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Renewable Energy Consumption and Economic Growth Nexus—A Systematic Literature Review

Miraj Ahmed Bhuiyan[1], *Qiannan Zhang*[1], *Vikas Khare*[2], *Alexey Mikhaylov*[3], *Gabor Pinter*[4]* *and Xiaowen Huang*[1]

[1]School of Economics, Guangdong University of Finance and Economics, Guangzhou, China, [2]School of Technology, Management and Engineering, NMIMS, Indore, India, [3]Department of Banking and Financial Markets, Financial University Under the Government of the Russian Federation, Moscow, Russia, [4]University Center for Circular Economy, University of Pannonia, Nagykanizsa, Hungary

An efficient use of energy is the pre-condition for economic development. But excessive use of fossil fuel harms the environment. As renewable energy emits no or low greenhouse gases, more countries are trying to increase the use of energies from renewable sources. At the same time, no matter developed or developing, nations have to maintain economic growth. By collecting SCI/SSCI indexed peer-reviewed journal articles, this article systematically reviews the consumption nexus of renewable energy and economic growth. A total of 46 articles have been reviewed following the PRISMA guidelines from 2010 to 2021. Our review research shows that renewable energy does not hinder economic growth for both developing and developed countries, whereas, there is little significance of consuming renewable energy (threshold level) on economic growth for developed countries.

Keywords: renewable energy, economic growth, consumption, Next-11 countries, Group 7

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***Correspondence:**
Gabor Pinter
pinter.gabor@uni-pen.hu

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INTRODUCTION

Consuming non-renewable energy may produce output and foster economic development, but undoubtedly it is a significant source of carbon emission and environmental degradation (Awodumi and Adewuyi 2020). Using non-renewable energy sources put countries in a dilemma in policy priority between pollution reduction and economic growth. Thus, whether renewable or non-renewable, the energy should be used carefully and efficiently as its sources are limited. In addition, due to climate change and global warming situation, renewable energy could be the most attractive alternative to fossil fuel, reducing the CO_2 emission process. However, introducing new renewable energy technologies, consuming, and making them available for the citizens, is very time-consuming and costly. On the other side, countries struggle to maintain economic growth and development. Due to the COVID-19 crisis, the situation has been worsening. The governments of both developing and developed nations have to balance spending for climate change mitigation and economic growth.

Moreover, there is still limited information regarding all the perceived critical factors in moving toward fully renewable energy sources. This article shows a comprehensive assessment of how renewable energy systems affect the country's economic growth. In this article, assessment is carried out based on G7 and Next-11 countries. France, Germany, Italy, Japan, the United States, the United Kingdom, and Canada make up the Group of Seven (G7) intergovernmental organization. Government officials from these nations meet regularly to discuss world economic and monetary matters, with each member alternating through the chairmanship.

FIGURE 1 | (Group Seven) G7 and (Next-11) N-11 countries.

TABLE 1 | Top 10 countries that invest in renewable sources.

General information			Technology-specific scores						
Rank	Country	RECAI score	Onshore wind	Offshore wind	Solar PV	Solar CSP	Biomass	Geothermal	Hydro
1	United States	70.2	58.6	59.4	58.1	45.8	44.5	48.9	48.0
2	China	67.8	54.5	55.0	60.0	53.8	52.1	30.3	54.7
3	Australia	66.4	54.5	30.6	57.0	36.0	39.6	18.0	42.6
4	India	65.2	54.1	27.5	62.7	48.9	47.1	26.9	47.8
5	United Kingdom	64.2	57.3	60.5	47.1	11.2	55.9	30.1	44.2
6	Germany	63.7	49.9	51.0	52.1	11.4	50.4	34.5	44.3
7	France	63.5	55.0	52.2	53.5	22.2	46.8	32.6	51.9
8	Japan	61.3	50.3	51.1	48.0	19.2	55.8	50.8	50.1
9	Netherlands	58.8	49.1	45.6	47.1	10.7	45.1	18.6	32.3
10	Spain	58	48.4	27.2	50.7	28.0	38.8	14.5	39.9

Source: Authors' elaboration on data RECAI, 2020.

Along with the BRICs, the Next-11 (or N-11) are eleven countries identified by Goldman Sachs as having a high potential to become the world's largest economies in the twenty-first century, namely, Bangladesh, Egypt, Indonesia, Iran, Mexico, Nigeria, Pakistan, Philippines, South Korea, Turkey, and Vietnam. **Figure 1** shows the name of G7 and Next-11 countries.

Energy resource has been the fundamental element for an economy or economic development (Xiong et al., 2014). It is clear that economic growth mainly depends on energy consumption, which is highly responsible for greenhouse gas (GHG) emissions, particularly CO_2, as stated by Gabr and Mohamed (2020). CO_2 emissions are a by-product generated by primary consumption sources of non-renewable energy, such as fossil fuels (Thollander et al., 2007). Starting from this general environmental framework due to non-renewable sources, several national economies, after having experienced several disasters, have tried to bring about a structural change in production methods and energy use. Some countries have mainly switched to renewable sources, leaving fossil fuels to no longer be based on non-renewable energy sources (Irfan et al., 2021). According to the EY Company's Renewable Energy Country Attractiveness Index (RECAI), which integrates new global trends, the countries with the most significant opportunities for investments in renewables are the United States, China, and India, three large economies that have been competing for these positions for several years now (RECAI, 2020). Implementing renewable energy sources (RES) is essential but still faces some challenges in some European countries. Perception and awareness toward RES are the main challenges in countries such as Montenegro (Djurisic et al., 2020).

One of the world's major power resource user countries, China, has put forward the "double carbon" target to reduce emissions (Jiang et al., 2022). China's domestic market has shown some resilience despite the end of domestic subsidies in December 2020 and the COVID-19 crisis, which affected 10% of new capacity additions. Chinese solar panel production grew by 15.7% compared to 2019 (RECAI, 2020). Australia represents the third, this country has experienced exponential growth in residential photovoltaics, distributing over 10 GW of solar energy to civilian homes and adopting necessary plans to export hydrogen to Asia (RECAI, 2020). India follows, from 7th to 4th place, and thanks to the growth of photovoltaic capacity to meet the ambitious national green goals for 2030 (RECAI, 2020). In addition to G7 and N-11 countries, **Table 1** shows the general information and technology-specific scores of the top 10 countries that invest in renewable energy sources, and **Figure 2** shows the data visualization of the dataset in **Table 1**.

Some studies tried to relate the consumption of renewable energy and economic growth. But most of the studies concern EU countries and other factors. For example Tutak and Brodny.(2022) have tried to

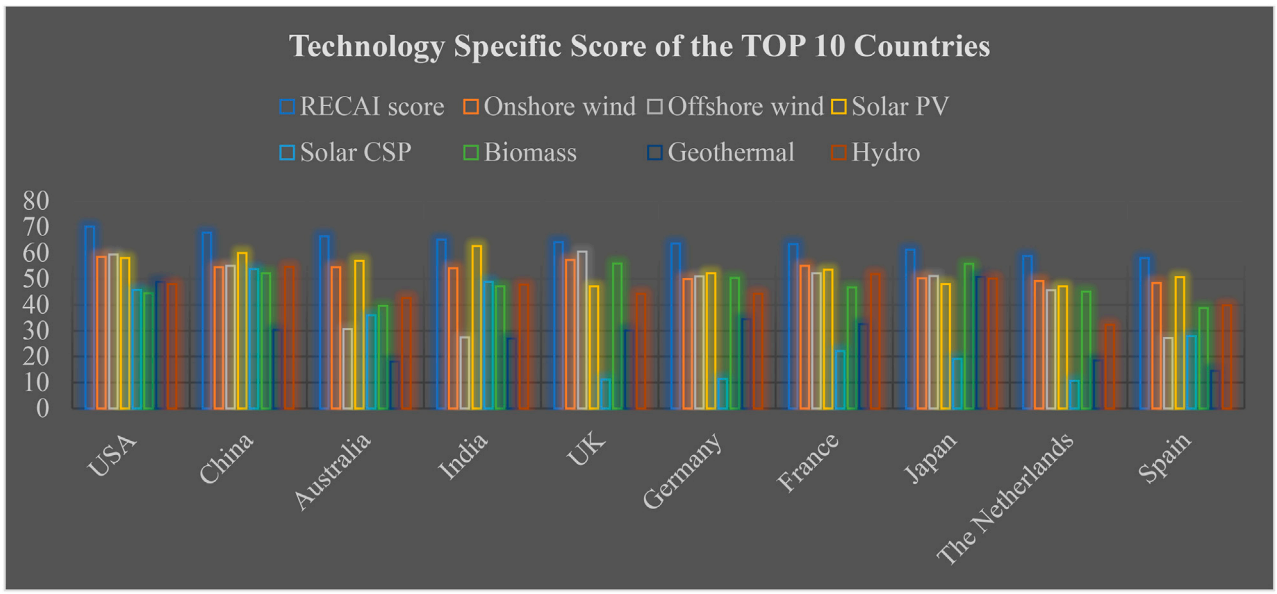

FIGURE 2 | Comparison of technology-specific score of top 10 countries.

analyze the impact of renewable energy on economics, environmental, and conventional energy sources. In addition, (Smolović et al., 2020), by using the pooled mean group (PMG) estimator in a dynamic panel setting (an ARDL model) has carried out a nexus between renewable energy consumption and economic growth in the traditional and new member states of the EU. Furthermore, the panel vector autoregression (PVAR) model (Koengkan, Fuinhas, and Marques 2019) has examined the relationship between financial openness, renewable and non-renewable energy consumption, CO2 emissions, and economic growth in 12 Latin American countries. Furthermore Lorente et al. (2022) found that there is an association between economic complexity and CO_2 emissions is inverted-U and further N-shaped relationship for Portugal, Italy, Ireland, Greece, and Spain.

