

Global Transformations of the Energy Market

MYKOLA BURMAKA¹,
SERHII RUDKOVSKYI²

ABSTRACT. The up-to-date terminological definition of transformation processes in the global energy market has been investigated. The researchers have been summarized the methodological framework of studying the global energy market on the basis of model approach by application of provisions of the theory of branch markets ("Structure-Conduct-Performance-Regulation" model, SCPR), the theory of transformation of social and economic systems, the concept of sustainable development, which contributed to market-determined, componential, organizational and innovational and technological features of transformation. The key parameters of transformation processes in the global energy market as a result of changing social values in the paradigm of sustainable development, the necessary preconditions, drivers and incentives, techniques, the main directions of transformation have been identified. The experts have been identified the main stakeholders who honestly promote or hinder the transformations, as well as incentives for transformation by national and international regulators and the emergence of new business models and ecosystems. Methodological approaches to the application of the basic SCP model with its adaptation to study the transformation of the global energy market in areas, dynamics, impact, response and socially significant effects have been fixed. The global trends of energy market transformation towards liberalization on the basis of demonopolization, competitive market patterns, state and institutional tools have been studied. The irreversibility of transformations of the global energy market has been proved, their sources and key factors have been determined (demonopolization, reduction of entry/exit barriers, decentralization, liberalization, corporate integration, diversification, and greening). The structural transformations of the energy market through the prism of changes in the structure of energy consumption, the level of market concentration, international mergers and acquisitions have been analyzed. The influence of qualitative and quantitative changes in the market structure on the transformation of stakeholder behavior (change of pricing models, growth of segmentation, reduction of market power of natural monopolies, growth of global intra-industry competition, and stimulation of implementing innovations) has been substantiated. The term of "regulation" in the adapted model of SCPR in the context of measures of influence, stimulation, motivation, optimization has been determined. The focus is made on the importance of developing and implementing the ecological paradigm of the global transformation of the energy sector as a basis for sustainable development in the fourth energy transition using the cutting-edge technologies and models.

KEYWORDS. Global economy, global energy transformation, market transformations, industry market, energy market, energy transition, SCP model, digitalization, decentralization, liberalization, ecological paradigm.

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¹ **Mykola Burmaka** — Candidate of Economic Sciences, Associate Professor, Honored Economist of Ukraine, Head of the Department of International Management, Kyiv National Economic University named after Vadym Hetman. Sphere of scientific interests: global economy, international investment, stock market, creative management. E-mail: nburmaka@ukr.net.

² **Serhii Rudkovskyi** — PhD in International Economic Relations. Sphere of scientific interests: globalization of economic development, international economic integration, transformation of the energy market.

Introduction

The pattern of up-to-date global economy paradigm under the influence of Industry 4.0 and the implementation of the global Sustainable Development Goals (SDGs) determines the global transformation of the global energy market. These processes are linked to purely institutional and energy innovations, the growing share of "new" energy and the corresponding change in the global energy architecture, as well as to information and digital changes in the economy, growing needs of the global economy, latest social and civilizational processes, climate change and other global problems of mankind. Due consideration to the latest millennium challenges, qualitative and quantitative changes in global development in general and global energy in particular, is a precondition for the implementation of a competitive national energy policy. Therefore, in scientific and methodological terms, the study of transformation processes in the global energy market are of current importance.

The papers of many domestic and foreign scientists are devoted to the problems of transformation of the global economy and individual global markets of the main resources of its development in the processes of post-industrial reconfiguration. These papers are aimed at investigation of sectoral markets and their transformation, the latest trends in energy development and its individual components, current issues of recent transformations of the global energy market.

The study of imperatives, determinants, trends and prospects of global transformation processes in the global energy market requires comprehensive coverage, while this issue truly remains relevant in both theoretical and scientific and practical aspects. Energy is actually one of the key resources of global economic development, along with information, innovation and intelligence segments. Transformations in the energy market, which show signs of global transformation and are diversified in areas and scales, are ongoing in all countries and cover most sectors, industries and infrastructure components of global and national economies.

At the same time, the energy market is currently experiencing a kind of convergence and coordination of development strategies, when countries with different levels of economic power, institutional maturity, localization of energy resources, taking care of their own interests, are mostly moving in the same direction. With this in mind, the dynamics of change and the pace of public awareness of the inevitability of these changes assumes a dimension. At the same time, scientific and methodological approaches to the selection of appropriate models and institutional tools for the formation and implementation of energy policies continue to grow in importance.

The aim of the article is to form theoretical and methodological basis of study of transformation processes in the global energy market, identification of up-to-the-minute trends of the global energy development and on the basis of selection of new profile of industry transformation, substantiation of practical recommendations on effective integration of national energy system to global energy market.

Methodological format of studying the energy market transformation

In the scientific literature, the concept of "transformation of the global industry market"³ is communicated as intrinsically determined, natural, interconnected and mutually stimulating, common in content and direction quantitative and qualitative dynamic transformations of multilevel and multifoci system of relations between stakeholders of internal and external environment on the modern innovational and informational principles. These transformations have different caliber, structural proportions, organizational models, sequence, cyclical nature, pace, tools at the national and regional levels, but together they lead to a new quality of the global industry market, significantly different from previous market stages of development.

The term "global energy transformation" has now become widespread to identify changes in the global energy market. It is necessary to distinguish semantically consonant terms: "energy transformation" and "energy conversion", the second of which in the general sense means the conversion of one type of energy into another, such as kinetic energy of wind at wind power plants (WPPs) into electricity.

IRENA, the International Renewable Energy Agency, proposes the following interpretation of the term "global energy transformation": a deep transformation of the global energy system, which differs from the main one based on fossil fuels, to a state that increases efficiency and is based on renewable energy⁴.

³ See: 1) *Artemchuk T. O.* Klyuchovi faktory uspikhu zavdyaky prohrami transformatsiyi enerhetychnoyi haluzi. *Ekonomichnyy analiz*. T. 24. № 2. 2016. S. 65-70. [in Ukrainian].

2) *Zymakov A. V.* Transformatsiya enerhetyky v Hermanyy: sud'ba atomnoy y uhol'noy otrasly. *Sovremennaya Evropa*. 2017. № 5. S. 74-85. [in Russian].

3) *Dangerman A. T. C. J., Schellnhuber H. J.* Energy systems transformation. *Proceedings of the National Academy of Sciences*. 2013. Vol. 110. Is. 7. P. E549-E558.

4) *Geall S. et al.* Solar energy for poverty alleviation in China: State ambitions, bureaucratic interests, and local realities. *Energy Research & Social Science*. 2018. Vol. 41. P. 238-248.

5) *Ürge-Vorsatz D., Hauff J.* Drivers of market transformation: analysis of the Hungarian lighting success story. *Energy policy*. 2001. T. 29. № 10. P. 801-810.

