raw materials (in fact, recyclable production waste) and the sale of spent or released carbon units, as well as in a new way of interaction between production participants by registering on a technological platform (ESG platform). The authors also note that the area of value creation is changing (decreasing), that is, the area of business competence will be determined by the principles of sustainable development. It should be noted that the level of economic security of petrochemical industries in the new conditions of transition to carbon neutrality directly depends on the value creation model.

**Keywords:** petrochemical industries; ESG projects; sustainable development; oil and gas sector of the economy; value chain; circular business models; low-carbon regulation; platform solutions; economic security

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## INTRODUCTION

The key task of any enterprise is to generate a profit model, each of which soon enough becomes obsolete due to the rate of change in technological solutions and consumer preferences, which also determines the development of approaches in this area. The new profit model should create value not only for owners and shareholders, but also for society, suppliers and related businesses. These are the principles laid down in the concept of sustainable development. The post-industrial economy is in conformity with the principles of sustainable development, which determines the transformation of existing profit models. In addition, enterprises have a growing risk of losing the market if they never change their approaches to forming business value, so it is necessary to assess the economic security of those entities that form the major bulk of state revenues. Since the principles of sustainable development mainly mirror the activities of carbon-intensive industries, the area of the given research interests is the petrochemical sub-sector of the economy, which contributes to the formation of the greatest added value in the national oil and gas sector. The authors analysed the activity industries in the West Siberian and Volga clusters of the petrochemical market.

Thus, the objective of the article is to enhance the profit generation model of petrochemical production based on the assessment of the economic security of existing approaches to value creation. For this aim, it is necessary to solve the following tasks:

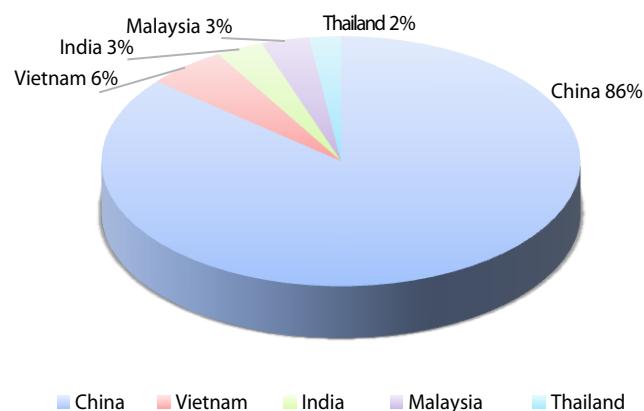
1. Perform an analysis of the data of the financial model of petrochemical production because of methodological approaches that allow determining the stability, inflow or outflow of values;
2. Improve the business models of petrochemical production through platform solutions for obtaining value for society and suppliers of related industries.

The hypothesis of the research is that when moving to a next level of economic development, it is necessary to have value formation models

transformed. Despite the fact that sustainable development presupposes renewable energy sources replaced traditional sources [1], some of the countries have not managed to reach their distribution at a large scale (Fig. 1). However, China's experience is one of the most interesting for Russia related to the capture technologies of CO<sub>2</sub> and obtaining alternative energy [2]. Moreover, the forecast for the domestic carbon regulation market indicates the application perspectives of this area (Fig. 2), which will contribute to the development of new types of business [3,4], and thus, the formation of completely new value models.

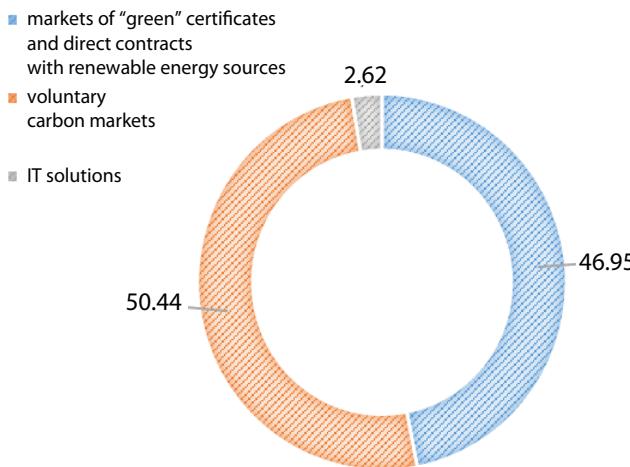
It is worth pointing out that a business model that contributes to the growth of value for one enterprise will not be effective for another. Since the unified approach does not exist. Besides, technological progress leads to a swift decline of relevance of existing models, which implies inevitable transformation of these models during the transition to a new (the 6th) technological paradigm.

