

Outstanding issues in ensuring more stable international deliveries of Russian fuel and energy resources to the segments of the world economy available for exports

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Abstract. *Relevance.* The paper discusses the digital ontology-driven approach to the development of a quasi-integrated supersystem. The supersystem includes the energy sector and its supporting elements of the financial and economic system of Russia and a group of friendly countries who are consumers of Russian fuel and energy resources (FER). The approach is employed to develop measures that ensure national and international economic and energy security. International deliveries of Russian fuel and energy resources to the segments of the world economy available for exports can become unstable due to the current crisis in international economic relations. The use of the digital ontology-driven approach is a response to the need to analyze the underlying processes and predict whether such instability can become critical in the future. This is done in conjunction with configuring properly the operation of the Russian infrastructure of production, transport, storage, processing, and deliveries of fuel and energy resources. To that end, they are to be adjusted so as to align with the transformation that the destinations and structure of Russian exports are undergoing. *Problem statement.* We argue for the adoption of the digital ontology-driven approach to the development of a quasi-integrated supersystem. The supersystem includes the energy sector and its supporting elements of the financial and economic system of Russia and a group of friendly countries who are consumers of Russian fuel and energy resources being parties to economic unions and bilateral agreements between the countries. We identify different variants of the impact of effected discriminatory practices and the state of commodity and financial markets. We study this impact as applied to 1) Russian energy companies supplying FERs abroad, 2) consumers of Russian FERs in Russia and abroad, 3) companies transporting FERs abroad and using other countries for transit through them, and 4) manufacturers of equipment for the energy sector. *Purpose of the study.* We aim to identify conceptual approaches clarifying the effect of macroeconomic factors on 1) Russian energy companies

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supplying FERs abroad, 2) consumers of Russian FERs in Russia and abroad, 3) companies transporting FERs abroad and using other countries for transit through them, and 4) manufacturers of equipment for the energy sector. To achieve this, we rely on agent-based methods and models for monitoring, assessment, and interpretation of peak price fluctuations in fuel and energy markets worldwide, which assumes configuring the operation of the Russian infrastructure for production, transport, storage, processing, and deliveries of FERs accordingly. *Results and key conclusions.* We have made a case for the expediency of development and implementation of digital systems for agent-based analysis, modeling, and forecasting relying on supercomputing. They facilitate the adoption of the "active knowledge" paradigm and data processing simulation services for monitoring, assessment, and interpretation of peak price fluctuations in fuel and energy markets worldwide. This aims to improve the stability of international deliveries of Russian fuel and energy resources taking into account price fluctuations in fuel and energy markets worldwide.

1 Introduction

Digital technology enables implementation of novel approaches to analyzing, modeling, and forecasting the world economic state of various components of the quasi-integrated supersystem. The supersystem includes the energy sector and its supporting elements of the financial and economic system of Russia and a group of friendly countries who are consumers of Russian fuel and energy resources (FER) and are parties to economic unions and bilateral agreements between countries [1, 2]. At the same time, it is possible to counteract the influence of natural market trends and deliberate threats. By such threats we understand those related to possible instability of international deliveries of Russian fuel and energy resources to the segments of the world economy available for exports, which is a consequence of the current crisis in international economic relations. This is done in conjunction with configuring properly the operation of the Russian infrastructure of production, transport, storage, processing, and deliveries of fuel and energy resources. To that end, they are adjusted so to align with the transformation that the destinations and structure of Russian exports are undergoing.

The inefficiency of the conventional methods of analysis, modeling, and forecasting of price fluctuations in fuel and energy markets worldwide is a key issue to be addressed in countering the risks and threats of instability of international supplies of Russian fuel and energy resources to the segments of the world economy available for exports. The risks are associated with the effect of discriminatory practices during periods of crisis in international economic relations. We propose to use supercomputing to adopt the active knowledge paradigm and data processing simulation services. This aims at monitoring, assessment, and interpretation of peak price fluctuations in fuel and energy markets worldwide in conjunction with configuring properly the operation of the Russian infrastructure of production, transport, storage, processing, and deliveries of fuel and energy resources.

