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The Impact of Energy Transition on Socio-Economic Issues: Evidence from Vietnam

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Abstract

This study analyzes the impact of energy transition on socio-economic issues in Vietnam. By combining qualitative and quantitative research methods during the 2015-2023 period, the study demonstrates that energy transition is an inevitable trend that brings multiple economic, social, and environmental benefits to Vietnam, with positive impacts such as promoting economic growth, creating new jobs, enhancing energy security, and improving environmental conditions and public health. However, this process also presents challenges in terms of investment costs, technology, and human resources. Quantitative analysis results show that in the short term, energy transition has not yet shown clear positive effects on economic growth, but has contributed to reducing poverty rates and improving average life expectancy. The study proposes comprehensive solutions regarding policy, finance, technology, and raising community awareness to promote fair and sustainable energy transition in Vietnam, aiming towards the net-zero emissions target by 2050.

Keywords: *Energy Transition, Renewable Energy, Sustainable Development, Socio-Economic, Vietnam.*

Introduction

Energy transition is the shift from traditional energy sources like fossil fuels and nuclear power to cleaner energy forms, reducing reliance on polluting fossil fuel-based power plants. While widely recognized in Europe and North America, this concept is relatively new in Asia. Energy transition encompasses not only environmental impacts but also the necessary economic and social changes to drive a global energy shift, effectively achieving the goals set out in the Paris Agreement on climate change.

Energy transition is a profound transformation of a country's or region's energy system, encompassing changes in how energy is produced, supplied, consumed, and managed. It is not merely about replacing traditional fossil fuel sources (coal, oil, natural gas) with renewable sources (solar, wind, hydro, biomass), but a comprehensive, multi-dimensional shift affecting many aspects of socio-economic life (IEA, 2021). It is a complex, systemic process involving comprehensive changes in how energy is produced, supplied, consumed, and managed. It is not simply about replacing fossil fuels with renewables, but also includes profound changes in technology, economics, society, and policy.

Energy transition occurs at multiple levels, from global to national, regional, and local. Each country and region will have its own characteristics in the energy transition process, depending on its natural, economic, social, and political conditions (UN, 2015). The ultimate goal of the energy transition is to build a sustainable energy system that fully meets energy needs for socio-economic development while ensuring energy security, environmental protection, and promoting social equity (WCED, 1987).

Vietnam is undergoing a significant energy transition, driven by the need to ensure national energy security, mitigate climate change impacts, and promote sustainable economic growth, while adhering to international commitments and targets outlined in its Nationally Determined Contribution (NDC) to achieve net-zero emissions by 2050. Accordingly, Vietnam has outlined a roadmap for transitioning from a traditional, high-emission energy-intensive economy to a green economy, utilizing cleaner and more diverse energy sources, with a focus on renewable energy development. To realize this goal, Vietnam has made significant strides in establishing a legal and policy framework to support the energy transition by issuing numerous legal

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documents, policies, schemes, and programs to strengthen the legal framework and facilitate the transition towards a more sustainable energy system.

Vietnam has achieved many successes in promoting economic development, improving living standards, and lifting millions of households out of poverty. Building on these achievements, Vietnam is determined to implement the 2030 Agenda for Sustainable Development. Vietnam strives to become a high-income country by 2045 and achieve net-zero emissions by 2050. According to the 2023 Voluntary National Review report, Vietnam has achieved many results in implementing the Sustainable Development Goals (SDGs); however, Vietnam still needs to accelerate the implementation of all SDGs on schedule by 2030. In the context of increasing geopolitical competition and economic instability, Vietnam faces greater development challenges, including strengthening economic resilience, poverty eradication, and addressing climate risks. This study is conducted to assess the impact of the energy transition process on socio-economic issues in Vietnam in the period 2015-2023, thereby identifying factors to influence and propose comprehensive solutions on policy, finance, technology, and raising community awareness to promote a just and sustainable energy transition in Vietnam, towards the goal of "net-zero" emissions by 2050.

Liturature Review And Hypothesis

The energy transition, from a fossil fuel-based system to a renewable energy-based system, is an inevitable trend to respond to climate change and ensure energy security. This energy transition, understood in "Schumpeterian" terms as "creative destruction," involves complex and multi-faceted changes in institutions, infrastructure, technology, products, and energy production practices (Davidson, 2019).

