

THE ROLE OF GREEN ENERGY IN MINIMISING THE EFFECTS OF GLOBAL WARMING

¹University of Kragujevac (Kragujevac, Serbia)

²Poltava State Medical University (Poltava, Ukraine)

Анотація: Зменшення наслідків зміни клімату вимагає розробки та впровадження нових технологій зеленої енергії. Поступовий перехід до стійких енергетичних систем все більше вимагає уваги, яка виходить за рамки багатьох досліджень і охоплює різноманітні теми від розробки технологій до їх впровадження. Енергетичний перехід означає перехід у споживанні енергії від систем на основі викопного палива до вуглецево-нейтральних альтернатив, що значно зменшує викиди CO₂. Декарбонізація є життєво важливим рішенням для зменшення глобального потепління. Стан екологічної деградації досліджується протягом багатьох років. Це дослідження спрямоване на оцінку впливу зеленої енергії на зменшення викидів парникових газів і вирішення проблем зміни клімату. Завдяки аналізу різноманітних технологій відновлюваної енергії, таких як сонячна, вітрова, гідро- та біомаса, ця стаття оцінює їхні переваги та недоліки в боротьбі із глобальним потеплінням. У статті аналізується ефективність та стійкість зелених технологій у порівнянні з традиційними джерелами енергії. Крім того, пропонуються стратегії поширення та впровадження зеленої енергетики. Висновки цього дослідження є основою для прийняття ефективних політичних рішень і стратегій у сфері енергетичної політики для зменшення впливу глобального потепління.

Ключові слова: відновлювана енергетика, «зелена енергетика», вуглецеві енергетичні ресурси, енергоспоживання, сталий розвиток, екологічна безпека, екологія, довкілля, шкідливий вплив.

Abstract. Reducing the effects of climate change requires developing and deploying new green energy technologies. The gradual transition to sustainable energy systems increasingly requires attention that goes beyond many studies and includes topics ranging from technology development to adoption. The energy transition represents a shift in energy consumption away from fossil fuel-based systems towards carbon-neutral alternatives, thereby significantly mitigating CO₂ emissions. Decarbonisation is a vital solution to reducing global warming. The state of environmental degradation has been studied for many years. Businesses continue to use carbon-based technologies to save money and enrich themselves. They do not aim to improve the environment or even preserve it. Another thing to consider is that carbon-free technologies are expensive in less developed economies. This study aims to evaluate the influence of green energy in mitigating greenhouse gas emissions and addressing climate change challenges. Through an analysis of diverse renewable energy technologies such as solar, wind, hydro, and biomass, this paper delves into their respective merits and drawbacks in combating global warming. The article analyses the efficiency and sustainability of green technologies compared to traditional energy sources. In addition, strategies for spreading and implementing green energy are proposed. The conclusions of this study serve as a basis for making effective political decisions and strategies in the field of energy policy to reduce the impact of global warming.

Key words: renewable energy, “green energy”, carbon-filled energy resources, energy consumption, sustainable development, environmental safety, ecology, environment, harmful impact.

Connection of the publication with planned research works.

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Introduction.

At the stages of society’s development and economic progress, the quality of the environment gradually deteriorates due to air pollution, reduction of forests, soil erosion, unstable water pH and other adverse circumstances that humans cause. Green growth is a concept of economic development that aims to ensure balanced economic growth, conserve natural resources, and reduce negative environmental impacts [1]. The primary objective is to foster economic development while minimizing reliance on natural resources and curbing environmental pollution. The concept of green growth involves advancing technologies and infrastructure to

enhance energy efficiency, harnessing renewable energy sources, mitigating greenhouse gas emissions, managing waste, and implementing sustainable practices. The concept of green growth recognises that economic development should consider both economic performance and social and environmental aspects, ensuring sustainability and long-term resilience. It has become an important area of development for many countries and international organisations looking for ways to achieve economic prosperity without harming nature and the threat of global warming [2]. To achieve this concept, it is necessary to regulate emissions based on demand, achieved through green technologies. In addition, innovations using clean technologies can also contribute to this. Green growth is actively used to control environmental degradation. Green technologies play a pivotal role in curbing CO₂ emissions and fostering economic growth. The escalating and continuous demand for energy is exacerbating significant environmental challenges.

Extensive literature underscores the imperative of adopting and producing clean energy to diminish reliance on non-renewable sources like gas, coal, and oil, thereby mitigating CO₂ emissions. Green growth is essential in preserving the environment, developing countries, and fighting poverty. Conversely, deteriorating air quality can harm economic development [3]. Tailored national policies play a pivotal role in navigating potential trade-offs between fostering green growth and alleviating poverty. Embracing clean energy options, including wind, hydropower, solar, geothermal, and biomass, is indispensable for realizing the goal of zero CO₂ emissions. Sustainable economic development and cleaner energy sources are interlinked, as production processes that use these cleaner energy sources have fewer externalities.

