DOI: https://doi.org/10.30525/2256-0742/2024-10-1-39-43

ANALYSIS OF MODERN TRENDS AND OPPORTUNITIES IN THE LOGISTICS CHANNELS OF ENERGY PRODUCTS PRODUCERS

Olexander Generalov[1]

Abstract. The *purpose* of the article is to highlight the crucial role of logistics in ensuring efficient, sustainable and reliable energy distribution, especially in the face of challenges posed by global events such as Russia's invasion of Ukraine and the ongoing energy crisis. The dynamics of logistics channels in the energy sector are undergoing significant transformation due to technological innovations, geopolitical developments, environmental considerations and changes in energy sources. This study examines the current trends and opportunities in the logistics channels of energy producers, with a particular focus on how these elements are affecting the logistics landscape of the energy market. *Methodology*. The methodological approach combines a comprehensive review of current literature, analysis of industry reports and case studies to assess the evolution of logistics practices in the energy sector. According to the study, the logistics framework of the energy sector is changing as a result of a strong push for sustainability and technological advancement, which is driving the need for creative logistics solutions. Efforts to promote environmental sustainability are driving green logistics, and digitalisation is increasing operational efficiency across the supply chain. *Results*. The article emphasises the importance of sustainable and diversified clean energy supply chains, and stresses the need for strategic international cooperation to overcome the complexities of the current global energy landscape. The *practical implications* of this study suggest that stakeholders in the energy sector, including policy makers, businesses and researchers, need to adapt to these new trends to promote a more sustainable, efficient and responsive logistics infrastructure. The *value/originality* of this research lies in the comprehensive analysis of the factors driving changes in energy product logistics, offering insights into the strategic directions for the development of sustainable energy supply chains in the face of ever-changing global challenges.

Keywords: energy logistics, sustainable energy, green logistics, digitalisation, energy crisis, renewable energy sources, supply chain sustainability.

JEL Classification: Q40, Q42, L92

1. Introduction

The global economy is deeply intertwined with the energy sector, a critical driver of industrial and commercial activity worldwide. The role of logistics in the energy products market is diverse and critical to ensuring the efficient and reliable delivery of energy resources from producers to consumers. Logistics encompasses all activities involved in the procurement, transportation and storage of energy products, including fossil fuels such as oil and gas, as well as renewable energy sources such as solar panels and wind turbine components. However, due to technological advances, political decisions, global conflicts, environmental issues and changes in energy sources, the logistics environment is changing rapidly.

Russia's invasion of Ukraine and instability in the Middle East have further disrupted supply chains and caused price volatility in fuel and energy markets. This once again highlights the fragility of the fossil fuel era and the urgency of transitioning to more sustainable energy systems to enhance countries' energy security and reduce their carbon footprint.

The global energy logistics landscape is undergoing significant change, driven by a push towards sustainability and technological innovation. The introduction of low-carbon technologies and environmental regulations is influencing energy efficiency and shaping the logistics of renewable energy sources. These advances point to a transfor-

[1] State University of Trade and Economics, Ukraine *(corresponding author)*
E-mail: generalov.aleksander@gmail.com
ORCID: https://orcid.org/0000-0002-9191-7871
ResearcherID: L-9359-2016

mative period for energy logistics, highlighting the need for innovative solutions to meet the sector's evolving needs (Junwei, 2022).

Technological progress, especially in low-carbon technologies, has been identified as a critical factor in improving energy efficiency and achieving emission reduction targets. However, the relationship between technological progress and energy consumption remains controversial, highlighting the need for further research into the impact of environmental regulations and technology on energy logistics (Ya, Zhanguo, 2022).

The primary objective of this article is to analyse and explain the critical role that logistics plays in the energy products market, highlighting how efficient logistics operations can improve the distribution, accessibility and sustainability of energy resources. The article aims to provide a comprehensive insight into the challenges, opportunities and technological advances shaping the logistics of energy products, from traditional fossil fuels to emerging renewable energy sources.

