MANAGEMENT OF SUSTAINABLE DEVELOPMENT OF INDUSTRIAL STRUCTURES WITHIN THE CONCEPT OF WATER-ENERGY-FOOD

Information about the Unit Implementing the Research Project

1. Name: Graduate School of Industrial Economics
2. Head of the Unit: Dmitrii Grigorevich Rodionov, Doctor of Economic Sciences, Professor, Director of the Graduate School of Industrial Economics,
3. Field of Science and Scientific Directions in accordance with the International Science Map of the Olympiad: Economics and Econometrics
4. Specific Project Titles (Ongoing and Completed):
1) Grant of the President of the Russian Federation (project NSH – 3792.2018.6). 2018 – 2019.
2) State Assignment of the Ministry of Education "Formation and Development of Regional Innovation Systems in the Russian Economy". 26.6446.2017/BCH. 2017 – 2019.
3) State Assignment of the Ministry of Education 26.1303.2014/K "Theory and Instruments for Shaping State Industrial Policy in the Context of an Innovative Economy".
4) Grant CBC INCROBB "Inclusive cross-border business networking of tomorrow" 2020.
5) State Order "Provision of services for investment packaging of projects of cluster participants for the needs of the "Moscow Innovation Cluster" Fund", contract dated September 20, 2021 No. 107/8-21.
6) State Order for the implementation of research and development work for LLC "Management Company "ROSNANO", contract dated December 20, 2021 No. 0912/2021.
7) State Assignment of the Ministry of Education “Development of a methodology for instrumental base formation for analysis and modeling of the spatial socio-economic development of systems based on internal reserves in the context of digitalization” (FSEG-2023-0008).

Research Project Theme and Content

1. Project Title: Management of Sustainable Development of Industrial Structures within the Concept of Water-Energy-Food
2. Research Project Lead: Dmitrii Grigorevich Rodionov, Doctor of Economic Sciences, Professor, Director of the Graduate School of Industrial Economics,
*3. Field of Science and Scientific Directions in accordance with the International Science Map of the Olympiad:*Economics and Econometrics
4. Working Languages of the Research Group: Russian and English. The use of Chinese and Hindi for collaboration with international partners is possible.
5. Research Project Objectives and Tasks
Objective: To develop and implement innovative methods, technologies, and management systems aimed at enhancing the sustainability of industrial structures while simultaneously achieving high economic efficiency in the face of global civilization challenges related to climate change. This objective will be achieved through progressive structural shifts in industrial sectors based on the Water-Energy-Food Nexus concept.
Main Tasks:
1. Formulating innovative methods focused on achieving rational energy conservation ratios in fuel and energy complex industries, taking into account the balance between optimizing economic efficiency and minimizing negative environmental and societal impacts.
2. Developing management systems that centralize resource flows (water and energy) in fuel and energy complex enterprises, facilitating progressive structural shifts in industrial structures.
3. Formulating innovative methodologies and technologies that contribute to reducing the negative impact of machine-building industries on natural ecosystems, while simultaneously enhancing the economic efficiency of industrial enterprises.

4. Developing integrated management systems that consider water and energy resources in the production processes of machine-building industries, fostering the sustainable and efficient functioning of industrial structures.
5. Formulating methods and technologies aimed at optimizing resource utilization in the "water-energy-food" chain within the agro-industrial complex, considering the achievement of economic efficiency in industrial structures.
6. Developing management systems that facilitate rapid adaptation of the agro-industrial complex to climate change by leveraging the "water-energy-food" nexus in the context of maintaining strategic agricultural sustainability.

6. Description of Scientific Approaches, Methods, and Equipment for Research Project Implementation

The project will leverage methods of systems analysis, economic-mathematical modeling, as well as innovative algorithms based on big data and machine learning. The equipment will include computing clusters for data processing, resource monitoring systems, and software packages for modeling resource consumption and assessing climate risks.

