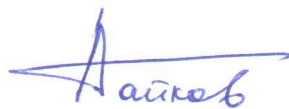


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**IMPORT SUBSTITUTION IN THE MINING INDUSTRY
OF THE REPUBLIC OF KARELIA AS A FACTOR
OF REGIONAL ECONOMIC DEVELOPMENT**

Specialty 5.2.3 – Regional and Industry (Sectoral) Economic

Abstract of the Dissertation

For the degree of Candidate of Economic Sciences

Scientific Supervisor

Doctor of Economic Sciences, Associate Professor

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Relevance of the Study.

Under external economic instability, strategically important sectors—including mining and mechanical engineering—remain highly dependent on imported solutions. This necessitates a systemic approach to import substitution aimed both at prompt responses and at the long-term development of the national economy. Import substitution in the mining industry is particularly significant due to capital intensity, technological complexity, and deep integration into global value chains. For the practical implementation of federal strategies, resource regions possessing mineral reserves and industrial infrastructure play a special role. The Republic of Karelia concentrates unique deposits of rock materials as well as advanced research, educational, and engineering institutions and enterprises. Based on these capabilities, an economically efficient comprehensive regional development program can be deployed.

Research objective and task.

To develop a comprehensive scientific approach to bringing the Republic of Karelia's mineral resources and associated secondary raw materials into effective economic circulation, based on advanced domestic technologies and appropriate organizational approaches to the process of import substitution. To achieve this aim, the dissertation addresses the following objectives:

- 1) to conduct a scholarly assessment of the types of mineral deposits in the Republic of Karelia in terms of their priority for development and exploitation;
- 2) to provide an empirical assessment of export prospects for the products of the Republic of Karelia's mining industry;
- 3) to identify the key categories of secondary raw materials in Karelia from the standpoint of their effective economic circulation;
- 4) to assess the intellectual and material resources required to implement effective import substitution in mineral processing;
- 5) to develop scientific and organizational solutions for implementing a comprehensive approach to efficient subsoil use in the Republic of Karelia.

Object of the Study. The regional mining complex.
Subject of the Study. Import substitution in the extraction and processing of natural resources in the Republic of Karelia.

Statements submitted for defense and representing scientific novelty:

1. A comprehensive systems assessment is provided of the feasibility of effective import substitution in mineral processing and in the use of secondary material resources (SMR) at enterprises of the Republic of Karelia. Within this proposition, the strategic significance of the industry is confirmed as a key driver of the region's socio-economic development. The application of modern domestic technologies in mining contributes to the power sector, chemical industry, construction materials, advanced materials, and water treatment. The contribution of the mining industry to export potential is identified. It is demonstrated that, under certain conditions, the export of processed products and technologies may contribute more to regional GRP than the export of ores. An especially promising area of regional growth is the expanded involvement of SMR in economic circulation. Crushed-stone waste and municipal solid waste (MSW) show high processing potential. Within the framework of the circular-economy agenda, mechanisms for addressing the processing challenge are developed. The sector's material and technical provisioning is assessed under sanctions, identifying opportunities for import substitution. Equipment types are determined for which rapid substitution is infeasible and those for which alternatives exist (Passport of Scientific Specialty 5.2.3 "Regional and Industry Economics," item 1.2 "Spatial organization of the national economy. Spatial distribution of economic resources").

2. The content of the notion "domestic equipment" within import substitution theory is refined. The approach distinguishes three equipment groups (fully domestic; partially localized; equipment with critical components from unfriendly jurisdictions) and introduces a stepwise assessment along four dimensions (use of imported components in production; their country of origin; availability of domestic analogues; sanctions risk). The assessment proceeds in three stages: analysis of equipment and component structure; classification via an

attributive-predicate method; and risk-based ranking (Passport 5.2.3, item 2.1 “Theoretical and methodological foundations for analyzing industrial-development problems”).

3. Based on cash-flow analysis, the investment attractiveness of import-substitution projects at mining and processing enterprises of the Republic of Karelia is evaluated. It is shown that, under current economic conditions, construction of a peat-processing plant is economically expedient. Compared with other capital-intensive projects, this project can be regarded as highly efficient (Passport 5.2.3, item 2.2 “Issues of evaluating and increasing the efficiency of business operations at enterprises and in industrial sectors”).

4. A model is developed for organizing a Regional Mining Inter-Industry Scientific and Technical Complex (RMISTC) that unites industrial enterprises, research institutions, and public authorities to implement effective import-substitution policy and technological development in the region (Passport 5.2.3, item 2.12 “Public-private partnership in industry”).

Significance of the Results for Theory and Practice.

On the theoretical side, it is substantiated that under external constraints import substitution becomes a priority path of industrial development in the short and medium term and requires accelerated implementation. The situation in which import substitution is a forced measure to be implemented within compressed time frames is examined. Available domestic technologies are identified, as well as equipment types that cannot be substituted quickly. Interlinked definitions of “domestic equipment” and “import substitution” are proposed, enabling the structuring and operationalization of the substitution process. The most relevant policy frame is industrial policy; at the regional level, the same support instruments as at the federal level are applicable.

