
Potential of Regional Fuel & Energy Complex, with the Typological Features of Regional Development

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Maxim Vasilyevich Chernyaev, Elena Mikhaylovna Grigorieva,
Tatiana Fedorovna Kreydenko¹

Abstract:

Purpose: Fuel & Energy Complex (FEC) has a significant share in the economic system and has the most extensive potential for introducing innovations. Authors suggest innovative potential of regional FEC considering the specifics of regional economic development.

Design/Methodology/Approach: To evaluate the attainability of economic growth in conjunction with the goals of energy efficiency and energy independence and to make decisions on adjustments in energy policy, the authors propose a three-component integrated index of elasticity of energy efficiency for each typological group of region, including the index of innovative potential of the regional Fuel & Energy Complex, the index of energy supply efficiency of consumers in the region and the sustainability index of the region's energy system.

Findings: The survey identified five typological groups of regions reflecting the features of regional FEC development. Considering the significance of factors affecting innovative potential, seven groups of such factors were proposed for formation, and the significance of each factor was determined in accordance with the typological group of the region.

Practical implications: Each of the three components of the integrated index makes its specific contribution to the resulting quantitative indicator, the value of which will reflect the degree to which the regional energy policy has reached its target priorities, and to meet the urgent challenges of modern innovative sustainable energy technologies.

Originality/Value: Realisation of the innovative potential of regional FEC should be closely linked with indicators of energy efficiency and energy independence in order to ensure the development of regional economies, including the achievement of global climate goals.

Keywords: Fuel & Energy Complex (FEC), innovative infrastructure, energy efficiency tools.

JEL codes:

Paper Type: Research study.

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¹Federal State Independent Educational Institution of Higher Education "Peoples' Friendship University of Russia" (RUDN University), m.chernyaev@mail.ru

1. Introduction

The Fuel & Energy Complex (FEC) is one of the main drivers for the development of the Russian economy and its economic growth, which is due to the wide intersectional landscape (taking into account inter-industry ties FEC accounts for 25% of Russian GDP, 60% of exports, 40% of investments, more than 30% of consolidated budget revenues and 7% of employees) (Novak, 2019). The Fuel & Energy Complex has significant economic and innovative potential also has specifics regarding the mechanisms for further use of this potential. We are talking about the passive use of such potential, and the active development of innovations in the FEC. In the first case, the mechanism works using fiscal instruments – levying taxes to replenish the budget, and further redistributing this income. This approach still prevails in the economic policy of Russia, which is expressed in separate measures for its implementation: the introduction of the “tax manoeuvre” and the use of the “budget rule” entail an increase in the fiscal burden and indirectly affect the price increase in the national FEC. This approach does not fully contribute to stimulating economic growth in the country and fully utilising the innovative potential of the Fuel & Energy Complex.

Nevertheless, one of the national goals is Russia's entry into the five largest economies of the world until 2024 (Presidential Decree of July 2018 No. 204 “About the national goals and strategic objectives of development of the Russian Federation until 2024”), which can be realised mainly using the innovative potential of the economy leading sector, which include economic entities of the FEC. According to the OECD data, Russia ranks eighth in the world in terms of R&D spending, behind countries such as the United States, China, Japan, Germany, South Korea, France, and the United Kingdom. The level of expenditures of our country is \$41,868 million at Purchasing Power Parity (PPP) for 2017, which is 12 times lower than the costs of countries such as the USA and China, 4 times lower than that of Japan, 3 times lower than Germany, 2 times lower than South Korea, 1.5 times lower than France, 1.2 times lower than Great Britain (OECD, 2013).

R&D spending dynamics are even lower than in other countries; only one country showed more than a hundred percent growth rate, China 168%, South Korea, Taiwan and Germany showed 98%, 73% and 59%, the UK and Italy increased R&D spending by 35%, the USA by 34%, France by 30%, Japan by 24%. Russia ranks tenth in terms of growth in R&D expenditures, with a growth rate of 21% (OECD, 2013).