Many studies show that the energy transition can promote economic growth. For example, research by IRENA (2021) indicates that the energy transition could create 122 million new jobs globally by 2050. Investing in renewable energy also stimulates economic growth by creating new industries and attracting foreign investment (OECD, 2017). However, the transition can also cause some short-term economic difficulties, such as job losses in the fossil fuel industry (Jakob & Steckel, 2014).

Scientific studies related to the energy transition process emphasize the long-term dynamics between economic development (measured by GDP per capita), energy consumption, and pollution, theoretically formalized by the Environmental Kuznets Curve (EKC). The inverted U-shaped curve explains the negative impact of economic growth on the environment through increased emissions up to a certain threshold. Beyond this threshold, the environmental impact of economic growth decreases, [1] often due to the emergence of innovative new technologies or the widespread use of renewable energy sources (Saqib and Benhmad, 2021; Verbič, Satrovic and Muslija, 2021).

Research by Nguyen et al. (2022) shows that renewable energy development can contribute significantly to Vietnam's GDP growth, create new jobs, and promote green economic development. The energy transition creates many new job opportunities in renewable energy, equipment manufacturing, construction, and operation of energy projects. An IEA (2021) study estimates that the clean energy sector could create 14 million new jobs by 2030. However, this process can also lead to job losses in the fossil fuel industry.

The sustainable energy transition process exacerbates social inequalities through differing access to energy (Bartiaux et al., 2019). Material deprivation, low personal income, and energy poverty challenge the concept of a just transition. Equity as an outcome of systems change requires both mechanisms that create public benefits and new infrastructure and practices of the socio-technical system (Sareen and Haarstad, 2020). Therefore, policies are needed to support workers in transitioning to new occupations and facilitate new employment opportunities (ILO, 2019).

The energy transition contributes to enhancing energy security by diversifying energy sources and reducing dependence on imported fossil fuels. Renewable energy, especially solar and wind, is widely distributed and available in many countries, helping to minimize the risk of supply disruptions (Bazilian et al., 2013). The energy transition helps Vietnam reduce its dependence on imported fossil fuels and strengthen national energy security (Ministry of Industry and Trade, 2021).

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The energy transition is an important factor in reducing greenhouse gas emissions and responding to climate change. Renewable energy does not emit or emits very few greenhouse gases, contributing to improving air quality and mitigating the impacts of environmental pollution (IPCC, 2021). The development of renewable energy helps Vietnam reduce greenhouse gas emissions, contributing to the implementation of international commitments on climate change (Nguyen & Phan, 2020). The socio-technical transition of the energy system refers to applying a comprehensive systems perspective on the components of the natural environment, individuals and organizations to support sustainable development patterns in the context of human-caused climate change and to identify future development trends (Li et al., 2015; Kern and Markard, 2016). The basic premise in this approach is the complementarity of natural and human resources, capital and investment, products and services as enabling or limiting factors for the creation and dissemination of new technologies and for the stability of the energy system (Markand and Hoffmann, 2016).

Air pollution from burning fossil fuels causes many serious health problems, including respiratory diseases, cardiovascular diseases, and cancer. The energy transition to clean energy sources helps improve air quality, reduce pollution-related diseases, and improve public health (World Health Organization, 2021). Energy productivity is negatively affected by globalization, contributing to environmental degradation, but is supported by innovations that improve environmental quality (Ahmad et al., 2021). Vietnam also faces challenges in the energy transition process, including high investment costs, a shortage of high-quality human resources, and the need to improve the legal framework (World Bank, 2022).

The energy transition is an inevitable trend and brings many socio-economic benefits, including economic growth, jobs, energy security, environmental protection, and human health. However, this process also poses challenges that need to be addressed. Studies on energy transition in Vietnam show the great potential of renewable energy in promoting economic growth, ensuring energy security, and protecting the environment. However, Vietnam needs to overcome challenges in terms of cost, technology, infrastructure, and policy to achieve the goal of energy transition. There are not many studies in Vietnam that analyze in detail the impact of energy transition on different economic sectors and geographical areas, therefore, the research direction of the topic is completely necessary.

To determine how the transition to renewable energy sources will impact Vietnam's economic growth from 2014-2023, the study uses two research hypotheses:

- **Hypothesis 1:** The energy transition has a positive impact on Vietnam's GDP growth.
- **Hypothesis 2:** A higher proportion of renewable energy leads to a greater GDP growth rate.