2. Modern Trends in the Logistics of Energy Products

Current trends in the energy sector to 2023 highlight several key shifts driven by current global challenges and a concerted drive towards decarbonisation and renewable energy. The three main trends shaping the energy sector, including logistics aspects, are as follows:

Continued impact of the energy crisis. The ongoing global energy crisis, exacerbated by geopolitical tensions and the COVID-19 pandemic, is having a serious impact on vulnerable populations, highlighting the interconnectedness between energy, food security and economic stability. According to the World Bank's Global Economic Prospects report, Russia's invasion of Ukraine has significantly slowed global economic growth and increased inflation, exacerbating the difficulties faced by low- and middle-income countries due to already high energy and food prices (Roy, 2022). This situation underscores the urgent need for developed countries to help those facing the economic crisis caused by rising energy prices and interest rates.

The crisis has highlighted the importance of accelerating the transition to sustainable energy sources to ensure accessibility and affordability for all, especially vulnerable communities at the nexus of food, energy and poverty. The war in Ukraine has not only been a humanitarian disaster, but also a turning point for the global energy sector, reshaping trade patterns and accelerating the growth of renewable energy as an alternative to fossil fuels (International Energy Agency, 2023).

In addition, the impact of war on food security cannot be overstated, as Ukraine, a major exporter of wheat, corn and oilseeds, faces the risk of war-related supply disruptions, which impacts global food supplies and underscores the need for effective policies to ensure food security in conflict. The interconnected issues of conflict, climate change and energy prices are complicating efforts to ensure food security, requiring a comprehensive approach to mitigating these crises (Leal Filho, 2023).

Ensuring global food and energy security requires coordinated international action, emphasising the need for sustainable solutions to address the root causes of these crises and prevent their recurrence in the future.

Environmental sustainability and green logistics. As environmental sustainability becomes a global priority, the logistics industry is undergoing a green transformation. Energy producers are increasingly adopting green practices, such as using alternative fuels for transport and optimising route planning to minimise carbon emissions. These changes not only contribute to global sustainability goals, but also meet consumer preferences for environmentally friendly products.

Despite dependence on fossil fuels, there's a clear movement towards decarbonised economies. The global energy crisis has catalysed the momentum behind renewable energy sources, with forecasts pointing to a significant increase in renewable power capacity over the next five years. This shift is expected to position renewables ahead of coal as the largest source of electricity generation globally by early 2025 (McKinsey & Company, 2023). However, challenges remain, including dependence on fossil fuels during extreme weather events and potentially weakening investment in renewable energy.

The global shift to renewable energy sources such as wind, solar and bioenergy is creating unique challenges and opportunities for logistics. Unlike traditional fossil fuels, renewable energy sources often require different transportation and storage solutions, which is driving the development of innovative logistics models. This transition is also driving the diversification of energy supply chains, making them more complex but also potentially more resilient to geopolitical and market fluctuations.

The global energy landscape is at a turning point: the energy crisis has become a catalyst for the accelerated growth of renewable energy. This shift offers an opportunity to reduce dependence on fossil fuels, improve energy security and move towards a more sustainable and resilient energy system (International Energy Agency, 2022).

Digitalisation and its impact on logistics. The advent of digital technology has revolutionised the logistics sector, offering unprecedented opportunities

for optimisation and efficiency. Digital platforms facilitate real-time tracking, predictive analytics for demand forecasting, and automated inventory management, significantly reducing operating costs and increasing supply chain transparency. In addition, digitalisation enables the integration of different logistics channels, creating a more sustainable and flexible distribution network.

Digitalisation is significantly transforming the logistics sector in various industries, including energy, through the use of advanced technologies such as artificial intelligence (AI), the Internet of Things (IoT) and blockchain. These innovations increase the efficiency, transparency and reliability of logistics operations.