We have noticed a research gap of systematic review analysis regarding economic growth and renewable energy consumption in recent years by analyzing other existing research work. From this point of view, our study tried to fill the research gap and make it a collection of systematic reviews in this field. Moreover, there were no such systematic reviews (including developing, developed, and underdeveloped countries) in this field of study.

Due to the higher cost of implementing and maintaining, cost-benefit analysis, and other external–internal factors, renewable energy is still under consideration to entirely depend on the energy source. Thus, this is a burning question for the researchers, policy makers, and related organizations whether introducing the renewable energy source would hinder or slow down the economic growth. Many researchers are trying to answer for their respective country or region of interest. No such review work tried to find the nexus between RE and EG for G7 and N-11 countries. This study attempted to gather the related research outcomes and give a broader picture of introducing and using the renewable energy and economic growth relationship.

BASIC INTERPRETATION WITH RENEWABLE ENERGY AND ECONOMIC GROWTH

Introducing renewable energy and economic growth is a widespread debate among researchers. From this point of view, by executing the panel data (1970–2017) (Konuk et al., 2021, 11), examined the relationship between economic growth and biomass energy consumption for N-11 countries. According to their research work, economic development and biomass energy consumption act together in the long run. In addition, Jenniches (2018) tried to assess the regional economic impacts of a transition to renewable energy generation in his review article. He believes clearly that defining technologies and assessment periods is very significant. Doytch and Narayan (2021) estimated the effects of non-renewable and renewable energy consumption on manufacturing and services growth. They have found that renewable energy enhances growth in high-growth sectors, that is, the services sector in high-income economies and the manufacturing sector in middle-income economies. Acheampong et al. (2021) investigated the causal relationship between renewable energy, CO_2 emission, and economic growth for 45 African (sub-Saharan) countries over 57 years (1960–2017). Using the GMM-PVAR method, they have concluded that a bidirectional causal relationship exists between economic growth and renewable energy (Acheampong, Dzator, and Savage 2021). Another old study (comparatively) in 2003 by Ugur and Sari examined the causality relationship between the two series

in the top 10 emerging economies and G7 countries. They have discovered bi-directional causality for Argentina, GDP to energy consumption causality for Korea and Italy, energy and consumption to GDP for Turkey, France, Germany, and Japan. Additionally, it was found that countries such as Argentina, Brazil, Paraguay, Uruguay, and Venezuela have low renewable energy participation in their energy mix. An effect between renewable energy consumption and fossil fuels, as a possible response to periods of scarcity in reservoirs, was detected for these countries (Koengkan et al., 2020b).

In contrast, economic growth may slow down due to energy conservation in the case of the rest four nations (Soytas and Sari, 2003). Another estimation suggested that non-renewable energy consumption has a significant and positive impact on economic activities and development across a large number of Organization for Economic Co-operation and Development (OECD) countries (Ivanovski, Hailemariam, and Smyth 2021). A review of hybrid renewable energy systems (HRES) in developing countries has been conducted by Zebra et al. (2021). They believe Asian developing countries perform better than African nations for renewable and non-renewable mini-grids maintenance and productivity. They also believe that, in general, the costs of mini-grids will continue to decline, making renewable sources even more competitive at the utility scale. Some researchers also tried to find the opposite relationship between economic growth (barriers) and renewable energy development. Seetharaman et al. (2019) believe technological, social, and regulatory barriers hinder the development of RE development, but economic constraints do not directly impact the outcome of renewable energy.

In some countries, renewable energy and consumption do not hinder economic development, and on the other side, it plays a vital role in hindering economic development. So, according to Islam et al. (2022), income growth shows positive and negative effects on renewable and non-renewable energy consumption. Consider that domestic and foreign investments positively affect renewable and non-renewable energy consumption. Furthermore, institutional quality has a positive impact on renewable energy consumption. Instead, the urbanization process has a negative impact on the consumption of renewable energy because it has a positive influence on the consumption of non-renewable energy (Islam et al., 2022).

Unfortunately, despite the revolutionary attempt to adopt renewable energy technologies, some industrial countries are still firm on the consumption of fossil fuels energies with the aim of recording faster and more impressive economic growth (Shrinkhal, 2019; Islam et al., 2021). Contrary to the positive effects on the environment generated with renewable energy sources, the economic serenity that can be reached using non-renewable enriches the coffers of different economies and the lifestyles of their people, but not those of the environment (Doytch and Narayan, 2016). In some cases, renewable energy consumption (threshold level) does not significantly affect economic growth for developed countries. Renewable energy (RE) and economic development indicators may not correlate in selected EU countries. Despite some debate and unstable economic conditions, the share of RE in total energy consumption in EU countries has been systematically growing and was not much dependent on economic factors (Ogonowski 2021). The economic value of solely replacing renewable energy with nuclear power and fossil energy could be very high and infeasible. They consider that electricity and power generation based on only renewable energy would cost an additional 35 trillion KRW/year for South Korea (Park et al., 2016). This method is infeasible, and customer willingness to pay will be low. Lema et al. (2021) by taking in-depth analysis, tried to measure to what extent direct and indirect economic benefits are created when Chinese investments in RE projects in sub-Saharan Africa. Their research revealed that the FDI and investments on RE projects might have "bounded economic benefits" for the region by creating new job opportunities, production and training activities, linkage with local systems, and so on. In addition, economic awareness, public opinion, and mass participation are essential for the use of RE in the region. Citizens of Kenya (73%) (both urban and rural) strongly approved the development of RE sources technologies and (91%) believe that RE technologies will reduce the cost of electricity and power generation (Oluoch et al., 2020).

METHODOLOGY USED IN REVIEW ASSESSMENT

We have considered Group seven (G7: Canada, France, Germany, Italy, Japan, UK, and the United States), countries (as developed nations and the Next-11 (N- 11: Bangladesh, Egypt, Indonesia, Iran, Mexico, Nigeria, Pakistan, Philippines, South Korea, Turkey, and Vietnam) countries (exclude South Korea) as developing countries.

To maintain the whole process, we have followed the PRISMA flowchart explained in **Figure 3**:

The PRISMA method—Preferred Reporting Items for Systematic Reviews and Meta-Analyzes—built a set of minimum elements based on the references highlighted in the systematic reviews and meta-analysis. The primary purpose of PRISMA is to focus primarily on studies that evaluate the effects of certain interventions. However, they can also be used to report systematic reviews that present with different objectives (e.g., from the evaluation of interventions) (Prisma, 2021).