The regression model includes the following variables:

- **Dependent variable:** GDP growth (%) - The annual real GDP growth rate, reflecting Vietnam's economic growth level.
- **Independent variable:** Proportion of renewable energy (%) - The percentage of renewable energy in the total final energy consumption, indicating the extent of the shift to renewable energy.
- **Control variables:**

Total investment capital (% GDP) - Total domestic and foreign investment capital as a percentage of GDP, reflecting the level of investment in the economy.

Labor (millions of people) - The total number of workers in the economy.

Trade openness (%) - Total import-export turnover as a percentage of GDP, reflecting the level of international economic integration.

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CPI (%) - The annual inflation rate, measuring the price increase of consumer goods and services.

Basic interest rate (%) - The interest rate announced by the State Bank, affecting lending interest rates in the economy.

Exchange rate (VND/USD) - The exchange rate between Vietnamese Dong (VND) and US Dollar (USD), affecting import, export, and foreign investment.

Renewable energy output (TWh) - Total electricity output from renewable energy sources, measuring the development of renewable energy.

Energy consumption per capita (toe) - The amount of energy consumed per capita, reflecting the economy's energy consumption level.

Energy intensity (toe/million USD) - Amount of energy consumed per million USD of GDP, reflecting the economy's energy use efficiency.

Greenhouse gas emissions (million tons of CO2eq) - The total amount of greenhouse gases emitted into the environment, measuring the impact of economic activities on climate change.

Average life expectancy (years) - The average life expectancy of people, reflecting quality of life and community health.

Poverty rate (%) - The percentage of households with income below the poverty threshold, reflecting income distribution and social inequality.

Regression models are used to analyze the relationship between energy transition and socio-economic variables. This model is based on statistical methods, building regression equations to describe the relationship between dependent variables and independent variables (Apergis & Payne, 2010). The regression model allows assessing the impact of energy transition on socio-economic indicators, such as: GDP growth, employment, greenhouse gas emissions, income inequality, public health co... Research by Apergis and Payne (2010) uses regression models to analyze the relationship between renewable energy consumption and economic growth in OECD countries. The results show that renewable energy consumption has a positive impact on economic growth.

Data and Methodology Research

Vietnam's data from 2015-2023 used for research is collected from publicly available data systems such as: Data on GDP growth, total investment capital, labor, poverty rate, and other factors. Other socio-economic indicators announced by the General Statistics Office of Vietnam (GSO); Data on the proportion of renewable energy, electricity output from renewable energy, and indicators related to the energy industry are taken from data published by the Ministry of Industry and Trade; Data on greenhouse gas emissions and environmental indicators are taken from data published by the Ministry of Natural Resources and Environment; Data on basic interest rates and exchange rates are taken from data published by the State Bank of Vietnam.

Table 1. Summary of Research Variables in the Model

Year	GDP_ Growth _Percent	Investment _Percent _GDP	Labor _Total	Trade_ Openness	CPI _Percent	Interest_ Rate _Percent	Renewable _Energy _Share
2015	5,75	27,91	560.000.000	164,03	3,15	6,31	12,15
2016	6,10	30,22	570.000.000	172,11	2,87	5,89	10,72
2017	5,80	29,45	580.000.000	180,42	3,01	6,05	13,45

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2018	6,20	31,33	590.000.000	190,12	2,93	4,98	11,34
2019	5,95	28,77	595.000.000	185,45	3,12	5,24	9,78
2020	5,50	26,89	600.000.000	170,56	2,75	4,87	8,92
2021	6,00	29,11	605.000.000	175,78	2,95	5,12	10,25
2022	6,30	32,45	610.000.000	195,67	3,21	6,01	14,32
2023	5,90	33,10	615.000.000	198,34	3,05	7,12	13,87

Source: Compiled by the author

Quantitative research methods were conducted to evaluate the impact of energy transition (represented by the share of renewable energy) on GDP growth, while controlling for other macroeconomic factors. Based on the collected data, descriptive statistics, correlation, and regression analyses were performed using Stata 14 software to validate the research model and hypotheses. The coefficients βiβi were estimated using the OLS regression method to determine the relationship between the share of renewable energy and GDP growth, as well as to assess the role of other macroeconomic factors in influencing economic growth. The statistical significance of the coefficients (βiβi) was tested to identify factors with significant impacts, and the model's fit was analyzed using indicators such as R2R2 and OLS assumption tests (e.g., homoscedasticity and absence of autocorrelation). If $\beta 1>0\beta 1>0$ and is statistically significant, this confirms that energy transition (increasing the share of renewable energy) has a positive impact on GDP growth in Vietnam.