The basis for the given research included theoretical approaches that determine the business model as a conceptual framework for business value. This was reflected in the works of Linder J., Cantrall S., Osterwalder A., Chesborough G. It should be pointed out that the system of creating value for petrochemical enterprises lays the foundation for generating profits in the oil and gas sector of the economy. Many scientists



**Fig. 1. Production of renewable energy (solar modules), %**

Source: compiled by the authors.



**Fig. 2. Forecast of the Carbon Market Volume in Russia in 2030, %**

Source: compiled by the authors.

dedicated their research work related to business modeling. Thus, P. Drucker described business as a set of proposals, P. Timmers characterised the model of forming a value proposition as a new way of making a profit, J. Magretta called the business model the architecture and transformation of the processes of creating a product, and K. Christensen presented the business model as a profit formula obtained through basic resources [5, 6, 7].

The principles of reduction of the carbon intensity in production were analysed by V. S. Anshin, E. Barbier, J. Forrester, V. I. Vernadsky and some other scientists, in view of new processes of generating added value in the post-industrial era. A. Smith, D. Riccardo, K. Marx and some other scientists provided the methodological foundations of value creation with basic approaches to defining the value system. M. Porter, G. Gereffi, M. V. Mayer, S. Shi, V. N. Tatishchev, M. V. Lomonosov etc. described ideas regarding the formation of value at the beginning and at the end of a practice-oriented chain of product creation. M. Levy defined the "value equation" and considered the formation of a business model in conjunction with the strategy of an enterprise. A. Pulik and A. Slivotsky analysed the indicators of the "strength" for a business model and the influence of intellectual capital on its effectiveness [8–11].

## METHODOLOGY OF THE STUDY

The following indicators were evaluated to examine the economic security of the given business model of petrochemical production:

1. Return on invested capital (ROIC) is an assessment of the company's profitability and its potential to create value in relation to capital:

$$ROIC = \frac{NOPAT}{E + LTD}, \quad (1)$$

where  $NOPAT$  — Net Operating Profit After Tax;  $E$  — equity;  $LTD$  — long-term debt.

2. Weighted Average Cost of Capital (WACC) is the average interest rate for all sources of financing of the company:

$$WACC = \frac{CE}{TCC} \times PE + \frac{BC}{CBC} \times TVC, \quad (2)$$

where  $CE$  — cost of equity;  $TCC$  — total cost of capital;  $PE$  — price of equity;  $BC$  — amount of borrowed capital;  $CBC$  — cost of borrowed capital;  $TVC$  — total value of capital.

The difference between ROIC and WACC determines the efficiency of business activity: a negative value indicates the lack of the generated value of the business model for stakeholders.

3. According to A. Slivotsky, the market value to revenue ratio reflects the strength of the business model. Within the period of value inflow, it has a greater value than 2.0. Meanwhile during the period of stability, the value ranges from 0.8 to 2.0. During the period of value outflow, the value drops below 0.8, which means the inability of the business to generate profit [12]:

$$\text{"The strength" of a business model} = \frac{\left( \frac{\text{Market value}}{\text{Revenue}} \right)^{t+1}}{\left( \frac{\text{Market value}}{\text{Revenue}} \right)^t}, \quad (3)$$

Economic added value (EVA) is the return on investment in business. A negative value of this indicator means a decrease in the value of the business for the owner:

$$EVA = \text{Invested capital} \times (ROIC - WACC). \quad (4)$$

Intellectual value added coefficient according to the Ante Pulik method (VAIC) indicates the use of physical capital at the expense of intellectual:

$$VAIC = CEE + HCE + SCE, \quad (5)$$

where: *CEE* — added value of physical capital; *HCE* — added value of human capital; *SCE* — added value of structural capital.

At the same time, the efficiency of value creation at the expense of the added value of physical capital depends on the invested resources; due to the added value of human capital generated from the intellectual abilities of people; due to the added value of structural capital obtained from the results of human activity.