For this purpose, PRISMA was used because it is helpful for the critical evaluation of the published systematic reviews of this study, although it is not a tool for assessing the quality of a systematic review. For the main results of the literature review according to the PRISMA guidelines, we have considered the available online date for the "Year" column. We have followed the MLA style for the author's name. The applied and references related theories are in the "Theories" column. Authors' article methodologies are considered in the "Methods" column. The author's near-future predictions or consequences are listed in the "Predictors" column. The results, conclusions, or outcomes are in the "Outcomes" column, followed by article keywords in the "Keywords" section. We have used google scholar citation for the

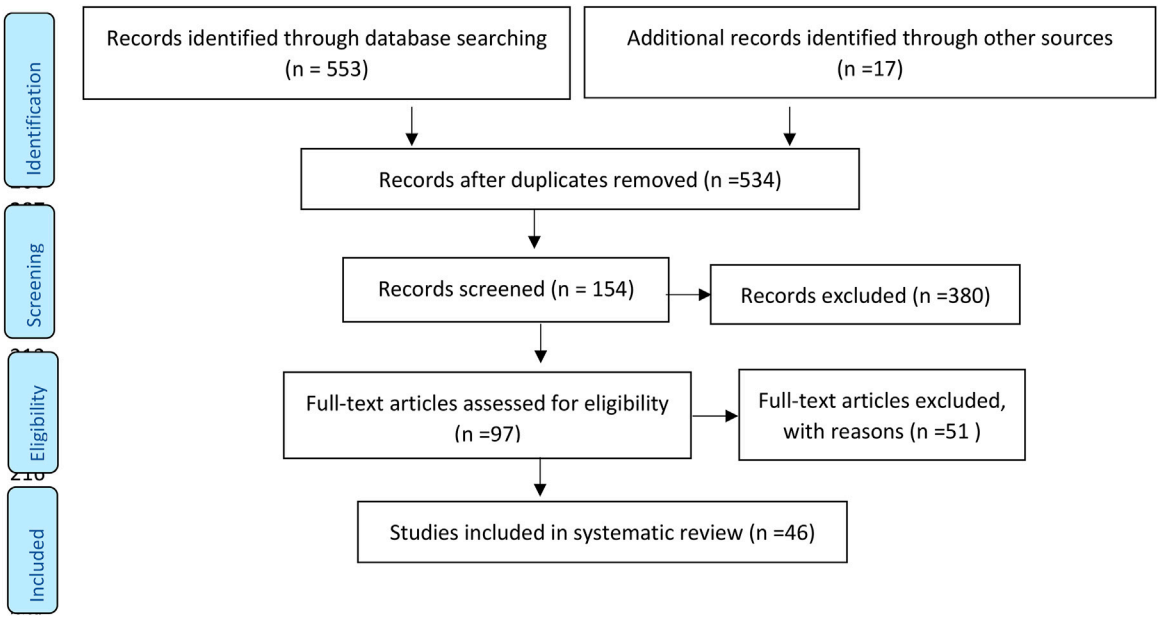

FIGURE 3 | PRISMA flow diagram.

citation column until the last week of December 2021. The citation number may vary as the citations are increasing every day. The last column is "Journal," which denotes the respective article published journal name.

We have used Google Scholar, Scopus, Science Direct, and PubMed for research articles. Initially, we searched the articles using the keywords "Renewable energy" and "Economic growth." We have 553 articles related to good governance and sustainable tourism mentioned in the article's title. There were 17 duplicate articles that we had to remove. We deducted the articles unrelated to the topic content from this initial screening. After removing the irrelevant articles, we had 97 full-text eligible articles. From these 97 articles, we have selected 46 closely matched full-text articles for review (**Figure 3**).

EFFECT OF RENEWABLE ENERGY IN ECONOMIC GROWTH G7 COUNTRIES

While presenting economic prosperity, the G7 countries can still not guarantee environmental well-being. In fact, using the annual frequency data from 1980 to 2016, the impact on the environment of some variables was ascertained using panel data. The results show that financial globalization and eco-innovation reduce the ecological footprint. On the contrary, urbanization stimulates environmental degradation by increasing the ecological footprint values (Ahmad et al., 2021).

Amri (2017), using the dynamic simultaneous-equation panel data approach, investigated, over the period 1990–2012, the relationship between three indicators (economic growth, renewable energy, and trade) in different income groups of countries and underlined the interdependence of these variables. Notably, the main findings reveal a bidirectional nexus between renewable energy consumption and GDP in all groups of nations; a persistent bidirectional relationship among foreign trade and renewable energies in all groups of countries; finally, a bidirectional nexus between trade and economic growth in developed, developing, and others developed countries. In addition, a team of researchers investigated the dynamic effect of RE consumption, biocapacity, and economic growth in the United States from 1985 to 2014. Using the ARDL model, the authors claim that a decline in environmental degradation can attribute to an increase in RE consumption through its negative effect on the ecological footprint. Their study revealed that biocapacity and economic growth would exert more pressure on the ecological footprint. Furthermore, a causal relationship was built between ecological footprint and economic growth and economic growth and biocapacity (Usman, Alola, and Sarkodie 2020).

Armeanu et al. (2021), investigated, using several statistical methods, the interrelationships, over the period 1990–2014, among renewable energy, types of energy, economic growth, CO_2 emissions, and urbanization in different income groups of countries, and highlighted that "In the case of the group of countries with a high level of income, the presence of the co-integration of the renewable energy use with the carbon releases, renewable and nuclear energy, electric power consumption, and the urban population was observed" and the relationship was satisfied, due to the interest of this group of countries to preserve the environment. Furthermore, through the Granger causality test, the authors find a single-bidirectional causal relationship

TABLE 2 | Factor that effected through the renewable energy system.

Country	Factor that effected through the renewable energy system				
	Positive effect = ↑, negative effect = ↓				
Canada	Economic growth ↑	Greenhouse gas emission reduction	Foreign direct investment ↑	Domestic investment ↑	Urbanization ↓
France	Economic growth ↑		Environmental sustainability ↑		Grid parity ↑
Germany	Economic growth ↑		Grid parity ↑		Urbanization ↓
Italy	Economic growth ↑		Environmental sustainability ↑		Grid parity ↓
Japan	Economic growth ↑	Grid parity ↑	Suboptimal quality of life ↑		Policy stabilization ↑
United Kingdom	Economic growth ↑		Grid parity ↑		Environmental sustainability ↑
United States	Economic growth ↑	Grid parity ↑	Suboptimal quality of life ↑		Policy stabilization ↑

between economic growth and energy intensity in the low-income countries, whereas many bidirectional relations among the variables in high-income countries, particularly between energy intensity and CO_2 emissions.

Another study was conducted by Hao et al. (2021) to investigate the effects of green growth on CO_2 emissions for G7 countries over the past twenty-five years, using second-generation panel data methods, for example, the distributive self-regressive-augmented transversal lag model (CSARDL). The results revealed that both short- and long-term GDP growth impact environmental impoverishment. Thus, the thesis that green growth supports the quality of the environment is confirmed. The authors highlighted that any changes in CO_2, GDP, green growth (GG), environmental taxes (ET), renewable energy consumption (REC), and human capital (HC) in one of the G7 countries would have consequences in other G7 countries in an interconnected nexus between G7 countries.

However, at the regional level, total energy consumption positively affects growth, while renewable sources negatively affect development in some regions in low- and middle-income countries (Namahoro et al., 2021a). Instead of testing the relationships among variables with appropriate and feasible econometrics modeling techniques, using panel data methodologies, Li and Leung (2021) evaluated the relationship between energy prices, economic growth, and renewable energy consumption. The results of Li and Lung's study (2021) highlighted the importance of economic growth in supporting renewable energy consumption, especially in G7 countries with developed economies. However, factors that are affected through renewable energy systems are listed in **Table 2**. By focusing on R&D spending and uniform policies, the G7 countries have transformed their economies from copying countries to a community of dynamic economies. As a result, and in tandem with the economy's digitalization. This study examines the relationship between energy, financial, environmental sustainability, and social performance of G7 countries using a data envelopment analysis (DEA)-like composite score. The foundation of this study is formed over the reconstruction and modification of regional emissions and examining aspects such as energy, efficiency, and usage, in addition to the prospect of having a regional development outline. Most prior research used certain essential methodologies to examine emission levels and variance depending on actors connected to energy efficiency, energy structure, financial development, production, industry, technological development openness, and population.

Namahoro et al. (2021b) underlined that renewable energy consumption affects economic growth, using an asymmetric analysis with a non-linear autoregressive-distributed lagged model (NARDL) and causality test. In contrast, Wang and Wang (2020) reveal that in the G7 countries, renewable energy consumption positively affects economic growth. The threshold value changes influence in this positive relationship. Thus, the role of growing renewable energy use to stimulate economic growth is non-linear. For example, if the EU countries increase their renewable energy over a threshold value, the position of renewable energy in supporting economic development is more significant. In the same line, in 2020, Chen et al. (2020) studied the causal link between renewable energy consumption and economic growth using a threshold model. The reference period is 1995–2015, and they confirm that renewable energies positively and significantly affect the economic growth in the OECD countries, whereas no significant effect is in the developed countries. The authors underlined that in developing and non-OECD countries, renewable energies significantly affect economic growth over a certain threshold of their consumption. In addition, Yang et al. (2021) found feed-in-tarrif (FIT) have higher expected output and profit, and lower market prices. The risks of production and gain is of relatively more significant. By contrast, the production and profit of renewable portfolio standard (RPS) remain relatively more stable. In the same year, Sharma et al. (2021) examined the interrelationships between sustainability indicators and financial growth performance, using Arellano–Bond dynamic panel data estimation, system dynamic panel data estimation, and the augmented mean group model. The results highlighted that the transition toward renewable energy is economically in the long run, positively impacting economic growth in line with the environment. From this point of view, total investment in RE and descriptive statistics with technological specific scores by G7 countries are listed in **Tables 3**, **4**, respectively. **Table 3** shows the Renewable Energy Country Attractive Index of different countries, and according to the score it is found

TABLE 3 | G 7 countries that invest in renewable sources.