The IoT market, which was valued at 544.38 billion USD in 2022, is projected to grow significantly to reach 3,352.97 billion USD by 2030, at a CAGR of 26.1%. This growth reflects the increasing role of the IoT in various sectors, including energy, where it enables real-time tracking of cargo and assets, thereby improving operational efficiency and decision-making (Fortune Business Insights, 2022). North America, which is currently leading the way in IoT adoption, is expected to overtake Europe in the near future, with the healthcare, industrial and automotive sectors experiencing significant growth from IoT adoption.

The integration of AI, IoT and blockchain technologies is creating a more connected, intelligent and efficient energy logistics network. This network is capable of supporting the complex needs of modern energy systems by improving efficiency, ensuring transparency, and enhancing supply chain resilience. The ongoing digital transformation of the logistics sector, driven by these advanced technologies, promises to redefine the operational capabilities of the energy sector, making it more adaptable to the demands of the 21st century.

3. Potential Energy Development Options

According to the World Energy Outlook 2023 of the International Energy Agency (IEA), the scenarios are divided into three groups to determine the directions of energy policy, which provides an in-depth analysis of potential energy development options (International Energy Agency, 2023):

– **"STEPS" / Stated Policies Scenario.** Based on existing policies and projections for the energy sector on the basis of current energy, climate and industrial policies.

– **"APS" / Announced Pledges Scenario.** Takes into account all national energy and climate targets announced by governments, provided they are fully and timely implemented.

– **"NZE" / Net Zero Emissions by 2050 Scenario.** The goal is to limit global warming to 1.5°C, which requires much greater progress and radical changes in the energy system and the way society lives.

Each scenario helps to identify potential pathways and allows to explore uncertainties, such as possible structural changes in the Chinese economy or the pace of solar adoption, which could affect future energy trends.

According to the IEA study, the decline in supply due to production cuts by OPEC+ countries, including Russia, in 2023 was primarily offset by production growth in other countries.

In the STEPS forecast, oil prices remain stable at around 83 USD per barrel, while in the APS scenario they gradually decline to 60 USD per barrel by 2050. In the NZE scenario, the price gradually declines to the level of the marginal cost of oil production, falling to 42 USD per barrel by 2030 and further declining by 2050.

According to the STEPS scenario, oil demand will peak at 101.5 million barrels per day in 2030, and then decline slightly to 97.4 million barrels per day by 2050 (Table 1).

The APS scenario shows a much more pronounced drop in demand – to 92.5 million barrels per day by 2030 and 54.8 million barrels per day by 2050. Demand for oil in vehicles is declining more sharply, with electric vehicles accounting for more than 75% of car and truck sales by 2050. Only petrochemicals and aviation will use more oil in 2050 than in 2022. The use of oil in maritime transport is reduced by 55% between 2022 and 2050, and half of the fuel used in ships by 2050 is low-emission fuel. Under the NZE scenario, oil demand falls to 77.5 million barrels per day by 2030 and 24.3 million barrels per day by 2050: about 70% of this demand is from the use of oil as a feedstock for petrochemicals and products such as paraffin, asphalt and bitumen, where oil is not burned.

4. Ensuring Diverse and Resilient Clean Energy Supply Chains

Since 2015, the development of supply chains in the clean energy sector has shown significant progress. In particular, significant progress has been made in the manufacturing sector, especially in the production of solar panels and batteries, where newly established businesses are benefiting from standardisation protocols and shorter production times. The increase in the number of production projects announced indicates that the market is expanding rapidly. If all announced solar PV projects are implemented, their cumulative global production, together with improved utilisation of existing capacity, is expected to exceed the deployment

Table 1
Global oil supply and demand under different scenarios, million barrels per day