High-quality build-up of Russian energy resources, their production and export, modernisation, expansion and diversification of energy infrastructure – these are the areas where the growth and expansion of innovations are laid down. Currently, in the mining enterprises included in the FEC, investments in reconstruction and modernisation in the total volume of investments in fixed assets are growing. While in general for all types of economic activity in the country, a decrease of this

indicator by 3.73% was observed (Federal State Statistics Service, http://www.gks.ru/free_doc/new_site/technol/tab_inv2-2.htm).

2. Literature Review

Numerous scientific and applied studies considering the comparative approach to regional specificity speak in favour of the influence of regional characteristics on the realization of the innovative potential of both individual business entities and industries (Badewi *et al.*, 2018; Cheung *et al.*, 2019; Markovitch *et al.*, 2017; Tan *et al.*, 2019). Certain factors affecting the innovative potential and innovative activity are reflected in the studies of foreign and domestic scientists and practitioners.

The relationship between the indicators of “investments in intangible assets” and “return on assets” was estimated using a regional approach to companies in the Central and Eastern Europe region (Bistrova *et al.*, 2017). The analysis showed that in the regional context, the innovative potential is higher for companies belonging to more developed countries.

Types of innovations and sources of financing were investigated using a comparative approach to the analysis of innovative cases in individual countries (Štěrbova *et al.*, 2019). The dependence between the effectiveness of the innovative activity development and the availability of state programs and financial resources is revealed. Many authors emphasise the need to study innovative development and innovative potential in the context of Regional Industrial Complexes (RIC) (Bezpalov *et al.*, 2019). It is concluded that it is necessary to develop and implement strategies for managing innovative development for specific regional industrial complexes and for individual enterprises that are part of RICs.

We share the opinion of the expert community that it is impossible to assess the level of innovation, considering only indicators such as the number of patents issued or published articles, since the development of innovations is determined by many factors, including those characterising the regional economic specificity. Thus, McKinsey experts suggest using an “industry archetype” as an approach to assessing innovative potential (McKinsey Innovation Practice Center for Innovation Development, 2018). In the process of research, four archetypes were identified that were methodologically determined based on the dominant source of innovation: scientific, engineering, consumer and the archetype of efficiency.

The study of the structure of archetypes showed that the oil and gas industry belongs to the archetype of industries, focused on efficiency, and the electric power industry – to the archetype of engineering innovation. It is worth noting that, according to McKinsey experts, the first archetype is characterized by the presence of a developed ecosystem of partnerships that contributes to the effective interaction of suppliers, manufacturers and customers. As for the second archetype, you need professionally trained personnel and the business environment that provides reliable

protection of intellectual property, the presence of developed industrial clusters, as well as the policy that helps to gain wider access to global sources of technology and knowledge. These characteristics confirm the high innovativeness of the oil and gas industry and the electric power industry, which are included in the country's energy sector.

3. Materials and Methods

It is advisable to carry out a substantiation of the particularities of the state and development of the innovative potential of regional energy companies from the point of view of the significance of the regional aspect of economic development and ensuring energy security and energy independence of regional economies. Features of the development of regional energy technologies are determined by many interrelated factors that ultimately affect the innovative potential of energy technologies in a particular region. The team of authors identified groups of factors to determine the typology of the region and the further process of universalization of the estimated indicators for assessing the energy efficiency and energy independence of regional Fuel & Energy Complexes as (Chernyaev *et al.*, 2019):

- climatic and spatial group of factors;
- a group of factors reflecting the sectoral and territorial structure of the region's economy;
- a group of factors providing the territory with energy resources;
- factors of the structure of energy sectors;
- price group of factors;
- a group of technological factors (technologies in electricity and heat supply and end consumers, as well as the nature of the use of production capacity).

The authors note the importance of regional ranking (typology), including the criteria of the region industrial structure. Energy companies operating in the region can be both regional and large corporations of an inter-regional, national and transnational level. The scale factor of energy companies should also be taken into account in terms of transaction costs. State support instruments and market instruments for large companies are more accessible and widely used by such companies, especially standardised financial market instruments.