General information			Technology-specific scores						
S. No.	Country	RECAI score	Onshore wind	Offshore wind	Solar PV	Solar CSP	Biomass	Geothermal	Hydro
1	United States	70.2	58.6	59.4	58.1	45.8	44.5	48.9	48.0
2	United Kingdom	64.2	57.3	60.5	47.1	11.2	55.9	30.1	44.2
3	Germany	63.7	49.9	51.0	52.1	11.4	50.4	34.5	44.3
4	France	63.5	55.0	52.2	53.5	22.2	46.8	32.6	51.9
5	Japan	61.3	50.3	51.1	48.0	19.2	55.8	50.8	50.1
6	Italy	59.7	44.7	31.2	48.8	41.3	38.9	42.2	44.9
7	Canada	57.9	51.8	26.7	43.9	18.3	33.6	17.9	45.6

Source: Authors' elaboration on data RECAI, 2020.

TABLE 4 | Descriptive statistics with technological specific scores of G7 countries.

Index	RECAI score	Onshore wind	Offshore wind	Solar Pv	Solar CSP	Biomass	Geothermal	Hydro
Std	3.95	4.82	13.27	4.71	13.88	8.35	11.52	3.06
Min	57.90	44.70	26.70	43.90	11.20	33.60	17.90	44.20
	Canada	Italy	Canada	Canada	United Kingdom	Canada	Canada	United Kingdom
Mean	62.93	52.51	47.44	50.21	24.20	46.56	36.71	47.00
Max	70.20	58.60	60.50	58.10	45.80	55.90	50.80	51.90
	USA	USA	United Kingdom	United States	United States	Japan	Japan	France
Count	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00
75%	63.95	56.15	55.80	52.80	31.75	53.10	45.55	49.05
50%	63.50	51.80	51.10	48.80	19.20	46.80	34.50	45.60
25%	60.50	50.10	41.10	47.55	14.85	41.70	31.35	44.60

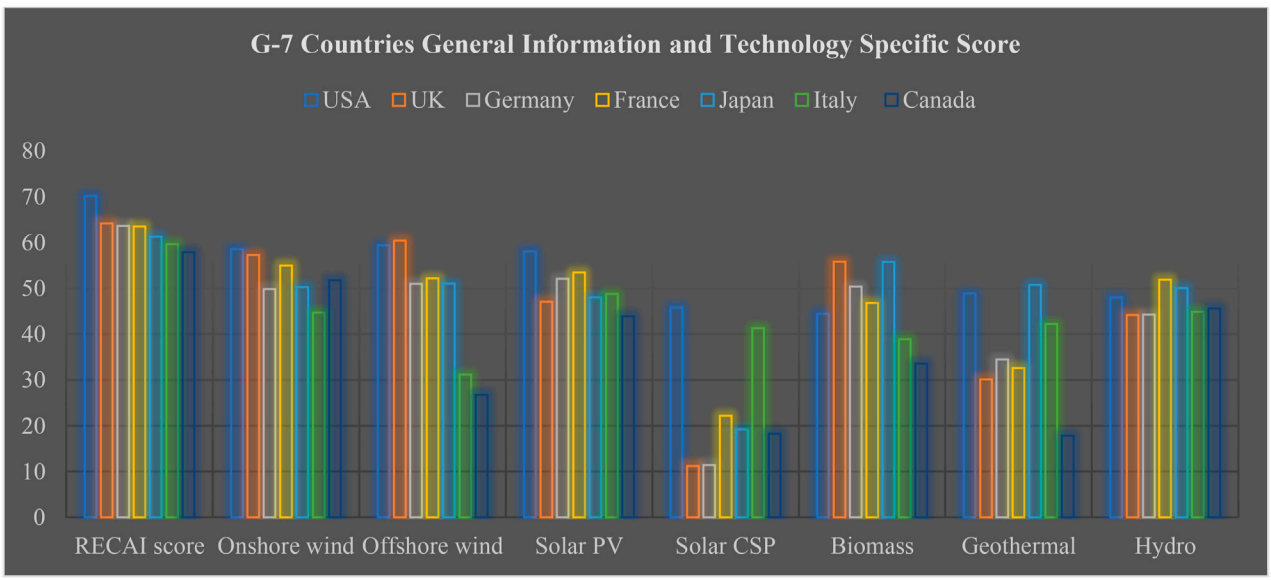

FIGURE 4 | Comparison of technology-specific score of G7 countries. Data source: author elaboration.

out in the USA the growth or electricity generation through the renewable energy in the wonderful way. Overall data also shows the growth rate of the onshore wind energy systems, solar PV, solar CSP, geothermal systems are better in the United States; on the other hand, the offshore wind energy system and biomass systems are popular in the

TABLE 5 | Main results of literature review according to PRISMA guidelines of G7 countries.

	Year	Author	Theory	Method	Predictor	Outcome	Keyword	Citation	Journal
1	2020	Djurisic et al.	Delphi method investigates the behaviors toward RES	Structural equation model (SEM), cause and effect relationship	Positive attitudes and behaviors can improve the RES scenario in Montenegro	Perception toward RES and constructing awareness toward RES is the main challenge	Renewable energy sources; public perception; attitudes toward RES; behavior toward RES; Montenegro	1	Energy reports
2	2021	Yang et al.	Game model of power production and effect comparison between FIT and RPS policy	Compares the effects of feed-in tariff (FIT) and renewable portfolio standard (RPS)	FIT have higher expected output and profit, and lower market prices. By contrast, the production and profit of RPS remain relatively more stable. When the cost is high, the incentive effect of the policy under FIT is better	Once the industry is mature, strategically integrate FIT and RPS to ensure a healthy and sustainable development	Feed-in tariff, renewable portfolio standard, and renewable energy uncertainty	7	Energy Strategy Reviews
3	2021	Ogonowski. P.	Cross sectional analysis	VMCM	The share of renewable energy in total energy consumption in EU countries has been systematically growing and was not dependent on economic factors	In terms of renewable energy development with adapted indicators, Denmark, Luxembourg, and Norway with the highest value of the aggregate measurements and were in the first class	Renewable energy sources, multidimensional comparative analysis; VMCM; and information society development	0	Procedia Computer Science
4	2018	Jenniches, S.	Review collection	Employment ratios, supply chain analyses, input–output models, and computable general equilibrium models	For an impact assessment of current renewable energy developments beyond employment in larger regions and IO tables are the most suitable approach	The findings suggest an overall need to clearly define the topics, such as technologies, that are assessed and evaluated the time period	Regional impacts of renewable energy economic impact assessment, economy and renewable energy literature review renewable energy and economics, guideline impact assessment, and renewable energy sources	102	Renewable and Sustainable Energy Reviews
5	2021	Come Zebra et al.	Hybrid renewable energy systems (HRESs),	Review	In general, the costs of mini-grids will continue to decline, making renewables (hydro, solar, wind, and biomass) even competitive at the utility scale	Despite the considerable growth in the number of mini-grids implemented across the globe, there are still barriers that hinder the successful implementation of these systems in developing regions	Developing countries off-grid rural electrification, hybrid renewable energy systems, ownership models, levelized cost of energy, and reliability of supply	20	Renewable and Sustainable Energy Reviews
6	2014	Xiong et al.	Three methods selecting the initial conditions for the GM (1,1) model	Optimized GM (1,1) model	Proposed model can also be used to forecast energy consumption in other countries	Energy resource has fundamental for economic development	GM (gray model) (1,1) model, initial condition, optimization, China's energy consumption and production, and predicting	61	Energy
7	2017	Amri	Dynamic simultaneous-equation panel data approach to research the bond across economic growth and renewable sort of energy	The Cobb–Douglas production structure and method of moment's generalized (GMM) estimator by Arellano and Bond	Linkage between income and renewable energy consumption, between trade and renewable energy consumption, and between trade and income	Policy makers should develop the renewable energy sector to achieve an important level of economic growth and to incorporate the renewable energy in any liberalization trade strategy. They should facilitate the openness to get a better degree of growth	Economic growth, trade Renewable energy consumption, developed countries, and developing countries	84	Renewable and Sustainable Energy Review

(Continued on following page)

TABLE 5 | (*Continued*) Main results of literature review according to PRISMA guidelines of G7 countries.