## RESEARCH RESULTS

To carry out the research, the authors processed a bulk of data set from the financial statements of the petrochemical production facilities of PJSC SIBUR Holding (*Table 1*). The reason for the choice of this object was determined by the fact, that it included key players in the Russian petrochemical market, divided into six clusters. Thus, the study of the general statements defines a concept of the business model of all enterprises included in the holding. The authors carried out the start-to-finish analysis of the West Siberian and Volga Region petrochemical clusters. Concurrently, the Herfindahl-Hirschman index reveals monopolisation and high barriers to entry into the petrochemical market; its values are 4642.1 for 2018 for the West Siberian oil-and-gas play and 7957.8 for the Volga Region oil-and-gas play. The main scientific interest stemmed from the point of view, how large enterprises respond to changes in the economic development model.

The analysis of the data for seven periods indicates the following (*Table 2*): starting from the year of 2022, the cost of capital (WACC) grew due of the fact that the price of equity and debt capital increased (interest on loans became higher). At the same time, the return on invested capital (ROIC),

which reflects the value of suppliers, shareholders and investors, is decreasing. This represents the inefficiency of the existing business model.

The change in economic added value (*Fig. 3*) indicates a decrease in the value of the business for the owners, which in turn is the evidence of an increase in the cost of capital. The cost of borrowed capital increased due to interest on loans (17.21 per cent for Ruble loans, 4.13 per cent for US Dollar loans in the year of 2022), and equity capital increased as a result of dividend payments to shareholders, which have increased six-fold since the year of 2017 (*Fig. 4*).

The line in the figure indicates that the existing business model is becoming obsolete.

*Figure 5* illustrates that since the year of 2021, the “strength” of the market potential of the business model has been sharply declining, and in the year of 2023 the indicator value was 0.476, which demonstrates an outflow of value, which means, that the business can no longer generate profit.

The figures in *Table 3* indicate that the intellectual capital of PJSC SIBUR Holding demonstrates a growing tendency, meanwhile wage costs are decreasing and the use of human capital is increasing, consequently, the added value of intellectual capital increases. Since the data for the year 2021 are partially presented in the given article, it was impossible to calculate some indicators for this period with more precision, however, this does not make any visible change of the indicated trend.

## DISCUSSION OF RESULTS

The analysis revealed that since the year of 2022, the existing model has ceased to be relevant, another words, it has lost the ability to bring value to owners, shareholders and other stakeholders. It is worth pointing out, that intellectual capital, on the contrary, has shown a tendency to grow. This demonstrates the efficiency of using the structural elements of the indicator, in particular, the human capital, which, however, did not allow increasing the value of the business model. Then K. Christensen's model has become the basis for the new approaches, as it involves the creation of

Table 1

**The Initial Data for Calculating the Performance Indicators of the Business Model of PJSC SIBUR Holding**

Indicator	Time period						
	1	2	3	4	5	6	7
Equity (thousand Rubles)	347121460	429833084	502182577	509265038	869375233	900263501	881263643
Long-term debt (thousand Rubles)	186329298	158172900	185299112	246655682	410108508	532699145	519327529
EBIT (thousand Rubles)	331679801	440876942	413116940	379263421	481874916	858835357	935965128
Net assets (thousand Rubles)	347122927	429839308	502188708	509271078	869381184	900269366	881269431
Revenue (thousand Rubles)	373705693	486061865	462950229	428705659	517008164	934504822	1031571277
Cost of sales (thousand Rubles)	244794465	307458323	316580546	311622196	302408695	622377949	698193738
Wages (thousand Rubles)	280 289	326 464	346 934	278 078	—	312 221	249 700
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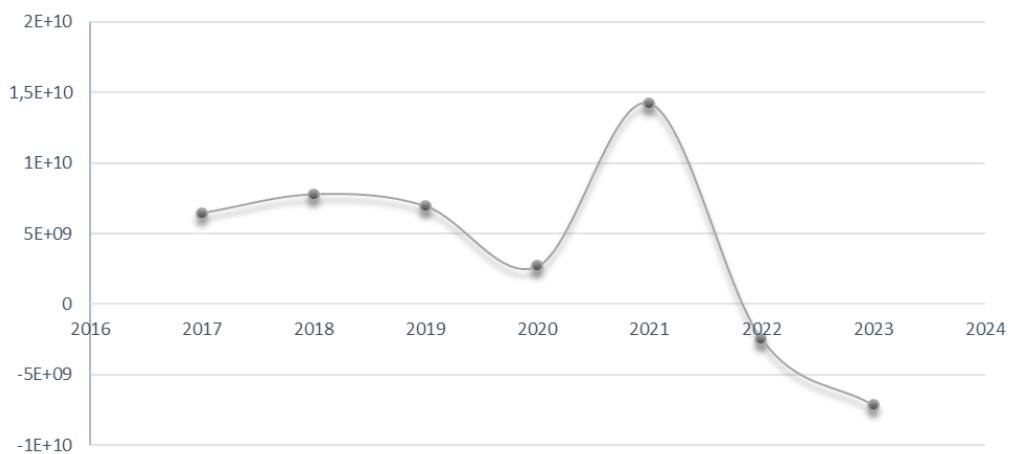
Source: compiled by the authors according to the financial statements of PJSC SIBUR Holding for the years of 2017–2023.

