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Issue Article

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DIVERSIFICATION OF ENERGY AND RAW MATERIAL SOURCES AS A TOOL FOR ENHANCING THE ENERGY INDEPENDENCE OF THE USA

Abstract: *This article reviews diversification of the sources of energy and raw materials as a strategic way of rising the energy independence of the USA. It examines the connection between the expansion of the use of renewable energy resources, the localization of the production of critical resources, and the development of national security. Economic, political, and environmental considerations are discussed, including reducing exposure to external shocks and making growth sustainable. Special attention is being paid to federal and regional support policies, including draft laws such as the Inflation Reduction Act, and programs for the development of rare earth and other strategic minerals.*

Key words: *energy independence, renewable energy sources, critical resources, economic resilience, USA.*

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Introduction

Against the backdrop of emerging geopolitical tensions, economic competition, and climatic challenges, the issue of energy independence (EI) is taking its growing position on the USA agenda. The dependence of the economy on the import of energy carriers and critical raw materials exposes it to external risks in the form of price volatility on the international market, disruption of supply, and foreign sanctions.

In response to these challenges, the country has stepped up a comprehensive strategy to diversify energy sources and localize production of critical materials. At its core lies the accelerated development of renewable energy sources (RES), support for storage technologies, and the stimulation of rare earth element processing and extraction. The adoption of legislation aimed at increasing domestic production reflects the country's intention not only to reduce external dependence, but also to strengthen the domestic economy, create new jobs, and achieve ambitious climate goals. The aim of this article is to analyze the role of the diversification of energy and raw material sources as tools for strengthening EI.

Main part. Theoretical foundations of EI

The ability of a state to meet its internal energy needs without critical dependence on external sources of supply is referred to as EI. It is a complex and multidimensional concept situated at the intersection of economics, politics, and ecology (table 1).

Table 1. Functional aspects of EI [1, 2].

The context	Goal	Risks in the absence of	Effects of achievement
Economic	Reducing dependence on external energy supplies and increasing the sustainability of the economy.	High volatility of energy prices, inflation risks, instability of macroeconomics.	Stable prices, predictability of economic policy, strengthening of industry.
Political	Ensuring the sovereignty of foreign policy and protection from political pressure.	Vulnerability to energy blackmail, limited political maneuver.	Increasing geopolitical autonomy and the ability to defend national interests.
Ecological	Reducing emissions and moving towards sustainable energy as part of climate commitments.	Rising emissions, environmental sanctions, environmental degradation.	Environmental sustainability, carbon footprint reduction, compliance with international environmental standards.

Thus, EI is not a permanent state, but a complex and progressive process of interaction of economic, political and environmental factors. In the context of USA, its reinforcement is an integral part of long-term national strategy for providing sustainable development and maintaining global competitiveness. The practical implementation is carried out through a set of interconnected directions, each of which plays an important role in shaping an autonomous and adaptive energy architecture (fig. 1).

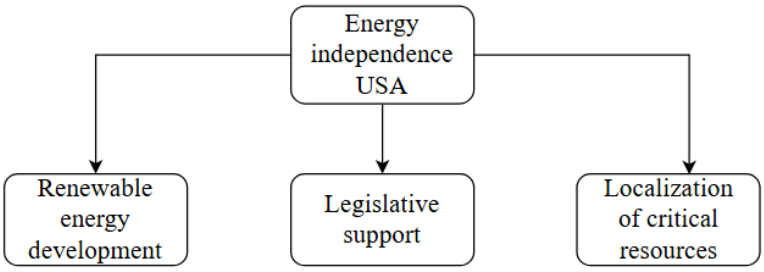

Figure 1. Mechanisms for achieving EI.

These directions reinforce one another, forming a stable foundation for an energy system capable of withstanding external challenges and internal imbalances. Their integrated application ensures a holistic approach to achieving EI under conditions of global transformation.

Strategies USA for the development of RES

The implementation of measures to strengthen global environmental requirements and the shift away from fossil fuels is leading to increased demand for RES. In 2023, the volume of its global market was estimated at 1,14 trillion USA dollars, and by 2033, it is projected to reach 5,62 trillion USA dollars. The average annual growth rate is expected to be 17,3% for the period from 2024 to 2033 (fig. 2).