The category of innovative potential is diverse and includes a large number of indicators that affect the innovative potential itself. There can be no universal methods for assessing innovative potential; differences between the objectives of the assessment by various organisations and the receipt of such an assessment by different users, relatively different sources of information base, constantly changing conditions for the development of economies, global goals for sustainable development, etc.

Table 1. International Innovation Rating Techniques

Name of methodology/rating	Developer	Evaluation indicators of industrial enterprises /industries
The index of scientific and technological potential as the main component of the integral indicator of assessing the country's competitiveness level (World Economic Forum)	Forum experts	The number of patents per 1 million people; the country's place in terms of technological development; the level of foreign investment in the innovative activities of national enterprises, etc.
A system for assessing the country's innovation activity with indicators on the European Innovation Scale (EIS)	Commission of the European Community	Investments in research and development, human and financial resources for innovation, cooperation with public and private institutions in the field of innovation, export and sales, the number of national innovations in the markets of other countries, intellectual property rights
The system of indicators for assessing the innovative activities of countries according to the methodology of the Organization for Economic Cooperation and Development (OECD)	Organisation for Economic Co-operation and Development, Statistical Office of the European Communities	The share of innovation-active enterprises, the share of innovative products in its total volume, research costs
The Knowledge Assessment Methodology (KAM)	The World Bank	-
Global Innovation Index	International Business School INSEAD, Boston Consulting Group (BCG)	Innovative costs, innovative efficiency, patent activity, etc.
Bloomberg Innovation Index	Bloomberg	The number on the domestic market of registered high-tech public companies, patent applications of residents, the total volume of applications and valid patents, per million people

Source: Compiled by the authors.

The International Innovation Rating Techniques are shown in Table 1. The rating approach is based on a combination of indicators reflecting the main aspects of the innovative element of the socio-economic development of the regions. In order to obtain an integral characteristic, the scoring method is mainly applied. This method is used in the annual studies of the national rating agency «Expert RA». Another example is the assessment of RIA Rating regions based on the data from Rosstat (Russian Federal State Statistics Service) “Index of scientific and technological

development of the constituent entities of the Russian Federation” (RIA Rating, 2018).

In addition, other approaches and methods can be cited for assessing the level of innovative potential of regional economic systems: a normative approach, an approach based on the integral innovative potential of a region, a method of complex multivariate assessment, correlation and regression analysis.

Considering the factors affecting the innovative potential allows us to fully represent the barriers and incentives for its development. The most complete representation can be obtained on the basis of Table 2 below:

Table 2. *Systematisation of factors affecting innovation potential*

Factors	Indication of “push” factors	Indication of obstacle factors
HR	High qualification, including advanced degrees	Staff shortage
Production and technological	R&D Investments	Low involvement in innovation processes
Scientific and technical	Introduction of scientific, technological innovations	Low degree of innovation
Financial	Government programs, financial support tools	The high cost of capital raising tools, high tax rates
Organisational and management	High innovative activity	The rejection of the need for an innovative component
Infrastructure	Availability of venture and investment funds	Low communication with scientific organizations, lack of clustering in the innovation sphere
Institutional	Stimulating legislative framework for innovation, effective state innovation policy	Undeveloped of state support in innovation sphere, non-transparency of the system of state institutions

Source: Compiled by the authors.

The innovation activity of the economic entities of the region and the institutional innovation environment are closely interconnected. Such an interconnection is manifested in the elaboration of the legislative and regulatory framework regarding innovations, execution and control measures, which form an effective state innovation policy that contributes to the development of the innovative potential of the regional economic system.

Achieving the required level of energy efficiency and energy independence of the regions is impossible without creating comfortable institutional and legal conditions. It is advisable to consider the micro and macro levels in determining institutional factors.

External macro factors that form institutions and determine the conditions of the institutional innovation environment include:

- legislative, regulatory acts;
- a culture of innovation;
- the existence of mechanisms for protecting property rights, the legitimacy of financial and economic activities, etc.

Internal factors of the micro level comprise:

- the cost of ongoing market transactions;
- the level of riskiness of transactions in the industry;
- the presence of informal associations and communities;
- level of business activity;
- level of trust in regional authorities;
- degree of support tools usage laid down in regional programs.