Using energy from renewable sources has several benefits, including reduced dependence on imported non-renewable energy. This helps to stabilise the country's macroeconomic performance, as the prices of imported non-renewable energy are often high.

The shift towards renewable energy sources can also yield positive effects on per capita energy consumption and real income levels. In addition, producing clean energy contributes to long-term sustainability and energy efficiency. Empirical research consistently validates the assertion that renewable energy sources are the most effective solution for bolstering energy security and mitigating the risks linked to global warming [4]. The United Nations Environment Programme (UNEP) advocates for a green economy that enhances the quality of life for individuals while concurrently mitigating environmental risks. At its essence, a green economy prioritizes low-carbon strategies, responsible resource stewardship, and societal inclusivity. Key characteristics include a focus on reducing carbon emissions and enhancing energy efficiency, which in turn contribute to increased income and employment opportunities. These efforts are supported by both public and private investments, which are directed towards sustainable development initiatives. These investments are additionally reinforced through strategic public expenditure, policy adjustments, and regulatory reforms designed to promote natural capital conservation and restoration. This approach recognizes natural resources as essential economic assets and vital sources of public goods, particularly for disadvantaged communities reliant on them for their livelihoods and security.

Specific enabling conditions are crucial to facilitate the transition toward a green economy. These conditions encompass a spectrum of factors, including national legislation, policies, subsidies, incentives, international market frameworks, legal infrastructure, trade agreements, and aid initiatives. Currently, many of these conditions are oriented towards bolstering the existing brown economy, which predominantly depends on fossil fuels. For instance, in 2008 alone, fossil fuel prices and production subsidies exceeded USD 650 billion, posing an important challenge to the shift towards renewable energy sources. National exemplars underscore conducive conditions for cultivating a green economy, which entail modifications in fiscal policies, the overhaul and mitigation of environmentally detrimental emissions, the adoption of innovative market mechanisms, directing public investment toward green sectors, advocating

for eco-friendly public procurement practices, bolstering environmental regulations, and fortifying enforcement mechanisms.

To date, substantial evidence suggests that transitioning to a green economy does not impede wealth generation or diminish employment opportunities. In fact, numerous green sectors exhibit promising investment prospects, leading to considerable wealth accumulation and job creation. However, attaining a successful transition to a green economy demands the creation of new, conducive environments, emphasizing the imperative for decisive action by policymakers worldwide.

A prevalent misconception is that the green economy is a privilege reserved solely for affluent nations, or worse, a strategy employed by developed countries to hinder progress and perpetuate poverty in developing nations [5]. Despite this perception, numerous examples exist of successful transitions to green economies within various sectors in developing countries, serving as exemplars for others to emulate and consider.

Over the past 50 years, the global economy has almost quadrupled. However, 60 percent of the world's basic life-sustaining resources have been significantly depleted or mismanaged. This is attributed to the predominant driver of economic growth in recent years, primarily stemming from the depletion of natural resources without the prospect of their swift independent replenishment.

The aim of the study.

Explore the role of green energy in minimizing the effects of global warming by analyzing the impact of using renewable energy sources, improving environmental sustainability and promoting long-term energy security. The study is also aimed at evaluating the effectiveness of modern green energy technologies, identifying obstacles and opportunities for their implementation, and developing recommendations for optimizing policies and strategies to increase the use of renewable energy resources.

Object and research methods.

A comprehensive examination was conducted on renewable energy sources, encompassing an overview of renewable energy technologies, including solar, wind, hydropower, and biomass. Comparative analysis was undertaken to evaluate the strengths and weaknesses inherent in renewable energy. The impact of green energy on climate change was assessed, analysing the reduction of CO₂ and other gases. A systematic review of scientific literature and analysis of publications on green energy and global warming was conducted. The results of previous studies were evaluated, current trends and unresolved issues in this area were identified. The study delved into the effects of utilizing renewable energy sources on preserving natural resources and biodiversity. The author analyses the reduction of the environmental burden and the risk of ecological disasters due to the transition to green energy. Data from official statistical sources were utilized to acquire information regarding energy production and consumption, greenhouse gas emissions, and various energy and climate change metrics. Drawing upon this statistical data, the article scrutinizes trends and correlations between green energy initiatives and global warming.

Main part.