2 Research methodology

The article studies the current crisis in international economic relations as a threat of price fluctuations in fuel and energy markets worldwide. We also argue for the feasibility of adopting the digital ontology-driven approach to the development of a quasi-integrated supersystem. Such a system would include the energy sector and its supporting elements of the financial and economic system of Russia and a group of friendly countries who are

consumers of Russian fuel and energy resources (China, India, etc.). We argue for further improvement of methods of analysis and forecasting of instability of international deliveries of Russian fuel and energy resources to the segments of the world economy available for exports. This includes the study of responses to different information signals backed by the "active knowledge" paradigm and data processing simulation services. We outline the approaches to the analysis of various options for combining metrics of price fluctuations in fuel and energy markets worldwide to maintain national and international energy security.

3 The use of the digital ontology-driven approach to analyze and forecast the instability of international deliveries of Russian fuel and energy resources to the segments of the world economy available for exports

Agent-based modeling proves an effective technology for analyzing the threats of instability of international deliveries of Russian fuel and energy resources to the segments of the world economy available for exports [3-4]. Against the backdrop of the current crisis in international economic relations, the task of mitigating the risks of fuel supply systems becomes paramount. This applies to the systems that rely on the Russian infrastructure of production, transportation, storage, processing, and deliveries of fuel and energy resources abroad [5].

Agent-based technologies allow conducting digital experiments based on the use of digital ontology-driven approach to the development of a quasi-integrated supersystem. The supersystem includes the energy sector and its supporting elements of the financial and economic system of Russia and a group of friendly countries who are consumers of Russian fuel and energy resources and are parties to the EAEU, SCO, BRICS, and bilateral agreements between countries [6]. To that end, it is necessary to monitor the effect of political and economic sanctions on 1) Russian energy companies supplying FERs abroad, 2) consumers of Russian FERs in Russia and abroad, 3) companies transporting FERs abroad and using other countries for transit through them, 4) manufacturers of equipment for the energy sector [as distributed agents involved in fuel and energy exports].

The use of the digital ontology-driven approach allows developing a library of scenarios of managerial actions in various situations, thus making it possible to neutralize a lot of manifestations of the effect of the array of political and economic sanctions imposed on 1) Russian energy companies supplying FERs abroad, 2) consumers of Russian FERs in Russia and abroad, 3) companies transporting FERs abroad and using other countries for transit through them, and 4) manufacturers of equipment for the energy sector [as distributed agents involved in fuel and energy exports].. The library of scenarios allows one to implement dynamically the decision-making support with respect to various managerial actions of distributed agents involved in fuel and energy exports so as to improve the stability of fuel and energy deliveries subject to influences induced by natural market trends and deliberate discriminatory practices.

Descriptions of information signals from fuel and energy markets worldwide available for analysis are mapped to detected and identifiable responses of companies (agents) that are part of the energy sector and its supporting elements of the financial and economic system of Russia and a group of friendly countries who are consumers of Russian fuel and energy resources. That is to say, the means of monitoring and analysis of information signals from fuel and energy markets worldwide, which are telling of the amplitudes of macro- and microeconomic fluctuations, can be used to identify the explicit and latent effects of instability of international deliveries of Russian fuel and energy resources to the segments of

the world economy available for exports. This also includes the determination of measures to ensure national and international economic and energy security.

The detected organizational and system links between the identifiable parameters of the responses of companies (agents) that operate as part of the energy sector and its supporting elements of the financial and economic system of Russia and a group of friendly countries who are consumers of Russian fuel and energy resources, allow us to calculate the consequences induced by a set of political and economic sanctions imposed on 1) Russian energy companies supplying FERs abroad, 2) consumers of Russian FERs in Russia and abroad, 3) companies transporting FERs abroad and using other countries for transit through them, and 4) manufacturers of equipment for the energy sector [as distributed agents involved in FER exports] We propose to compare the calculated parameters of the standing of 1) Russian energy companies supplying FER abroad, 2) consumers of Russian FERs in Russia and abroad, 3) companies transporting FERs abroad and using other countries for transit through them, and 4) manufacturers of equipment for the energy sector against the parameters of fluctuations in the global fuel and energy markets.

4 Operation of the proposed system

The breakdown of different types of identifiable responses of 1) Russian energy companies supplying FERs abroad, 2) consumers of Russian FERs in Russia and abroad, 3) companies transporting FERs abroad and using other countries for transit through them, and 4) manufacturers of equipment for the energy sector [as distributed agents involved in FER exports] into different categories of price fluctuations in fuel and energy markets worldwide contains the information necessary for clarifying the parameters of the standing of companies (agents).