Currently, development institutions operating in Russia at the federal level are sufficiently developed and have a stable regulatory framework.

4. Results

The analysis of individual approaches to the determination of innovative potential proposed by foreign and domestic authors, most clearly representing the main types of techniques, allows us to formulate the authors' approach to calculating the index of innovative potential of the FEC. This comprehensive indicator should take into account the specifics of the region's energy sector based on an integrated approach (using a comprehensive multivariate assessment) and include the following fundamental issues:

- the level of innovative resources of the regional FEC;
- the efficiency of their use and the impact on the socio-economic development of the region;
- tactical and strategic instruments for the innovative development of the regional FEC;
- regional innovation policy for the development of the FEC.

It is proposed to apply seven groups of indicators, as shown in Table 3 below.

Table 3. Grouping of indicators of innovative potential of a regional Fuel & Energy Complex

Group	Indicators
1. Scientific and technical component	- R&D financing per unit of gross revenue of the regional Fuel&Energy Complex

2. Production and technological component	<ul style="list-style-type: none"> – Salvage Value rate – Fixed assets input ratio
3. Group of financial indicators	<ul style="list-style-type: none"> – The share of corporate expenses for the introduction of new technologies in the total expenses of the regional Fuel&Energy Complex – the share of government (local budget expenditures) expenditures on the introduction of new technologies in the total expenditures of the regional Fuel&Energy Complex – Leasing of innovative equipment – Tax burden in the regional Fuel&Energy Complex
4. Personnel component	<ul style="list-style-type: none"> – The share of staff with a scientific degree in the total number of employees in the regional Fuel&Energy Complex – The share of R&D personnel in the total number of employees in the regional Fuel&Energy Complex
5. Organizational component	<ul style="list-style-type: none"> – Number of organisations providing training for the FEC, – Number of organisations performing technological development for the FEC
6. Infrastructure group	<ul style="list-style-type: none"> – The share of enterprises performing R&D in the total number of organisations in the region – Number of technoparks, technopolises, business incubators
7. Institutional group	<ul style="list-style-type: none"> – Availability of innovative innovation support programs – Application of targeted tools to support and develop innovations in the regional Fuel&Energy Complex

Source: Compiled by the authors.

Based on worldwide experience, we can say that under the conditions of creating a favourable climate, innovative activity of companies is developing and increasing, which leads to the growth of science, thereby stimulating the innovation climate – this is the primary task of innovative oriented and developed countries. The strategic mechanism of the state goal of this policy is the stimulation and assistance in promoting scientific and innovative activities. An example is the R&D funding mechanism.

R&D tax credits have become one of the most widely used tools to promote innovation. Governments can choose among various tools to promote R&D. Tax incentives for R&D business include subsidies and loans, as well as other forms of favourable tax treatment, such as permission to accelerate depreciation of R&D capital expenditures (OECD, 2013).

5. Discussion

Thus, we can talk about the validity of indicators that will be considered when assessing the index of innovative potential of the regional Fuel & Energy Complex.

Table 4 presents the formulae and information base for calculating the integral index of innovative potential of the regional Fuel & Energy Complex.

Table 4. *Formulae included in the calculation of innovative potential of the regional FEC*