Research Finding

The statistical analysis results show that: GDP Growth ranges from 5.5% to 6.3%, with an average of 5.94%, indicating stable growth aligned with Vietnam's economic conditions in recent years, particularly in the context of transitioning to a sustainable economy. Investment/GDP Ratio ranges from 26.89% to 33.1%, with an average of 29.91%, reflecting Vietnam's high investment levels in infrastructure and economic sectors, including renewable energy. Labor Total has steadily increased over the years, with an average of 591.67 million people, demonstrating the potential for economic growth due to a large labor force, which also supports industries and energy sectors. Trade Openness ranges from 164.03 to 198.34, with an average of 181.39, indicating Vietnam's high trade openness, facilitating access to technology, investment capital, and international markets, particularly in the renewable energy sector. Inflation (CPI) remains stable at an average of 3.00%, creating a favorable macroeconomic environment for implementing renewable energy development policies without significant pressure on prices. Interest Rate ranges from 4.87% to 7.12%, with an average of 5.73%, which is relatively low, providing favorable conditions for financing investments in renewable energy projects. Renewable Energy Share ranges from 8.92% to 14.32%, with an average of 11.64%, showing significant growth in renewable energy usage, partly driven by supportive policies and investments in this sector.

Table 2. Descriptive Statistics of Variables in the Research Model

Descriptive statistics	Year	GDP Growth (%)	Investment (% GDP)	Labor Total	Trade Openness	CPI (%)	Interest Rate (%)	Renewable Energy Share
Year	9	9	9	9	9	9	9	9
Mean	2019	5.9444	299.144	591,666,667	1.813.867	3.1944	5.7322	11.6444
Std	2.739	2.442	2.0619	18,540,500	11.8380	1.459	7.407	1.9176
Min	2015	5.5	26.89	560,000,000	164.03	2.75	4.87	8.92
25% Percentile	2017	5.8	28.77	580,000,000	172.11	2.93	5.12	10.25
50% Median	2019	5.95	29.45	595,000,000	180.42	03.01	5.89	11.34
75th Percentile	2021	6.1	31.33	605,000,000	190.12	3.12	06.05	13.45

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Max	2023	6.3	33.1	615,000,000	198.34	3.21	7.12	14.32

Source: Stata 14

Based on the research hypothesis and identified variables, the study employs an OLS regression model to evaluate the impact of energy transition on economic growth in Vietnam during 2015-2023. The OLS regression model aims to estimate the effect of renewable energy share on GDP growth while controlling for other macroeconomic factors. The model formula can be expressed as follows:

$GDP\_Growth_t = \beta_0 + \beta_1 RenewableEnergy_t + \beta_2 Investment_t + \beta_3 Labor_t + \beta_4 TradeOpenness_t + \beta_5 CPI_t + \beta_6 InterestRate_t + \epsilon_t$

In which:

• GDP_Growth: GDP growth (%)

• RenewableEnergy: Share of renewable energy (%)

• Investment: Total investment (% of GDP)

• Labor: Total labor force (log can be used if needed)

• TradeOpenness: Trade openness (total import-export value / GDP)

• CPI: Consumer Price Index (%)

• InterestRate: Base interest rate (%)

• ϵ: Random error term

Using STATA 14 for regression estimation, the study obtained the following results:

GDP Growth Rate = 316.8944 - 2.3930 * Renewable Energy Share - 0.3701 * log_Total Investment - 0.0054 * Labor + 0.4698 * Trade Openness

In which, log_Total Investment is the natural logarithm of Total Investment (% of GDP)

The estimation results show that the regression coefficient of Renewable Energy Share is -2.3930, indicating that for every 1% increase in the share of renewable energy in final energy consumption, GDP growth rate decreases by 2.3930%. However, this coefficient is not statistically significant ($p > 0.05$), meaning there is insufficient evidence to conclude about the impact of energy transition on GDP growth. Total investment has a negative but statistically insignificant effect on GDP growth. Labor force has a negative and statistically insignificant impact on GDP growth. Trade openness has a positive and statistically significant effect ($p < 0.05$) on GDP growth. Other indicators show impacts but are not statistically significant. Regarding model fitness: The R-squared value is 0.729, indicating that the model explains 72.9% of the variation in GDP growth rate.