Table 2

**Analysis of the Effectiveness of the Business Model of PJSC SIBUR Holding**

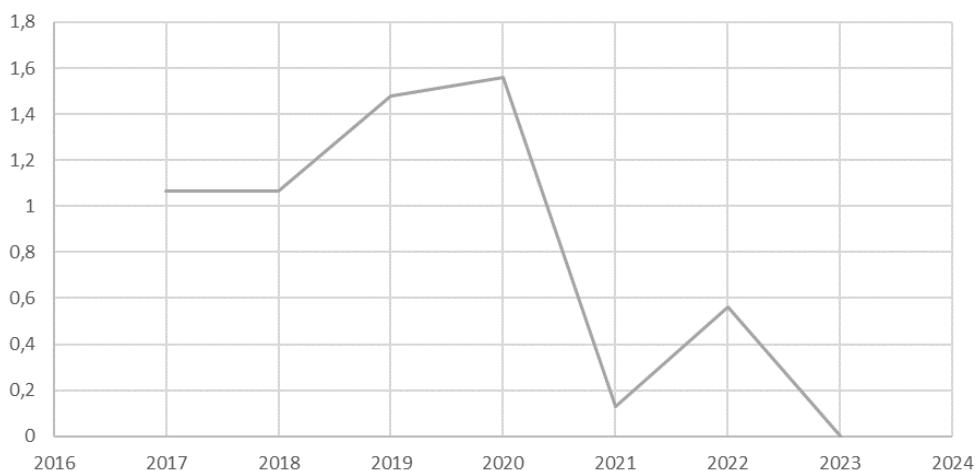
Indicator	Time period						
	1	2	3	4	5	6	7
IC (investment capital. thousand Rubles)	533 450 758	588 005 984	687 481 689	755 920 720	1 279 483 741	1 432 962 646	1 400 591 172
NOPAT (after-tax profit. thousand Rubles)	941 329 56	1 084 394 62	1 119 106 73	371 236 87	1 909 804 85	1 858 165 76	907 442 30
ROIC, %	17.646	18.442	16.278	4.911	14.926	12.9679	6.479
WACC, %	5.578	5.121	6.191	1.3848	3.814	14.705	11.609
Revenue growth	1.034	1.301	0.952	0.926	1.206	1.808	1.104
Economic value added (EVA. thousand Rubles)	6 437 749 473	7 778 777 386	6 934 876 630	2 665 804 439	14 218 560 896	2 489 839 432	7 184 407 786
ROIC-WACC	12.068	13.320	10.087	3.526	11.113	-1.738	-5.129

Source: compiled by the authors according to the financial statements of PJSC SIBUR Holding for the years of 2017–2023.