Scientific Approaches and Methods:

• Systems Analysis: This approach allows for the comprehensive examination of interrelationships between components of an industrial structure (water, energy, food), identifying key factors influencing its sustainability. Multi-factor data analysis will be employed to identify key variables impacting resource utilization efficiency.
• Economic-Mathematical Modeling: This approach is used to optimize resource (water, energy) utilization in production processes, considering climate change and socioeconomic factors. Linear and non-linear programming, along with multi-criteria problem modeling methods, will enable the evaluation and forecasting of the impact of proposed management solutions on industrial structure sustainability.
• Big Data Analysis: This method focuses on processing large volumes of data, including resource consumption data, economic indicators, and climate projections. Technologies such as Hadoop, Spark, and specialized databases for big data storage and analysis will be employed. Correlations between various aspects will be identified through correlation analysis and the development of regression models.
• Machine Learning: Machine learning will be used to forecast resource consumption based on external factors (temperature, humidity, seasonal fluctuations). Clustering and classification methods will help identify data patterns, facilitating the creation of more adaptive resource management systems.
• Scenario-Based Modeling: This approach evaluates various resource utilization scenarios and their impacts on the economic and ecological sustainability of industrial structures. Models will consider potential changes in policy, economics, and climate, allowing for projections and the development of optimal management strategies.
• Monitoring and Management Systems: Real-time monitoring systems will be implemented to ensure the reliability of resource consumption data. These systems will enable the control of water and energy flows within enterprises and optimize their utilization in response to changing external conditions.

Equipment:

• Computing Clusters: These are essential for complex calculations and data analysis. They will allow for the processing of large datasets, modeling resource utilization scenarios, and testing

management models. Supercomputers and cloud platforms with parallel computing support will be employed for these purposes.
• Software Packages for Mathematical Modeling: These enable the development, testing, and optimization of resource management models with high accuracy.
• Resource Monitoring Systems: These will collect data in real-time. Sensors for measuring water and energy flow, and other indicators will be installed in enterprises, enabling process optimization based on current conditions.
• Platforms for Big Data Analysis and Processing: These allow for efficient collection and analysis of data from various sources, conducting cluster analysis, predicting risks, and finding optimal solutions for resource management.
• Implementation of Intelligent Resource Management Systems: Based on automation and predictive analysis, these systems will enhance the energy efficiency of industrial facilities. They will be integrated with software packages to optimize water and energy flows within enterprises.

Postdoctoral Position Description

1. Research Project Tasks and Functions:

• Analysis of Current Resource Consumption in Target Industries: The postdoctoral researcher will conduct data collection and analysis on water and energy consumption, evaluating their impact on environmental and economic efficiency.
• Development and Testing of Innovative Resource Management Models: The postdoctoral researcher will participate in the development of mathematical models and algorithms for optimizing resource utilization within enterprises. They will also test these models in laboratory settings and subsequently implement them in industrial facilities.
• Preparation of Scientific Publications and Reports: The postdoctoral researcher will prepare scientific articles for publication in international journals, as well as technical reports on the project's progress. Publications will present research findings, including developed models and their practical testing.
• Collaboration with International Partners: The postdoctoral researcher will engage in international scientific collaborations (primarily with research teams from India and China), exchange expertise and knowledge with colleagues from other countries, and adapt developed solutions for application in diverse economic and climatic contexts.
2 Position, Employment, Contract Duration - Research Scientist, 1 year
3. Salary: 120,000 RUB per month
4. Additional Support:
• Assistance with visa application
• On-site accommodation/assistance with rental
• Russian language courses

5. Requirements for Postdoctoral Researcher:

- Experience with Big Data and Resource Management Systems (Proficiency in Python, Hadoop, Spark, Apache Kafka, SCADA, IBM Watson IoT, Tableau, Power BI, SQL, Google Cloud Platform).

- Proficiency in Economic-Mathematical Modeling and Data Analysis (Expertise in R, MATLAB, Stata, EViews, Excel (with macros and modeling), SciPy, NumPy, GAMS, Julia, CPLEX, Simulink, AnyLogic, Monte Carlo Simulation, Linear Programming, Dynamic Programming, Neural Networks, Regression Analysis, Multivariate Analysis, Time Series Analysis, Game Theory, Network Analysis).

- Machine Learning and Artificial Intelligence Experience - Proficiency in machine learning libraries and frameworks (TensorFlow, PyTorch, Scikit-learn, Keras), Experience applying deep learning techniques for big data analysis (Development and implementation of predictive models for resource management and process optimization.

• Cloud Computing and Platform Experience (Experience with cloud computing platforms (AWS, Microsoft Azure, IBM Cloud), optimization of computing processes using cloud technologies for model scaling and data analysis).

