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ASSESS THE ECONOMIC, ENVIRONMENTAL, SOCIAL BENEFITS OF RENEWABLE ENERGY ADOPTION

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ABSTRACT
In light of the urgent requirement for sustainable development over the long term, this study explores the trends in research that are occurring at the junction of economic growth and renewable energy. This research offers useful insights into the changing research landscape by conducting a detailed bibliometric analysis of 6794 research publications that were sourced from the Web of Science database. The time period covered by this research spans from 1990 to June 2022. Within the context of this multidisciplinary area, it throws light on foundational works, notable writers, and emerging themes throughout the field. When it comes to achieving sustainable economic growth, the findings of this study highlight how very important it is to make use of renewable energy sources. In addition to the environmental benefits that have been amply demonstrated, renewable energy also plays a critical part in the process of bringing about a green economic transition. This transition not only reduces the negative effects on the environment, but it also generates employment opportunities, contributes to the growth of local communities, and improves energy security. Furthermore, our research reveals that there is a compelling positive association between the utilization of renewable energy sources and important economic indicators, such as the expansion of the Gross Domestic Product (GDP), the productivity of the industrial sector, and the development of new technologies. This association is especially strong in locations that are endowed with an abundance of renewable resources, which serves to reinforce the potential for renewable energy to boost investment, push economic progress, and promote equitable development. The purpose of this study is to advocate for the incorporation of renewable energy sources, the advancement of sustainable economic growth, and the design of successful policies.
Keywords: *Economic, Environmental, Social Benefits.*

INTRODUCTION

The utilization of non-renewable energy sources places nations in a predicament where they must choose between reducing pollution and fostering economic growth as their policy priorities. Because of this, the energy should be utilized with caution and efficiency, regardless of whether it is renewable or non-renewable, because its sources are finite. In addition, because of the current climate change and global warming crisis, renewable energy may be the most appealing alternative to fossil fuel, which would result in a reduction in the process of carbon dioxide emission. On the other hand, the process of introducing new renewable energy technology, purchasing them, and making them accessible to the general public is extremely time-consuming and expensive. On the other hand, nations face enormous challenges in their efforts to sustain economic growth and development. A worsening of the situation has been occurring as a result of the COVID-19 crisis. In order to achieve a balance between spending on climate change mitigation and economic growth, the governments of both emerging and industrialized nations are required to make expenditures.

It is anticipated that renewable energy will become a significant source of power generation in the not too distant future. This is due to the fact that we can utilize these resources repeatedly in order to generate energy

that is of use. In general, the energy resources can be broken down into three categories: nuclear energy resources, renewable energy resources, and fossil fuels. A variety of renewable energy sources, including hydropower, wind, solar, biomass, ocean energy, biofuel, geothermal, and others, all provide between 15 and 20 percent of the total energy that is produced in the world. The world is going to become a global village as a result of the increased demand for energy that is caused by the rapid growth of the population. This demand for energy leads to the utilization of fossil fuels such as coal, gas, and oil in order to meet the demand for energy. This leads to situations that are not sustainable and many problems, such as the depletion of fossil fuels, environmental and geographical conflicts, the greenhouse effect, global warming, and fluctuations in fuel prices. Renewable energy is considered to be a sustainable energy source since it is less harmful to the environment and produces less emissions of gases. Additionally, it is beneficial to society based on all aspects, including economic, social, and environmental considerations. It is estimated that over 1.6 billion people do not have access to electricity, and approximately 1.1 billion people do not have access to water supplies. The world's energy demand can be met by renewable energy resources, which also have the potential to safeguard the environment and ensure energy security. Despite the fact that these resources have a number of outstanding advantages, they also have a few drawbacks. One of these drawbacks is the fact that the output of wind and hydroelectric power plants can vary due to seasonal changes. As a result, these plants require a special design and consideration, which can be satisfied by the hardware and software that has been developed as a result of advancements in computer technology.

Energy benefits

The successful completion of the SAI goals for photovoltaic (PV) installation will result in the generation of a substantial amount of power resources, which will result in the displacement of generation from more conventional sources. Calculating the quantity of power generation that will be produced as a result of both the high and low scenarios is the initial step in the process of assessing the benefits that the SAI will provide. Following that, the estimates of the PV energy are utilized in order to ascertain the economic and environmental benefits that are discussed in later sections of this research.

