

PERSPECTIVES OF POWER-ORIENTED ECONOMIC GROWTH CONVERSION (WITH SPECIAL REFERENCE TO RUSSIA)

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The slogan of economic growth acceleration and GDP doubling in Russia is very popular and appears almost in every public speech and economic program of political parties. However, few Russian (and not only Russian) economists, sociologists and philosophers reveal the reasons for a fast or slow economic growth, its structure, sources, factors and the algorithm of conversion from the energy-oriented to innovation-oriented type. Economic and political discussions take into account neither the volatility, craftiness and even pseudo-evidence of statistics, nor the illusion of sustainable development, the impossibility of the economic and ecological industrial systems' harmony based on the exaggerated ideas about the unlimited intellectual and power possibilities of man. There exists a non-equivalent power exchange between the socio-economic system and Nature, and hence the evolutionary (ecological and economic) crisis is inevitable. The ways of overcoming this misbalance point out either to reduction of nature exploitation or non-traditional sources of power use. But the implementation of these methods is impossible for the most part of the world, particularly for those countries which possess large amounts of natural and power resources. The latter could lead to the so-called "economic diseases" (Holland, Venezuela, etc.).

Keeping in mind these considerations, the purpose of the present paper is to analyze modern economic growth indicators connected with the energy factor, to introduce new types of economic growth – innovation-oriented and energy-oriented – and to propose the possible convergence of these types in different scenarios of Russian industrial development.

Energy factor in Economic Growth type formation

Economic growth classification could be based on different criteria. In the common sense of quantitative or qualitative factors, their contribution to economic growth could be divided into extensive and intensive. The economic growth, depending on socio-economic systems and leading sectors, is called agrarian (traditional),

industrial and post-industrial (informational). We could also classify growth into power- and innovation-oriented or their combination, depending on the resources.

The power engineering shift of the 18th–19th centuries came out as the leading moving force of extensive power consuming growth satiating with power all sectors and spheres of the economy. We could call this type of growth energy-oriented, defining it as a long-term increase of the productive

capacity of the country, based on the search, handling (assimilation) of new power sources, extraction and transportation of mineral resources. In the process of scientific, technical and technological revolutions of the 20th–21st centuries, the economic growth becomes innovative defined as a long-term increase of the productive capacity of a country, based on the scientific, technical, technological and managerial progress.

Simultaneously the power engineering shift of the 20th–21st centuries became a moving force of the power-saving intensive economic growth and came out as a power-innovation type based on the new power technologies capable to provide a fair distribution of power. Energy has the time and space coordinates. The time coordinate means the maximum increase of power production and productivity margin due to the optimal distribution of energy resources. The space coordinate means the optimal combination of effectiveness and fairness. The problem of choice arises in this consideration: growth as an effective allocation of resources or growth as fairness and public good. This choice between the time and space factors points out two possible alternatives: priority of high growth rates by any means (extensive type), or priority of public good focusing on public interests of concrete groups of population and certain regions or countries (intensive type). Hence, this division of economic growth into interconnected intensive and extensive types acquires new facets of not measured properties.

The problem of the type of growth choice is being solved differently in different countries and regions. Developing countries and transitional economies choose the extensive resource consuming growth, developed countries prefer the intensive resource saving growth, public good accompanied by the innovation-orientated economy.

The main parameters of the modern economic growth from the beginning of the industrial revolution until the second part of the 20th century

are the following: the rates of growth increased from 1–2% to 3–5%, investment ratio from 5–8% to 15–28%, saving ratio from 10 to 23–25%, government expenses from 11–13% of GDP to 30–32%, structural shift reflected in the decrease of the primary sector in the industrial output from 50–55 to 10–13%. The qualitative indicators changed: the extent of inequality decreased; it was accompanied by the level of education illustrated by the number of secondary school graduates (23–25% to 85–90% of the population) and the simultaneous growth of life duration (from 35–45 to 65–75 years) and a decrease of the birth and death rates. The economy is transferred to a more open type and the export ratio in the GDP rises from 15–20 to 23–26%.