• Experience with Automation System Implementation in Production (Experience with industrial process automation systems (PLC, DCS, SCADA), Knowledge of methods and technologies for automated resource management in industrial enterprises).

• Knowledge of International Standards in Energy Efficiency and Sustainable Development (ISO 50001 (Energy Management), ISO 14001 (Environmental Management), LEED, BREEAM, GRI (Global Reporting Initiative), IEA (International Energy Agency) standards, SDGs (Sustainable Development Goals), Paris Agreement, Kyoto Protocol, PAS 2050 (Carbon Footprint), IPCC (Intergovernmental Panel on Climate Change) guidelines, WBCSD (World Business Council for Sustainable Development) frameworks, C2E2 (Copenhagen Centre on Energy Efficiency) standards).

• Interdisciplinary Research and International Project Experience: Conducting comparative research in different countries; Working with universities and research centers; Collaborating with international non-governmental organizations; Co-authoring scientific articles with researchers from various countries; Participation in international scientific conferences; Writing grants for international funding.

6. Expected Outcomes of the Research Project

- *Publications. Scientific publications based on the research project's findings on resource management models and systems in journals related to sustainable development and economics. Publication of articles in high-impact factor journals is expected. The focus of publications will be on developing and applying economic-mathematical models for optimizing resource utilization, managing water and energy flows, and promoting sustainable industrial structure development.*
** Publications will include research exploring environmental, economic, and technological aspects of resource management.*
- *Intellectual Property: Patenting developed resource management solutions and algorithms. Development and patenting of unique algorithms for managing water and energy flows in industrial systems. These algorithms will be based on the results of big data analysis and the application of machine learning methods for optimizing resource consumption. Development and patenting of technologies related to energy-saving resource management systems, including the integration of automated solutions and intelligent energy management systems.*
- *Conferences*. Participation in international scientific conferences to present research findings. Presentations of research results are expected, including new resource management methods and the implementation of innovative technologies.
Personnel Development: Supervision of students and postgraduate students within the scope of research work. Training of young researchers in the latest methods of resource management. Supervision of postgraduate students and undergraduates in their research projects related to the development of resource management methods, optimization of industrial processes, and the implementation of sustainable technologies. Conducting workshops and training courses for students and young researchers on data analysis techniques, resource management process modeling, and the application of software tools for their analysis. Expected participation of

postgraduate students and young researchers in international internships and exchange programs with leading universities and research centers to share experiences and deepen knowledge in the field of sustainable development. Preparation of textbooks or manuals on resource management and sustainable development for undergraduate and postgraduate students.

PORTFOLIO PARAMETERS (SCIENTIFIC PROFILE) OF THE RESEARCH PROJECT LEAD

1. *Personal Professional Information:*

Dmitrii Grigorevich Rodionov currently serves as the Director of the of the Graduate School of Industrial Economics within the Institute of Industrial Management, Economics and Trade, at Peter the Great St. Petersburg Polytechnic University.

Dmitrii Grigorevich Rodionov is a renowned scholar in the field of fundamental research on the development of national and regional innovation systems in the context of the new technological revolution and the digital economy. He has successfully promoted groundbreaking achievements of Russian science within the global scientific community. H-index 19.

Dmitrii Grigorevich Rodionov has made significant contributions to:

- Developing the rationale for the strategy and shaping the trajectory of transformation of management mechanisms for systems at various levels, considering the constraints and priorities of innovative development.
- Formulating an effective model for innovation management in the context of digitalization, based on the interconnectedness of research and educational institutions, businesses, and government agencies, generating a multiplicative effect from the commercialization of innovations.

Dmitrii Grigorevich Rodionov has over 25 years of experience in scientific and teaching activities.