⁴ International Renewable Energy Agency, IRENA, 2020. REmap Global Renewables Outlook 2020 edition. — URL: <https://www.irena.org/Statistics/View-Data-by-Topic/Energy-Transition/REmap-Annual-Energy-related-Emissions>.

Based on the analysis of the scientific literature on the study of the processes of transformation of social relations in a broad context and the industry market, in particular, the global industry market, we can identify the common features of transformation (Table 1).

Table 1

COMMON FEATURES OF TRANSFORMATION OF THE GLOBAL INDUSTRY MARKET

Manifestations of transformation	Established form of market relations
Significant change in market structure, appearance of new players	Regrouping of existing components and entities
Significant change in communications in the market structure	Stable disposition
Combination of evolutionary and revolutionary forms of development of economic relations	Evolutionary movement of economic relations to the basic steady state
Rapid changes in most states, especially in developed countries	Changes in market conditions in different countries are stretched over time
Option of direct and reverse directions of development (innovation and upgrading)	Focusing stakeholders' efforts to maintain the status quo
Transitions between established patterns of behavior in society	Conventional way of acquiring knowledge, steadiness of social relations
Forms' hybridity of old and new patterns	Personification of forms of social relations
Rejection of ineffective forms of the present, although they are still used	Conservation of current forms of the present patterns
Facing with innovations	Emergence of innovations and their individual application
Variety of business entities conduct	Invariance (conformity) of business entities behavior
Rejection of previous forms of economic relations	Use of previous but updated forms of economic relations
Incomplete transformation process, but awareness of the need to move to a new market model that has not yet been established	Identification of the existing market model
Changing the purpose of market participants	Fixed goal of market participants
Strategic state intervention to change market conditions	Government regulation aimed at fixing the existing market conditions
Growing role of international coordination in the implementation of market transformations	International coordination practices are aimed at supporting established market models by outsiders in the global industry market
Possibility of negative external social effects from transformations	Removal of the main negative external social effects by market and institutional means
Transforming the global business environment (outside the industry market)	Lack of radical change in the global business environment (external environment to the industry market)

Source: developed by authors on the basis of ⁵

⁵ 1) Hrazhevs'ka N. I. Vidobrazhennya transformatsiynykh protsesiv u systemi katehoriy sotsial'no-ekonomichnoyi dynamiky. *Ekonomichna teoriya*. 2007, № 4. S. 19-29. [in Ukrainian].

2) Hromyko O. Zmist ponyattya "transformatsiya" yak bazovoyi naukovoyi katehoriyi. *Efektivnist' derzhavnoho upravlinnya*. 2016. Vyp. 1/2 (46/47). CH. 1, S. 125-131. [in Ukrainian].

To describe the current key trends in energy sector, the scientists and practitioners widely use the term "energy transition" in line with rare use of the term "energy turn" (from German "Energiewende").

In addition, there are differences in interpretation of the term "energy transition", but common things are in the available interpretations, which in different ways fix the qualitative and quantitative changes in the structure of primary energy consumption, generation and architecture of national and regional energy systems⁶. Note that energy transitions do not occur immediately, but gradually, evolutionarily, they last for a certain period and coexist in parallel at different stages in different countries.

It is also important to understand a certain polemic of the concept "transformation of the global energy market" as a result of intrinsic general civilizational processes within the energy transition. Thus, global energy transformation is considered as the culmination of the energy transition that is already taking place in many countries⁷. The energy transition can be both determined by the government policy and by the interaction of a number of key development factors. In particular, in course of current energy transition, various factors "will affect the existence, speed and nature of the transition to low-carbon economies."⁸ Thus, the peculiarity of the energy transition as a phenomenon is that it may have different dynamics and differ significantly in individual national energy systems, but is characterized by common global trends and the nature of change.

3) Kryms'kyi S. Kontseptual'nyy lad analizu perekhidnoho protsesu. *Naukovi zapysky NaUKMA. Seriya: Filosofiya ta pravo*. 1999. T. 8. S. 4–10. [in Ukrainian].

4) Shayhorods'kyi Y. Ponyattya «transformatsiya» yak instrument analizu sotsial'nykh zmin. *Osvita rehionu. Naukovy zhurnal*. 2010. №4. S. 52–58. <http://social-science.com.ua/article/323>. [in Ukrainian].

⁶ See: 1) Bolwig S., Bazbauers G., Klitkou, A., Lund, P. D., Blumberg, A., Gravelin, A., D. Blumberg, A. (2018). Review of modelling energy transitions pathways with application to energy system flexibility. *Renewable & Sustainable Energy Reviews*. 2018. No. 101 (March). P. 440–452. — URL: 10.1016/j.rser.2018.11.019.

2) Fischer-Kowalski, M., Rovenskaya, E., Krausmann, F., Pallua, I., & Mc Neill, J. R. Energy transitions and social revolutions. *Technological Forecasting and Social Change*. 2019. Vol. 138. P. 69–77.

3) International Renewable Energy Agency, IRENA, 2020. *REmap Global Renewables Outlook 2020 edition*. — URL: <https://www.irena.org/Statistics/View-Data-by-Topic/Energy-Transition/REmap-Annual-Energy-related-Emissions>.

4) King L. C., Van Den Bergh J. C. J. M. Implications of net energy-return-on-investment for a low-carbon energy transition. *Nature Energy*. 2018. 3. 4. P. 334–340.

5) Kittner N., Lill F., Kammen D. M. Energy storage deployment and innovation for the clean energy transition. *Nature Energy*. 2017. T. 2. No. 9. C. 17125.

6) Melosi M. Energy transitions in historical perspective. *Energy and Culture*. Routledge, 2017. P. 27–42.

⁷ International Renewable Energy Agency, IRENA, 2020. *REmap Global Renewables Outlook 2020 edition*. — URL: <https://www.irena.org/Statistics/View-Data-by-Topic/Energy-Transition/REmap-Annual-Energy-related-Emissions>.

⁸ Fouquet R. Historical energy transitions: Speed, prices and system transformation. *Energy Research & Social Science*. 2016. No. 22. P. 7–12.

Modification of the SCP basic model for studying the energy market transformation

When studying the essence of transformation processes in the global energy market, we propose to use the methods of causal analysis of the industry market. In our opinion, the most appropriate is the methodology of the basic paradigm of analysis of the industry market "structure-conduct-performance" (SCP), (hereinafter – the SCP model or SCP).

The Harvard School of Microeconomic Analysis as part of J.S. Bain's neoclassical economic theory developed the SCP model in 1959, which conducted a thorough analysis of the industry market⁹, continuing E.S. Mason's¹⁰ pioneering work and E.H. Chamberlin's¹¹ research. The model is focused on the relationship between the market structure of the industry with the determination of the market power, concentration, vertical integration and market behavior, which often contradicts (harms) the public interest. Thus, it best meets the objectives of the study of transformation of the global energy market with widespread natural monopolies, vertically integrated international companies (TNCs and MNEs).