The rapid growth of the world's population and the development of civilisation over time have led to an increased demand for energy use. Fossil fuels are an exhaustible energy source but are still the primary source of human use. The combustion of fossil fuels produces methane, carbon dioxide and nitrous oxide. Due to the rapid pace of economic development, these emissions are only growing and will continue to grow. The emission of greenhouse gases into the atmosphere precipitates anticipated alterations in weather patterns, climate dynamics, sea level elevation, degradation of public health, and other consequential factors. Given these facts, countries have begun implementing strategies to avoid threats to humans and the planet. Governments have initiated a review of strategies to address and mitigate these challenges effectively. Diverse approaches have been proposed to partially or comprehensively diminish greenhouse gas emissions and tackle associated concerns. Various approaches are suggested to enhance the efficacy of current technologies, innovate new efficient devices with reduced environmental footprints, or transition to renewable energy sources [6]. The latter, primarily relying on renewable energy sources, emerges as the most promising avenue to phase out the utilization of diverse fossil fuels swiftly. It should be noted, however, that many challenges and obstacles need to be overcome to implement renewable energy sources. Extensive research and concerted efforts have been dedicated to understanding and surmounting the barriers hindering the widespread deployment of renewable energy as a dependable electricity source. To address the negative impacts associated with the extraction and utilization of carbon-based energy resources within the broader energy production and consumption context by 2035 and beyond, there is a strong recommendation to implement proactive measures aimed at increasing the share of renewable energy production. Such initiatives, which do not compromise the environment and adhere to the principles of sustainable development, are highly recommended.

In general, from 2015 to 2018, there has been a significant global trend towards heightened investment by energy companies in renewable energy production, in contrast to investments in the exploration and development of non-renewable energy sources [7]. The average annual growth of renewable energy will be 0.7 percentage points, half of the total.

Advancing the development of efficient and robust devices for harnessing renewable energy is a crucial objective to enhance efficacy and diminish costs. This represents one of the key challenges hindering the widespread adoption of renewable energy sources compared to conventional alternatives. The technical hurdles encountered predominantly pertain to renewable energy harvesting technology. It all starts with availability, feasibility, building infrastructure, connecting to the grid, the human factor, and the availability of skilled labour [8].

From a technological point of view, solar photovoltaics is an excellent example of technological progress. In the modern world, third-generation solar photovoltaic cells are used, which successfully solve numerous problems related to energy efficiency and cost. Enhancements in solar photovoltaic (PV) cells have decreased prices, led to the adoption of less energy-intensive production

methods, optimized available material resources, and avoided the use of precious metals. Nevertheless, one of the primary hurdles for photovoltaic projects lies in their grid connection, predominantly owing to their intermittent nature. Due to their significant intermittency compared to other renewable energy sources, solar and wind energy are frequently called "variable renewable energy" (VRE). Energy storage systems (ESS) are widely recognized as the ultimate solution for mitigating this challenge and stabilizing the power generation pattern of VRE sources. A shortage of skilled labor presents another technical obstacle for Variable Renewable Energy (VRE) projects. The deployment of VRE often necessitates a highly trained workforce with specialized expertise in installing, commissioning, operating, and maintaining VRE facilities. Recent expansions in renewable energy have led to restricted access to training programs and expertise in this field, posing challenges for large-scale deployment of VRE. Furthermore, prevailing standards, codes, certification procedures, and requirements have historically centred on fossil fuel resources, necessitating a critical technical reassessment of these documents to tailor them to accommodate VRE projects [9].

To enhance the efficiency of solar photovoltaic (PV) systems and repurposed batteries for energy storage, the authors suggest:

- reducing subsidies for the commercial and industrial sectors if profits can be made without them;
- provide subsidies in the residential sector;
- implement policies that incentivize the adoption of photovoltaic (PV) systems and the reutilization of recycled batteries for energy storage;
- encourage provinces with low PV economics to establish local subsidy systems.

Shading is a significant hurdle in solar power generation, which can adversely impact power output. Maximizing the power output of a solar photovoltaic (PV) system necessitates monitoring the maximum power point at which a solar PV panel can operate. Various methodologies have been proposed for this purpose, with traditional optimization methods typically employed under standard PV system operating conditions. However, under uneven solar radiation, such as partial shading, solar PV panels can have more than one maximum power point (MPPT), significantly complicating their operation.

The researchers suggest that scaling up CSP and government subsidies through tax breaks for the renewable energy industry will help commercialise CSP. In another study scientists conducted a feasibility analysis of a solar heat pump for water heating under three business models. The results showed that government support is needed to reduce the cost difference between traditional fuel systems ("cheap") and renewable energy systems ("expensive") for the commercialisation of this system.