Next, we calculate the parameters of the standing of 1) Russian energy companies supplying FER abroad, 2) consumers of Russian FERs in Russia and abroad, 3) companies transporting FERs abroad and using other countries for transit through them, and 4) manufacturers of equipment for the energy sector. They are treated as arrays of data for equivalent models and get broken down into types to develop a library of scenarios of managerial actions in various situations. This allows mitigating a number of manifestations of the effect of the array of political and economic sanctions.

Identifiable fluctuations in fuel and energy markets worldwide are presented by their descriptions in conjunction with the manifestations of the current crisis of international economic relations [7]. 1) Energy companies supplying FERs abroad, 2) consumers of Russian FERs in Russia and abroad, 3) companies transporting FERs, and 4) manufacturers of equipment for the energy sector [as distributed agents involved in FER exports] respond to different types of price fluctuations in fuel and energy markets worldwide. Descriptions of different types of such responses that are identifiable can be grouped into information units with the determination of modalities forming instabilities of international deliveries of Russian FERs to the segments of the global economy available for exports.

The accumulated pool of information units on responses of 1) energy companies supplying FERs abroad, 2) consumers of Russian FERs in Russia and abroad, 3) companies transporting FERs, and 4) manufacturers of equipment for the energy sector to different categories of price fluctuations in the global fuel and energy markets constitute the basic pool of metadata.

These metadata are fed to an array of digital technologies of the agent-based analysis, modeling and forecasting system to map signals of peak price fluctuations in fuel and energy markets worldwide to a library of scenarios of managerial actions in various situations. This results in selecting appropriate solutions for various managerial actions of distributed agents

involved in fuel and energy exports, which aims at improving the stability of deliveries of fuel and energy resources.

Distributed agents perform various managerial actions related to FER exports. The choice of appropriate decisions made with respect to such actions serves as the basis for assessment of the structural and functional variability of the behavior of the quasi-integrated supersystem. The system includes the fuel and energy sector and its supporting elements of the financial and economic system of Russia and a group of friendly countries who are consumers of Russian FERs (China, India, etc.). This yields a projection of Russian FER deliveries to segments of the world economy available for exports [9-11].

5 Development of digital systems for analysis, modeling and forecasting of metrics affecting the deliveries of Russian fuel and energy resources to the segments of the world economy available for exports

To maintain national and international economic and energy security, it is necessary to develop digital systems of analysis, modeling, and forecasting of metrics affecting the deliveries of Russian fuel and energy resources to the segments of the world economy available for exports. This requires addressing the following key tasks:

- to develop a digital platform for processing complex structured data coming from monitoring systems of the energy sector and its supporting elements of the financial and economic system of Russia and a group of its friendly countries who are consumers of Russian fuel and energy resources;

- to form a toolkit of automated services of agent-based analysis, modeling, and forecasting of price fluctuations in fuel and energy markets worldwide that relies on supercomputing

- to develop a subsystem of validation and wrangling of the data coming from data processing services for monitoring, assessing, and interpreting peak price fluctuations in fuel and energy markets worldwide;

- to introduce supercomputing for the purpose of adopting the active knowledge paradigm and data processing simulation services so as to implement methods and models of agent-based analysis, modeling, and forecasting of price fluctuations in fuel and energy markets worldwide;

- to adapt data processing services to the needs of the subsystem of decision-making support for various managerial actions of distributed agents involved in fuel and energy exports so as to improve the stability of fuel and energy deliveries.

The digital platform being developed should include a software package that allows one to formulate guidelines on-the-fly for 1) energy companies supplying FERs, 2) consumers of Russian FERs in Russia and abroad, 3) companies transporting FERs, and 4) manufacturers of equipment for the energy sector [as distributed agents involved in FER exports] in order to ensure national and international economic and energy security [12].

6 Conclusion

The proposed technology enhances our understanding of the directions to be pursued in the development of analysis, modeling, and forecasting tools targeting the metrics affecting the deliveries of Russian fuel and energy resources to the segments of the world economy available for exports [13-15]. We argue for the necessity of development and adoption of digital systems for agent-based analysis, modeling, and forecasting based on supercomputing. This would facilitate the adoption of the "active knowledge" paradigm and

data processing simulation services for monitoring, assessment, and interpretation of peak price fluctuations in fuel and energy markets worldwide. Furthermore, this would prove instrumental in configuring the operation of the Russian infrastructure of production, transport, storage, processing, and deliveries of fuel and energy resources.