He is a laureate of the Government of St. Petersburg Prize for his work, "Integration of Digital Educational Technologies into the Model of Practical Training of Students Based on the “Polytech-Invest” Software Package of Financial and Economic Solutions" (2021). For his outstanding contribution to the development of fundamental and applied research in the field of economics and innovation management and the creation of a corresponding scientific school, Dmitrii Grigorevich Rodionov was awarded the Government of St. Petersburg Prize for Outstanding Scientific Achievements in the Field of Science and Technology: Social Sciences. V. V. Novozhilov for 2022. He was also awarded the "Scientist of the Year" Medal (2011) and the medal of the Engineering and Economic Institute of St. Petersburg State Polytechnic University for his contribution to the university's educational and methodological activities (2006). He is also

a winner of the second competition of the Ministry of Finance of the Russian Federation "Budget for Citizens". He is a laureate of the Government of St. Petersburg Prize for Outstanding Achievements in Higher Education and Secondary Vocational Education for 2021. He is an Honored Worker of Science and Technology of the Russian Federation. He is a laureate of the Government of St. Petersburg Prize for Outstanding Scientific Achievements in the Field of Science and Technology: Social Sciences - the V.V. Novozhilov Prize for 2022. He is a member of the editorial board of the journal "Sustainable Development and Engineering Economics", the chairman of the annual international scientific conference "Innovations in the Digital Economy", a member of the Academic Council of Peter the Great St. Petersburg Polytechnic University, and the chairman of the Dissertation Council U.5.2.3.19 at Peter the Great St. Petersburg Polytechnic University.

2. Experience in Scientific and Pedagogical Work - Over 25 years

3. Field of Science and Scientific Directions in accordance with the International Science Map of the Olympiad: Economics and Econometrics

4. Links to Profiles in Bibliometric Systems (Google Scholar, RSCI, etc.):

- Scopus: https://www.scopus.com/authid/detail.uri?authorId=56087793300
- ORCID: https://orcid.org/0000-0002-1254-0464
- eLIBRARY: https://www.elibrary.ru/author_items.asp?authorid=421413
- Web of Science: https://www.webofscience.com/wos/author/record/A-9693-2017
- Google Scholar: https://scholar.google.ru/citations?user=TItQxpsAAAAJ

Theme and Content of Research and Educational Activities

1. Specific Project Titles (Ongoing and Completed), Roles in the Research Project (Principal Investigator, Executor), and Achieved Results:

1) Grant of the President of the Russian Federation (project НШ – 3792.2018.6). 2018 - 2019 - Principal Investigator.
Results: Theoretical, methodological, and practical guidelines were developed, along with practical recommendations for applying a complex of innovation management mechanisms at the micro, meso, and macro levels of the modern economic system of the Russian Federation.

2) State Assignment of the Ministry of Education "Formation and Development of Regional Innovation Systems in the Russian Economy". 26.6446.2017/БЧ. 2017 - 2019 - Principal Investigator.
Results: Theoretical foundations for managing the innovative modernization of the Russian socio-economic system were developed; provisions of the concept of forming an innovative development environment for the Russian socio-economic system were supplemented; modeling of the processes of forming an innovative environment for the Russian socio-economic system was conducted; methods and models of regional industrial policy were developed, and its effectiveness was assessed.

3) State Assignment of the Ministry of Education 26.1303.2014/К "Theory and Instruments for Shaping State Industrial Policy in the Context of an Innovative Economy" - Principal Investigator.
Results: The current state and instruments for forming industrial clusters in the Russian economy were analyzed, information support for monitoring the territorial-production cluster was presented,

instruments for implementing cluster policy in the region were presented, and the characteristics of the warehouse distribution network of enterprises in the industrial cluster were reflected.

4) Grant CBC INCROBB "Inclusive cross-border business networking of tomorrow" 2020 - Principal Investigator.
Results: Based on the conducted research, a digital cross-border inclusive network dynamic database was developed for SMEs and unemployed specialists in the region to support these entities in selecting effective teams. Along with this database, a practical guide on cross-border cooperation was developed and proposed for SMEs participating in the project, in Russian and Finnish languages.

5) State Order "Provision of services for investment packaging of projects of cluster participants for the needs of the "Moscow Innovation Cluster" Fund", contract dated September 20, 2021 No. 107/8-21 - Lead of the working group and activities for fulfilling the customer's technical specifications.
Results: Investment packaging was conducted for 12 innovative projects of cluster participants of the MIC Fund.

6) State Order for the implementation of research and development work for LLC "Management Company "ROSNANO", contract dated December 20, 2021 No. 0912/2021 - Lead of activities for fulfilling the customer's technical specifications.