The process of economic growth acceleration reflected in the above indicators is accompanied by the expansion of production and individual power consumption. Usually the indicator of economic growth is connected with the power consumption rate. Long-term world economic dynamics [20, 21] showed that through the period of industrial revolution and industrial-energy model development of the 19th–20th centuries a strict interconnection between economic growth and power industry development was established. It appeared that the national product rate of 1% demanded the rates of power consumption growth of 1–2%. This correlation was very obvious for all the countries and regions of the world economy at least until the middle of the 70s of the 20th c. when the energy evolutionary crisis expanded through the world economy [7]. These indicators changed and illustrated the non-traditional trend through the last 30 years. The developing and transitional economies proceed in the similar direction, while developed countries show the counter-direction of the rates of growth and power consumption.

Long-term power development forecasts of OPEC Secretariat and U.S. Department of Energy

(DOE) until 2025 presupposed a moderate dynamics of the world economy and power consumption growth without revolutionary breaks and essential changes in the energy policy. The leading power resource is still oil due to the transport sector development.

The OPEC forecasts that the world economy development will inherit the previous tendencies. Implementation of new technologies will continue the R&D development and provide an increase of power consumption effectiveness throughout the foregoing 20 years. The OPEC constructs its base forecast on these prepositions. The forecast includes the following assumptions.

1. The decrease of the world population growth.
2. Average rates of world growth decrease from 3.9% in 2003–2005 to 3.6% in 2025, including 5.6% to 5% in developing, 2.6% to 2.5% in OECD, 5.2% to 3.6% in Central and Eastern Europe and the former USSR countries [25].
3. There exists an uncertainty of the economic growth rate forecast (the key indicator for power consumption calculation) due to the uncertainty of the future rates of growth in the South-Eastern Asia and China in the first turn. The OPEC assumes that throughout this period the average rates of growth will show a reduction: regional indicators may decrease from 6.3% to 5.4%, Chinese from 8% to 6.4%¹.

Energy resources will provide the world economy by the 21st c. with necessary volumes, but price increase is inevitable. Annual costs of world power industry will increase 2.5–3 times by the middle of the 21st c. and 4–6 times by its end compared to 1990. The average cost of a power unit will rise by 20–30% and 40–80%, respectively. This tendency took place already during 2003–2005 when the dynamics of oil prices showed a more than 2-time rise. By the end of

October 2005 (19.10.05) the oil price reached \$ 60 per barrel at the New York Stock exchange².

The OPEC confirms that by the end of the 20th century the world has changed crucially; this requires a basic correction of the economic conceptions concerning the future development of the world economy and world power engineering. In the 21st c. the power consumption (particularly electricity consumption) growth will continue due to the economic growth of developing countries and the increased level of living.

The basic scenario of DOE is based on the assumption that the world economic growth will slow down to 3% per year (2001–2025), 2.4% in developed countries and 4.6% in developing countries. Maximum rates of growth will be demonstrated by China (6.1%), India (5.2%) and the former Soviet republics (5.2%). In accordance with the basic variant of DOE, the world power consumption will rise by 1.8% annually, lagging behind the rates of economic growth by more than 1%. The DOE pointed out that not only the uncertainty of growth rates in the Southern and South-Eastern region of Asia but also the rates of economic growth compared to the rates of power consumption growth influence the long-term forecast. The ODE scenario assumes the rates of GDP and the rates of power consumption to be inter-related, but the extent of this relationship varies in different countries and regions of the world (Table 1).

The OPEC and DOE forecast figures and International Energy Agency estimates [15] on the world store of power resources (oil resources will be exhausted in 40–60, natural gas in 60–80, coal in 200–250, U235 in 50–100 years) stress the problem of effective use of power resources (Fig. 1) and hence the problem of the factors and types of economic growth – extensive or