To date, enough empirical studies confirm the basic hypothesis of the SCP model, in particular, on the impact of such a parameter of the industry structure as concentration on the parameters of performance, profit and profitability. Concentration of 70 percent is considered to determine the behavior of industry market participants¹². This paradigm of industry analysis has not lost its relevance to date; based on it, they study transformation processes, for example, social and economic transformations under the influence of Industry 4.0¹³ and in specific economy sectors, in particular, in energy sector. The positive practice of this paradigm is an option to study dynamic changes in industry markets, which is especially important for the analysis of market transformations.

Using SCP basic paradigm, the researchers not both adjusted it to specific areas and improved some of its components. Thus, in order to analyze the causal relationship between the structure, behavior and performance in the gas and electricity markets of the United Kingdom,

⁹ Bain J. S. Industrial Organization. Wiley. 1959.

¹⁰ Mason E.S. Price and Production Policies of Large-scale Enterprise. American Economic Review. 1939. No. 29 (March). P. 61-74.

¹¹ Chamberlin E. H. Monopolistic Competition Revisited. *Economica*. 1951. Vol. 18. No. 72. P. 343–362. *JSTOR*. — URL: www.istor.org/stable/2549607.

¹² Sijses, S. Structure, Conduct And Performance In The International Chain Of Jepara-Made Furniture 4. *Dynamics in Chains and Networks*. 2004. P. 118.

¹³ Michele Lo Re, Veglianti E., Monarca U. The metaphor of the compass as a theoretical tool to trigger the analysis of the Industry 4.0 economic paradigm. *L'industria Società editrice il Mulino*. 2016. No. 3. P. 451-472.

D. Peng and R. Poudineh picked out the regulatory aspect outside the categories of "structure-conduct-result" and the basic market conditions¹⁴. These scientists have proposed a modified version of the SCP model, which is called "structure-conduct-performance-regulation", SCPR (hereinafter — the SCPR model or SCPR).

The determination of government regulation in this model is quite relevant for the energy market, as energy plays an important strategic, security, social&economic role for each country. Moreover, this market often has prevailed non-competitive forms of business, especially at the current stage of economic globalization, given the growing political competition between leading countries. Mechanisms of government regulation are aimed to offset certain results of market conduct that have negative effects on society, and to trigger progressive transformations. Therefore, the SCPR modification with separation of the parameters of government regulation in course of analysis of transformations in the energy market has been used in further research. For example, researchers at the Oxford Institute for Energy Research have used this model to analyze market constraints and in course of on-grid renewable energy investments¹⁵.

However, government regulation does not cover all aspects of influencing the market structure and the conduct of market players, especially in developing countries. There are several interpretations of the term in the domestic scientific discourse, which would cover various subjects outside the government regulation, which have an impact on the public interest¹⁶. This influence of non-governmental institutions can be obtained as a result of the state transferring of a part of its functions to the public sector or as a result of the international organizations' practices. The term "public policy" seems to be the most adequate at present. The main criterion for the application of this concept is the focus of non-governmental institutions to obtain a predetermined positive result.

At the same time, the latest studies of energy transformations use the basic interpretation of the model, which considers government regulation (see, for example, the analysis of the Chinese market of non-renewable resources (including energy resources)¹⁷. They use SCPR model with fixing of basic conditions and interpretation of the

¹⁴ Peng D., Poudineh R. A holistic framework for the study of interdependence between electricity and gas sectors. *Energy Strategy Reviews*. 2016. No.13. P.32-52.

¹⁵ Fadekunayo A. Overcoming the market constraints to on-grid renewable energy investments in Nigeria. 2019.

¹⁶ Teleshun S., Sytnyk S., Reyterovych I. Publichna chy derzhavna polityka — vitchyznyana dylema vyboru. *Visnyk Natsional'noyi akademiyi derzhavnoho upravlinnya*. S. 185-196. <http://visnyk.academy.gov.ua/wp-content/uploads/2013/11/2012-4-25.pdf>. [in Ukrainian].

¹⁷ Li Jiachen, Lihong Yu. Double externalities, market structure and performance: an empirical study of Chinese unrenewable resource industries. *Journal of Cleaner Production*. 2016. No. 126. P. 299-307.

parameter "regulation" as a public policy in the energy market. The parameters of "regulation" apply to "structure", "conduct" and "performance". The author interprets «Regulation» in general as a public policy pursued by the government, local authorities, international organizations, NGOs.

The basic conditions include the GDP energy intensity, which reflects both technological horizon of energy use to form added value and country's profile, as it is believed that countries in unfavorable climatic conditions will consume more energy than others compared to the same management environment. Market structure (natural monopoly, oligopoly, competition) was fixed as the basis of the key paradigm of SCP and its modification of SCPR (Fig. 1).

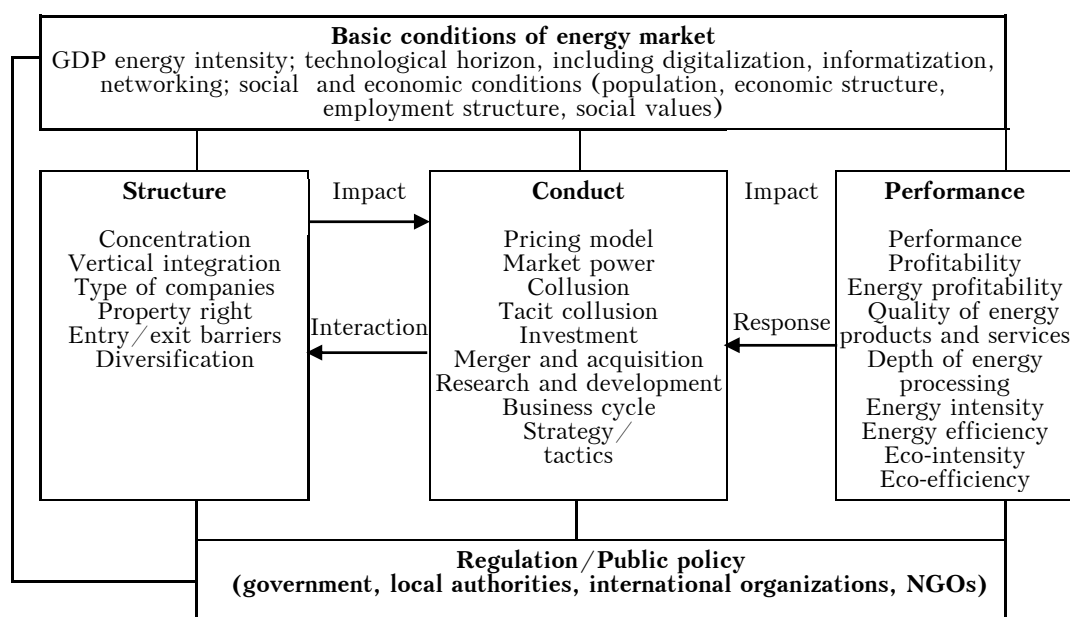


Fig. 1. Adjustment of the SCPR model to the analysis of the global energy market transformation

From the standpoint of the theory of external factors, the change in demand is one of the determinants of changes in the market structure, because such a change is out of the producers' supervision¹⁸. Therefore, among the basic conditions we have identified social and economic conditions (population, economic structure, employment structure, social values).