	Year	Author	Theory	Method	Predictor	Outcome	Keyword	Citation	Journal
8	2020	Gabr and Mohammed	Economic growth mainly depends on energy consumption	Model for energy management and emissions control (EMEC)	Insulation thermal properties act directly on both energy losses and economics	Economic growth mainly depends on energy consumption	Energy conservation, emissions, fuel switching, HEN, and piping insulation	1	Int. J. Energy Water Resour
9	2007	Thollander et al.	Evaluation of the highland project, two largest Swedish energy program aimed at SMEs	Review	End-use energy efficiency issues at the actual firms	CO_2 emissions as major sources of non-renewable energy	Energy efficiency, energy audits, and industrial energy programmes	204	Energy Policy
10	2021	Irfan et al.	The scale items for the determination of awareness (ARE) derived from Alam et al. (2017)	Questionnaire survey, SPSS (26.0) and AMOS (26.0) software	Analysis of factors influencing consumers' intention to adopt RE in Pakistan	Factors such as consumers' perception of self-effectiveness, environmental concern, cost of RE generation, awareness of RE, perception of neighbor's participation, and belief about RE benefits might affect their intention to adopt RE	Renewable energy, influence factors, consumers, structural equation modeling. Pakistan	23	Environ. Sci. Pollut. Control Ser
11	2022	Md. Monirul Islam et al.	The Bangladesh power sector mainly based on two non-renewable sources, including natural gas and oil	Two different models to categorize energy consumption as renewable energy consumption and non-renewable energy consumption	Growing demand for energy strongly associated with the growth of the population living in cities	Heterogeneous relative effects of economic and demographic factors on renewable and non-renewable energy consumptions in Bangladesh	Renewable and non-renewable energy consumption, income growth, FDI, urbanization, infrastructure, and institutional quality	0	Renewable Energy
12	2019	Shrinkhal	Dramatic environmental degradation caused by human activity in the name of development	Critical analysis of phytomanagement	Evidence on the socio-legal concerns associated with the practical application of phytomanagement techniques	Industrial countries prefer fossil fuels because they favor economic growth	Sustainable development, biofuel, phytoremediation, ILUC, indigenous peoples, food vs. fuel, and technology	4	Phytomanagement of Polluted Sites
13	2020	Wang and Wang	The non-linear relationship between renewable energy and economic growth in OECD countries was investigated by developing panel threshold regression models	The non-linear panel threshold regression (PTR) model	Effect of renewable energy consumption on economic growth is positive. This relationship changes as the threshold value changes, thus the role of growing renewable energy use to promote economic growth is non-linear	The energy transition and the increase of renewable energy will stimulate economic growth. The OECD countries government should boost investments in renewable energy, because the renewable energy consumption is growing	Economic growth, renewable energy consumption, panel data OECD economies, and threshold effect	43	Energy
14	2020	Chen et al.	Causal link between renewable energy use and economic growth by employing a threshold model using a 103-country sample has been investigated	The GMM estimation approach and the sup-Wald test proposed by Seo and Shin in 2016	Nexus between renewable energy consumption and economic growth depends on the amount of renewable energy consumption	Renewable energies positively and significantly affect the economic growth in the OECD countries, whereas no significant effect is in the developed countries. For developing countries to achieve positive economic development from their investment in renewable energy, they need to overcome a certain threshold of renewable energy use	Renewable energy consumption, economic growth, threshold, non-linear effects, and panel data OECD countries	59	Energy Policy

(Continued on following page)

TABLE 5 | (*Continued*) Main results of literature review according to PRISMA guidelines of G7 countries.

	Year	Author	Theory	Method	Predictor	Outcome	Keyword	Citation	Journal
15	2021	Armeanu et al.	The nexus among energy, CO_2 emissions, economic growth, and urbanization has been gathered at the worldwide level	The Pedroni co-integration test, impulse response function, and the Granger causality test	The empirical findings confirmed a long run associations	As energy intensity contributes to lowering the CO_2 emissions, policy makers have to boost companies to use renewable energy by the stimulus of incentives. The renewable energies could promote a offset between ecological scarcity and sustainable economic development	Renewable energy, pollution, economic growth, urbanization, and panel data analysis	11	Renew Sustain Energy Rev
16	2021	Islam et al.	The economic transformation has resulted in various changes in natural resources and energy consumption	Dynamic ARDL simulations' model by Jordan and Philips (2018)	Effect of globalization, foreign direct investment, economic growth, trade, innovation, urbanization, and energy consumption on CO_2 emissions in the presence of institutional quality in Bangladesh over the period 1972–2016	Predict positive and negative shocks occurring in independent variables and their influences on the dependent variable	Bangladesh, CO_2 emissions, dynamic ARDL simulations model, economic factors, environmental degradation, and globalization	15	Environ. Sci. Pollut. Control Ser
17	2016	Doytch and Narayan	Sadorsky's studies, 2010, Sadorsky, 2011 with panel data	Effect of FDI on industrial energy consumption by controlling per capita GDP and energy prices	Effects of sectoral distribution of FDI on renewable and non-renewable industrial energy consumption	FDI contributes to reducing the usage of non-renewable energy	Energy consumption, energy efficiency, capital flows, and sectoral FDI	134	Energy Econ
18	2010	Hallódorsson et Kováacs	Conceptual framework that reflects on the immediate and tangible effects of a sustainable agenda on logistics and SCM	Literature review	Era of the energy climate challenges the nature of business and management activities	Logistics and SCM have a role to play in the transition to a low carbon economy	Supply chain management, energy management, sustainable development, and distribution management	156	International Journal of Physical Distribution & Logistics Management
19	2021	Hao et al.	Green growth sustains environment quality	Second-generation panel data methods	Interconnected nexus between G7 countries	Impact of both short and long-term GDP growth is environmental impoverishment	CO_2 emissions, environmental taxes, green growth, human capital, renewable energy, and sustainable environment	72	Science of the Total Environment

United Kingdom. The Renewable Energy Country Attractiveness Index (RECAI) rates the attractiveness of renewable energy investment and deployment prospects in the world's top 40 markets. The rankings reflect our evaluations of market attractiveness and worldwide market trends. **Table 4** describes the different statistical parameters with central tendency in terms of mean, mode, and median of renewable energy sources. It also finds most of the energy sources are minimum RECAI for Canada and maximum for the United States.

In **Figure 4**, we have listed the comparative technology-specific scores in various factors among G7 countries.

There are also different phenomena in energy sector resources, capacity, and different level scales may have different outcomes. There is a possibility of reducing energy and resource consumption and to advance degrowth-related ideals of energy local production at local and small-scale energy systems in Spain and Greece (Tsagkari, Roca, and Kallis 2021). The authors summarize that despite the degrowth potential of these local energy projects, their prospects are limited to revitalizing local economies and empowering local communities. The summary results of the literature review regarding G7 countries are listed in **Table 5**.

EFFECT OF RENEWABLE ENERGY IN ECONOMIC GROWTH NEXT-11 COUNTRIES

Rural people in impoverished and developing nations lack access to electricity that is dependable, economical, and long-lasting. Even though these countries have limited renewable energy sources, many urban and rural people rely on kerosene, diesel, and other fossil fuels to meet their energy

needs. The renewable energy capacity in the Next-11 nations is shown in **Table 6**.

The Bangladesh's energy sector remains deficient, impeding the country's smooth economic activity, and progress. For greening growth and meeting sustainable development goals (SDGs), increasing the amount of renewable energy in the energy resources mix and reducing and reducing the material consumption utilized for energy generation is critical (Baniya, Giurco, and Kelly 2021). The government attempts to close the gap between supply and demand for electricity by installing short-term power plants, coal-fired power plants, and importing from neighboring nations. However, the country still has a long way to produce and supply enough power. Furthermore, increased FDI inflows connected to energy limit the country's extensive usage of renewable energy. At the same time, increased economic growth and CO_2 emissions in the area, particularly in Bangladesh, stimulate the use of renewable energy (Murshed 2021). Another renewable energy source, tidal power, may play an essential part in the nation's electrical supply by adding to it (Ahmad and Hasan 2021, 25). This will very certainly stimulate the industry and commercial activity along the shore. The answer may be alternatives to current energy sources, such as renewable energy resources. More renewable energy sources will be introduced and consumed, reducing energy scarcity, and promoting economic activity and growth (Bhuiyan, Mamur, and Begum 2021). Researchers such as Alam et al. (2017) proposed a one-way causal relationship between economic growth and overall energy demand (renewable and non-renewable). They claim that even a cautious approach to energy sources would not affect the country's economy, but that because economic success leads to increased energy consumption, Bangladesh must pursue renewable energy and demand-side management (Alam, Ahmed, and Begum 2017). Nigeria, one of the NEXT-11 countries, is one of the Africa's largest fossil fuel exporters. However, this country has recently experienced a significant energy problem. Biofuel has been identified as renewable energy (bioethanol and biodiesel) in recent years. Waste materials and feedstocks are widely available and accessible, potentially fueling Nigeria's socio-economic progress (Adewuyi 2020). Islam et al. describe the economic effect of renewable and non-renewable energy systems. The dynamic simulations approach looks at the influence of income growth, foreign direct investment, domestic investment, urbanization, physical infrastructure, and institutional quality on renewable and non-renewable energy consumption in Bangladesh from 1990 to 2019. According to empirical evidence, income growth positively and negatively impact renewable and non-renewable energy usage. Domestic investment has a favorable influence on renewable and non-renewable energy usage. It has been observed that foreign direct investment has a beneficial effect on renewable energy use. Although urbanization has a negative impact on renewable energy consumption, it positively impacts non-renewable energy consumption. Physical infrastructure has a positive and negative influence on renewable and non-renewable energy usage. Factor that effected through the renewable energy system on N-11 countries is listed in **Table 7**.