A comparison of the high and low scenarios is presented in Table 1, which illustrates the expected annual PV electricity generation that would be produced if the SAI were to fulfill its PV installation goals. The National Renewable Energy Laboratory (NREL) calculated that the average yearly solar capacity factor was 19 percent based on national solar insolation data1. These results are based on that estimate. The actual levels of insolation will differ depending on the position or orientation of the sun. Comparatively, the Energy Information Administration (EIA) estimates that in 2004, 397 megawatts (MW) of photovoltaic (PV) capacity was added across the country, resulting in the production of 579,000 megawatt hours (MWh) annually, which corresponds to a capacity factor of roughly 17 percent2.

On the basis of these assumptions, it is anticipated that the SAI will generate 10–20 TWh/yr of photovoltaic electricity in the year 2015, and 110–170 TWh/yr in the year 2030, based on the installed PV capacity in both the high and low case scenarios. EIA forecasts that the total amount of energy generated in the United States will be 4,713 TWh/yr in 2015 and 5,788 TWh/yr in 20303. As a consequence of this, photovoltaics would be responsible for the displacement of around 0.2–0.4 percent of the entire electrical generation in the United States in the year 2015 and between 2–3 percent of the overall generation in the year 2030. According to the findings of the Residential Energy usage Survey conducted by the Energy Information Administration (EIA) in 2001, the average annual power usage of households in the United States is approximately 10,000 kWh. PV would consequently generate sufficient electricity to power between one and two million households in the year 2015 and between ten and twenty million homes in the year 2030 under the SAI.

Table 1: Estimated SAI PV Generation and Total U.S. Electricity Generation

Scenario	Installed PV Capacity (GW)	PV Generation (TWh/yr)	Total U.S. Generation (TWh/yr)	PV Percent of Total Generation
2015 Low	5	8.3	4,713	0.2%
2015 High	10	16.6	4,713	0.4%
2030 Low	70	116.5	5,788	2.0%
2030 High	100	166.4	5,788	2.9%

In the process of generating energy, the SAI will be able to eliminate the need for natural gas, which is one of the most significant advantages. PV generating is well adapted to balance a portion of peak electricity demand, which is typically provided by natural gas power plants. This is because PV output is highly associated with peak demand on the electricity system, which means that PV generation can very effectively counter peak demand.

The following assumptions were used to calculate the amount of natural gas fuel savings that may be achieved for each of the SAI capacity scenarios:

1. According to Denholm and Margolis (2006), photovoltaic (PV) generation from fossil fuels would completely replace fossil fuel generation at relatively low penetration levels, which would be less than ten percent of overall energy generation.
2. Based on the findings of various studies that were analyzed for this research, it is expected that the transmission and distribution (T&D) losses for fossil fuel generating are approximately 7 percent on average across the board. This indicates the amount of electricity that is lost as it moves through the wires from the power plants that generate it to the people who utilize it. As a result of these losses, fossil fuel plants are required to generate seven percent more electricity than photovoltaic systems in order to supply end-users with an equivalent quantity of electricity.
3. According to the findings of Connors et al. (2005), who conducted a recent study on the load-shape following features of the United States electrical generation system, seventy-five percent of the generation from photovoltaic technologies would displace the generation from natural gas. The remaining twenty-five percent of photovoltaic generation would primarily replace coal-based generation.
4. During the years to come, it is anticipated that the average heat rate for all natural gas plants that are offset by photovoltaic power will be 7,100 BTU/kWh. There is a wide range of heat rates for natural gas plants, which changes depending on the type of plant and the year it was built. Compared to the heat rate of a conventional natural gas combustion turbine (NGCT), which is 11,100 BTU/kWh, the heat rate of modern natural gas combined cycle (NGCC) facilities in india is significantly lower, coming in at 7,100 BTU/kWh (Margolis 2006). It is anticipated by the EIA that the heat rate of new NGCC plants will continue to decrease over the course of time, reaching a minimum of 6,333 BTU/kWh in the year 20155. The assumption for this analysis is that the natural gas offset by PV will come from a combination of existing and new NGCC and NGCT facilities. It is for this reason that an average heat rate of 7,100 BTU/kWh is anticipated.