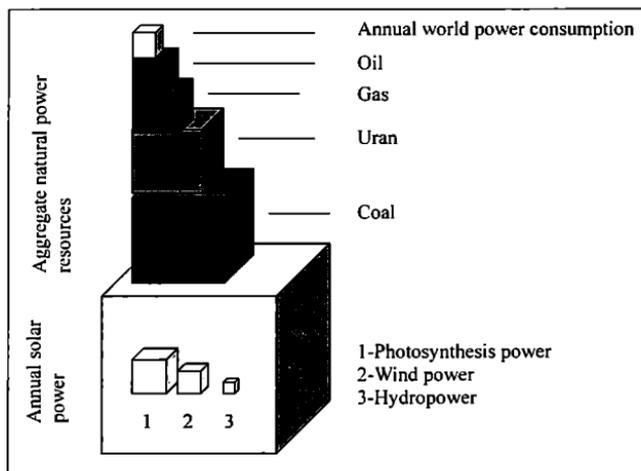
¹ The base forecast assumes that oil prices will decrease to \$20–25 per barrel.

² (<http://ukroil.com.ua/news/show/7009.html>). This trend will survive throughout the future century (www.opec.com)

Table 1. Rates of GDP and rates of power consumption ratio, basic scenario, 2001–2025, % (DOE forecast)

	Rates of GDP	Rates of power demand	Rates of oil demand	Rates of natural gas demand
World	3.0	1.8	1.9	2.2
OECD countries	2.4	1.2	1.2	1.8
Developing countries	4.6	2.7	2.8	2.9
Russia	3.8	1.3	2.1	1.6

Source: Energy Forecasts of OPEC and the USA. 2005 (<http://neft.tatcenter.ru/analytcs/24993.htm>)



Source: Clerici Alessandro. WEC Survey of Energy Resources, 2004.

Fig. 1. Order of magnitude of energy resources

intensive – in countries with different levels of development.

Developed countries show a weak connection between the rates of GDP growth and power consumption. The latter is lagging behind essentially from the economic growth indicator after the crisis of the 70s. Hence the economic growth becomes less dependent on the growth of power consumption. Developed countries, having a high level of power saturation, of their economic development and living standard, enjoy a high but stable per capita power consumption. Electric

equipment in industry and the communal sector is high and raising due to the implementation of modern facilities with an economic regime of power consumption. The gap between the above indicators will be kept in the developed part of the world economy in the long run due to: 1) the rise of power price and implementation of power-saving technologies; 2) the obligation of the developed countries to decrease the exhaustion of the so-called steam gases.

Hence the developed countries show the prevalence of the intensive type of economic

growth characterized by low indicators of resource and power consumption, higher rates of economic growth compared to the rates of power consumption (sometimes these indicators are moving in different directions), a low ratio and high effectiveness of power accumulation.

Data of Fig. 2 illustrate the reduction of the significance of energy as an extensive factor of growth in the developed economies. Energy is losing its role as a long-term leader in the modern economic growth provision.

The average- and low-level economies are characterized by a prevalence of power consumption rates over the economic growth rate. Energy plays a role of the driver of their economic dynamics. Their electrical equipment level is not very high and has a tendency of expansion and saturation. In developing countries, these indicators show a high dynamics and variation. This group of economies is transferred into the leading part of the world economy: the aggregate indicator of goods and service production increased in 2004 by 5.1% versus 6.6% of GDP growth in developing and transitional economies. The annual average rate of growth in China reached almost 10%; the CIS

countries and the developing countries of Asia showed 7%. Even less-developed countries of Tropical Africa exceeded the average world's rate in 2004 and are estimated to read 6.8% in 2005. The leaders among average-scaled economies are Turkey and Venezuela (13%). Large-scaled economies (India, Indonesia and Brazil) grew according to the accelerated rates and influenced greatly the aggregate rates of the world economic and power consumption growth (Fig. 3).

The interrelation between the rates of economic growth and power consumption in the developing countries will become stronger due to the following factors: 1) development of power-consuming sectors (communication and transport); 2) intensification of investment activity from developed to developing regions; 3) transfer of power-consuming branches from developed to developing countries.