Optimal utilization of renewable energy sources necessitates advancing efficient and economically viable devices capable of converting these sources into electricity, deemed the "highest quality form of energy." Fuel cells are widely seen as an optimal solution to achieve this goal, as they directly convert the chemical energy found in biomass resources into electricity. Hydrogen, derived through water electrolysis utilizing diverse renewable energy sources, can be efficiently converted

into electricity with minimal environmental footprint and high efficacy within fuel cells. Fuel cells are categorized based on the fuel utilized, the type of electrolyte membrane, and the operating temperature. Low-temperature cells function at ambient temperatures and reach up to 120°C, whereas medium-temperature and high-temperature fuel cells can achieve temperatures of up to 500°C. Each type of fuel cell exhibits distinct advantages and drawbacks. The transportation sector accounts for a substantial proportion of pollution.

Hydropower plants use water flow to turn turbines to generate electricity. This technology has been used for a long time and is one of the most efficient and reliable methods of electricity generation [10]. Reservoirs created for hydroelectric power plants can also serve as energy storage, regulating electricity supply according to demand.

Tidal power plants harness the energy of tidal waves of seawater to generate electricity. This technology is relatively new, but it is developing rapidly, as it has great potential to produce stable and predictable electricity.

There are many advantages to using water resources for electricity generation, including low emissions, great potential for large-scale use and reliability. However, these technologies can also negatively impact the environment, including local flora and fauna, as well as the hydrological regime of rivers and oceans. Therefore, balancing using water resources for energy with minimizing negative environmental impacts is essential. However, hydropower development also faces challenges and limitations. For example, the construction of large hydropower plants can lead to flooding large areas of land and loss of biodiversity. Moreover, changes in river regimes can affect ecosystems and natural processes in water basins.

In view of this, some researchers suggest developing less impactful and more innovative forms of hydropower, such as micro-hydropower plants or pumped storage systems. These technologies may be smaller in scale and have less environmental impact. In particular, a study shows that the development of micro-hydroelectric power plants can be an attractive option for green energy production, especially in remote regions or countries with limited resources. Such systems can be locally oriented and more suitable for preserving the natural environment.

Overall, using water resources in green energy requires a careful balance between energy production and environmental protection. Continued research and development of new technologies are crucial to ensure hydropower's efficient and environmentally sustainable utilization.

Wind energy is acknowledged as one of the most promising and eco-friendly renewable energy sources in modern green energy initiatives. Wind turbines harness the wind's kinetic energy to generate electricity, thereby mitigating harmful gas emissions and bolstering efforts to combat climate change.

Significant developments in wind energy technologies have occurred in recent years. Research indicates that, with the introduction of new materials and tech-

nological approaches, wind turbines are becoming more efficient and less noisy, making them more acceptable for use in different ecosystems and human habitats.

As per research the advancement of wind energy contributes to lowering the cost of electricity generation while ensuring stable and uninterrupted access to electricity. This reduces dependence on traditional energy sources such as coal or gas and ensures the sustainability of electricity supply even in remote regions.

Conclusions.

Green energy serves as a cornerstone in mitigating the impacts of global warming and safeguarding our environment for generations to come. This article explores the intricate landscape of renewable energy sources, including solar, wind, hydro, and biomass energy, in the context of combating climate change. Embracing green energy reduces greenhouse gas emissions, promotes the conservation of natural resources, and reduces dependence on hydrocarbon fuels. The research methods used in this article have shown that green energy is an environmentally friendly and cost-effective alternative for modern society. With ongoing technological advancements and supportive regulatory frameworks, the development of green energy emerges as pivotal in transitioning towards a sustainable and clean energy future. These investments in green initiatives will also play a significant role in fostering the emergence of new industries and technologies, which will be essential for economic growth and advancement in the future. These encompass renewable energy technologies, energy-efficient buildings and equipment, low CO₂ public transportation systems, clean energy transport infrastructure, and waste management and recycling facilities.

Investments in human capital, specifically in knowledge, management, and technical competencies pertinent to environmental sustainability, are imperative for facilitating a seamless transition towards more sustainable development. A key revelation is that a green economy fosters growth, elevates incomes, and stimulates job generation. The purported "trade-off" between economic advancement and environmental sustainability is unfounded, particularly when wealth is assessed regarding natural resources alongside production. Further research is warranted to comprehensively comprehend all facets of the impact of green energy on global warming and to formulate effective strategies for deploying these technologies.

In summary, the findings of this article underscore the necessity for continued investment and endeavors in advancing green technologies and infrastructure to fulfill the objectives outlined in the Paris Agreement and safeguard a sustainable climate for future generations.

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