A specific aspect of regional development is identified—namely, the contribution of the mining sector to core economic indicators. It is demonstrated that upgrading the sector’s technological level, deepening resource processing,

localizing equipment production, and developing export capabilities can form the basis for a new cycle of economic growth in the Republic of Karelia.

On the practical side, the results have high applied value for designing regional strategies of sustainable socio-economic development, especially under limited access to foreign technologies. The materials can be used in the educational process of relevant universities in the North-West of Russia. The proposed approaches may be employed in shaping the economic policies of the constituent entities of the Russian Federation aimed at production localization, the development of domestic growth drivers, and reducing import dependence. The results have been implemented in the commercial practice of NPK “Mechanobr-Tekhnika” (implementation act) and have been partially used within a Russian Science Foundation project (grant No. 20-79-10125).

Proposals concerning the rational use of the mineral resource base and the involvement of SMR in economic circulation are particularly relevant; they increase the efficiency of regional asset use, broaden the tax base, stimulate investment in processing industries, and create additional jobs.

The work presents substantiated directions for optimizing the regional economic structure using the Republic of Karelia as a case, including recommendations on industrial diversification, increasing value added, and enhancing export potential. Based on financial-indicator analysis of a peat-processing plant project and a molybdenum concentrator, their investment attractiveness is assessed. The dissertation contributes to solving key tasks of regional economics: ensuring macroeconomic resilience, stimulating industrial growth, and developing mechanisms aimed at reducing import dependence.

Reliability of the Findings.

The reliability of the results is based on the use of official statistical sources; analysis of publications validated by the scientific and technical community; and modern analytical methods. The main propositions were presented at three international conferences in 2022–2023.

Approbation of the Results.

Seven publications totaling 2.8 author's sheets have been issued on the topic of the dissertation.

A. Articles indexed in international databases (Scopus):

1. Paikov A. A.; Paikova V. A. Issues of Import Substitution in the Mining and Processing Industry. *Obogashchenie Rud*, 2022, No. 4, pp. 35–38 (Scopus Q2).
2. Korovnikov A. N.; Mikhailova N. V.; Paikov A. A.; Trofimov V. A. Vibrational Classification of Solid Secondary Material Resources: Industrial Experience. *Obogashchenie Rud*, 2022, No. 6, pp. 40–44 (Scopus Q2).
3. Paikov A. A. On the Rational Organization of Regional Subsoil Use. *Obogashchenie Rud*, No. 2, pp. 22–27 (Scopus Q2).

B. Articles indexed in RSCI (Russian Science Citation Index):

4. Mezenin A. O.; Paikov A. A. Prospects for Import Substitution in the Mining and Processing Industry. In: Proceedings of the International Conference “Plaksin Readings 2022”, Vladivostok, pp. 78–81.

C. Other publications:

5. Paikov A. A.; Paikova V. A. Import Substitution in the Mining and Processing Industry. *Zoloto i Tekhnologii (Gold and Technologies)*, 2022, No. 2 (56), pp. 122–125.
6. Paikov A. A.; Chubakova A. S. Import Substitution of Laboratory Equipment for the Processing Industry. In: Proceedings of the Scientific-Practical Conference with International Participation “Issues of Regional Economics and Ecology of Subsoil Use”, Saint Petersburg, NPK “Mechanobr-Tekhnika,” 2022, pp. 48–53.
7. Paikov A. A. Import Substitution and the Organization of Regional Subsoil Use. In: XIX International Forum of Young Scientists “Actual Problems of Subsoil Use”, Russian Federation, Saint Petersburg, SPGU, 2023, pp. 396–397.

Chapter 1. The chapter sets the theoretical and historical frame. It briefly reconstructs the evolution of mining machinery in the USSR/Russia and in the Republic of Karelia: from early reliance on foreign models to the predominance of domestic designs and the subsequent vulnerabilities of the 1990s, which shaped today's constraints and the demand for import substitution. It then reviews core

approaches to import-substitution policy—from classical structuralism (Prebisch) to contemporary industrial-policy frameworks (Chang, Rodrik)—and argues for a “hybrid” trajectory suitable for Russia (import substitution in critical segments while maintaining export specialization in resource sectors). Within this logic, a practical-methodological block is introduced: the need to formalize the notion of “domestic equipment” and align it with existing regulatory criteria is substantiated, enabling operationalization of import substitution in sectoral and investment decisions. Policy instruments are grouped into three classes: trade protection; industrial-policy measures (subsidies, tax incentives, public procurement, concessional finance); and scientific-technological cooperation. The chapter concludes with an analysis of inter-industry integration theories and the domestic experience of inter-industry scientific-technical complexes (ISTC) (e.g., “Mechanobr” and “Eye Microsurgery”) as an institutional model for accelerated technology deployment. The role of the circular economy and the involvement of SMR (separation, flotation, vibrational disintegration) in raising value added and reducing import dependence is additionally demonstrated. Thus, the chapter forms the methodological basis of the dissertation: import substitution is considered a forced yet feasible short-term strategy; a working definition of “domestic equipment” is introduced; and the need for a regional integration model (RMISTC) is justified using the Republic of Karelia as an example.