	2010	2022	STEPS		APS		NZE	
			2030	2050	2030	2050	2030	2050
Road Transport	36,5	41,3	41,1	35,5	37,6	15,9	29,1	1,6
Aviation and Shipping	9,9	10,6	13,5	17,2	12,5	9	10,5	2,1
Industry	17,2	20,6	23,3	25,5	21,4	17,8	20,3	14,3
Buildings and Energy	12,4	11,4	9,5	6,7	8,6	4,1	6,1	0,5
Other Sectors	11,1	12,6	14	12,5	12,4	7,9	11,4	5,7
Global Oil Demand	**87,1**	**96,5**	**101,5**	**97,4**	**92,5**	**54,8**	**77,5**	**24,3**
Liquid Biofuels	1,2	2,2	3	4,5	4,8	7	5,6	5,4
Low-emission Hydrogen Fuels	-	-	0	0,2	0,2	3,6	0,7	6
Global Demand for Liquid Fuels	**88,4**	**98,7**	**104,5**	**102,1**	**97,5**	**65,4**	**83,7**	**35,7**
Conventional Crude Oil	67,4	62,8	61,3	58,2	54,9	29,8	48	15,8
Tight Oil	0,7	8,3	11,1	10,2	10,3	6,9	7,6	1,8
Liquid Natural Gases	12,7	19	21,2	19,4	20,1	13,6	16,2	4,4
Extra-heavy Oil and Bitumen	2	3,7	4,4	5,5	3,9	2,5	3	1,5
Other Production	0,5	0,9	1	1,2	0,9	0,3	0,3	0
Global Oil Production	**83,1**	**94,8**	**99,1**	**94,5**	**90,2**	**53,1**	**75,1**	**23,5**
OPEC Share	40%	36%	35%	43%	35%	45%	37%	53%
Global Oil Refining	2,2	2,3	2,4	2,9	2,4	1,6	2,3	0,7
Global Oil Supply	**85,3**	**97,1**	**101,5**	**97,4**	**92,5**	**54,8**	**77,5**	**24,3**
IEA Crude Oil Price (USD 2022/barrel)	103	98	85	83	74	60	42	25

Source: compiled by the author based on data from (International Energy Agency, 2023)

requirements set out in the International Energy Agency's 2030 Zero Emissions (NZE) scenario (International Energy Agency, 2023). Similarly, the expected demand for electric vehicles (EVs) and grid storage batteries by 2030 will be almost met under the same circumstances.

However, the expected rate of growth in the availability of critical mineral resources does not match that of the expansion of manufacturing capacity for clean energy technologies, despite the increasing number of project announcements in this area. The speed of the overall transition is typically determined by the slowest moving component, underlining the importance of intensifying efforts to strengthen investment in critical mineral supplies.

Several key actions are needed to ensure the sustainability and diversity of clean energy supply chains (International Energy Agency, 2024):

Accelerate the diversification of mineral supplies. Reducing the high concentration of supply requires initiating new projects in different geographical regions. This can be achieved by promoting cross-investment between producing and consuming countries, enhancing cooperation through multilateral initiatives, and introducing financial instruments to reduce investment risks.

Support for the diversity of midstream refining processes. There is an urgent need to pay attention to promoting diversity in the refining and downstream sectors.

Leverage Technology and Recycling. Maximising the potential of technology and processing is essential to reducing supply tensions. This involves expanding research, development and deployment efforts to reduce the amount of critical minerals required for product manufacturing, as well as minimising energy and water consumption in mining and processing. Particular attention should be paid to reliable tracking and control of materials, as well as exploring methods to increase recyclability, reuse of mineral raw materials and end-of-life practices.

Promote Market Transparency. Addressing the limited price transparency in key mineral markets is crucial to mitigate volatility and encourage new investment. Transparent markets and enabling environments need to be developed, and due diligence and traceability practices need to be strengthened.

Incentivize Sustainable and Responsible Production. Stakeholders should commit to implementing sustainable and responsible practices to reduce environmental, social and governance (ESG) risks.

Foster International Collaboration. More joint efforts are needed, especially in the areas of data exchange, security of supply, downstream competitiveness, sustainable practices and long-term strategic planning.