Figure 2. Global RES market volume, trillion USA dollars [3].

These trends emphasize the necessity of active USA participation in the transformation of the energy sector not only for domestic supply, but also to maintain its position as a technological and economic leader in the international system. Significant acceleration in this direction has been ensured by the adoption of the Inflation Reduction Act in 2022. It provides for allocations of more than 370 billion USA dollars to support clean energy and reduce carbon emissions. The incentives included in the act are tax rebates to consumers and producers of RES, subsidies for the installation of solar panels and wind turbines, and investment in upgrading the infrastructure of the electric grid [4]. One of the main objectives is not only the reduction of the carbon footprint, but also the establishment of a secure domestic energy base that reduces dependence on fossil fuel imports.

Apart from federal initiatives, state-level programs have an important role to play. For example, California, Massachusetts, New York, and Texas demonstrate high rates of RES integration into the energy system, while actively attracting private investment and developing their own regulatory mechanisms [5]. The success of such approaches is due to their adaptation to the regional characteristics of the resource base. For instance, the south-western regions have most developed solar production, while the central and coastal areas have extensive wind power.

One of the main elements of the USA policy is the **modernization of the energy sector at the technological level**. The state and private sector are investing a lot of money in the production of new solar panel generations, more efficient wind turbines, and geothermal stations with higher efficiency. The reduction of the price of RES and the growth of their technological effectiveness are drivers for the increase of the share of clean energy in the overall energy balance.

However, such growth is accompanied by new challenges related to the variability of production and the need for accumulation. In this regard, the USA emphasis is heavily on **energy storage infrastructure development**. Active employment of lithium-ion batteries allows compensation of intermittency in power production and guarantees stability in the supply of power. Additionally, the nation is drawing up plans for utilizing hydrogen as a carrier of energy, particularly where it is problematic to electrify directly. At the same time, connection of scattered RES to the common grid is being introduced. For example, development of so-called «smart grids», enables real-time optimization of energy transmission and load balancing.

The RES development strategy, thus, is a policy of regulation support, innovative development, and infrastructure modernization. The objective is not merely to reduce emissions and fulfill international climate commitments, but also to build a safe and robust energy system that will ensure the long-term economic and strategic autonomy of the nation.

Localization of critical resource production as an element of EI

One of the most important directions in providing of EI is the **localization of the production of strategically important resources** necessary for the functioning of modern energy and technological complexes. They consist of a wide range of strategically important materials, from cobalt and lithium to rare earths. They are also important components in the manufacture of batteries, wind turbine components, solar panels, electronics, and devices used for energy transmission and storage. The high concentration of global supplies of these resources in the hands of a limited number of states creates vulnerability for import-dependent economies, including the USA.

In the American scientific and political agenda, critically important resources are interpreted as raw materials of high importance for national security and economic development, but subject to the risks of supply disruptions [6]. They can be associated with both geological and geopolitical, logistical and economic constraints. In the course of the global reshuffling of the energy market, dependency on strategic raw materials is as critical as dependence on hydrocarbons in the previous decades.

Recognizing the structural vulnerability, the USA government is taking comprehensive measures to reduce dependence on imports of such resources. The most prioritized direction is the **intensification of geological exploration and the development of domestic extraction capacities within the country**. In recent years, there has been a revival and reassessment of mineral resource policy. At the same time, emphasis is placed not only on extraction but also on the development of processing infrastructure since a significant portion of materials extracted in the USA had previously been sent abroad for processing [7].

At the same time, **measures to develop recycling and substitution are being strengthened**. The disposal of lithium-ion batteries is considered as a strategic initiative aimed at creating a closed supply cycle that would significantly reduce dependence on external supplies. Encouragement is also provided to the work on creating alternative technologies and materials without the usage of rare components, which becomes even more important according to the conditions of technological independence.