¹⁸ Fligstein N. Markets as politics: A political-cultural approach to market institutions. *American Sociological Review*. 1996. Vol. 61. P. 656–673.

We have also singled out the economy general technological horizon. The level of the country informatization and networking at the current stage of globalization reflects its ability to make progressive transformations in the energy market. Basic conditions in the global energy market are determined by the dominant technological practices.

When adjusting these methodological approaches, it is appeared that the transformation of the global energy market is manifested in changes in the market structure, volume and structure of supply and demand by type of energy and geographical structure. Such changes affect the conduct of stakeholders, including intra-industry competition, cyclical development, priority of tactical or strategic decisions (including the volume of investment, merger and acquisition, research and development). Conduct influences the energy effectiveness, which we consider both in terms of industry and in terms of externalities (environmental impact, social effects, etc.).

Liberalization paradigm of energy market transformation

One of the manifestations of transformation processes in the global energy market is liberalization, which has covered the markets of natural monopolies of gas and electricity, but is seem to be a new evolutionary stage in the development of any segment of the energy market¹⁹.

The emergence of natural monopolies in energy sector is caused by both technical and economic factors, and considerations of national security, political influence and geoeconomic interests. We would like to note that natural energy monopolies could operate at different scales: in the national and/or regional markets. The main technical and economic factors of the existence of natural monopolies in energy sector include the following: the specific nature of energy supply; impossibility or (in relation to certain energy types) high cost of storage of produced energy; scale effects, including savings on diversification, when the production of a particular energy resource enables to supply other products and services; vertical integration of production processes, when a certain enterprise provides production, manufacturing and supply of energy to consumers; high cost and long payback of investment projects; an option of long-term forecasting of the industry segment; government control and uniqueness of manufactured products; inexpediency of parallel infrastructure projects: electric networks, product pipelines, thermal networks, etc.

¹⁹ Voytko S. V., Volynets' K. V. Doslidzhennya dynamiky obsyahiv investuvannya v al'ternatyvnu enerhetyku za sektoramy ta rehionamy. *Ekonomichnyy forum*. 2017, No. 1. S.58-62. [in Ukrainian].

The priority tasks of energy security, which determine the existence of a natural monopoly, are the following: management of a strategically important economy area; import share in the provision of primary energy sources; share of a certain supplier of imported energy resources; security of infrastructure facilities; filling the budget and forming national development funds, ensuring political stability.

The monopoly in energy sector provides the representatives of certain policy makers with important levers of influence on macroeconomic indicators, social&economic and political stability, and the level of welfare in the country as a result of price policy. An important informal tool for influencing the natural monopoly practices is the appointment of leaders loyal to a certain part of the ruling elite. Such an appointment can provide both financial flow and formal but non-core financing of the regional, national or international projects needed by these elites, including social, infrastructural and political ones. Also, a natural monopoly in the energy sector gives certain stakeholders an option to influence the redistribution of transaction costs, for example, by transferring them to consumers.

Geoeconomic interests that determine the maintenance of a monopoly in energy sector include strategic partnership in international relations between suppliers and consumers of energy resources, control over international infrastructure (within the contractual relationship) and its use to put pressure on partners, and a significant share in regional and global markets results in gaining leverage over social&economic stability and the position of certain political classes in other countries.

Still, society has significant price and non-price losses due to the existence of natural monopolies. Price losses include an option of price discrimination, which can be explained by social considerations (in the form of so-called "cross-subsidization"). Low elasticity of demand leads to inflated prices, which may be subsidized by the state for certain economic entities or the population, but society as a whole will have losses. Among the non-price losses we note the low quality of products and services provided (for example, voltage shortage leads to failure of household appliances of consumers, which cannot be challenged due to lack of quality standards), low motivation of technical and technological upgrading in case of low investment attractiveness, high corruption risks.

The state is trying to compensate for the negative impact of high concentration in the sector by tariff policy, fixing of "price ceilings" and "price corridors", limiting the rate of return, regulation of marginal capacity. The introduction of certain non-tariff methods is aimed at adjusting the business conditions that would ensure a balance between the monopolists' motivation to provide high quality products/services

and their ability to benefit at a prices affordable to society. Such tools include standardization, certification, and independent certification audit of business consequences, segmentation of consumers with the identification of vulnerable persons, who are subject to preferential services (socially determined institutions, such as health, education, defense and public order institutions).

The application of non-tariff regulation measures can encourage the monopolists to minimize costs and improve the quality of products and services provided. However, in economies with weak market institutions, it is difficult or impossible for the consumer to comply with standards and regulated quality requirements (for example, temperature criteria are set to provide the population with hot water and heating, but actually in order to exercise the right to quality services, the consumer must make mega-huge efforts and time). Although there is a positive practice of using economic incentives (fines, sanctions, etc.), the observance of public interests requires the existence of clear legal framework governing the monopolists' compliance with quality.

The basic principles of liberalization of the energy market and international energy trade are based on international agreements and institutions. In particular, the currently established International Energy Charter continues and reflects the progressive development of the provisions set out in the European Energy Charter "in order to resolve general energy issues at the national, regional and international levels, including the evolution of the global energy architecture."²⁰

In countries with weak or incompletely formed market institutions, the existence of a natural monopoly in the energy sector is justified by social determinacy, but in fact, on the one hand, due to non-transparent formation and distribution of financial flows, it is often a source of enrichment for some political elites, and on the other hand, due to social&economic, security and strategic importance of the industry — a tool for influencing policy and the national economy. With the above said, some groups prevent from substitution of the market monopolized structure to a liberalized one.

European strategies for energy development are described in the works of V.H. Lezhepokova²¹, H. Melin²², O.M. Sukhodolia²³,

²⁰ International Renewable Energy Agency, IRENA, 2018. Global Energy Transformation: A Roadmap to 2050, International Renewable Energy Agency, Abu Dhabi.

²¹ Lezhepokova V. H. Elektroenerhetyka Ukrayiny u vymiri stratehichnoho partnerstva z YES. *Ekonomika. Finansy. Pravo*. 2017. №6. S. 29-33. [in Ukrainian]

²² Melin H. Towards a Climate of Entrepreneurship: Ideas to Reform EU Policy Design for a Digital Single Market (SSRN's eLibrary). 2015. — URL: <http://dx.doi.org/10.2139/ssrn.2649429>.

²³ Sukhodolia O. M. Heopolitychni ta ekonomichni priorytety enerhetychnoyi bezpeky Ukrayiny. *Stratehichna panorama*. 2017. № 1. S. 42-52. [in Ukrainian].