Group No.	Indicator	Formula	Infobase
1	R&D financing per unit of gross revenue of regional FEC	$F_{R\&D} / GR_{FEC}$ $F_{R\&D}$ - the total amount of all types of R&D financing; GR_{FEC} - the gross revenue from the sale of products (works, services) of the regional FEC	Russian Federal State Statistics Service, consolidated reporting of the regional FEC corporations
2	Salvage Value rate	$1 - r_{FA}$ r_{FA} - accumulated depreciation rate to fixed assets	Russian Federal State Statistics Service, consolidated reporting of the regional FEC corporations
	Fixed assets input ratio	V_{FAI} / V_{FA} V_{FAI} - the value of the fixed assets input, V_{FA} - the value of fixed assets at the end of the year	Russian Federal State Statistics Service, consolidated reporting of the regional FEC corporations
3	The share of corporate expenses for the introduction of new technologies in the total costs of the regional FEC	$CE_{R\&D} / TE_{FEC}$ $CE_{R\&D}$ - the corporate expenses of the regional FEC on the R&D; TE_{FEC} - the amount of total expenses of the regional FEC	Russian Federal State Statistics Service, consolidated reporting of the regional FEC corporations (profit and loss statement)
	The share of government (local budget expenses) expenses on the introduction of new technologies in the total expenditures of the regional FEC	$GE_{R\&D} / TE_{FEC}$ $GE_{R\&D}$ - government expenses the regional FEC on the R&D; TE_{FEC} - the amount of total expenses of the regional FEC	Russian Federal State Statistics Service, consolidated reporting of the regional FEC corporations (profit and loss statement)
	The share of innovative high-tech equipment obtained through leasing in the volume of fixed assets at the end of the year	V_{FAI_LEAS} / V_{FA} V_{FAI_LEAS} - the value of the fixed leased assets input; V_{FA} - the value of fixed assets at the end of the year	Russian Federal State Statistics Service, consolidated reporting of the regional FEC corporations (profit and loss statement)

	Tax burden in the regional FEC	$T_{FEC} / (GR_{FEC} + NOI_{FEC})$ T_{FEC} - total amount of all taxes paid; GR_{FEC} - the gross revenue from the sale of products (works, services) of the regional FEC; NOI_{FEC} - non-operating income in the regional FEC	Federal Tax Service of the Russian Federation, consolidated reporting of the regional FEC corporations
4	The share of employees with a scientific degree in the total amount of employees in the regional FEC	$E_{degree_FEC} / E_{total_FEC}$ E_{degree_FEC} - the average amount of employees with a scientific degree E_{total_FEC} - the total amount of employees in the regional FEC	consolidated reporting of the regional FEC corporations (profit and loss statement)
	The share of R&D employees in the total amount of employees in the regional FEC	$E_{R\&D_FEC} / E_{total_FEC}$ $E_{R\&D_FEC}$ - the average number of R&D employees; E_{total_FEC} - the total amount of employees in the regional FEC	Russian Federal State Statistics Service, Non-financial reporting of FEC organisations
5	Number of organisations providing employee training for the FEC	N_{empl_FEC}	Russian Federal State Statistics Service, Official website of regional authorities
	Number of organisations performing technological development for the FEC	$N_{R\&D_FEC}$	Russian Federal State Statistics Service, Official website of regional authorities
6	The share of enterprises performing R&D in the total amount of organisations in the region	$Ent_{R\&D} / Ent_{total}$ $Ent_{R\&D}$ - the amount of organisations involved in R&D; Ent_{total} - the total amount of organisations in the region	Russian Federal State Statistics Service, Official website of regional authorities
	The amount of technoparks, technopolises, business incubators	$O_{R\&D} / O_{total}$ $O_{R\&D}$ - the amount of organisations specialised in R&D O_{total} - the total amount of organisations in the region	Russian Federal State Statistics Service, Official website of regional authorities

7	Availability of innovation support programs for the region FEC	P_{inn_FEC}/P_{total} P_{inn_FEC} - the amount of innovation support programs for the region FEC P_{total} - the total amount of existing state programs in the region	Russian Federal State Statistics Service, Official website of regional authorities
	Application of targeted tools to support and develop innovations in the regional FEC	St_{FEC}/St_{total} St_{FEC} - the amount of targeted support tools used by FEC organisations St_{total} - the total amount of legitimate support tools used in the region	Russian Federal State Statistics Service, Official website of regional authorities

Source: Compiled by the authors.

Calculation IIP_{FEC} is an index of the innovative potential of the FEC of the integral indicator of innovative potential by the additive method of convolution of criteria, which is based on the construction of an integral criterion calculated in the form of a simple sum or a weighted sum of criteria:

$$IIP_{FEC} = \sum_{i=1}^m k_i * G_i \tag{1}$$

where k_i - weight coefficient of influence of a group of criteria, determined on the basis of expert assessment, G_i - calculated quantitative value of the i-th group of factors.