7) State Assignment of the Ministry of Education "Development of a methodology for forming an instrumental base for analyzing and modeling the spatial socio-economic development of systems in the context of digitalization, relying on internal reserves" (FSEG-2023-0008) - Principal Investigator.
Results (2023):
- Developed methodological foundations for forming an instrumental base to ensure the economically secure development of Russian regions in the face of external and internal destabilizing factors, based on modeling the dynamics of human capital reproduction factors in relation to the influence of economic security threats, taking into account the role of digital transformation processes in raising the level and improving the quality of life of the population, as well as the features of the country's economic space.
- Developed methodological foundations for organizing the monitoring of innovation risks and forming a set of measures to mitigate innovation threats for key actors at different levels of the national innovation system based on the development of risk management tools.
- Developed a set of tools to ensure the sustainable development of the nuclear energy industry, taking into account its spatial aspects, the use of which enables the development of solutions for managing complex facilities while minimizing the risk of economic losses and assessing the impact of complex interactions with the external environment.

2. List of Key Publications Over the Past 5 Years:

1. Dmitriy Rodionov, Irina Rudskaia, Daria Krasnova, Elena Zhogova The Role of Higher Education in Regional Development // International Journal of Technology. Vol. 15 (5). 2024. pp. 1021-1032.
2. Olga Saychenko, Dmitriy Rodionov, Elena Schislyaeva, Inna Krasovskaya, Kristina Plis The main scientific and practical directions and priorities of management and development of the digital economy at the enterprises of modern shipbuilding // Journal of Law and Sustainable Development. v.11, n. 12, 2024, pp. 01-11, e01611.

3. Terenteva D., Rodionov D., Konnikova O., Konnikov E. Measuring the Level of Responsible Consumption Influenced by the Digital Environment: A Case Study of University of Barcelona and Bielefeld University Students // Information (Switzerland). 2023. T. 14. № 2. C. 73.
4. Eremina I., Rodionov D. The Special Aspects of Devising a Methodology for Predicting Economic Indicators in the Context of Situational Response to Digital Transformation //International Journal of Technology. – 2023. – T. 14. – №. 8.
5. Rodionov D. et al. Risk Modeling in the Oil and Gas Industry //International Journal of Technology. – 2023. – T. 14. – №. 8.
6. Rodionov D. et al. Methodology for Assessing the Digital Image of an Enterprise with its Industry Specifics // Algorithms. 2022. T. 15. № 6.
7. Rodionov D. et al. Analyzing the Systemic Impact of Information Technology Development Dynamics on Labor Market Transformation // International Journal of Technology. 2022. T. 13. № 7. C. 1548.
8. Rodionov D. et al. Information Environment Quantifiers as Investment Analysis Basis // Economies. 2022. T. 10. № 10. C. 232.
9. Samoilova L., Rodionov D. Production Function Based on Input–Output and Growth Rate Indicators as a Tool for Assessment of Innovation Climate in Russian Regions // Economies. 2022. T. 10. № 12. C. 297.
10. Rodionov D. et al. Impact of COVID-19 on The Russian Labor Market: Comparative Analysis of the Physical and Informational Spread of the Coronavirus // Economies. 2022. T. 10. № 6.
11. Konnikov E., Rodionov D., Konnikova O., Yuldasheva O. Analyzing Natural Digital Information in the Context of Market Research // Information (Switzerland). 2021. T. 12. № 10.
12. Zaytsev A., Dmitriev N., Rodionov D., Magradze T. Assessment of the Innovative Potential of Alternative Energy in The Context of the Transition to The Circular Economy // International Journal of Technology. 2021. T. 12. № 7. C. 1328-1338.
13. Rodionov D.G., Konnikov E.A., Nasrutdinov M.N. A Transformation of the Approach to Evaluating a Region's Investment Attractiveness as a Consequence of the COVID-19 Pandemic // Economies. 2021. T. 9. № 2.
14. Rodionov D. et al. Modeling Changes in the Enterprise Information Capital in The Digital Economy // Journal of Open Innovation: Technology, Market, and Complexity. 2021. T. 7. № 3.
15. Zaytsev A., Rodionov D., Dmitriev N., Ilchenko S. Assessing Intellectual Capital from the Perspective of its Rental Income Performance // International Journal of Technology. 2020. T. 11. № 8. C. 1489-1498.
16. Rodionov D., Perepechko O., Nadezhina O. Determining Economic Security of a Business Based on Valuation of Intangible Assets According to the International Valuation Standards (IVS) // Risks. 2020. T. 8. № 4. C. 1-14.
17. Rodionov D., Velichenkova D. Relation Between Russian Universities and Regional Innovation Development // Journal of Open Innovation: Technology, Market, and Complexity. 2020. T. 6. № 4. C. 1-26.