Addressing the challenges facing both clean energy technologies and critical minerals will require a comprehensive and decisive strategy that combines investment initiatives, innovation efforts, recycling practices and rigorous sustainability standards to strengthen more resilient and diversified clean energy supply chains. Enhanced international cooperation will be indispensable in this effort.

5. Conclusions

Thus, the critical importance of logistics in the energy sector, especially in a changing technological, geopolitical and environmental landscape, underscores the need for sustainable and diversified clean energy supply chains. This imperative has been underscored in response to shocks such as the Russia-Ukraine conflict and the ongoing global energy crisis.

Current trends in energy product logistics reflect a marked shift towards environmental sustainability, as evidenced by the increasing use of renewable energy sources and the integration of digital technologies into logistics operations. These trends demonstrate a concerted effort to combat climate change and improve energy security through innovative approaches to supply chain management.

Proactive measures are needed to ensure the resilience and diversity of clean energy supply chains. These include accelerating the diversification of mineral supplies, enhancing the diversification of refining and downstream, technology and recycling, promoting market transparency, improving data availability, incentivising sustainable production practices and facilitating international cooperation.

In essence, addressing the challenges facing clean energy technologies and critical minerals requires an integrated and collaborative approach. By integrating investment, innovation, recycling practices and rigorous sustainability standards, stakeholders can create sustainable and diversified clean energy supply chains that can navigate the intricacies of today's energy landscape.

References:

Fortune Business Insights (n.d.). Market Research report. Internet of Things. Available at: https://www.fortunebusinessinsights.com/industry-reports/internet-of-things-iot-market-100307

International Energy Agency (2022). Renewables 2022. Analysis and forecast to 2027. Available at: https://iea.blob.core.windows.net/assets/ada7af90-e280-46c4-a577-df2e4fb44254/Renewables2022.pdf

International Energy Agency (2023). World Energy Outlook 2023. Available at: https://www.iea.org/reports/world-energy-outlook-2023

International Energy Agency. Overcoming the Energy Trilemma: Secure and Inclusive Transitions. Available at: https://iea.blob.core.windows.net/assets/29875a66-aebe-49aa-a2b1-d0824db302c2/OvercomingtheEnergyTrilemma_SecureandInclusiveTransitions.pdf

International Energy Agency. Russia's War on Ukraine. Available at: https://www.iea.org/topics/russias-war-on-ukraine

Leal Filho, W., Fedoruk, M., Pires Eustachio, J. H. P., Barbir, J., Lisovska, T., Lingos, A., & Baars, C. (2022). How the War in Ukraine Affects Food Security. Foods, 12(21). Available at: https://www.mdpi.com/2304-8158/12/21/3996

Li, Y., & Wei, Z. (2022). Regional Logistics Demand Prediction: A Long Short-Term Memory Network Method. *Sustainability*, 14(20). Available at: https://www.mdpi.com/2071-1050/14/20/13478

McKinsey & Company. Decarbonizing the world's industries: A net-zero guide for nine key sectors. Available at: https://www.mckinsey.com/capabilities/sustainability/our-insights/decarbonizing-the-world-industries-a-net-zero-guide-for-nine-key-sectors

Roy, N. (2022). Stagflation Risk Rises Amid Sharp Slowdown in Growth. World Bank. Available at: https://www.worldbank.org/en/news/press-release/2022/06/07/stagflation-risk-rises-amid-sharp-slowdown-in-growth-energy-markets

Shi, Y., & Junwei, Y. (2022). Environmental regulation low-carbon technology progress and energy efficiency. Frontiers in Environmental Science, 10. Available at: https://www.frontiersin.org/articles/10.3389/fenvs.2022.1012229/full

World Bank (2022). Stagflation Risk Rises Amid Sharp Slowdown in Growth. Available at: https://www.worldbank.org/en/news/press-release/2022/06/07/stagflation-risk-rises-amid-sharp-slowdown-in-growth-energy-markets'

Received on: 02th of February, 2024
Accepted on: 18th of March, 2024
Published on: 05th of April, 2024