Post-socialist countries don't illustrate such a direct interaction between the rates of economic and power consumption growth. The crash of the USSR and COMECON in the 90s resulted in a drastic power consumption reduction in all post-socialist states. Their industrial production and

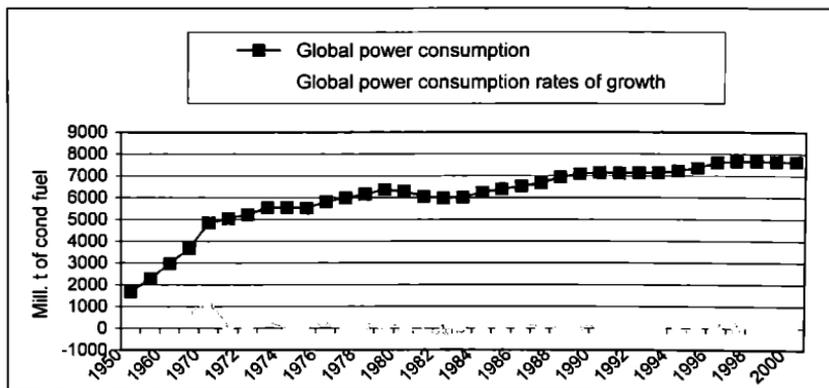
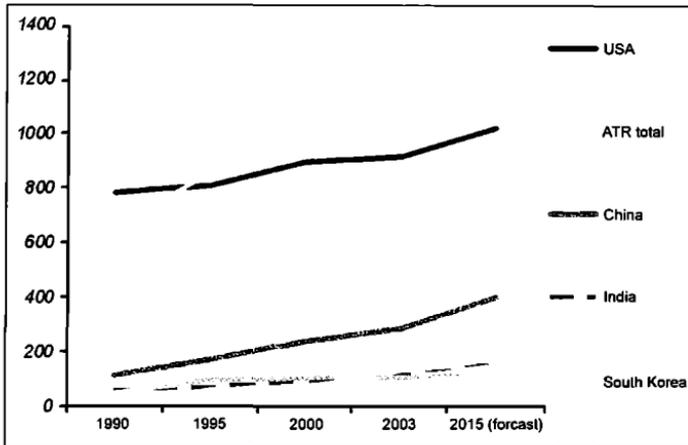


Fig. 2. Global growth and power consumption rates (1950–2000)



Source: Миров В. Проблемы энергетической политики России. Москва, 1 февраля 2005 г., Московский Центр Карнеги.

Fig. 3. Power (oil) consumption in the USA and ATR (incl. China, India, South Korea) in 1990–2015, mill t. per year

growth decreased not only in relative but also in absolute figures, resulting in a raised ratio of power consumption to GDP, which was always higher in socialist than in developed and even developing countries. Most of these countries overcame the fast power consumption reduction from the middle of the 90s due to the reconstruction of their economy and restoration of the living standard. This tendency is expected to continue through the forecast period. According to a report of the European Bank of Reconstruction and Development³, in these countries the level of power consumption will remain higher than in developed and developing economies. This indicator by 2025 will be twice as high in Russia and CIS countries than in the developing and five times higher than in the developed world [3].

The ratio and effectiveness of power accumulation in 1993–2002 are illustrated by the

data of Table 2. These figures reflect the joint contribution of labor productivity growth and industrial structure change stimulated by a full load of productive capacities, the elasticity of labor and power parameters [13].

Calculations prove that in developing and transitional countries the trend of extensive economic growth is very obvious. The high indicators of power consumption, equality or excess of power consumption under the economic growth rates, the high ratio and low effectiveness of power accumulation argues this trend.

Data confirm that keeping in mind the long-term tendency of power consumption growth we can realize the significance of energy as an extensive factor of growth in developed countries. Energy is still one of the long-term leaders in the modern economic growth provision⁴.

³ Transition Report, 2001, p. 94.