I.V. Taranenko²⁴, in the records of the European Commission²⁵. Due to the liberalization of the energy market and the cost reduction for the renewable energy practices, the consumer becomes an active subject of its transformation in line with appearing the new subjects. For example, in the European market, these are prosumers who have the possibility and legal capacity both to consume and to produce and sell energy to the grid and to provide other services on the market. As a result, households, energy cooperatives (for example, community choice aggregators, CCA's in Europe, the US, Australia, Japan), etc. are future competitors to powerful energy companies. The economic meaning of such processes lies in the greater efficiency of a competitive market than a monopolized one, even if it is regulated by the government.

Despite a number of benefits of market liberalization for consumers and society as a whole, there are problems of capability to balance "peak loads", ensure distributed generation, energy quality, attract large-scale investment both to reproduce fixed assets and to restructure the country's energy sector with cutting-edge and information principles. Competitive organization of the energy market involves not only changes in the organizational form of market participants (corporatization, privatization), but also the appropriate technological horizon of the energy system, which can ensure the competitive conditions, on the one hand, and safety, availability and affordability, quality and environmental friendliness on the other hand at all stages of energy products' manufacturing and sale. This technological horizon implies appropriate investments in infrastructure and new business models in the energy market.

Large energy companies show weak motivation to invest in the development of a new energy architecture, so a huge role belongs to the government stimulus tools. However, the existence of a monopoly structure of the energy market does not mean directing investment to infrastructure upgrading. Although large energy companies, which are natural monopolies, can accumulate significant financial resources, the motivation for manufacturing upgrading is at issue. Under these conditions, investment stimulating in the industry is one of the priorities of the government in any structure of the energy market.

²⁴ Taranenko I. V. Stratehichni zavdannya Enerhetychnoho sovuzu YES u konteksti rozvvtku svitovoho enerhetychnoho rynku. *Visnyk Pryazov's'koho Derzhavnoho Tekhnichnoho Universytetu. Seriya: Ekonomichni nauky*. 2015. № 30. S. 144-152. [in Ukrainian].

²⁵ European Commission. Clean energy for all Europeans package. 2020. — URL: https://ec.europa.eu/energy/topics/energy-strategy/clean-energy-all-europeans_en; European Commission. EU Energy Strategy 2030. — URL: <http://ec.europa.eu/energy/en/topics/energy-strategy/2030-energy-strategy>; European Commission. EU energy security strategy. — URL: <https://ec.europa.eu/energy/en/topics/energy-strategy/energy-security-strategy>.

One of the tools to accelerate transformational change is international mergers and acquisitions. The peculiarities of the implementation of these international agreements in the energy sector are the required consideration of current trends in the global energy market and the restrictions imposed by national governments because of energy security strategies in any country. The economic effects of mergers and acquisitions depend on the global energy market, the motivation and the size of the companies implementing the deal.

The largest mergers in the energy sector were in the oil&gas sector, for example, between Exxon Corp and Mobil Corp in 1998, Dutch Petroleum Co and Shell Transport & Trading Co in 2004, and Royal Dutch Shell PLC and BG Group PLC in 2015 for a total of USD 223 billion²⁶. The development of theoretical and methodological background for the study of economic effects and performance indices in case of international mergers and acquisitions, with due consideration to the specific features of the energy sector and current trends in the global energy market is a scientific task of current importance.

Using the SCPR model, it is possible to identify current trends in the global energy market transformation (Table 2).

Table 2

**GLOBAL ENERGY MARKET TRANSFORMATION DIRECTIONS
(ACCORDING TO SCPR MODEL)**

Decrease	Increase
Basic conditions in the energy market	
GDP energy intensity	Technological horizon (including digitalization, informatization, networking)
Inefficient consumption	Ecological consciousness
	Individual needs
	Population
	Electric transport, incl. individual transport
Structure	
Structure of primary energy consumption	
Hydrocarbon types of fossil fuels	Renewable energy
Oil consumption	Production of unconventional gas deposits Trade volumes of liquefied natural gas (LNG)
Share of developed countries	Share of developing countries

²⁶ Galperina L. P., Klen Y. V. Risks in mergers and acquisitions of international companies in the energy sector the example of Royal Dutch Shell. Scientific letters of academic society of Michal Baludansky. 2017, №5(1). P. 56–60.

Decrease	Increase
Structure of final energy consumption	
Organic fuels	Share of transport
Share of industrial production	Share of utilities
Regional structure of global energy market	
Share of energy consumption in Europe and North America	Share of energy consumption in Asia, Africa, Latin America
Entry/exit barriers	
Entry/exit barriers	Public-private partnership
Natural monopoly	Corporatization
Property right	
State property	Private property Collective property
Conduct	
Market power	Segmentation
Collusion	Competition
Silent collusion	Liberalization
Monopoly pricing	Exchange pricing
State-regulated pricing	Market pricing
Generation system	
Centralized generation	Decentralization
Coincidence in time (simultaneous) of generation and consumption of electricity	Energy storage technologies
Unidirectional power grids	Active conduct patterns ("active consumer")
Hierarchy of power grids	Integration of high, medium and low voltage power grids
Investing	
Motivations for investing in the architecture of power systems	Private investment
	Level of research and development costs
	Mergers and acquisitions, including in the field of renewable energy
Priority of decision making	
Tactical	Strategical

Decrease	Increase
Performance	
Return on investment in fossil fuels	Return on investment in renewable energy
	Economic profitability
	Production performance
	Energy profitability
	Quality of energy products and services
	Depth of processing
Energy intensity	Energy efficiency
Eco-intensity	Eco-efficiency
Regulation (Public Policy)	
Subsidizing natural monopolies	Antimonopoly policy
Tariff incentives for renewable energy	Growing role of international organizations in standardization of requirements for man-made safety of energy facilities (including energy infrastructure)
	Requirements for diversification of supply sources
	Environmental safety requirements and criteria
	Energy efficiency requirements
	Requirements for energy resources quality
	Requirements for power system reliability
	Stimulating investment in renewable energy
	Stimulating investment in the new architecture of power systems

Source: developed by the authors.

Structural transformations of the global energy market

The transformation of global energy markets depends not only on energy innovations. One of the up-to-date transformation drivers is an ecological driver, first of all — climatic. Currently, many countries have made commitments to control greenhouse gas emissions under the Paris Climate Agreement 2015, regulate carbon dioxide emissions and contain global average temperatures of no more than 2°C relative to the pre-industrial level²⁷ under the UN Framework Convention on Climate

²⁷ The 21st Conference of the Paris to the United Nations Framework Convention on Climate Change. — URL: <http://www.un.org/sustainabledevelopment/cop21/>.

Change (United Nations Framework Convention on Climate Change, UNFCCC)²⁸ and sustainable development. Since then, environmental requirements and commitments to contain, mitigate and adjust to climate change have become a crucial factor of transformational change as part of the global energy market.

