

Analysis of the Role of Renewable Energy Investment in China's Economic Growth

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Abstract: Following the Industrial Revolution, global dependence on non-renewable energy has led to significant environmental challenges and resource scarcity. Recognizing the need for a sustainable energy system, China has committed to investing in renewable energy, evidenced by the substantial allocation outlined in its 13th Five-Year Plan. This study examines the multifaceted impacts of renewable energy investment on economic growth, considering both short-term inhibitory effects due to initial infrastructure costs and long-term benefits related to economic efficiency and environmental sustainability. Additionally, this paper explores the critical role of renewable energy investment in fostering economic growth in China, particularly in the country's transition from traditional energy sources. The analysis also incorporates cases from various countries at different levels of development, enabling a comparative understanding of China's renewable energy landscape. Limitations of the current research, including the need for more comprehensive data on regional disparities and socio-economic effects, are acknowledged. Future research directions are suggested to enhance understanding of the socio-economic implications of renewable energy investment across diverse demographics and to evaluate the effectiveness of policy interventions aimed at promoting sustainable energy development in developing nations.

Keywords: Renewable Energy Investment, Economic Growth, China, Sustainable Development, Energy Transition.

1. Introduction

After the Industrial Revolution, with the rapid economic development, countries worldwide have been increasingly dependent on and consuming non-renewable energy. However, non-renewable energy has many problems, such as being non-renewable in the short term, scarce resource allocation, and environmental pollution. Therefore, because of the excessive consumption of traditional energy systems, environmental problems, and the inseparable relationship between them and economic growth, people have begun to explore the transition to a sustainable energy system, including power access, energy efficiency improvement, clean energy use, and the application of renewable energy [1]. In addition to considering the application of technology, the transition to a renewable energy system also requires considering the economic benefits it brings. Some studies suggest that no country can achieve long-term economic growth before transitioning to a modern, clean energy system [2]. For many European developed countries, using renewable energy is an essential part of economic growth [3]. Similarly, as a developing country with a large economy, China has relied heavily on

traditional energy sources. However, recognizing the need for sustainable development, China is now making significant efforts to transform both its energy and economic structure. China's actions demonstrate the government's strong commitment to promoting and supporting renewable energy development. In the 13th Five-Year Plan, the government set a goal to invest 2.5 trillion yuan in renewable energy, a nearly 39% increase compared to the investment in the 12th Five-Year Plan. There are relatively few studies examining whether energy investment can contribute to China's economic growth, whether this impact can be sustained in the long term or only in the short term, and whether there are differences across industries or regions. Therefore, this paper incorporates the multiple effects of renewable energy investment into the economic growth model and uses a combination of case analysis and theoretical research to explain this series of issues by adding the situation between renewable energy and economic development in countries with different levels of development and comparing it with China.

2. Literature Review

2.1. Theoretical Basis of Renewable Energy Investment and Economic Growth

Renewable energy refers to resources constantly regenerated in nature that humans can use and supplement. The general range of renewable energy types currently includes solar, wind, hydropower, biomass, and geothermal energy. In addition to the renewable properties, with the continuous development and utilisation of renewable energy, humans have begun to pay more attention to its environmental and economic benefits. Its ecological benefits are mainly to reduce the emission of greenhouse gases and pollutants, but the impact on economic benefits is more complicated. In recent years, many studies have studied the effects of renewable energy on economic growth. Among them, He [4] defined the concept of renewable energy investment in China at the micro level and studied the effect of renewable energy investment on employment. The study believes that renewable energy investment should be defined as cash renewable energy companies use to build fixed assets, intangible assets and long-term payments. Its empirical results show that renewable energy investment will increase employment in the renewable energy industry but will suppress jobs in the traditional energy industry. Therefore, the relationship between renewable energy and economic growth must be more clearly and deeply defined. Wang [5] proposed a variety of hypotheses on the relationship between renewable energy and economic growth, including the growth hypothesis, conservative hypothesis, feedback hypothesis and neutral hypothesis. The growth hypothesis posits that renewable energy has a positive impact on economic growth, while the conservative hypothesis argues that economic growth drives the development of renewable energy. The feedback hypothesis combines these views, suggesting a two-way causal relationship where both renewable energy and economic growth influence each other. In contrast, the neutral hypothesis believes there is no causal relationship between the two. Different academic studies have obtained the results of the above four hypotheses in recent years. Therefore, for China, the mechanism of the impact of renewable energy investment on economic growth still needs to be analysed in detail, which is also the core of this article.