Ramadan et al. discuss the economic evaluation of new regulatory tariffs for renewables in Egypt. After 25 years of operation, the results show that adding a CAES system will increase the profitability of the Egyptian government's new tariff for wind installations, with an NPV of $306 million compared to $207 million for a stand-alone wind system. Furthermore, the economic advantages rise if the government incentives for new renewable energy system installations or decreases financing rates. Ghouchani et al. investigate Iran's renewable energy development potential. Three potential possibilities for the Iran's renewable energy sector are examined in this report "long-term technology acquisition programs," "policy stabilization," and "attraction of international investment." The findings indicated that renewable energy policy planning and implementation success is determined by selecting the most adaptive policies to national goals, technological capabilities, and economy. To swiftly and successfully develop and implement a comprehensive renewable energy plan, a thorough analysis of limits, impediments, available facilities and technologies, international sanctions, and foreign investment is essential. Sovacool et al. investigated and provided remedies to the likelihood of corruption in the Mexico's renewable energy sector. The report then examines particular corruption risks in four nations (Mexico, Malaysia, Kenya, and South Africa) before offering five recommendations and solutions to help combat corruption. These approaches include corruption risk mapping, subsidy registries, sunset clauses, transparency initiatives, anti-corruption regulations, and shared ownership models. In the Economic Community of West African States' renewable energy plan framework, Ozoegwe et al. examined Nigeria's solar energy policy goals and tactics. This initiative is advised since the national solar energy strategy document lacks policies on encouraging the solar technology company in Nigeria. The proposals emphasized the requirements of the Renewable Energy Policy of the Economic Community of the West African States, which are currently in place. Case studies supported the recommendations for a community-shared business model for home end users and clusters of small companies in physical market places and an energy management contract business model for large organizations.

Ajayi et al. (2022) examined the influence of sustainable energy on national climate change, food security, and job opportunities in implications for Nigeria. It looked at international data on the links between energy and renewable energy adoption, national development, population growth, job creation, rural–urban integration, and the inherent benefits of renewable energy resources in mitigating climate change and global warming incidents. If Nigeria wants to continue economic growth, particularly in agriculture and food security, renewable energy for power generation must be included in the country's rural development policy. It also shows that renewable energy can minimize its anthropogenic climate change contribution. From this point of view, total investment in RE and descriptive statistics with technological specific scores by N-11 countries are listed in **Tables 8**, **9**, respectively. According to **Table 8**, RECAI of Egypt is maximum, and the growth rate of renewable energy in Egypt is also maximum. **Table 8** also shows that the RECAI score of some

TABLE 6 | Renewable energy capacity in 11 countries.

Country	Renewable energy capacity (MW)
Bangladesh	650.53
Egypt	3700
Indonesia	14690000
Iran	107004.24
Mexico	94500
Nigeria	1562.5
Pakistan	12406
Philippines	10000
South Korea	120500
Turkey	49398
Vietnam	35649

of the countries in the offshore wind, such as Vietnam and geothermal in Egypt is minimal. The World Bank is putting out a long-term offshore wind roadmap for Turkey to issue a tender in the next 2 to 3 years. Following the cancellation of a 1.2 GW offshore wind auction in mid-2018, the World Bank is now in charge of disbursing EU money to support the feasibility and environmental studies in preparation for a second sale. **Table 9** describes the different statistical parameters with central tendency in terms of mean, mode, and median of renewable energy sources. The 57th edition of our Renewable Energy Country Attractiveness Index (RECAI) demonstrates that there is a room for further renewable energy investment and strong demand for it. Institutional investors, in particular, have the ability and desire to offer massive, long-term capital injections required to support the fast-growing global renewable energy sector.

In **Figure 5**, we have listed the comparative technology-specific scores in various factors among N-11 countries.

The impact of renewable energy use on Nigeria's environmental quality in several sectors was studied by Maji and his colleagues. The influence of renewable energy consumption on sectoral environmental quality is being examined in Nigeria as part of the government's effectiveness. A regression analysis was used to estimate a dataset from 1989 to 2019. The per capita indicator, environmental quality indicators, and sectoral output from the agricultural, manufacturing, construction sectors, transportation, oil, residential, commercial, and public services sectors, and other sectors were examined. Adelaja et al. discussed the several barriers to national renewable energy adoption in Nigeria. Despite the privatization of Nigeria's largest power utility company, the Power Holding Company of Nigeria (PHCN), the country's electrical demand is rarely met. Nigeria's electricity output has lately been reduced, despite a massive increase in demand.

To fill the hole, polluting electric generators, inefficient energy sources including candles, kerosene lamps, paraffin devices, and entire energy abstention have all been employed. These problems lead to missed commercial and economic prospects, low quality of life, and missed long-term development potential. Lin et al. looked at how Nigeria's renewable energy program affected the country's total output. Based on Nigeria's Renewable Energy Program aims, this research asks three main questions, Is it possible for Nigeria's economy to be built entirely on renewable energy? Is it feasible to replace non-renewable energy with renewable energy? What is renewable energy's economic impact? This study focuses on the growth of renewable energy in Nigeria. We calculate, among other things, the economic effect, production elasticity, and substitution possibilities of renewable and non-renewable energy sources. Our findings, based on a dataset from 1980 to 2015 and analyzed using the translog production function, demonstrate that capital and labor are the key drivers of output in Nigeria; however, although being positive, the economic effect of renewable and non-renewable energy sources is negligible. Wang and Wang. (2020) studied the non-linear behavior of aggregated and disaggregated renewable and non-renewable energy consumption on GDP per capita in Pakistan. This research looked at how diverse forms of energy, such as renewables, fossil fuels, oil-based electrical generating, and hydroelectric power, impact Pakistan's output. While using fossil fuels to boost economic growth may be beneficial in the early stages of production, it is not helpful in the later stages of production. According to the study, using clean energy, while not beneficial in the early stages of production in expanding production activities in Pakistan, is useful in the later stages of production, not only for production but also for the environment.

Mohamed et al. (2021) in Pakistan discussed the role of renewable energy in combating terrorism. This study looks at the relationship between terrorism, renewable energy, and fossil fuel consumption in Pakistan, taking into account several variables such as economic development and income disparity. Using the autoregressive-distributed lag testing technique, this study evaluated the long-term connection between the examined variables throughout the yearly period of 1980–2015. Their variables have long-term relationships, as shown by the Wald test. The summary results of the literature review regarding the Next-11 (N-11) countries are listed in **Table 10**.

Granger causality identifies the long-term bi-directional causal links between all variables. The research demonstrates short-term unidirectional causes between terrorism and fossil energy, GDP and renewable energy, and wealth disparity and fossil energy, even though there are bidirectional causal links between renewable energy and fossil energy in the near run. In reality, long-term statistics demonstrate that fossil fuels decrease terrorism while renewable energy increases it.

Wang and Wang (2020) studied renewable energy use, economic growth, and the human development index in Pakistan. This study examines the link between renewable energy consumption, economic growth, and the human development index in Pakistan from 1990 to 2014 using the two-stage least square approach. According to empirical research, using renewable energy does not improve Pakistan's human development. Surprisingly, the lesser a country's degree, the higher its income will be. CO_2 emissions also contribute to the enhancement of the human development index. Furthermore, trade liberalization stifles Pakistan's progress in terms of human development. Again, the long-term feedback idea between environmental

TABLE 7 | Factor that effected through the renewable energy system on N-11 countries.