⁴ Absolute figures of the world and national power consumption illustrate an upswing in developed and a

Table 2. The ratio and effectiveness of power accumulation in different countries and regions of the world. 1993–2002

No	Country and region	Power production* (Mtoe)		Power production rate of growth	Power production to GDP ratio	Effectiveness of power accumulation
		Yi-1 2002	Yi 2003	$Y_i - Y_{i-1} / Y_i$		
	1	2	3	4	5	6=5:4
1	World average	9465.0	9741.2	0.028	0.29	10.35
2	OECD	5356.2	5397.9	0.008	0.19	23.75
3	Middle East	416.8	426.8	0.023	0.68	29.56
4	Former USSR	958.0	987.0	0.030	1.48	49.3
5	Asia	1699.2	1730.1	0.017	0.9	52.9
6	Latin America	455.0	465.5	0.022	0.29	13.18
7	Africa	287.6	299.6	0.040	0.84	21.0
8	China	1035.7	1178.3	0.121	0.90	7.4
9	USA	2296.7	2297.8	0.0004	0.25	625.0
10	Russia	647.6	670.8	0.033	0.88	26.6

Calculated on the data base: <http://www.worldenergy.ru/mode.1876-id.7841-type.html>
Key World Energy Statistics/ International Energy Agency, 2004.

The stabilization of per capita power consumption is characteristic of the world development in the long and medium run. This long-term trend is not connected with the power consumption and economic growth rates whatever the historical period. Per capita power consumption reached 0.15–0.18 t.o.e. throughout the period 2nd c. B. C. – 8th A. D. in the Mediterranean antique states, Middle East, India, China. The industrial revolution of the 17th–18th centuries triggered the European exponential raise of power consumption which turned into the world trend of doubling per capita power consumption each 40 years by the end of the 19th c. A change in this threatening tendency

happened in the 70s of the 20th c. in developed countries after the oil crisis of 1974–1975. They were stimulated to the power-saving scenario of economic development. Recently certain countries of the developing world have shown the same tendency of per capita power consumption stabilization. The most vivid example is China, a new energetic giant. Russia ignored this tendency and paid for that with an unprecedented economic depression [9].

Possible scenarios of Russian economic development in the new type of energy-innovation growth formation

Russia should integrate into the international division of labor and occupy certain niches in the world economy, beneficial from the economic and political points of view. To achieve this goal, it is necessary to process the perspective development scenarios and select the most effective one.

down-swing in developing economies depending on the phase of long-term and medium-term cycles. The mineral fuel consumption is an important indicator of an extensive swing of energy growth. The contribution of mineral fuel consumption constitutes about 90% and coal consumption makes 25% of the aggregate power consumption. The world mineral fuel consumption raised 3.5 times from 1950 to 2000. A downswing of aggregate world mineral fuel consumption happened only in 2000.

We could represent three possible economic development scenarios based on the analysis of the industrial structure and industry as a dominating part of the Russian economy:

1st scenario: the further development of extracting industries, resulting in the conversion of Russia into a raw material periphery of the world economy;

2nd scenario: part of manufacturing industry (power- and material-consuming in the first turn) together with the extracting branches are included into the international division of labor;

3rd scenario: creation of the high-tech, innovative economy where the core of growth belongs to scientific knowledge, information and ability to implement this knowledge into practice, structural shift from industrial to post-industrial sectors.

The first scenario is realized in Russia *de facto* for a number of reasons. The first reason is the relative abundance of resources easy to extract and export. This situation is forced by the initial capitalization, injurious exploitation of natural resources by young “sharks of capitalism” not loaded with moral and ethical imperatives⁵. The second reason certain objective circumstances. In the short run Russia could not refuse its mighty fuel-power engineering complex. This is connected not only with its hyper-development as a core of industrial structure, a source of hard-currency flow for a solid financial and credit system and formation of golden-currency reserves, but also with the climate peculiarities of Russia. Geography defines Russia as a country with continental

climate, long, stern and snowy winters. Building and productive construction requires the depth of foundations reaching 180–200 cm and 5–7 months of heating. Climate dictates an exaggerated significance of the power engineering complex and a high extent of power consumption compared to the Western countries.