The institutional framework whereby the processes are enacted is mandated in many legislative acts and strategic documents. Of notable mention among them is the **Defense Production Act** under which the federal government can invoke mobilization of resources in the nation's interests for security matters at a national level, as well as issuance of subsidies and contracts to key minerals-handling

projects. In 2022, the act was expanded by presidential decree to comprise mining lithium, cobalt, graphite, and nickel as being within energy security [8]. Another extremely significant policy is the **Critical Minerals Strategy**, which was developed by the Department of the Interior and other federal agencies. This document sets out priority areas for expanding extraction, developing processing, and ensuring the resilience of supply chains [9].

Thus, the localization of critical resource production is an integral element of the strategy for energy and technological independence. It covers the entire life cycle from extraction and processing to reuse and material innovation forming a sustainable platform for the functioning of the new energy sector. These processes not only reduce vulnerability to global risks but also contribute to the formation of an industrial base for economic growth in the context of the «green» transition.

The impact of critical resource localization and RES development on USA energy security and economic stability

Comprehensive measures aimed at developing the domestic potential of RES and localizing the production of critical resources have a systemic impact on the energy security and economic resilience of the USA. These two aspects are interconnected categories, as long-term stability of macroeconomic indicators is impossible without predictable, reliable, and sovereign provision of the country's energy needs.

Most importantly, the increase in the share of locally produced energy on the basis of RES **increases the structural stability of the national energy system, making it less susceptible to external shocks**. International energy crises are significantly losing their destructive power in conditions where a significant part of energy consumption is provided by sustainable, renewable, and local sources. This makes it possible to stabilize internal markets, protect consumers from premature changes in prices, and reduce the budget burden of government mechanisms for fuel price compensation. As a result, conditions are created for predictable economic policy and strengthened investor confidence.

In addition, the development of the domestic resource base eliminates one of the main sources of strategic vulnerability. Dependence on a narrow range of external suppliers makes the national economy sensitive to export restrictions, trade wars, and logistical disruptions. It is especially relevant in situations when minerals such as lithium, cobalt, nickel, and rare earth become the foundation of a new technology paradigm. The formation of a reliable and diversified domestic supply chain in this context serves not only as a tool for reducing external dependence, but also as a factor in maintaining the USA innovation and industrial competitiveness.

The economic effect of implementing these strategies manifests itself in several areas. Firstly, both public and private capital investments in the clean energy sector **stimulate the creation of new high-tech jobs**. This is favorable for restructuring the labor market, renewing the industrial regions, and building new poles of economic growth. Secondly, investments in green energy infrastructure have a technology spillover, promoting the **establishment of allied industries and stimulating domestic demand**.

An equally important aspect is the **formation of a stable fiscal foundation**. Reduction of foreign reliance on the importation of energy carriers and strategic raw materials lessens the need for foreign currency reserves for international trade transactions and allows the government to switch funds to domestic priorities. Furthermore, reduction of energy shock vulnerability **contributes favorably to stability in inflation expectations**, which is essential in creating a credible macroeconomic setting.

Thus, localization of production of critical resources and strategic development of RES not only increase the energy security of the USA but also create a foundation for long-term economic stability. These measures establish the basis of a new industrial policy founded on the principles of technological sovereignty, environmental sustainability, and growth. Collectively, they are transforming the country’s energy landscape, contributing to the formation of a more balanced and protected economic system under conditions of global transformation.

Conclusion

The diversification of energy and raw material sources serves not merely as an adaptive mechanism in the context of growing uncertainty in the global energy system, but as a fundamental strategy that ensures sustainable development and national security for the USA. The establishment of a policy targeting the use of domestic capability in RES, and localizing of key production of resources, has enabled the country to move from its vulnerably position to the creation of a technologically advanced, adaptable, and eco-friendly independence.

This process has long-term implications. It strengthens the institutional foundation of the energy sector, reduces the economy's dependence on foreign shocks, increases growth in priority sectors, and assists in achieving climate goals. At the same time, diversification does not mean isolation from the external market, on the contrary, it strengthens the position of the USA as a participant and regulator of global processes, ensuring a more sustainable and equitable distribution of energy risks.

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