Country	Factor that effected through the renewable energy system					
	Positive effect = ↑, negative effect = ↓					
Bangladesh	Economic growth ↑	CO_2 emission ↓	Foreign direct investment ↑	Domestic investment ↑	Urbanization	
Egypt	Economic growth ↑			Electricity sustainability ↑		
Iron	Economic growth ↑		The attraction of foreign capital ↑		Policy stabilization ↑	
Mexico	Economic growth ↑			Shared ownership models ↑		
Nigeria	Economic growth ↑	Physical market places ↑	Energy management ↑	Environmental quality ↑	Sustainable development ↑	Suboptimal quality of life ↑
Pakistan	Economic growth ↑		Human development ↑		Terrorism reduction ↑	
Philippines	Economic growth ↑		Environmental quality ↑		Service growth ↑	
South Korea	Economic growth ↑	Research and development sector ↑	Environmental quality ↑		Electricity sustainability↓	
Turkey	Economic growth ↑		Electricity sustainability ↓		Environmental quality ↑	
Vietnam	Economic growth ↑		Green job ↑		Tariff price ↓	
Indonesia	Economic growth ↑	Green job ↑	Environmental sustainability ↑	Energy management↑	Research and development sector↑	

TABLE 8 | Next-11 countries that invest in renewable sources.

General information			Technology-specific scores						
S.N.	Country	RECAI score	Onshore wind	Offshore wind	Solar PV	Solar CSP	Biomass	Geothermal	Hydro
1	Philippines	55.8	41.9	17.8	47.1	20.1	39	43.1	40.3
2	South Korea	57.6	38.1	39.6	50	17.9	47.6	13.8	33.4
3	Turkey	55.8	47.2	21.1	47.9	28	37.4	43.6	44.1
4	Vietnam	55.7	44.2	42.9	46.9	16.8	37.1	13	46.1
5	Indonesia	51.4	38.2	18.2	45.3	17.1	42.2	57.6	45.9
6	Egypt	57.8	48.2	15.4	54.5	35.3	20.4	12	23.6
7	Mexico	54.3	42.8	19	47.7	23.9	34.8	42.7	32.2
8	Nigeria	Out of top 40 countries in the RECAI score							
9	Pakistan								
10	Bangladesh								
11	Iran								

Source: Authors' elaboration on data RECAI, 2020.

TABLE 9 | Descriptive statistics with technological specific scores of N-11 countries.

Index	RECAI score	Onshore wind	Offshore wind	Solar PV	Solar CSP	Biomass	Geothermal	Hydro
Count	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00
Mean	55.49	42.94	24.86	48.49	22.73	36.93	32.26	37.94
Std	2.17	3.97	11.36	3.00	6.88	8.41	18.79	8.49
Min	51.40	38.10	15.40	45.30	16.80	20.40	12.00	23.60
	Indonesia	South Korea	Egypt	Indonesia	Vietnam	Egypt	Egypt	Egypt
0.25	55.00	40.05	18.00	47.00	17.50	35.95	13.40	32.80
0.50	55.80	42.80	19.00	47.70	20.10	37.40	42.70	40.30
0.75	56.70	45.70	30.35	48.95	25.95	40.60	43.35	45.00
Max	57.80	48.20	42.90	54.50	35.30	47.60	57.60	46.10
	Philippines	Egypt	Vietnam	Egypt	Egypt	South Korea	Indonesia	Vietnam

influences and human development is supported by causality analysis.

Islam et al. (2022) demonstrate how renewable energy helps Pakistan prosper economically. The research aims to look at the link between renewable energy consumption and economic growth in Pakistan, taking into account capital and labor as possible production function variables. In this work, the autoregressive-distributed lag (ARDL) model and the rolling window approach (RWA) were used to

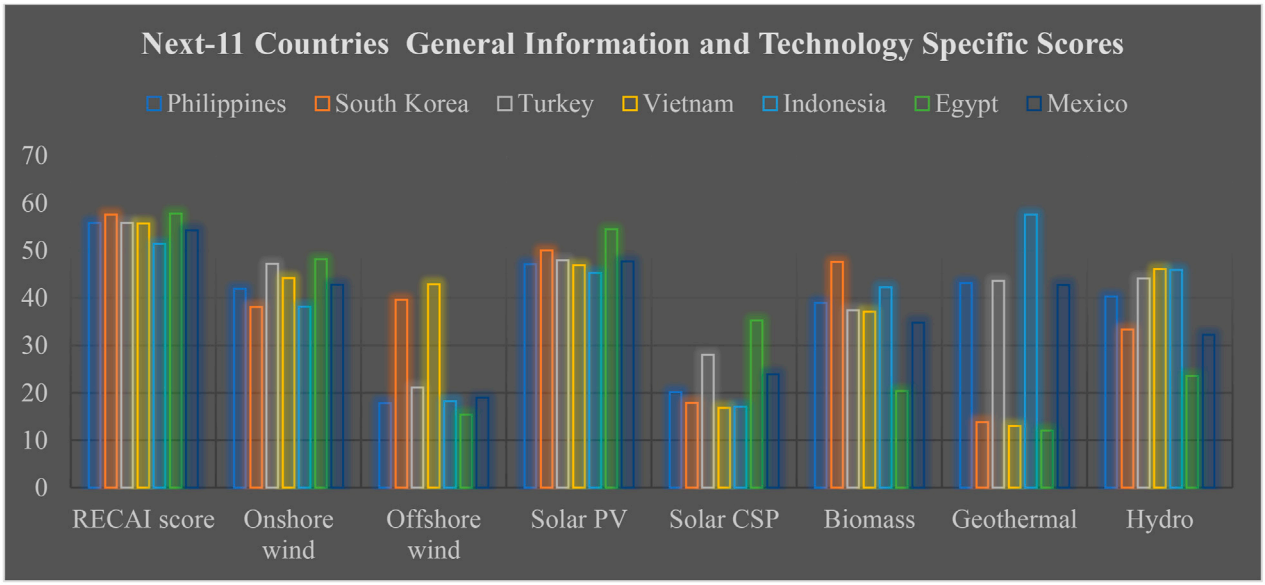

FIGURE 5 | Comparison of technology-specific score of N-11 countries.

integrate data in a Pakistani scenario. Quarterly data from 1972Q1 to 2011Q4 were used in the study. Bertheau and his colleagues looked into it. A geospatial and techno–economic study for the Philippines was based on 100% renewable energy micro-grids. As a result, this study recommends a hybrid approach that combines geospatial analysis, cluster analysis, and energy system modeling: To begin, they identify islands that are not connected to the power grid. Second, cluster analysis is used to identify trends. Third, we perform simulations of energy systems employing solar, wind, and battery storage to generate 100% renewable energy systems. Our research will focus on 649 non-electrified islands with 650,000 people. These islands are grouped into four groups based on population and renewable resource availability. They determined that cost-optimized 100 percent renewable energy systems rely on solar and storage capacity for each cluster, with additional wind capacity. According to Doytch and Narayan (2021), renewable energy boosts economic growth. This study examines the influence of non-renewable and renewable energy consumption on economic development, distinguishing between manufacturing and service growth. Our empirical model is based on an endogenous growth framework with an increasing number of intermediate capital goods that comprise non-renewable and renewable energy inputs. We examine the impacts of non-renewable and renewable energy consumption on manufacturing and service growth, broken down by the type of usage (industrial, residential, and total final energy consumption) while accounting for well-known growth variables. Park and his colleagues looked at the procedures used by South Korean renewable energy cooperatives. This research focuses on citizen participatory RE co-ops as a vital niche in the community-led energy route. This study did a narrative analysis based on the RE co-ops' present state and in-depth interviews. We examined key changes and inertia in the conventional energy system at the national, regional, and local levels by comparing within and across scales. Each scale was made up of a tangle of sub-regimes such as market, policy, and culture. We believe a niche may play a creative role in changing sub-regimes of various sizes based on resources that can be handled, such as money resources, rules, and connections. Sim J et al. looked at the economic and environmental benefits of R&D investment in the renewable energy sector in South Korea. The South Korean government has announced a strategy to invest in renewable energy to shift the country's economy away from fossil fuels and toward renewables. This study assesses R&D investment in six types of renewable energy sources: biomass, waste, solar thermal energy, photovoltaic energy, marine energy, and wind power energy while taking into account several uncertainty factors such as the amount of renewable energy produced, R&D investment, unit price, and risk-free interest rate. According to Yurtkuran et al., agriculture, renewable energy generation, and globalization all influence CO_2 emissions in Turkey. This study investigates the impact of agriculture, renewable energy production, and globalization on CO_2 emissions in Turkey between 1970 and 2017. It uses the Gregory–Hansen integration test, bootstrap autoregressive-distributed lag (ARDL) approach, fully modified ordinary least squares, dynamic ordinary least squares, and long run estimators. The KOF indices for politics, society, and economics are explanatory variables. The Gregory–Hansen test and the bootstrap ARDL approach imply co-integration variables. In Turkey, Shan et al. investigated the role of green technology innovation and renewable energy in achieving carbon neutrality. A Granger causality test determines the causal relationship between green technology innovation, energy consumption, renewable energy, population, per capita income, and carbon dioxide emissions. Green technology innovation, renewable energy, energy consumption, population, per capita income, and carbon dioxide emissions are all co-integrated in the long run. Furthermore, while green technology innovation and renewable energy reduce carbon dioxide emissions, energy consumption, population, and per capita carbon emissions

TABLE 10 | Main results of literature review according to PRISMA guidelines of Next-11 Countries.

