



THE SYSTEM OF FACTORS INFLUENCING THE IMPROVEMENT OF THE ECONOMIC EFFICIENCY OF ALTERNATIVE ENERGY TECHNOLOGIES

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ABSTRACT

This thesis provides a scientifically grounded analysis of the system of factors influencing the improvement of the economic efficiency of renewable energy technologies. The study reveals the interrelationships among technological, investment, institutional, resource, and management factors. In addition, practical recommendations aimed at reducing costs, increasing production efficiency, and ensuring sustainable economic development in the use of renewable energy sources have been developed.

Introduction

Today, global climate change, the limited nature of conventional energy resources, and the need to ensure energy security have made the development of renewable energy technologies an urgent task. At the same time, improving the economic efficiency of these technologies during their implementation is of great importance. The economic efficiency of renewable energy technologies depends not only on technical indicators but also directly on a system of economic, institutional, and organizational factors.

Improving economic efficiency involves optimizing the use of resources through technological innovations, better combinations of capital and labor, improved management, a skilled workforce, efficient systems, and supportive policies. All of these are aimed at achieving maximum output with minimal waste and are implemented under the influence of factors such as competition, digital adoption, and strategic planning. The key driving forces include innovation (new technologies and processes), productivity (more efficient use of resources), and market dynamics (prices and competition), which require investments in research and development, training, and smart infrastructure.

Main part

The economic efficiency of renewable energy technologies is crucial for the rational use of energy resources, reducing production costs, and ensuring a stable energy supply. The factors influencing the improvement of this efficiency are systemic in nature, and their mutual interaction ultimately determines the overall economic outcome.

1. Technological factors

Technological development is one of the primary drivers of economic efficiency in renewable energy systems. Enhancing the performance of solar panels, wind turbines, biogas units, and hydropower equipment increases energy production and reduces the cost per unit

of energy generated. Advanced energy storage technologies, including batteries and hydrogen systems, ensure continuity of energy supply and improve the overall efficiency of the system.

2. Economic and Financial factors

Economic efficiency is closely linked to investment volume, return on capital, and production costs. Although renewable energy projects often require high initial investments, their low operational costs generate long-term economic benefits. Access to credit resources, subsidies, grants, and government guarantees reduces financial risks and improves the economic viability of renewable energy projects.

3. Managerial and Organizational factors

Effective project planning, implementation of monitoring and control systems, and scientific basis for managerial decisions increase the efficiency of renewable energy technologies. Optimizing production processes and enhancing workforce qualifications directly influence economic outcomes. Additionally, cooperation between the private and public sectors plays a significant role in improving overall efficiency.

4. Institutional and Legal factors

A stable and transparent regulatory framework creates a favorable investment environment for the development of renewable energy technologies. Policies such as tariff regulations, green certificates, and guaranteed power purchase agreements (PPAs) contribute to higher economic efficiency. Government support mechanisms ensure the long-term sustainability of renewable energy projects.

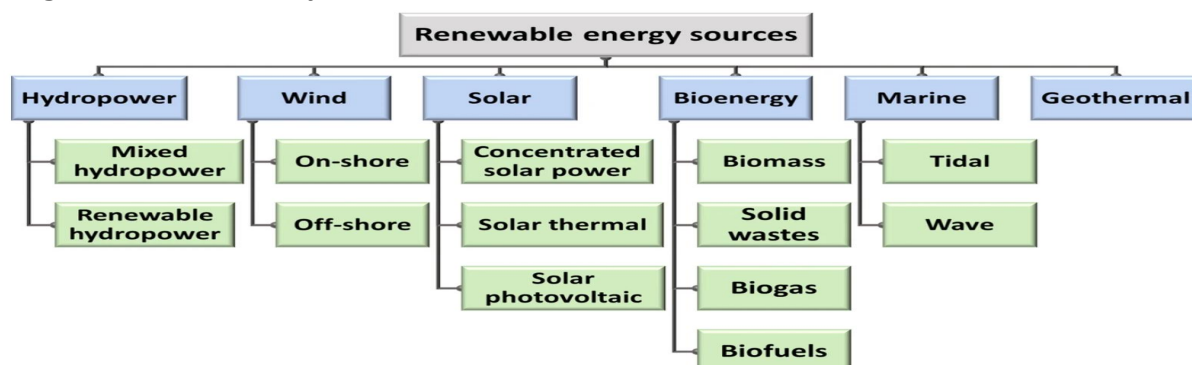
5. External and Market factors

Market demand and supply, fluctuations in conventional energy prices, and the competitive environment significantly affect the economic efficiency of renewable energy technologies. Furthermore, increasing environmental requirements and global policies aimed at reducing carbon emissions enhance the economic advantages of renewable energy sources.

A favorable legal environment, tax and customs incentives, tariff policies, and market competition are important external factors that improve economic efficiency. A stable institutional environment increases investor confidence. External influences and market failures can lead to economic inefficiency and impose constraints on the effective allocation of resources. Externalities can have positive or negative impacts on third parties, while market failures occur when resources are not efficiently allocated by the market.