On the basis of these assumptions, the predicted savings in natural gas that will be achieved by the SAI are around 0.05–0.1 quadrillion BTU (quads) in the year 2015 and 0.5–1.0 quads in the year 2030. In 2015, the EIA forecasts that the overall consumption of natural gas in the United States will be 26 quads, and in 2030, it will be 27 quads.6. Due to the SAI, it is anticipated that photovoltaic (PV) power will displace between 0.2 and 0.4 percent of natural gas use in the year 2015, and between 2 and 4 percent of natural gas usage in the year 2030.

When considering the prospective impact on liquefied natural gas (LNG) imports, one further method to analyze the benefits of lower natural gas usage is to take into consideration the potential impact. The demand for LNG in the United States has expanded by a significant amount between the years 1997 and 2005, with a significant portion of this demand being driven by the increased consumption of natural gas for the generation of electricity.7 The consumption of natural gas for the creation of electricity climbed by 1.8 quadruples, which is equivalent to 43 percent, during this same time period.

Economic benefits

In the event that the SAI is successful in achieving its installation goals, it will trigger a substantial number of economic activities, as resources will be focused into companies associated to solar energy. Despite the fact that this activity will be partially compensated by decreasing economic activity in other sectors, the new PV resources will displace more conventional power sources, which will result in a loss in economic activity overall.

On the other hand, the gross impacts of the SAI only take into account activities that are associated with photovoltaic (PV) construction, installation, and maintenance. They do not take into account the expenditure that is not being done in other energy sectors. For the purpose of this research, ECONorthwest also compared the expected consequences of the SAI to a counterfactual scenario in which the majority of the power that would be supplied by PV is instead assumed to be provided by natural gas facilities. The term "net impact of the SAI" refers to the difference in economic impacts that occur as a result of the hypothetical situation versus the hypothetical situation that really occurred. This signifies that the SAI would result in 100 more jobs than would have occurred in the event that the SAI was not achieved and electricity was instead delivered by natural gas generation. For instance, if a net impact of 100 new jobs is reported, this indicates that the SAI would result in 100 more jobs than would have occurred. In this portion of the report, the impacts of the SAI are broken down into two categories: gross and net.

Environmental benefits

The purpose of this portion of the report is to provide an overview of the significant environmental and health benefits that could be anticipated as a consequence of achieving the solar generating goals set by SAI and, consequently, reducing the amount of power generated by fossil fuels. In particular, we make an effort to reduce emissions of carbon dioxide, nitrogen oxides, and sulfur dioxide. When conducting our study of these benefits, we make use of the energy calculations that are detailed in the section of this report titled "Energy Benefits." These calculations demonstrate the amount of displaced electricity generation that will occur in the event that the SAI PV installation goals are accomplished.

According to the Environmental Protection Agency (EPA), the generation of electricity is currently the most significant industrial source of air pollutants in the United States. Power plants that burn fossil fuels are accountable for forty percent of the carbon dioxide (CO2) emissions that are caused by human activity,

twenty-three percent of the nitrogen oxide (NOX) emissions that are produced in the country, and sixty-seven percent of the sulfur dioxide (SO2) emissions.'18' In addition to being linked to a wide variety of health issues, these emissions are also responsible for the production of haze and smog. Furthermore, the emission of greenhouse gases, such as carbon dioxide, by power plants that are powered by fossil fuels contributes to an increase in the likelihood of climate change. In contrast, the emissions that are produced by solar power generation are essentially nonexistent because the generation of electricity does not involve the combustion of any fossil fuels.