3. R&D (Inventions, Patents, etc.)

- Rodionov D.G., Konnikov E.A., Tikhomirov A.F., Lyamin B.M., Kuprov Yu.Yu., Dmitriev N.D. Program for Comparative Assessment of the Degree of Significance of Interest Categories for Consumer Groups Using a Quantification Tool. Certificate of Registration of Computer Program RU 2024664348, June 19, 2024. Application date: June 7, 2024.
- Arteyeva V.S., Schwediani A.E., Rodionov D.G. Program for Collecting and Preprocessing Information about Vacancies Posted on Online Job Search Platforms. Certificate of Registration of Computer Program RU 2023666133, July 26, 2023. Application No. 2023665322, July 24, 2023.
- Arteyeva V.S., Schwediani A.E., Rodionov D.G. Program for Visualizing, Statistical, and Cluster Analysis of Data on Skills and Competencies Required in the Labor Market. Certificate of

Registration of Computer Program RU 2023686198, December 4, 2023. Application date: November 29, 2023.
- Rodionov D.G., Konnikov E.A., Blagoi N.A. Program for Simulation Modeling of Indicators of the State of the Risk Environment of Oil and Gas Industry Enterprises. Certificate of Registration of Computer Program RU 2023689106, December 26, 2023. Application date: December 20, 2023.
- Rodionov D.G., Schwediani A.E., Kudryavtseva T.Yu. Program for Evaluating the Compliance of the Distribution of Regional Cluster and Industry Localization Indicators with Normal, Lognormal, and Uniform Distributions. Certificate of Registration of Computer Program RU 2022684926, December 19, 2022. Application No. 2022684777, December 15, 2022.
- Rodionov D.G., Kudryavtseva T.Yu., Schwediani A.E. POLITEKH-INVEST. Certificate of Registration of Computer Program RU 2021614355, March 23, 2021. Application No. 2021613315, March 17, 2021.
- Rodionov D.G., Kudryavtseva T.Yu., Schwediani A.E. Program for Econometric Analysis and Modeling of Regional Industry Specialization. Certificate of Registration of Computer Program RU 2021686732, December 16, 2021. Application No. 2021686581, December 14, 2021.

5. Experience in Scientific Supervision of Student and Postgraduate Research:

Dmitrii Grigorevich Rodionov has supervised 8 Doctor of Science (DSc) candidates and 25 Candidate of Science (PhD) candidates.

Over the past 5 years, the following dissertations were defended under the supervision of Dmitrii Grigorevich Rodionov:

- Melnichenko, Aleksandra Mikhailovna - DSc in Economics, "Institutional Foundations of Managing the Formation and Development of an Innovative Environment at the Macro, Meso, and Micro Levels", 2020.
- Daniali, Sara Mehrab - PhD in Economics, "Formation of Integrated Organizational-Economic Foundations for Improving Management in the Oil and Gas Complex System of the Islamic Republic of Iran", 2020.
- Velichenkova, Daria Sergeevna - PhD in Economics, "Ensuring the Efficiency of the Regional Innovation System Based on the Integration of Universities' Innovative Activities", 2020.
- Alferyev, Dmitry Alexandrovich - PhD in Economics, "Economic-Mathematical Modeling of Decision-Making in the Innovative Activities of Small Industrial Enterprises", 2020.

6. Teaching Experience (Educational Program and Course Titles):

- Head of the Educational Program 01.04.05_01 "Modeling and Analysis of Big Data in Economics."
- Developer and Instructor of courses, including distance learning courses: "International Finance", "Budget Systems", "Public and Municipal Finance."
- Head of the working group for developing the Master's Program "Digital Economy and Business Analytics" at the Higher School of Industrial Economics (HSIE) of St. Petersburg Polytechnic University. The working group led by Dmitrii Grigorevich Rodionov received international ACCA accreditation for two educational programs: Master of Economics "Accounting, Analysis & Audit in the Management System of Organizations" and Master of Economics "Finance".