References

1. A.S. Bugaev, E.L. Loginov, A.N. Raikov, V.N. Saraev, The semantics of network contacts, *Scientific and Technical Information Processing*. 2009. Vol. 36. No. 1. P. 68-72.
2. S.I. Bortalevich, V.U. Chinaliev, E.L. Loginov, A.I. Soldatov, Strategic planning of integrated development in the field of science and technology of the enterprises of the machine-building production, *Journal of Physics: Conference Series*. 2019. P. 12041.
3. E.L. Loginov, V.V. Grigoriev, P.A. Bojko, V.S. Balandin, G.S. Ivanovskij, Convergent use of neural network information technologies for monitoring and evaluating the performance of digital control operators of situational centers at critical infrastructure facilities, *IOP Conference Series: Materials Science and Engineering*. 3. Series "III International Scientific and Practical Conference on Innovations in Engineering and Technology" 2020. P. 012044.
4. A. Ageev, S. Bortalevich, E. Loginov, D. Sorokin, A. Shkuta, There is need in new generation smart grid for the space and ground energy systems, *MATEC Web of Conferences*. 2018. P. 01001.
5. E.P. Grabchak, E.L. Loginov, V.V. Grigoriev, Ensuring observability and controllability of complex technical systems in difficult and irregular situations when commands with a large distortion component are received, *Lecture Notes in Electrical Engineering*. 2021. Vol. 729 LNEE. P. 624-631.
6. V.Y. Afanasiev, E.P. Grabchak, E.L. Loginov, S.V. Mischeryakov, Digital transformation of TPP control systems: transition to an intelligent equipment life cycle management model, *Socio-economic Systems: Paradigms for the Future*. Springer International Publishing, 2021. P. 1765-1772.
7. E.L. Loginov, A.N. Raikov, Network information attacks on the control systems of power facilities belonging to the critical infrastructure, *Thermal Engineering*. 2015. Vol. 62. No. 4. P. 233-239.
8. A. Bugaev, E. Grabchak, V. Grigoriev, E. Loginov, Ensuring the security of cyber-physical systems in the energy sector in the context of the expansion of digital management services, *CEUR Workshop Proceedings*. Proceedings of the II International Scientific and Practical Conference "Information Technologies and Intelligent Decision Making Systems" (ITIDMS-II-2021). Aachen, Germany, 2021. P. 164-173.
9. E.L. Loginov, V.V. Grigoriev, V.S. Balandin, A.A. Shkuta, P.A. Boyko, The use of electronic semantization of the cognitive activity manifestations with the aim of detection of intentions of the group of people leading to the destabilization of the digital super system, *IOP Conference Series: Materials Science and Engineering*. 1. Series "1st International Conference on Innovative Informational and Engineering Technologies, IIET 2020" 2020. P. 012002.
10. E.P. Grabchak, S.I. Bortalevich, E.L. Loginov, A.I. Soldatov, Controlling the operation of the intelligent generator and energy translator integrated from space and planetary objects as the elements of a power plants in space (in orbit), *Journal of Physics: Conference Series*. 2019. P. 12040.

11. A.R. Bahtizin, V.Y. Bortalevich, E.L. Loginov, A.I. Soldatov, Using artificial intelligence to optimize intermodal networking of organizational agents within the digital economy, *Journal of Physics: Conference Series*. 2019. P. 12042.
12. E.L. Loginov, V.V. Grigoriev, A.A. Shkuta, V.Y. Bortalevich, D.D. Sorokin, Intelligent monitoring, modelling and regulation information traffic to specify the trajectories of the behaviour of organizational agents in the context of receipt of difficult-interpreted information, *IOP Conference Series: Materials Science and Engineering*. 2019. P. 012015.
13. E.L. Loginov, V.V. Grigoriev, A.A. Shkuta, D.D. Sorokin, V.Y. Bortalevich, The use of artificial intelligence's elements to block the manifestations of individuals' behavioral activity going beyond the quasi-stable states, *IOP Conference Series: Materials Science and Engineering*. 2019. P. 012028.
14. E.L. Loginov, A.N. Raikov, Optimization of the introduction of end-to-end technologies to the energy critical infrastructure on the basis of cognitive simulation, Proceedings of 2018 11th International Conference "Management of Large-Scale System Development", MLSD 2018. 2018. P. 8551883.
15. A. Bakhtizin, E. Loginov, A. Shkuta, V. Abramov, Counter-strategy to emergencies in the coal mining industry based on the use of multi-agent systems and fuzzy logic, *E3S Web of Conferences*. 3rd International Innovative Mining Symposium, IIMS 2018: Electronic edition. 2018. P. 010092.