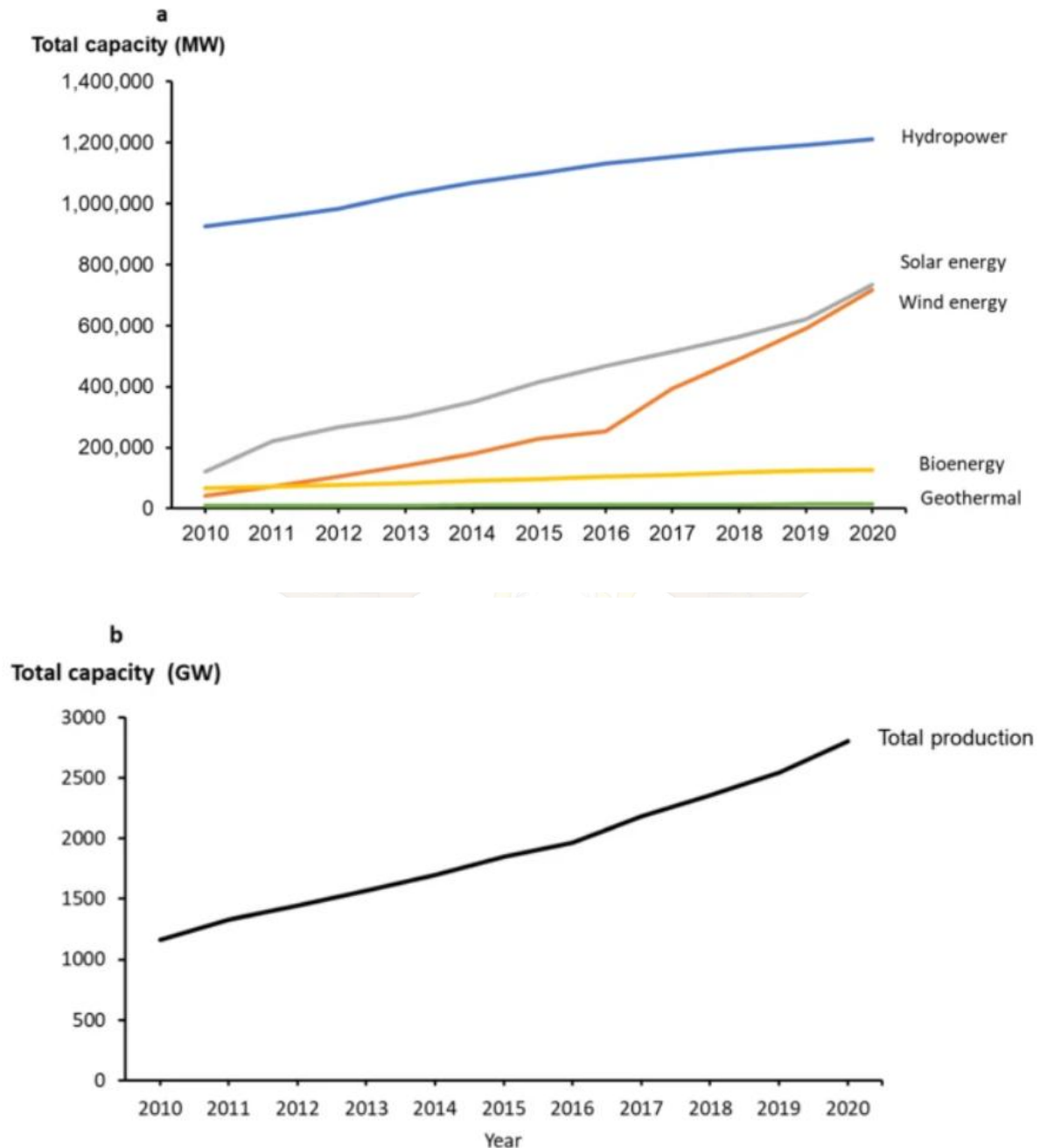
Fig. 1

From: Social, environmental, and economic consequences of integrating renewable energies in the electricity sector: a review



Different types of renewable energy. The field of renewable energy technology encompasses various methodologies, including solar, wind, geothermal, biomass, and hydropower energy generation. Integrating renewable energy into the electricity grid is crucial to addressing global climate change.

Fig. 2



Worldwide renewable energy sources' generating capacity from 2010 to 2020. The proportion of renewable energy sources (a) used in electricity generation increased steadily from 2010 to 2020. Total production capacities from renewable energy sources reached 2802 gigawatts (GW) (b) in 2020. Hydropower represents the highest share in renewable energy production, followed by wind and solar energies.

Conclusion

Improving the economic efficiency of renewable energy technologies is a crucial condition for sustainable economic development, ensuring energy security, and mitigating environmental challenges. This efficiency represents a multi-factor system formed by the integrated interaction of technological, economic, managerial, institutional, and external environmental factors.

The study results indicate that the implementation of modern and energy-efficient technologies, digitalization of production processes, and the use of innovative approaches reduce the cost of renewable energy projects and enhance their investment attractiveness. At the same time, establishing effective management systems, rational use of financial resources, and developing human capital play a significant role in increasing economic efficiency.

Government support measures, including tax and customs incentives, subsidies, and the improvement of the legal and regulatory framework, facilitate the widespread deployment of renewable energy technologies. Furthermore, the development of market infrastructure, the formation of a competitive environment, and increasing demand for energy resources create additional opportunities to enhance economic efficiency in this sector.

In conclusion, improving the economic efficiency of renewable energy technologies requires a comprehensive and integrated approach. Technological advancement, effective management, active investment, and coherent government policies act as key determinants. Implementing these factors systematically can ensure the competitiveness and long-term economic viability of the renewable energy sector.

Economic efficiency also implies the optimal allocation of scarce resources to maximize production and social welfare. Economists consider the existence of economic efficiency as the best response to the fundamental economic problem of resource allocation. In the context of the economy, economic efficiency serves as a central concept applied across numerous domains to achieve optimal resource distribution.

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