The regression results suggest that in the short term, energy transition (increasing renewable energy share) has not shown clear positive effects on economic growth in Vietnam. This could be because energy transition requires a longer time to demonstrate effectiveness, especially in the context where energy infrastructure and technology are still in development stages. However, comparative analysis shows that energy transition has positive impacts on social aspects such as reducing poverty rates and increasing average life expectancy. This reflects that while economic impacts may not be clear in the short term, energy transition can bring sustainable benefits in the long run, including improved quality of life and human

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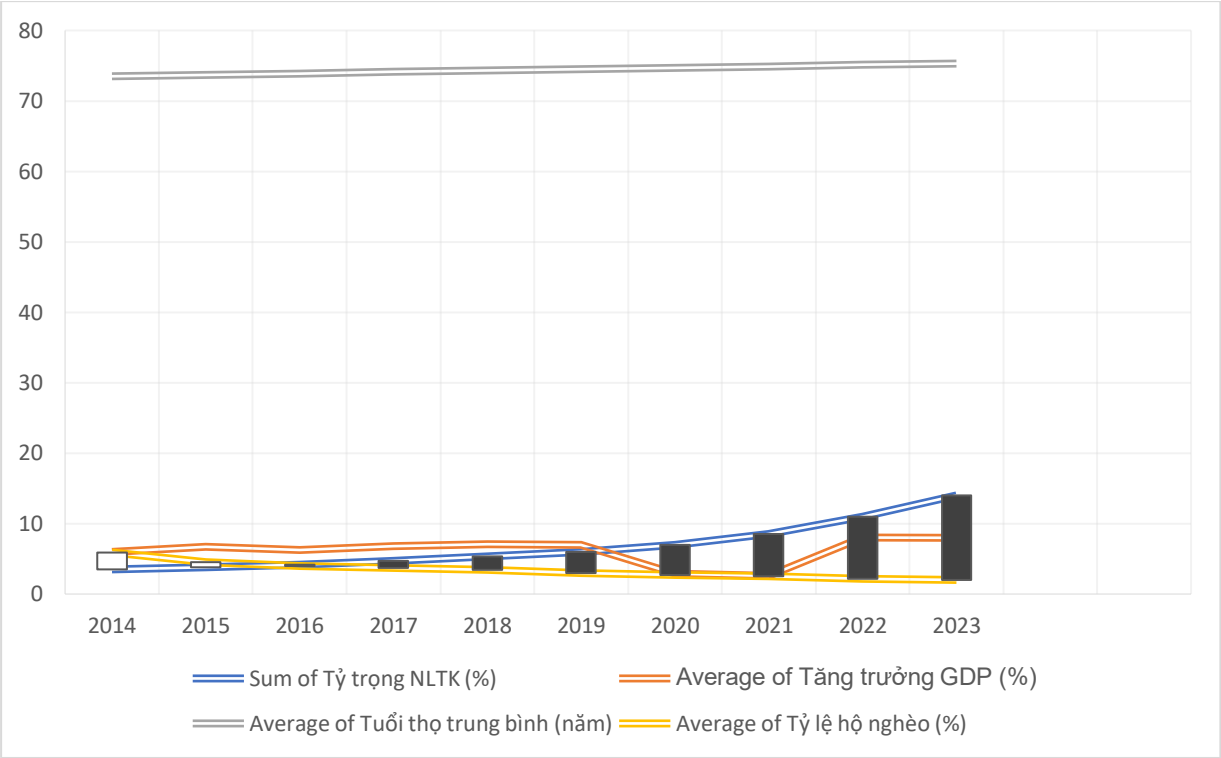
development.

Figure 1. Comparative Analysis Results of Research Model Variables



Source: Self-compiled and analyzed

The graph illustrates the fluctuations of key socio-economic indicators during 2014-2023. Average life expectancy remains stable at 73-75 years with a slight upward trend. GDP growth fluctuates between 5-8%, despite a decline in 2020 due to the Covid-19 pandemic, but maintains an overall upward trend. Notably, the poverty rate has significantly decreased from about 7% to approximately 3%, while the share of renewable energy in total energy consumption has increased substantially from 3% to about 15%, particularly during 2020-2023. Overall, these indicators reflect positive development trends in the socio-economic landscape over the past decade.