Focusing on the "structure" parameter of the SCPR model, we would like to note that the global energy market has high entry/exit barriers, significant concentration and monopolization, predominant vertical integration. High entry/exit barriers are caused by significant investments in exploration, production, storage, transportation and consumption of energy resources; the great impact of energy infrastructure on national security; government regulation of subsoil use. The peculiarity of the energy market is the architecture of energy systems developed under conditions when the production of the most of energy resources and their consumption had to take place simultaneously, and therefore both national and international companies were developing mainly as vertically integrated. All this led to a high level of concentration, which contributed to the industry monopolization, in particular the expansion of natural monopolies. At the same time, at the present stage, the transformation of the global energy market is taking place towards concentration reduction through a certain liberalization of the industry.

Companies of different types are represented on the global energy market depending on the legal status, form of ownership (private, collective, state and communal), association of capital, nationality, scale. There is a great variety of companies and their associations: corporations, cartels, trusts, syndicates, consortia, concerns, holdings. By type of companies that have a high concentration in the global energy market, public TNCs, MNCs (including VIOCs), and IOCs predominate.

Currently, the diversification of consumption is governed not only by the market situation in the global energy market, but also by regulatory requirements caused by national interests and security.

Changes in the structure of primary energy consumption have common features for the most of global countries, regardless of the availability of their own energy resources. The regional structure of consumption of primary energy resources by type for the period 1965-2019 reflects the macroeconomic, demographic and social profile of countries and regions²⁹. According to IRENA study, "the EU and North America account for over half of world GDP. Sub-Saharan Africa,

²⁸ United Nations Millennium Declaration (A/55/L.2). 8 September 2000 in New Works. — URL: [http: www.un.org/millennium/declaration/ares552e.htm](http://www.un.org/millennium/declaration/ares552e.htm).

²⁹ BP, 2020. Statistical Review of World Energy, June 2020. — URL: [http: www.bp.com/statisticalreview](http://www.bp.com/statisticalreview).

Southeast Asia and Oceania account for small shares of world GDP³⁰. As can be seen from Fig. 2, in the global primary energy consumption since 1965 and to this day, the Asia-Pacific region (APR) has leading positions, with the largest natural population growth, increasing share of jobs in global employment segment, and improving welfare of the population.

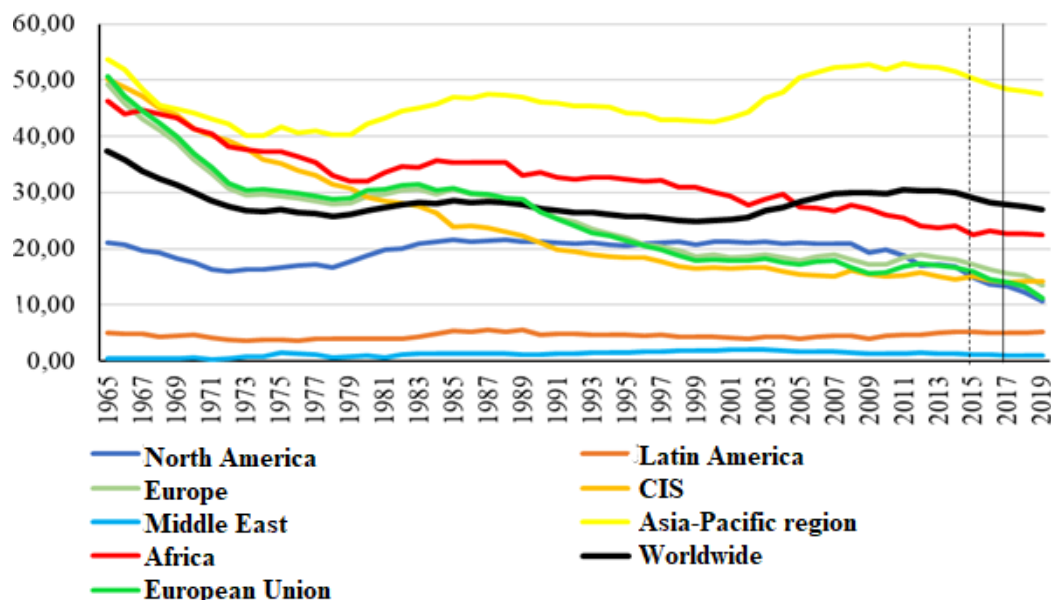


Fig. 2. Regional structure of primary energy consumption, 1965-2019, (exajoule)³¹.

As you can see, the diagram of global energy consumption coincides with the Asian trend. Since 2015 (the beginning of the fourth energy transition), energy consumption has been declining in most regions of the world.

Gas is estimated³² to remain the largest source of energy due to the prevailing relatively cheap shale gas and LNG production procedures. In developing countries, coal is becoming more important. The global oil market will grow due to the accelerated population growth in Asia and Africa and the rapid processes of urbanization in Africa. According to

³⁰ International Energy Charter, 2015. — URL: http://www.energycharter.org/fileadmin/DocumentsMedia/Legal/IEC_EN.pdf.

³¹ BP, 2020. Statistical Review of World Energy, June 2020. — URL: <http://www.bp.com/statisticalreview>.

³² Yevrointehratsynny portal. Ukrayina zavershuye implementatsiyu tret'oho enerhopaketu. 2019. <https://eu-ua.org/novyny/ukrayina-zavershuye-implementatsiyu-tretogo-enerhopaketu>. [in Ukrainian].

BP experts³³, China will lag behind India in the growth rate of energy consumption, which is due to both the slowdown in economic growth in China and the introduction of higher environmental standards.

The structure of consumption of the global primary energy resources by type in the period 1965-2019 shows the predominance of fossil energy sources in all regions of the world. In global energy consumption, the share of oil, coal and nuclear energy is declining, hydropower — at a stable level, natural gas and renewable energy — is growing (Fig. 3).

