

Title: An examination of the relationship between economic growth and renewable and non-renewable energy consumption across a wide range of countries.

1. Introduction

This literature review investigates the relationship between economic growth and renewable and non-renewable energy consumption across various countries. Renewable energy sources, such as solar, wind, hydroelectricity, geothermal, and biomass, have gained significant interest and investment in recent years. In contrast, non-renewable energy arises from the extraction and burning of fossil fuels. It is a finite source of energy due to humans' high volume of use. Studies have shown that there is a relationship between economic growth, air pollution, and sustainable and non-renewable energy (Bhattacharya et al., 2016; Ivanovski et al. 2021). Moreover, many countries in the European Union are trying to reduce air pollution across Europe and globally. This is achieved by enforcing laws on industrial factories and other polluting factors and supporting the idea of green facilities to reduce non-renewable energy consumption (European Commission, 2010). Over the next decade, efforts will be made to protect the environment, to increase the possibility of boosting the economy and reducing the unemployment rate.

2. Literature review

According to research conducted on the topic, anthropogenic pollution, a direct result of human activity, such as rising carbon dioxide (CO₂) emissions, as well as other greenhouse gasses elevation, significantly impacts the environment. Some argue that non-renewable energy sources, which originate from fossil fuel burning, limit long-term economic growth. The European Union has made substantial progress toward a carbon-free energy sector. The European Commission's Europe 2020 Strategy, proposed in 2010, sets three major goals for 2020: a 20% reduction in greenhouse gas emissions, a 20% increase in final energy consumption from renewable sources, and finally, a 20% increase in energy efficiency. By 2030, the EU should reduce greenhouse gas emissions by at least 40%, boost renewable energy production, and improve energy efficiency by at least 27% (European Commission, 2010). A strength of this strategy is that the plan to be enacted will increase economic growth in European Union countries. It will inject the workplace with more employees, resulting in a decrease in the unemployment rate. High growth in the amount of power produced from renewable sources, renewable energy-based distributed generation (RDG), and energy democracy in low-income communities can all be used to create a significant impact on employment generation. While current approaches such as RDG technologies have emerged as a way to achieve sustainable economic growth (Ramos et al., 2019).

Sharma et al. (2021) investigated the relationship between economic growth and the energy growth nexus in 27 European Union countries. Data analysis was achieved using sustainability indicators such as human development and financial development indexes, urban population, renewable energy and non-renewable energy consumption, ecological footprints, carbon emissions, and economic growth indicators. The results of the study demonstrated a two-way negative relationship between economic growth and renewable energy and a two-way positive relationship between economic growth and non-renewable energy. Moreover, the study suggests that economic growth is significantly impacted by ecological footprints, non-renewable energy consumption, and carbon emissions. In comparison, an increase in renewable energy consumption results in a decrease in economic growth. The study is valuable because it serves as empirical evidence that long-term renewable energy will effectively impact economic growth in EU countries, unlike short-term effects. According to the paper, some nations have seen favorable economic effects from major expenditures on renewable energy, including employment growth and technical advancement. These effects are of high value because they depend on the development of the renewable energy industry. In addition, they rely on the level of regulatory support, and the accessibility of natural resources, which could lead to future research.

Moreover, a study conducted by Rasoulinezhad and Saboori (2018) examined the links between economic growth, CO₂ emissions, and renewable and non-renewable energy consumption. The authors investigated a regional international organization, the Commonwealth of Independent States (CIS) region. This consists of former Soviet republics and Central Asian republics, including 12 sampled countries over the period of 1992–2015. The study findings are relevant as they revealed the existence of a long-term, bidirectional relationship between every variable in the 12 tested countries, with the exception of the relationship between economic growth and renewable energy consumption. According to the authors, there is a short-run panel causation that runs unidirectionally from economic growth, financial openness, and trade openness to CO₂ emissions from renewable energy sources.

A comparable study by Bhattacharya et al. (2016), supports the previous findings by analyzing data from 38 top countries regarding renewable energy consumption over a two-decade period. Using long-run output elasticities, it was found that 57% of the countries examined benefited economically from renewable energy consumption increases. Another study builds on previous research by revealing that in BRICS countries, a group of leading emerging market economies around the world, there is one-way causality from labor force and exports to economic growth. Additionally, there is a bidirectional causal relationship between economic growth and foreign direct investment and carbon emissions, meaning that an increase in economic growth leads to an increase in carbon emissions, and an increase in carbon emissions leads to an increase in economic growth (Iqbal et al., 2023).

As a final point, Ivanovski et al. (2021) argue that the extent to which economic growth is affected by renewable and non-renewable energy is highly dependent on a country's classification. The study revealed that throughout the majority of the study period, the impact of renewable energy consumption on economic growth in these countries was statistically equivalent to zero. Furthermore, consumption of both renewable and non-renewable energy stimulates economic growth in non-OECD nations.

3. Conclusion

To conclude the relationship between economic growth, renewable and non-renewable energy consumption is highly complex. The involvement of a wide range of factors promotes the creation of a nexus, which is difficult to study in the short-term. However, long-term research using various methods enables the visualization of these mechanisms and their interactions. This indicates that renewable energy infrastructure may have increased initial costs, but it has long-term advantages including less emissions, increased energy security, and possible cost savings. Additionally, over the past two decades, boosting energy independence and security has been increasingly critical in developing the next-generation energy policy framework for many developed countries, particularly EU nations. Energy independence has also become essential in EU foreign policy challenges and frameworks, due to the consequences of energy security from economic growth, development, and even social cohesion perspectives.

4. Resources:

Bhattacharya, M., Paramati, S. R., Ozturk, I., & Bhattacharya, S. (2016). The effect of renewable energy consumption on economic growth: Evidence from top 38 countries. *Applied Energy*, Volume 162, Pages 733–741. <https://doi.org/10.1016/j.apenergy.2015.10.104>.

European Commission (2010). *Europe 2020 – a strategy for smart, sustainable and inclusive growth*. European Environmental Agency, Pages 1-35. <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:2020:FIN:EN:PDF>

Iqbal, A., Tang, X., & Rasool, S. F. (2023). Investigating the nexus between CO2 emissions, renewable energy consumption, FDI, exports and economic growth: Evidence from BRICS countries. *Environment, Development and Sustainability*, 25(3), 2234–2263. <https://doi.org/10.1007/s10668-022-02128-6>.

Ivanovski, K., Hailemariam, A., & Smyth, R. (2021). The effect of renewable and non-renewable energy consumption on economic growth: Non-parametric evidence. *Journal of Cleaner Production*, Volume 286, Pages 124956. <https://doi.org/10.1016/j.jclepro.2020.124956>.

Ramos, C., García, A. S., Moreno, B., & Díaz, G. (2019). Small-scale renewable power technologies are an alternative to reach a sustainable economic growth: Evidence from Spain. *Energy*, Volume 167, Pages 13–25. <https://doi.org/10.1016/j.energy.2018.10.118>.

Rasoulinezhad, E., & Saboori, B. (2018). Panel estimation for renewable and non-renewable energy consumption, economic growth, CO2 emissions, the composite trade intensity, and financial openness of the commonwealth of independent states. *Environmental Science and Pollution Research*, 25(18), 17354–17370. <https://doi.org/10.1007/s11356-018-1827-3>.

Sharma, G. D., Tiwari, A. K., Erkut, B., & Mundi, H. S. (2021). Exploring the nexus between non-renewable and renewable energy consumptions and economic development: Evidence from panel estimations. *Renewable and Sustainable Energy Reviews*, Volume 146, Pages 111152. <https://doi.org/10.1016/j.rser.2021.111152>.