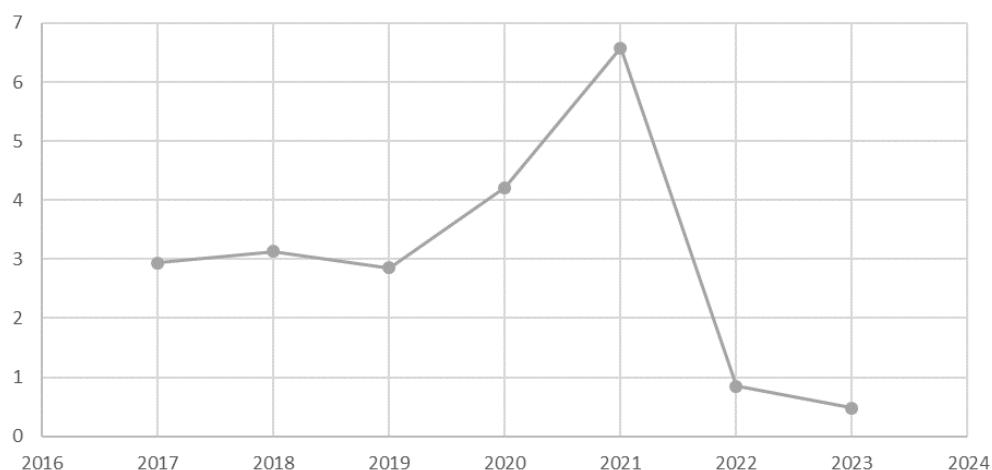
**Fig. 3. Economic Value Added (EVA) of PJSC SIBUR Holding (2016–2024)**

Source: compiled by the authors.



**Fig. 4. Trends in the Value Generation Process of PJSC SIBUR Holding**

Source: compiled by the authors.



**Fig. 5. The Market Potential of the SIBUR Holding PJSC Business Model According to Adrian Slivotsky**

Source: compiled by the authors.

Table 3

## Intellectual Capital of the SIBUR Holding PJSC

Indicator	Time period						
	1	2	3	4	5	6	7
VAIC	378.562	488.341	378.728	314.369	-	1547.140	2196.507
CEE	0.198	0.270	0.190	0.115	-	0.337	0.391
HCE	377.366	487.073	377.539	313.258	-	1545.804	2195.116
SCE	0.997	0.998	0.997	0.997	-	0.999	0.999

Source: compiled by the authors according to the financial statements of PJSC SIBUR Holding for the period of 2017–2023.