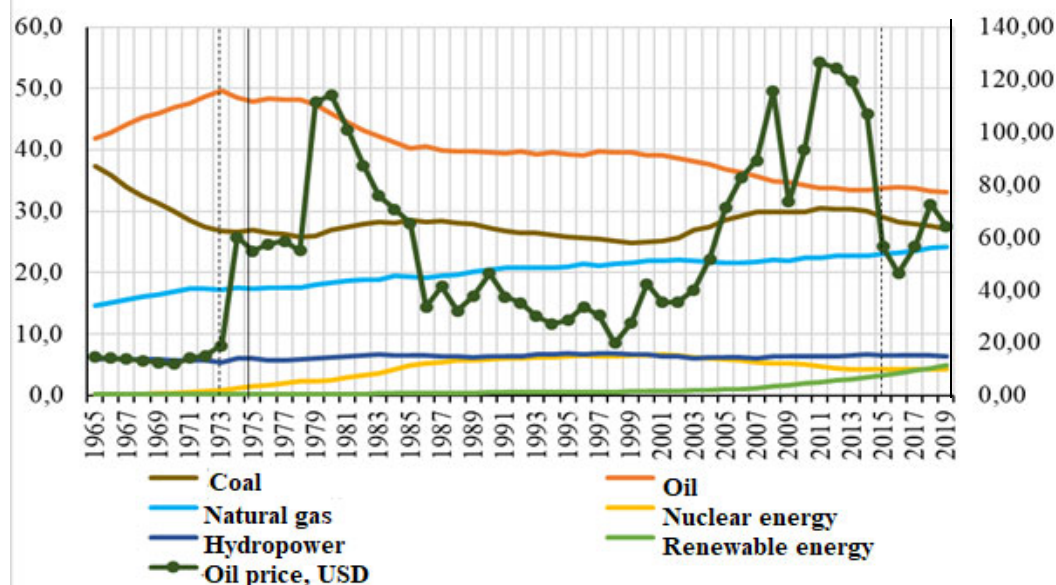


Fig. 3. Structure of global primary energy consumption by type of fuel, percentage (left scale), and Brent oil price, USD/barrel (right scale)³⁴.

In the short-term period, from 2015 to 2019, there was a slight increase in global energy consumption during 2016-2017 and a decrease in 2019 due to the CoViD-19 coronary virus pandemic. The renewable energy, gas and oil hit the consumption records during the pandemic.

Qualitative and quantitative changes in the structure of energy systems are common to many countries and the global energy market as a whole, but differ significantly by region. This is resulting from the level of economic development of countries, the state of their market institutions, which is reflected in the timing, completion and sequence of energy transitions. In fact, the observed structural differences in

³³ BP, 2018. Energy Outlook 2018. — URL: <https://www.bp.com/content/dam/bp/pdf/energy-economics/energy-outlook-2018/bp-energy-outlook-2018.pdf>.

³⁴ BP, 2020. Statistical Review of World Energy, June 2020: <http://www.bp.com/statisticalreview>.

energy consumption in the global regions reflect not only the availability of natural fuel resources, but also the ability of national economies to primary and final production and consumption. In addition, such differences are caused by economic growth rates, economic structure (ratio of energy-intensive and energy-efficient industries), population, social structure of society (ratio of different segments of the population, change in employment structure, including energy), welfare, institutional and regulatory tools to trigger the current energy transition.

At the present stage of globalization, special attention is paid to environmental issues, which are not limited to purely climatic and are crucial for the development of energy strategies at the meta, macro and micro levels. In fact, the current fourth energy transition differs from previous structural changes in energy sector and energy systems by environmental rather than economic determinants, so the study of the origin and formation of the environmental imperative of the global energy transition also becomes relevant and scientifically practical.

One of the structural parameters of the development of the global energy market (parameter "structure" in the SCPR model) is merger and acquisition, which affect the level of concentration, vertical integration, and changes in ownership structure. Current trends in mergers and acquisitions in the global energy market are determined by global economic cycles. Thus, from 1985 to 2000 inclusive, there was an upward trend. The regional Asian financial crisis of the late 1990s did not affect this market, while the global recession of 2000-2001 was marked by a reduction in the number of transactions and a sharp decline in their value. However, from 2003 to 2010 the general trend became upward. The global financial crisis of 2007-2010, on the contrary, led to an increase in the number of transactions and maximization of their value in 2007 (USD 678.6 billion), the largest number of transactions occurred in 2010 (3,729 transactions for USD 531.9 billion).

The differentiation of economic effects achieved in case of international mergers and acquisitions in the energy sector is related to regional and sectoral trends in the global energy market. The use of international mergers and acquisitions in energy sector as a strategy to increase the competitiveness of an international company is growing in number and value of transactions. The main regions of mergers and acquisitions in the energy sector are North America, Europe and the Asia-Pacific region³⁵. The predominant trend for countries with different levels of development is an increase in the volume and value of

³⁵ Galperina L., Klen Y. Global Trends of International Mergers and Acquisitions in the Energy Sector. The International Economic Policy. Scientific Journal. 2017. Issue №1(26). P. 46–71.

agreements in renewable energy segment (the number of agreements in the US and Canada increased by a third, doubled in Europe and the Asia-Pacific region, tripled in Latin America), which is also typical for Ukraine³⁶.

The conduct of energy companies in the global market of mergers and acquisitions in 2019-2020, as well as in other industry markets, was determined by the economic consequences of the CoViD-19 pandemic, i.e. the market was marked by a sharp decline in transactions and their value. In 2019, the value of 3,204 transactions out of the total number in all sectors (49,327 pcs) amounted to USD 517.61 billion out of USD 3.37 trillion. In 2020, the number of transactions in global energy sectors decreased 3.4 times to 955 agreements, and the value decreased four times to USD 129.768 billion dollars³⁷.

Greening of global transformations of the energy sector

The importance of the energy sector to ensure social, security and sustainable development causes great interest of scientists in a wide range of problems in this area, among which the problem of identifying environmental factors of global energy transformation, which emerges in multispeed and different-scale energy transition.

Industrialization has become global feature and has led to environmental pollution. Since the publication of the report "The Limiting to Growth"³⁸ in 1972, there has been a widespread perception by the public, scientists and governments of the need for environmentally and socially balanced economic development. Since then, the global agenda have been developed on the principles of environmental development. An example is the Stockholm Declaration (Declaration of the United Nations Conference on Environment of June 16, 1972, Stockholm), which set out twenty-six environmental principles, the principles of international environmental cooperation for the sustainable use of natural resources (including energy resources) and the beginning of international environmental law³⁹.

The aggravation of environmental problems has led to the introduction of international initiatives both for states and for corporate and public sectors. In particular, this refers to Global Compact (UN, 1999, Davos), in which three of the ten principles deal with environmental protection (these are principles 7, 8 and 9, concerning

³⁶ Ibid.

³⁷ Website of the <https://imaa-institute.org/m-and-a-by-industries/>.

³⁸ Meadows D. H., Meadows D. L., Randers J., Behrens W. W. *The Limiting to Growth* N. Y.: Potomac, 1972. 207 p.

³⁹ Stok·hol'm's'ka Deklaratsiya OON «Pro vytannya navkolyshn'oho seredov'yshcha»; Mizhnarodnyy dokument. Vytyah vid 16.06.1972. http://zakon3.rada.gov.ua/laws/show/995_454. [in Ukrainian].

environmental precautions; introduction of initiatives to increase responsibility for the state of environment, promoting the development and propagation of environmentally friendly technologies)⁴⁰.

Moreover, we'd like to note the global dimension of the United Nations Millennium Declaration (2000, New York), where Goal 7 provided for environmental sustainability⁴¹. Following the achievement of the Millennium Development Goals, the UN member states approved the following seventeen Sustainable Development Goals (2015, New York)⁴². Most of them relate directly or indirectly to environmental and sustainable principles, including Goal 13 "Take urgent actions to combat climate change and its consequences".