Basic interpretation with renewable energy and economic growth

Researchers have a lot of disagreements about whether or not the introduction of renewable energy will lead to economic growth. Taking this perspective into consideration, Konuk et al. (2021, 11) conducted an analysis of the panel data spanning the years 1970 to 2017 to investigate the correlation between economic growth and the usage of biomass energy for the N-11 countries. After doing their research, they came to the conclusion that economic growth and the consumption of biomass energy work together throughout the course of time. As an additional point of interest, Jenniches (2018) attempted to evaluate the effects on the area economy that would result from a shift toward the development of renewable energy in his review article. It is quite evident that he is of the opinion that establishing technologies and assessment periods is of crucial importance. According to Doytch and Narayan (2021), the expansion of manufacturing and services was predicted to be affected by the consumption of both non-renewable and renewable sources of energy. The researchers came to the conclusion that renewable energy has the ability to boost growth in high-growth sectors, specifically the manufacturing sector in middle-income economies and the services sector in high-income economies. Over the course of 57 years, from 1960 to 2017, Acheampong et al. (2021) conducted research on the nature of the causal relationship that exists between renewable energy, CO2 emission, and economic growth for 45 indian countries. Acheampong, Dzator, and Savage 2021) have reached the conclusion that there is a causal relationship that goes in both directions between economic growth and renewable energy. This conclusion was reached by using the GMM-PVAR approach. In 2003, Ugur and Sari conducted a study that was relatively old in comparison to other studies, and they investigated the causation relationship between the two series in the top 10 rising economies and the G7 countries. They found that there is a bi-directional causation for Argentina, that there is a causality between GDP and energy consumption for Korea and Italy, and that there is a causative relationship between energy and consumption and GDP for Turkey, France, Germany, and Japan. Furthermore, it was discovered that countries like Argentina, Brazil, Paraguay, Uruguay, and Venezuela have a low percentage of their energy mix that is comprised of renewable energy. An connection between the consumption of renewable energy and fossil fuels was shown to exist for these countries. This effect was found to represent a likely response to periods of scarcity in reservoirs.

Sadly, in spite of the revolutionary efforts that have been made to adopt renewable energy technology, there are still industrialized nations that remain steadfast in their commitment to the consumption of fossil fuels as a means of achieving faster and more stunning economic growth. The economic tranquility that may be achieved through the use of nonrenewable energy sources enriches the coffers of various economies and the lifestyles of their people, but it does not improve the environment. This is in contrast to the positive effects that renewable energy sources have on the environment. There are certain circumstances in which the consumption of renewable energy (at the threshold level) does not have a substantial impact on the economic growth of industrialized countries. There may be no correlation between metrics of economic progress and renewable energy (RE) in certain countries within thechhattisgarh. The percentage of renewable energy in total energy consumption in EU countries has been steadily increasing and has not been much influenced by

economic reasons (Ogonowski 2021). This is despite the fact that there has been some discussion and that the economic conditions have been unstable. There is a possibility that the economic value of replacing renewable energy sources with nuclear power and fossil fuels alone would be extremely high and impossible to achieve. (Park et al., 2016) suggests that if South Korea were to generate electricity and power only through the use of renewable energy sources, the country would incur an additional annual expenditure of 35 trillion Korean won. It is not possible to implement this strategy, and the willingness of customers to pay will be low. In their study, Lema et al. (2021) conducted an in-depth analysis with the purpose of determining the extent to which Chinese investments in renewable energy projects in sub-Saharan Africa result in the creation of direct and indirect economic benefits. Their research showed that foreign direct investment (FDI) and investments in renewable energy projects might potentially have "bounded economic benefits" for the region. These benefits could include the creation of new job possibilities, production and training activities, connectivity with local systems, and other similar activities. Not only that, but the utilization of RE in the region is contingent upon the existence of economic consciousness, public opinion, and widespread participation. Seventy-three percent of Kenyans, both urban and rural, have shown their strong support for the development of renewable energy sources technologies. Additionally, ninety-one percent of Kenyans feel that renewable energy technologies will save money on the cost of electricity and power generation (Oluoch et al., 2020).

CONCLUSION

For the purpose of this study, a comprehensive bibliometric analysis was carried out on 6794 scholarly publications that were retrieved from the Web of Science database. The time period covered by this study was from 1996 to June 2022. Within the context of sustainable development, the goal was to get a full understanding of the intricate relationship that exists between renewable energy and economic growth. As a result of the analysis, interesting insights were supplied into the research environment, important papers, notable authors, and developing themes in this important area of study.These findings highlight the enormous significance of exploiting renewable energy sources as a catalyst for long-term economic development. The study was conducted to investigate the significance of this topic. Renewable energy sources represent a shift toward an economy that is more environmentally friendly and successfully lessen the negative environmental impacts that are associated with traditional energy sources. Implementation of renewable energy sources is an indication of this shift. Renewable sources of energy, in addition to their positive effects on the environment, also provide promising commercial options, which can help maintain energy stability, contribute to the expansion of regional economies, and generate employment opportunities. In order to disentangle environmental degradation from economic growth, it is necessary to do additional research to investigate the potential of technological advancements and environmentally favorable practices. It is possible to obtain substantial information regarding the development of sustainable development by conducting an investigation into the effectiveness of environmentally sustainable behaviors, renewable energy sources, and sustainable technology technologies.

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