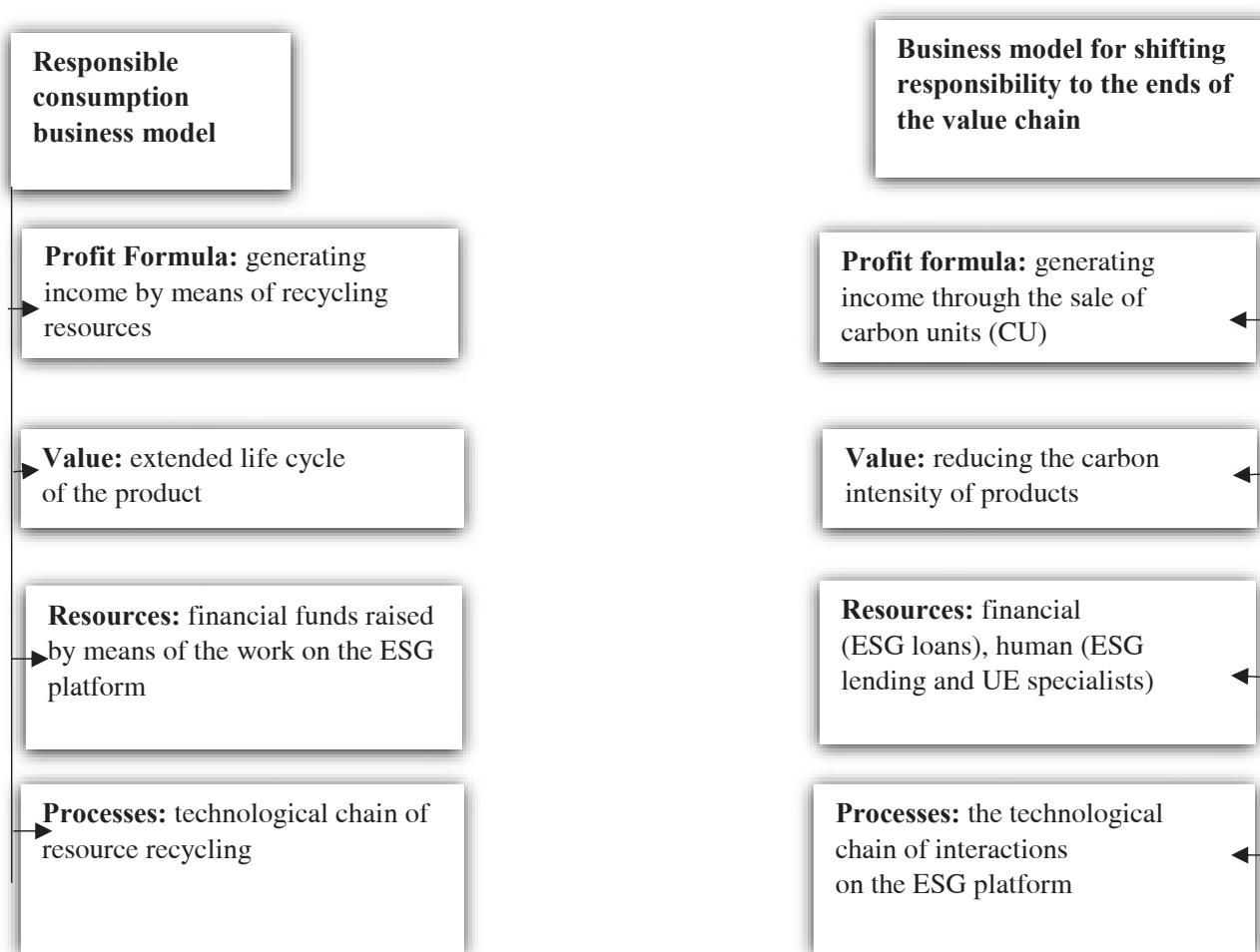


Fig. 6. Architecture of Business Models for Profit Formation of Petrochemical Industries in the Context of Transition to Carbon Neutrality

Source: compiled by the authors.

value by means of generating resources and key activities (Fig. 6). From our point of view, the most important element is the “profit formula”, which takes into account the values of suppliers

and consumers. The “profit formula” contributes to an increase in life cycle of the product, which is advisable to start from the “input level” of the value chain, taking into account the prin-

ciples of sustainable development. Furthermore, actions are possible within the framework of the manufacturer's value chain: the introduction of technologies into their business processes to capture CO<sub>2</sub>, the development of ESG projects, as well as the use of funds raised as part of the working process on the ESG platform.

The proposed model is based on generating profits by means of resource recycling, increasing the life cycle of the product, obtaining funds on the ESG platform, as well as using an innovation technology to enable interaction between the supplier and the consumer. However, there arises a problem, not all production facilities are ready for this, but they must meet market requirements and create value not only for the owners, but also for raw material suppliers and associated manufacturers. The authors envisage a proper solution in transferring responsibility: namely, production facilities that have not met the requirements for the reduction limit of CO<sub>2</sub> can purchase carbon units from the enterprises that generate the units. This model is in consistency with the principles of generating profits suggested by Christensen, however, the model provides for not only the development of technologies that help reduce of missions CO<sub>2</sub>, but also new forms of interaction between supplier, producer and consumer through a technological (ESG) platform [13].

Thus, the transition to a new (post-industrial) economy is distinguished by a change in the profit generation model. Otherwise, enterprises will lose value for suppliers and consumers, as well as for shareholders and subsequently for owners, which will eventually lead to a decrease in their share in the market and withdrawal from

the market. This situation also applies to the petrochemical sub-sector, as it became a key source of value creation in the oil and gas sector of the economy.

## CONCLUSIONS AND RECOMMENDATIONS

The article analyses the economic security of the model capable to generate profit of petrochemical production facilities including the SIBUR Holding PJSC group of companies, which demonstrates an outflow of value since the year of 2022. This occurs as a result of the excess of the weighted mean cost of capital over its profitability, which indicates a decrease in value for the supplier. Besides, since the year of 2022, the indicators of economic value added have negative numbers, which means a loss of business value for owners. The slowdown in the process of value generation also represent the evidence of the necessity to transform the existing model for petrochemical production facilities in the context of transition to a new technological mode, which confirms the hypothesis of the given research.