The second scenario is more attractive and has started to come into national economic practice. The industrial production in Russia is 3–3.5 times more power-consuming than in developed countries. Power consumption related to the unit of production increased by 15% in Russia over the last 10 years versus a 30% decrease in developed countries during the last 30–40 years. The average capacity use in machinery reaches only 45% from the calculated capacity. This index should be at least 60–70% – the life-time dream of all Russian managers. The technological structure was formed 20–30 years ago and has an essential misbalance due to the prevalence of extracting industries⁶. Machinery as a technological core of the industry is oriented to the provision of the extracting sector which employs conservative, slowly changing technologies. Distraction of machinery resources from the high-tech branches prevents conversion from the energy-oriented to innovation-oriented economic growth.

The third scenario – the innovation growth strategy directed to the creation of the national innovation system – would provide Russia with a favorable place in the international division of labor and permit to achieve a high level of

⁵ The first scenario has a strong support inside and outside the country. Inside, lobbyists insist on the necessity of developing the extracting industries, pointing out to the tax revenues and contribution to the GDP gained from this sector, foreign investors vote for the power engineering complex development with direct investments and their extracting equipment delivery according to special discount credits.

⁶ The journal “Expert” has proceeded a questionnaire of researchers and specialists from the Ministry of Science and Industrial Policy and Ministry of Economic Development and Trade, which showed a list of still strong positions in the Russian high-tech. In the first turn it is nuclear power engineering and cosmic industry. Инвестиции в России, 20 июня 2003 (<http://stra.teg.ru/lenta/innovation/1175/>)

competitiveness. Although theoretically this model of development should be pointed out as a strategically correct in the process of industrial policy formation, it is not provided with a real resource base and with the program of the state support⁷.

Actually, the second scenario has a potential of evolutionary unification with the first scenario. The most interesting variant of development could be unification of the first and third scenarios. Let us list certain conditions of such convergence of extracting (oil extracting and manufacturing) and high-tech sectors.

1. Both sectors have the potential of high dynamics. The oil and natural gas sector is particularly showy due to the fast capitalization, creation of working places, fast growing export, etc. The high-tech sector is dynamic by origin and because of the qualified, highly educated and active human resources.
2. The raw material sector and its core – oil and natural gas extraction – had reached the point of their saturation. It is explained by the following factors: 1) the owners and managers comprehend the necessity of renewal and modernization of their own enterprises; 2) the prospected and economically effective natural resources are close to exhaustion; 3) R&D investments happen to be more profitable. It is widely known that 1 t of oil or 1000 t of natural gas export gives 50–100 US\$ of profit equal to 1 kg of the high-tech product export.
3. The power engineering complex of Russia has a high level of capitalization, well-qualified employees and chances for the highly educated working force attraction. It could be reoriented to the production of high-tech, low resource-

consuming products. Hence this complex could be the core of the innovative economic growth.

Some countries showed such example. Norway illustrated the application of such conversion in two phases. The oil and gas sector as the leading sector of the Norwegian economy throughout 1960–1970 gave a push to the Scandinavian model of welfare state formation, created the basis for the socially-oriented market economy and reproduction of highly qualified, educated and socially protected working force. In the second stage, in 1980–1990, Norway proceeded to the conception of the innovative economic growth satiating all sectors (including extracting industries) with the avalanche of innovations. The end of the 20th – beginning of the 21st c. was characterized by an intensive economic growth of Norway⁸.

The short-term “Concept of innovative policy of Russia in 1998–2000” and the long-term program “Basics of the policy of the RF in the field of science, and technology up to 2010” were processed by the government of Russian Federation to put into practice the instruments of the innovative policy. The latter program lists the main competitive advantages of Russia, which are the scientific and technical complex, fundamental science, unique technologies, highly-qualified personnel, developed transport and communication infrastructure, rich natural resources, experience in nation-wide decision making. This long-term program stated strategic goals: transition to the innovative way of development, growth of GDP and population living standard, new high-tech niches in the international division of labor conquering.

However, most of strategic directions such as protection of intellectual property rights, creation

⁷ The practice of developed countries which have chosen such way of development (Finland, Israel, etc.), shows that the horizon of planning should be no less than 7–10 years. Russian medium-term programs still have a 2–3-year planning period.