2.2. Comparison of the Economic Benefits of Renewable Energy Investment and Traditional Energy

Although there has been no consensus on the relationship between renewable energy and economic growth due to reasons such as countries, periods and research methods, in the short term, for most countries, the economic benefits of renewable energy are not as good as traditional energy. There are two main reasons for this. First traditional energy sources, which have been used for a long time and are relatively easy to extract, still hold a dominant position in the global energy structure. Fossil fuels remain the primary source of global energy consumption, especially in sectors like transportation and

electricity. Secondly, the initial investment cost of renewable energy makes it difficult for renewable energy to enter the market [6]. Therefore, its comprehensive economic benefits are not better than traditional energy in the early stage. However, when considering long-term economic benefits, the economic benefits of renewable energy are better than conventional energy in the case of growth assumptions and feedback assumptions. Alper [7] believed that in the long run, the popularisation of renewable energy positively impacts economic growth for EU countries. In the United States, every 10% increase in the proportion of renewable energy use will reduce its GDP by US\$29 billion to US\$53 billion [8]. According to the New York State Energy Office, wind energy systems create 25-70% more jobs than traditional energy generation systems. Moreover, when both environmental and economic impacts are considered, renewable energy proves to be far more sustainable. While traditional energy sources can create comparable economic returns, they do so at a much higher environmental cost. In essence, the GDP growth fueled by traditional energy comes at the expense of environmental degradation, unlike renewable energy. Bildirici [9] also found that the rate at which traditional energy creates economic benefits equals the carbon emissions it causes, which will also affect the global climate change issue to a certain extent. In summary, under the condition that the growth hypothesis is established, renewable energy is superior to traditional energy in terms of its impact on economic benefits, except for the initial infrastructure costs and technical barriers, both in the long run and in terms of environmental benefits.

2.3. The Current Status of Domestic and Foreign Research

In China, studies on the relationship between renewable energy and economic growth have gradually increased in recent years. However, most of them study the relationship between renewable energy consumption and economic growth, while there are few studies on the relationship between renewable energy investment and economic growth. Many studies support the feedback hypothesis between China's renewable energy consumption and economic growth. A study in the Chinese context shows a long-term two-way causal relationship between renewable energy consumption and China's economic growth. In other words, rapid economic development will be conducive to developing the renewable energy industry, and thus, renewable energy will lay the foundation for further economic development [10]. However, there is a particular regional heterogeneity in renewable energy consumption in China because China is a developing country with a large population concentrated in rural areas. The increase in renewable energy in rural areas will bring slightly more significant GDP growth than the same level of renewable energy consumption in urban areas. However, it must be acknowledged that the rise in the proportion of renewable energy also brings certain political and economic challenges. These include the high initial infrastructure investment costs associated with renewable energy development, as well as the potential for structural unemployment in industries reliant on traditional energy sources [11]. The research on renewable energy investment on economic growth is mainly from a policy-driven perspective or micro-level study of the impact of renewable energy enterprises' investment on employment [4]. There are few case studies in China, and they need a macro perspective and systematicity. In contrast, foreign countries have more research perspectives on renewable energy. In the United States, although the decline in the proportion of coal-fired power generation will bring about inevitable structural unemployment in the traditional energy power generation industry, the expansion of natural gas, solar energy and wind energy has not only made up for the unemployment caused by the previous traditional energy transition but also increased the employment rate. Therefore, renewable energy investment positively impacts the United States' economic growth [12]. In addition, some studies highlight the importance of regulatory intensity in renewable energy investment. In countries with stronger regulatory frameworks, the impact of renewable energy investment on economic growth tends to be more efficient and significant [13].

3. Analysis of the Economic Impact of Renewable Energy Investment in China

Renewable energy investment has gradually become one of the crucial elements of modern economic development. As many studies have concluded, it is not only a means to deal with climate change and environmental pollution but also essential for the sustainable development of the economy. Investment in renewable energy is different from consumption because investment determines the energy production structure to a certain extent. The energy production structure will further affect the energy consumption structure, and the change in consumption structure will affect industrial industry and economic development. It will also impact the environment and climate change. Renewable energy investment can directly drive economic development by acting on infrastructure construction and employment, while renewable energy investment also has specific indirect effects; that is, there is a particular intermediary industrial structure which can improve the production efficiency of the entire society by acting on technological innovation and industrial structure, thereby promoting rapid economic development. This section will analyse the driving effect of renewable energy investment on the economy from both direct and indirect perspectives.