Current research findings lack sufficient evidence to definitively conclude that energy transition directly impacts economic growth. However, the social benefits and long-term potential of energy transition remain important factors that need to be considered. Gathering more long-term data and expanding research will help better assess the impact of energy transition on economic growth and sustainable development.

Conclusions and Policy Implications

Vietnam needs to establish a national energy transition strategy by 2050 with clear objectives, detailed roadmaps, and solutions tailored to the country's socio-economic conditions. At the same time, energy transition goals should be increasingly integrated into the Socio-Economic Development Strategy and sectoral plans to ensure consistency and effectiveness. The transition process must place a strong emphasis on fairness by developing programs to support job transitions for workers in fossil fuel industries, such as coal mining, while ensuring the rights and participation of vulnerable communities. Furthermore, enhancing international cooperation is an urgent requirement. Vietnam should proactively participate in global initiatives like the Just Energy Transition Partnership (JETP) to attract capital, technology, and international experience, while collaborating with advanced nations to transfer technology and access green financing sources.

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Regarding policies to support renewable energy development, improving the legal framework is a top priority. This includes issuing specific regulations on renewable energy auctions, feed-in tariffs (FIT), or floor pricing mechanisms to provide stability for investors. Policies to encourage investment in energy storage technologies (such as lithium batteries and green hydrogen) and smart grids should also be developed. The government should implement tax incentives, preferential credit support, or establish green financial funds to support renewable energy projects. Additionally, a transparent competitive energy market should be developed to encourage private sector participation, along with mechanisms for direct power purchase agreements (DPPA) between renewable energy producers and large energy consumers.

On greenhouse gas emission reduction policies, carbon taxes or carbon pricing mechanisms should be implemented to encourage businesses to reduce emissions. A gradual transition plan for coal-fired power plants should be developed, including shifting to liquefied natural gas (LNG) or other clean energy sources. Investments in carbon capture and storage (CCS) technology should also be prioritized to reduce emissions from industrial plants. Moreover, regulations on energy efficiency standards for electrical equipment, buildings, and vehicles should be issued, along with programs to promote energy savings in industry, transportation, and daily life.

On energy infrastructure development policies, upgrading the power grid is a prerequisite for enhancing the integration of intermittent renewable energy sources such as solar and wind power. Large-scale energy storage facilities need to be established to ensure a stable electricity supply. In the transportation sector, it is essential to develop a nationwide network of electric vehicle charging stations and promote the use of electric vehicles as well as public transportation solutions powered by clean energy. Additionally, land planning should prioritize renewable energy projects while ensuring harmony with other land uses, such as agriculture and forestry.

On awareness-raising policies and human resource development, communication campaigns should be implemented to increase public and business awareness of the benefits of renewable energy and sustainable development. Renewable energy and climate change topics should be incorporated into educational curricula at all levels. At the same time, specialized training programs on renewable energy, smart grids, and energy storage technologies should be developed in universities and vocational training centers. Support should also be provided for retraining workers in fossil fuel industries to transition to new occupations. Furthermore, investments in research and development (R&D) centers for renewable energy technologies, energy storage, and clean energy should be prioritized. Collaboration between universities, research institutes, and businesses should be encouraged to foster innovative energy solutions.

To effectively implement the above recommendations and policies, close coordination between the government, businesses, social organizations, and communities is crucial. Additionally, efforts to mobilize funding from international funds, financial institutions, and the private sector must be strengthened to invest in renewable energy and energy infrastructure. A monitoring and evaluation system for the effectiveness of energy transition policies should be established, enabling timely adjustments and improvements to achieve the set objectives.

Conclude

Vietnam is currently presented with a significant opportunity to transition towards a sustainable energy system that aligns with global trends and addresses the pressing challenges of climate change and energy security. This transition is not only an essential step to meet the growing energy demands of the country but also a strategic move to reduce greenhouse gas emissions, foster green growth, and enhance resilience against environmental risks. The outlined recommendations and policy proposals play a crucial role in accelerating this energy transition by promoting the adoption of renewable energy technologies, improving energy efficiency, and ensuring the integration of sustainability into the energy sector. Furthermore, these measures emphasize the importance of fairness, inclusivity, and long-term effectiveness, ensuring that the benefits of this transition are equitably distributed across society. By implementing these strategies, Vietnam can not only achieve its energy and climate goals but also contribute to socio-economic development,

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enhance national competitiveness, and protect the environment for future generations.

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