The authors developed a typology of regions that reflects the close connection of the analysed technical and economic indicators with the energy efficiency and energy security of the studied regions (Kreydenko *et al.*, 2018). Five types of regions were identified by the nature of the influence of the Fuel & Energy Complex on the socio-economic development.

The first type is energy-surplus regions with an export-oriented FEC, the sphere of interests of the largest state energy companies. The second type is the regions with developed diversified infrastructure of the FEC and a diversified structure of the economy. The third type is regions with an energy-intensive sectoral structure of the economy and insufficient provision of their own energy resources. Regions with a weak energy base, difficult natural and geographical conditions, and low socio-economic development fall into the fourth and fifth types.

It is proposed to evaluate the attainability of such a set of results using the three-component integral index of elasticity of energy efficiency, which includes a set of characteristics that allow us to evaluate the influence of specific and general factors.

The calculation of this index is a formula of three components:

$$I_{EEE} = k_1 \times I_{RESE} + k_2 \times I_{RESS} + k_3 \times IIP_{FEC} \quad (2)$$

I_{EEE} - energy efficiency elasticity index;

I_{RESE} - regional energy supply efficiency index;

I_{RESS} - region energy system sustainability index;

IIP_{FEC} - index of innovative potential of regional FEC;

$k_{1,2,3}$ – index weights coefficients, calculated individually for each region based on their fuel&energy balances.

Based on the content of each group of factors and the typological group of the region, the authors carried out the distribution of weight coefficients from 0.1 to 0.2 (Table 5).

Table 5. Significance of factor groups of innovative potential for certain types of regions.

	1st type of regions	2nd type of regions	3rd type of regions	4th type of regions	5th type of regions
1. Scientific and technical component	0,2	0,2	0,2	0,1	0,1
2. Production and technological component	0,1	0,1	0,1	0,2	0,2
3. Group of financial indicators	0,2	0,2	0,2	0,2	0,2
4. HR component	0,1	0,1	0,1	0,1	0,1
5. Organisational component	0,1	0,1	0,1	0,1	0,1
6. Infrastructure group	0,1	0,1	0,1	0,1	0,1
7. Institutional group	0,2	0,2	0,2	0,2	0,2

Source: Compiled by the authors.

As can be seen from Table 5 above, weights reflect the significance of the factor group for a region of a particular type. For the regions of the first type, the institutional, scientific and technological group and the group of financial indicators are most significant. In the regions of this type, the presence of large diversified companies predominates. Such companies are the most active consumers of innovative programs, widely use support tools due to the low level of transaction costs, and also, in addition to internal corporate financing, use financial instruments to diversify sources of financing for innovations (leasing, credit, tax optimisation, attracting government sources of financing, etc.). In most cases, the introduction of

innovations takes place on the basis of large corporations and after reducing the cost of new technology, it is replicated to medium and small organisations.

The regions of the fourth and fifth types are characterised by specific climatic and geographical conditions. The high level of cost of final energy, combined with the necessary level of its environmental friendliness, highlights the degree of significance of the factor group “production and technological component”. The introduction of innovative technologies, including renewable energy sources, innovative technologies for its storage and transportation, requires the modernisation of equipment, which belongs to the category of fixed assets.

By choosing indicators for one of the typical regions compiled by the typological logic map of energy efficiency of the country's regions, it is possible to form a standard picture of the Innovation Potential Index of the regional FEC, which will make it possible to calculate a three-component energy efficiency elasticity index for a typical region.

6. Conclusion

The Fuel & Energy Complex has a high innovative and economic potential that allows betting on it within the framework of the implementation of state and regional economic policies to achieve the national goals of economic growth and the global goals of achieving energy sustainability. Realisation of the innovative potential of regional FEC should be closely linked with indicators of energy efficiency and energy independence in order to ensure the development of regional economies, including the achievement of global climate goals.

Each of the three components of the integrated index makes its specific contribution to the resulting quantitative indicator, the value of which will reflect the degree to which the regional energy policy has reached its target priorities, and improved to meet the urgent challenges of modern innovative sustainable energy technologies and national economic development priorities.

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