⁸ Aschehoug & Gyldendal (<http://www.norvegia.ru/facts/economy/growth/growth.htm>) and (<http://www.norway.polpred.ru/tom5/5.htm>)

of the national innovative system, acquiring of international standards of quality and certification, development of fundamental and applied science, formation of technological parks using the high scientific and technological potential still have a declarative character due to the absence of the mechanisms of their realization.

Conclusions

1. Economic growth classification could be based on different criteria. In the common sense of the quantitative or qualitative factors, economic growth could be divided into extensive and intensive.
2. The power engineering shift of the 18th–19th c. industrial revolution came out as the main moving force of extensive power consumption growth. The structural changes in power engineering of the 20th–21th c. became the driving force of power-saving intensive economic growth.
3. The index of economic growth is connected with the power consumption rate. This correlation was very obvious for all countries and regions of the world until the middle of the 70s of 20th c. when the evolutionary crisis of energy expanded through the world economy.

4. The OPEC and DOE forecasts confirm that by the end of the 20th c. the world has changed crucially. This requires a basic correction of the economic conceptions concerning the future development of the world economy and power engineering.
5. The developed countries show the priority of the intensive type of economic growth characterized by low indicators of resource and power consumption, higher rates of economic growth compared to the rates of power consumption, a low ratio and high effectiveness of power accumulation.
6. The developing and transitional economies demonstrate a direct correlation between power consumption and the rates of extensive economic growth. The level of power consumption of post-socialist countries will remain higher than in the developed and developing economies.
7. Three possible economic development scenarios based on the analysis of the industrial structure of the Russian economy argue that the problem of the Russian sustainable development and economic growth achievement lies not in the revolutionary liquidation of the existing energy-oriented structure of the economy, but in its adaptation to the innovative economic growth realities.

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ENERGIJA PAGRĮSTO EKONOMINIO AUGIMO VIRSMO PERSPEKTYVOS (RUSIJOS PAVYZDŽIU)

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Santrauka

Ekonominio augimo tipai klasifikuojami pagal įvairius kriterijus. Apskritai ekonominis augimas skirstomas į ekstensyvų ir intensyvų pagal darančius jam įtaką kiekybinius ir kokybinius veiksnius. Ekonominis augimas, pagrįstas socialinių-ekonominių sistemų periodišku ir prioritetinio sektoriaus pletra, vadinamas agrarinis (tradiciniu), industriniu ir postindustriniu (informaciniu). Energetinis postūmis, įvykęs šiuolaikinėje istorijoje po keleto technologinių revoliucijų (industrinės, mokslinės, techninės ir technologinės), atliko pagrindinį ekstensyvaus ekonominio augimo, pagrįsto energijos išteklių panaudojimu XVIII–XIX a., ir intensyvaus ekonominio augimo, pagrįsto energijos taupymu XX–XXI a., vaidmenį. Tradiciškai ekonominio augimo tempai siejami su energijos vartojimo dydžiais. Ilgo periodo pasaulio ekonomikos dinamika parodė tiesioginę ekonominio augimo ir energijos sektoriaus raidos priklausomybę XIX–XX a.

XX a. aštuntojo dešimtmečio viduryje, kai energijos raidos krizė paplito po visą pasaulio ekonomiką, šios priklausomybės kryptingumas pasikeitė ir parodė per tolesnius 30 metų netradicines tendencijas. Besivystančios ir transformuojamos ekonomikos plėtojosi ta pačia kryptimi, išsivysčiusiose šalyse ekonominio augimo ir energijos panaudojimo kryptys buvo priešingos.

Šis straipsnis skirtas šiuolaikinių ekonominio augimo, grindžiamo energijos panaudojimu, rodiklių analizei. Šiuolaiki nauji ekonominio augimo tipai: augimas grindžiamas inovacijomis, ir augimas, pagrįstas energijos panaudojimu. Straipsnyje analizuojami trys galimi Rusijos raidos scenarijai, susiję su jos ekonomikos struktūra, ir įrodinėjama, kad pasiekti naujos ekonominio augimo, grindžiamo inovacijomis, kokybė įmanoma, kai ekonomika pagrįsta energijos panaudojimu.

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