The priority of environmental issues for the global community is maintained by the Conference of the UN Framework Convention on Climate Change (COP 21), the meeting under the Kyoto Protocol (CRP-11), which proposed to keep the average global temperature increase within 2 °C (2015, Paris)⁴³. Although people have already exceeded these targets and the temperature rise could reach 3 °C⁴⁴, the growth of international competition is slowing down the implementation of the Paris Conference, in particular by the United States, where vertically integrated companies in the fossil fuel sector have a strong influence on the government decisions.

The catastrophic consequences of environmental degradation and climate change caused by human activities have prompted the gradual awareness of global environmental problems by the states, the global community, the corporate sector and the adoption of global decisions to reduce anthropogenic pressure on the environment and creating conditions when environmentally harmful behavior is condemned by society and actually impossible.

Environmental risks are paid considerable attention in the annual reports of the World Economic Forum in Davos on global risks. In particular, the Report 2020 identifies environmental risks among the Top 10 global risks, in particular, climate change, environmental natural and man-made disasters, extreme weather conditions, and

⁴⁰ UN Global Compact. — URL: <https://www.unglobalcompact.org/>.

⁴¹ United Nations Millennium Declaration (A/55/L. 2). 8 September 2000 in New York. — URL: <http://www.un.org/millennium/declaration/ares552e.htm>.

⁴² UN Sustainable Development Summit from 25–27 September 2015 in New York. — URL: <http://www.un.org/sustainabledevelopment/summit/>.

⁴³ The 21st Conference of the Parties to the United Nations Framework Convention on Climate Change. — URL: <http://www.un.org/sustainabledevelopment/cop21/>.

⁴⁴ UNIDO Energy Programme Sustainable Energy for Inclusive Development and Climate Action. Vienna, UNIDO. 2015. 40 p.

biodiversity loss⁴⁵. Environmental risk management, minimization and prevention go beyond the framework of international organizations, national governments, corporations, public sector and becomes an urgent need of each individual person. Namely, it is about the environmental conditionality of energy policy, decisions on energy production, generation, consumption, use and transportation, changing of the dominant business model in global energy sector, flexible organization of national and megaregional (e.g., European) energy systems. The scale of the environmental imperative in energy sector should be considered in both industry and economy segments as a whole by "legislation greening" in the meaning of "complex issue, including educational, organizational, technological, research, economic and other factors."⁴⁶

The main vectors of current transformations of the global energy market are the following: increasing the RE share in the energy balance, improving new energy technologies ("green hydrogen") and corresponding changes in energy infrastructure (maintaining of flexibility through distributed generation, development of smart grids, development of energy storage technologies, introduction of "active consumers", boosting energy efficiency, implementing a new business model of power industry), as well as transformation of energy systems on a democratic basis with the development of engineering solutions to provide flexible architecture.

Currently, the global determining transformational trends in the global energy market are: growth of energy consumption due to economic growth, population growth, improved welfare; social aspects of energy consumption, including changes in the employment structure in the energy sector, as well as institutional and regulatory framework for accelerating the energy transition, including international agreements at the highest level on environmental protection. The main drivers of the structural transformation of the global energy market at the present stage are the development of information, innovation and network energy infrastructure, national and international environmental requirements, energy efficiency requirements, demonopolization, liberalization and decentralization of the energy market, reduction of transaction costs, business support, digitalization marketing strategies for RE distribution, energy security measures, ensuring public access to "clean" energy, cutting-edge socially focused business models, which together follow the post-industrial energy paradigm.

⁴⁵ The Global Risks Report 2020. World Economic Forum. Insight Report 15th Edition in partnership with Marsh & McLennan and Zurich Insurance Group. — URL: http://www3.weforum.org/docs/WEF_Global_Risk_Report_2020.pdf.

⁴⁶ *Struk A., Avdeychik O., Beresneva A.* Environmental Imperative of Innovative Industrial Production. *Machines. Technologies. Materials.* 2018. 12(6). P. 248-250.

Conclusions

Terminological description of the concepts "transformation of global energy market", "global energy transformation", "energy transformation", "energy transition", which is used in the current scientific and methodological discourse, is intended to highlight the common by nature and development vector quantitative and qualitative dynamic, mutually promotional, interconnected regular transformations of multilevel and multifactorial system of relations in the energy sector between stakeholders of the internal and external environment on the latest innovational and informational, institutional and infrastructural principles. These transformations have different caliber, structural proportions, organizational models, sequence, cycling, dynamics, tools and implementation technologies at both national and regional levels, but together lead to the development of a new quality of the global energy market, different from former identified market models.

Global transformations of the global energy market take place within the framework of an objective general civilizational process of development in all country and regional segments regardless of the achieved level of economy, decentralization, monopolization, informatization, digitalization, networkization, fossil energy supply and processing technologies, energy consumption and proposal structure, and state of energy infrastructure. Different level and sequence of transformations cause different duration and pace of transformation processes, which are lasting so far, but naturally outline the pattern of the "new" energy sector with new market parameters, structure, pricing models, architecture of energy systems, participants, digital-oriented business models and types of communications.

Since the current decisions of the main stakeholders are influenced by objectively determined unquestionable environmental requirements, which can be met only through compliance with the global environmental agenda, the fourth global energy transition ("green energy", "informational energy", "innovative energy") is imperatively driven by the close interaction of environmental, technological (digital and networking, informational and intellectual) and organizational (demonopolization, decentralization and liberalization) determinants.

The modified SCP model with selection of the parameter of "public policy in the energy market" as one of the basic conditions was taken as methodological basis for the study of global transformations of the global energy market. The model adjustment with the classification of indicators by the key parameters of the model ensures the analysis of the relationship between market structure, conduct of entities, industry

performance and obtaining socially significant positive effects. Further improvement of the methodology of study of the global energy market based on the system approach can be carried out by, for example, algorithmization of transformational changes, in particular conjunctural, structural, organizational, technical and technological. This approach will help to justify the further targeted application of public policy instruments.

Structural diversification of energy consumption in the global regions reflects not only the availability of natural fuel resources, but also the ability of national economies to primary and final production and consumption. Such differences are caused by economic growth rates, economic structure (ratio of energy-intensive and energy-efficient industries), population size, social structure (ratio of different segments of population, change in employment structure, including energy sector), level of welfare, institutional and regulatory instruments to trigger the current transformation processes in energy sector.

The architecture of the global energy market is currently changing towards a liberal model due to organizational, institutional and engineering imperatives for deregulation, corporatization, segmentation, widespread use of informational and advanced technologies and networking. The rejection of the imperative of organizing the energy market in the form of a natural monopoly has become possible firstly due to excess supply, secondly, the separation of different market stages from energy production to supply to consumers, including maintenance of equipment and infrastructure, and thirdly, improvement of technical and engineering options to ensure market competition (dispersed generation, regulation of "peak loads", etc.) and fourth, due to the global adjustment of the functions of political will.

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