3.1. Theory of the Pull Effect of Renewable Energy Investment

First, the direct pull effect refers to the role of renewable energy investment in the infrastructure construction of the renewable energy industry and the support for the initial development of the industry. Both the past development of traditional energy and the current development of the renewable energy industry require the construction of infrastructure on a large scale. Renewable energy infrastructure will involve the construction of facilities such as power generation, heating and sewage treatment. The construction of power generation facilities includes conventional hydropower stations, solar power stations, biomass power stations, pumped storage power stations and wind farms. Heating includes geothermal energy supply systems. These large-scale infrastructure projects directly stimulate growth in local industries such as manufacturing, transportation, construction, and materials production. In addition, developing renewable energy infrastructure construction at the city level will also have a strong radiation effect, driving economic growth in many surrounding areas, promoting regional employment, and attracting a large amount of foreign investment and technology investment. Therefore, from the perspective of direct effects, renewable energy investment has a specific direct compensation effect on economic growth.

Although the mechanism of the indirect pull effect is slightly complicated, its effect is equally significant. The most crucial point is that it plays a role in technological innovation and upgrading industrial structures. The difference between it and the direct effect on technological progress is that the direct effect of technological progress is to create new production machines and products and then create new product sectors. The indirect effect of technological innovation refers to the advancement of science and technology that improves production and work efficiency, thereby driving production and employment. Innovations brought about by indirect effects on technological innovation and industrial upgrading are indispensable for developing renewable energy. Because the development of the renewable energy industry is inseparable from the research and development of new technologies and materials. For example, improvements in the efficiency of solar panels are inseparable from breakthroughs in materials science and microelectronics. In contrast, improvements in wind energy equipment rely on advances in precision mechanics and fluid dynamics. In addition, investing in renewable energy can also promote economic development by improving energy security and the energy mix. Excessive import of traditional energy will prevent countries with low resource endowments from having an energy crisis and restrict economic development. Renewable energy development can alleviate the pressure caused by the energy crisis to a certain extent and is more conducive to healthy economic development.

To sum up, investment in renewable energy drives economic development through direct and indirect effects. The direct impact affects the economy through employment and infrastructure construction. At the same time, the indirect implications promote economic growth by improving production efficiency and sustainable development through technological innovation, industrial structure optimisation, and energy structure optimisation.

3.2. Theory of the Inhibition Effect of Renewable Energy Investment

Investment in renewable energy may have a specific inhibitory effect in promoting economic structural transformation and reducing environmental pressure. Especially in the early investment stage, some developing countries may have a higher initial investment cost [8].

From a direct perspective, the inhibitory effect of renewable energy investment is reflected in replacing traditional energy industries. From a market perspective, there is a direct competitive relationship between renewable energy investment and fossil energy, and the rapid development of renewable energy will lead to a decrease in the market demand for traditional energy. In addition, investment in renewable energy requires a large amount of initial capital investment in the early stage, which will form a specific crowding-out effect on other industries. From an indirect perspective, investment in renewable energy will affect market expectations and cause structural unemployment to a certain extent. The emergence of renewable energy will make it impossible for skilled workers in the traditional energy industry to adapt to the new industry, resulting in unemployment and affecting economic development.

The above analysis shows that the inhibitory effect of renewable energy investment mostly appears in the early stage of industry development. In the long run, renewable energy investment has a particular positive effect. Therefore, the impact on renewable energy investment needs to be dynamically analysed under specific economic environments and technical conditions.

3.3. Economic Impact of Renewable Energy in China

In recent years, China's investment in energy transition has risen significantly, with the 2023 figure nearly quadrupling that of 2020. This trend underscores the Chinese government's strong commitment to advancing renewable energy development. Additionally, the growth in China's renewable energy capacity is closely linked to per capita GDP. Despite being a developing nation, China has a lower overall country risk compared to similar economies. Wang's research [5] further confirms that the expansion of China's renewable energy sector positively contributes to economic growth. Although fossil fuels still dominate China's energy consumption, the installed capacity of renewable energy sources is on the rise. Solar and wind power have seen substantial growth in capacity, while hydrogen and biomass energy have experienced only modest increases, emphasizing the need for further development in these areas.

4. Conclusion

Renewable energy investment plays a vital role in China's economic growth. Although for developing countries, the initial infrastructure construction and learning costs make renewable energy investment have a specific inhibitory effect on economic development, in the long run, renewable energy investment has a positive impact on improving economic benefits and environmental problems. In addition, if we want to maximise the advantages of renewable energy investment, we also need guidance from reasonable government policies and the optimisation of market mechanisms. This will minimise the problems caused by the inhibitory effect and lay the foundation for the sustainable development of the renewable energy field.

However, it is important to acknowledge certain limitations in the current analysis, such as the lack of comprehensive data on the regional disparities in renewable energy development and the potential socio-economic impacts on vulnerable communities. Future research should focus on exploring the specific impacts of renewable energy investments across different regions, assessing the socio-economic implications for various demographics, and examining the effectiveness of policy interventions in enhancing the growth and sustainability of renewable energy in developing countries.

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