The authors have developed the architecture of business models for the transfer of responsibility and responsible consumption, based on the theoretical platform of K. Christensen, including a group of the following elements: profit formula, value proposition, resources, processes. Besides, the authors have proposed new means of generating profit (income from the sales of carbon units) and creating value (by increasing the life cycle of the product through the reproduction of raw materials), as well as integrating the links of suppliers-producers-consumers through an ESG platform.

## REFERENCES

1. Shirov A.A. Low-carbon development of Russia under the foreign economic restrictions. *Zhurnal Novoi ekonomicheskoi assotsiatsii = Journal of the New Economic Association*. 2022;(4):206–212. DOI: 10.31737/2221-2264-2022-56-4-11
2. Chen X. Transboundary carbon regulation: A view from China. *Mirovaya ekonomika i mezhdunarodnye otnosheniya = World Economy and International Relations*. 2023;67(4):75–80. (In Russ.). DOI: 10.20542/0131-2227-2023-67-4-75-80

3. Vechkasova M. ESG-transformation of Russian petrochemical industries based on a targeted approach. *Human Progress*. 2023;9(1):4. (In Russ.). DOI: 10.34709/IM.191.4
4. Deberdieva E. M., Vechkasova M. V., Golikava H. S., et al. Experience in the management of business processes with the use of digital technologies by Russian companies of a petrochemical complex. *IOP Conference Series: Materials Science and Engineering*. 2019;483:12066. DOI: 10.1088/1757-899X/483/1/012066
5. Osterwalder A, Pigneur Y. Business model generation: A handbook for visionaries, game changers, and challengers. Hoboken, NJ: John Wiley & Sons; 2010. 288 p. (Russ. ed.: Osterwalder A., Pigneur Y. Postroenie biznes-modelei. Nastol'naya kniga stratega i novatora. Moscow: Alpina Publisher; 2013. 288 p.).
6. Johnson M., Christensen K., Kagermann H. Reinventing your business model. *Harvard Business Review*. 2008;87(12):52–60. URL: <https://radio.shabanali.com/reinventing-your-business-model.pdf>
7. Debelak D. Business models made easy. Irvine, CA: Entrepreneur Press; 2006. 240 p. (Russ. ed.: Debelak D. Biznes-modeli: printsipy sozdaniya protsvetayushchei organizatsii. Moscow: Grebennikov Publ.; 2009. 256 p.).
8. Smith A. Recherches sur la nature et les causes de la richesse des nations. Vol. 1. Paris: Buisson; 1794. 438 p.
9. Porter M. The economic performance of regions. *Regional Studies*. 2003;37(6–7):549–578. DOI: 10.1080/0034340032000108688
10. Porter M. E. Competitive advantage: Creating and sustaining superior performance. New York, NY: The Free Press; 1998. 592 p. (Russ. ed.: Porter M. Konkurentnoe preimushchestvo: Kak dostich' vysokogo rezul'tata i obespechit' ego ustoichivost'. Moscow: Alpina Publisher; 2016. 1321 p.).
11. Ricardo D. On the principles of political economy and taxation. London: John Murrey; 1817. 589 p. (Russ. ed.: Ricardo D. Nachala politicheskoi ekonomii i nalogovogo oblozheniya. Moscow: Eksmo; 2007. 953 p.).
12. Slywotzky A. J. Value migration: How to think several moves ahead of the competition. Boston, MA: Harvard Business Review Press; 1995. 336 p. (Russ. ed.: Slywotzky A. Migratsiya tseennosti: chto budet s vashim biznesom posle zavtra? Moscow: Mann, Ivanov & Ferber; 2006. 412 p.).
13. Wong W.-K., The B.-H., Tan S.-H. The influence of external stakeholders on environmental, social, and governance (ESG): Toward a conceptual framework for ESG disclosure. *Forsait = Foresight and STI Governance*. 2023;17(2):9–20. (In Russ.). DOI: 10.17323/2500-2597.2023.2.9.20

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#### **Author's contributions**

**Marina V. Vechkasova** — general concept development, research data processing.

**Vera V. Plenkina** — formulation of the research hypothesis, definition of the research problem.

**Alexander A. Zubarev** — development of the structure of the article.

**Elena P. Kiselitsa** — formulation of the article's relevance.

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