Chapter 2. A comprehensive assessment is provided of the role and potential of the mining sector in the economy of the Republic of Karelia. The sector’s contribution to the regional economy is shown to exceed the national average, and the industry can pull along waste processing and R&D. The resource base is analyzed (granite/crushed stone, quartz, shungite, graphite, peat, molybdenum, perovskite, iron ores) along with domestic technological solutions—vibrational disintegration and utilization of fine fractions; deep peat processing into a high-calorific “supercoal” concentrate; and perovskite beneficiation schemes (including peat-derived reagents). Institutional conditions (Arctic regime) and current constraints are noted: infrastructure, supply-chain disruptions in 2022–2023, and a

shift toward less technologically intensive output. Techno-economic evaluations are performed for two projects: a standard peat-processing plant ($PI > 1$; $IRR \approx 43\%$; payback period ≈ 3 years) and a molybdenum concentrator at the Lobash deposit ($PI > 1$; $IRR \approx 26\%$; payback ≈ 4 years). Preference is given to the peat project as more efficient under the assumed risks. Export analysis shows: raw-material exports are vulnerable and geographically concentrated, whereas processed products (dimension stone, shale/shungite) yield a much higher unit value and should be scaled up. Recommendations include a shift toward deep processing and the export of products/technologies, development of cooperation platforms, and exploration of alternative markets. The chapter establishes the industry's strategic significance and outlines practical "growth points" through technologization, localization, and an export pivot.

Chapter 3. The conceptual-methodological foundation and practical mechanisms of import substitution for Karelia's mining sector are developed. A predicative approach is proposed for the terms "domestic equipment" and "import substitution": an attributive predicate is introduced with transparent criteria (degree of localization; origin of critical components; availability of domestic analogues; sanctions risk), a step-by-step method (composition analysis $\rightarrow$ classification into fully domestic / partially localized / with critical unfriendly components $\rightarrow$ risk ranking), and a process logic (strategic marketing and planning $\rightarrow$ predicate-based analysis $\rightarrow$ project investment $\rightarrow$ production). Applicability is shown for the most import-dependent nodes of mineral processing; integration of the method into a state information system for monitoring import substitution is proposed.

As the institutional contour, the creation of a Regional Mining ISTC (RMISTC) in a PPP format is proposed, led by a strong non-state integrator in close interaction with public authorities. The structure includes object-oriented clusters (mining-metallurgy, chemistry, special-purpose engineering) and functional blocks (finance and investment; big-data; education; government engagement; marketing/project management; quality). The advantages of the ISTC model (more centralized and manageable technology deployment under Karelia's infrastructural

constraints) and sources of support (R&D and homologation subsidies) are substantiated. Priority objects include peat (producing high-calorific semicoke/“supercoal” for distributed energy), Lobash (molybdenum), and non-metallic materials (crushed stone, “heavy” manufactured sand).

A practical import-substitution map is drawn: mechanisms (direct domestic production; high-localization joint releases; parallel import; re-orientation to China/India) and equipment nomenclature. Rapid full substitution by domestic solutions is feasible for crushers (including KID-type vibratory crushers), screens, magnetic/electrostatic separators, filters (ceramic, vacuum), thickeners, pumps, laboratory lines, etc. Critical bottlenecks include HPGRs, large-volume mills $> 250 \text{ m}^3$, vertical ore mills, and gearless drives $> 8 \text{ MW}$ (for some positions only parallel import/re-orientation is feasible). For the crushed-stone market, the replacement of withdrawn imported crushers (Metso, Sandvik, etc.) by energy-efficient KID vibratory crushers without foundation redesign is shown. For laboratory equipment, a production increase ($\sim 40\%$) and a statistically stable demand structure (Fisher’s angular transformation) are recorded.

A technological line for SMR and MSW processing is formed on a domestic basis: industrial vibratory screen-separators (GIS-61M type) as an alternative to drum units—at equal capacity they have substantially lower mass and footprint, higher separation efficiency (in tests: $\sim 21.2 \text{ t/h}$ at $\sim 14.8 \text{ kW}$; recovery of SMR/combustibles in oversize $\sim 87\%$; biodegradable fraction in undersize $\sim 90\%$), prevent blinding of screening surfaces, and reduce building CAPEX by 80–100 million rubles. The potential for producing “heavy” manufactured sand from fines is demonstrated, embedding recycling into the import-substitution contour and raising value added.

Conclusion.

The study’s outcomes are summarized, and further work is outlined: pilot implementation of the RMISTC in the Republic of Karelia; development of the predicate-based method for assessing “domestic equipment”; and scaling projects of deep processing and recycling.