	Year	Authors	Theories	Methods	Predictors	Outcomes	Keywords	Citations	Journal
1	2021	Ahmad et al.	Existence of CD and slope heterogeneity issues in the data	Second generation methods, Pesaran and Yamagata (2008) test, second-generation panel co-integration test of Westerlund (2007), short- and long run coefficients using the CSARDL method and the AMG estimator, Dumitrescu–Hurlin causality test	Linkages between EF and its determinants, including economic growth (GDP), financial globalization, eco-innovation, and urbanization in the panel of G7 countries	G7 countries, while thriving economically, have not been able to safeguard the well-being of the environment	Financial globalization, urbanization,eco-innovation, ecological footprint, CS-ARDL, G7 countries	46	Sustainable Cities and Society
2	2021	Namahoro et al.	Total energy is significantly and positively affects economic growth in three income groups	Cross-sectional augmented autoregressive-distributed lagged (CS-DL) and common correlated effect means group (CCEMG)	Negative and neutral effects of renewable energies on growth prevail over those of total energy	Use of renewable sources negatively affects growth in some regions in low- and middle-income countries	Renewable energy, economic growth, energy consumption, CCEMG CS-DL	0	Energy
3	2021	Li and Leung	Test relationships among variables with appropriate and feasible econometrics modeling techniques	Panel data methodologies	Renewable energies as inputs for production processes and real GDP as a measure of the output of an economy (and economic growth)	No evidence of Granger Causality from renewable energy consumption to economic production	Renewable energy, economic growth, coal price, natural gas, price, OECD, Europe	9	Energy Reports
4	2021	Namahoro et al.	Asymmetric nexus of renewable energy consumption and economic growth, and the impact of agriculture and capital on economic growth	Non-linear autoregressive-distributed lagged model (NARDL) and causality test from 1990 to 2015 in Rwanda	Significant negative impact of long-term positive shock and an insignificant positive impact of a long-term negative shock to renewable energy consumption on economic growth	Renewable energy consumption affects economic growth	Renewable energy consumption, economic growth, asymmetric analysis, NARDL	1	Renewable Energy
5	2021	Sharma et al.	Interrelationships between the performance on sustainability indicators and economic growth	Arellano–Bond dynamic panel data estimation, system dynamic panel data estimation, and Augmented Mean Group model	Two-way positive relationship between economic growth and non-renewable energy and a two-way negative relationship between economic growth and renewable energy	Transition to renewable energy is economically feasible in the long term	Sustainability indicators, economic growth, renewable energy, European union, panel data, environmental kuznets curve	7	Renewable and Sustainable Energy Reviews
6	2021	Tsagkari, Roca, and Kallis	Degrowth theory	Case study approach	Local and small-scale energy systems may have the potential to reduce energy and resource consumption	Degrowth potential of local energy projects, their prospects are limited to revitalizing local economies and empowering local communities	Local energy, Degrowth islands, Southern Europe energy transition and energy democracy	1	Energy Research & Social Science
7	2020	Oluoch et al.	Ordered logistic regressions	Ologit regression for renewable energy	Citizens living in both urban and rural areas strongly approve the development of renewable energy technologies (73%) and believe that renewable energy technologies will reduce the cost of electricity (91%)	Most studies of renewable energy diffusion, however, take a top–down approach, focusing exclusively on the policy makers, while neglecting the grassroots perspectives	Awareness, attitudes, acceptance, renewable energy, Kenya, and ordered logistic regression	13	Scientific African
8	2020	Usman et al.	Toda–Yamamoto causality test; Cholesky decomposition test	Autoregressive-distributed lag (ARDL)	Country-specific energy policies that increased the share of RE in the energy portfolio would do a better job	14.79% and 8.91% of RE consumption and trade policy caused 0.60% and 9.88% deterioration in the environment	Ecological footprint; renewable energy consumption, trade policy, and innovation-accounting tests	78	Renewable Energy
9	2021	Konuk et al.	Econometric analysis	CDLM test	Next-11 countries can only realize such a serious, costly biomass energy investment when they achieve economic growth	Conservation hypothesis is valid for the NEXT-11 countries	BEC, economic growth, NEXT-11 countries, and panel data analysis	2	Energy Reports
10	2019	Seetharaman et al.	Theory of diffusion	OLS, SEM, and PLS	Social, technological and regulatory barriers hinder RE development. Not direct relation between economic barriers on RE development	Lower tariff energy solution, higher profit for manufacturers will create satisfied atmosphere for all stakeholders	Business	70	Heliyon
11	2016	Park et al.	Willingness to pay (WTP)	Contingent valuation method	People who are sensitive to economic feasibility do not prefer RE	Government should execute more realistic budget planning regarding RE development	CVM, nuclear power, ordered logistic regression, RE, and WTP	38	Nuclear Engineering and Technology
12	2020	Adewuyi. A.	Production process theory	Case study analysis	Challenges hampering the development of biofuel as a form of renewable energy in Nigeria includes land tenure system, high production cost, weak governmental policies, and competition between biofuel feedstock and food	It might be necessary to create more awareness on the importance of biofuel as well as encourage and create suitable business environment for local and international investors	Bioethanol, biofuel, and renewable energy	51	Energy Reports

(Continued on following page)

TABLE 10 | (*Continued*) Main results of literature review according to PRISMA guidelines of Next-11 Countries.

	Year	Authors	Theories	Methods	Predictors	Outcomes	Keywords	Citations	Journal
13	2021	Lema et al.	In-depth analysis	Author's developed conceptual framework	There might have "bounded benefits" for RE projects by Chinese investors in the sub-Saharan region	Policy makers should be wary of overly optimistic expectations when it comes to assessing the co-benefits of RE projects	Economic co-benefits, RE, investment- centered GVC, China, Africa, Investment projects	5	World development
14	2022	Islam	Renewable and non-renewable energy consumption in Bangladesh	Dynamic autoregressive-distributed lag	Economic factors, urbanization, physical infrastructure, and institutional quality	Foreign direct investment is found to have positive influencing factor for renewable energy consumption	Income growth, FDI, urbanization, infrastructure, and institutional quality	0	Renewable Energy
15	2018	Ramadan	New regulating tariffs for renewables in Egypt	Numerical modeling using MATLAB	Economic investigation was carried out based on calculation of net present value	The results show that the addition of a CAES system would increase the profitability for the new tariff for wind systems set by the Egyptian government with a NPV of $306 m compared to a NPV of $207 m of a stand-alone wind system at the end of 25 years of operation	Economic assessment, energy storage systems, wind energy, and large scale renewable energy	10	Thermal Science and Engineering Progress
16	2021	Ghouchani M.	Perspective on the use of renewable energy in Iran	Delphi method	Long-term technology acquisition programs", "policy stabilization" and "attraction of foreign capital	The success of the planning and implementation of renewable energy policy relies on the selection of policies that are most adaptive with national targets, technical abilities, and the country's economy	Future research cross impact analysis causal-layered analysis	3	Technological Forecasting and Social Change
17	2021	Sovacool B. K.	Examining corruption risks and solutions for the renewable energy sector	20 policy recommendations organized across five themes	New private actors in selected renewable electricity markets in a sample of countries	Corruption can involve covert acts such as diverting public resources for private means, artificially inflating renewable energy costs, or inefficiently allocating contracts	Corruption, transparency, energy governance, wind power, and solar energy	0	Energy Strategy Reviews
18	2021	Ozoegwu C. G.	Strategies against the backdrop of the renewable energy policy of the economic community	Policy-driven business models	The linkages between the objectives and strategies of the policy were examined	The recommendations highlighted the already applicable provisions in the Renewable Energy Policy of Economic Community of West African States	Solar energy, solar thermal, solar PV, energy policy, and solar energy policy	5	Renewable and Sustainable Energy Reviews
19	2022	Ajayi et al.	Sustainable energy for national climate change for Nigeria	Data analysis	National climate change, food security, and employment opportunities	The enormous renewable energy potential across the geopolitical zones of the nation has largely been untapped. While they represent sustained opportunity at making the nation energy sufficient, renewable energy resources require funding for development	Energy development, energy policy Nigeria, renewable energy, and Rural and urban integration	1	Fuel Communications
20	2021	Maji I. K.	Impact of renewable energy consumption on sectoral environmental quality in Nigeria	A regression analysis was used to estimate a dataset for the period of 1989–2019	Environmental quality indicators and sectoral output from the agricultural, manufacturing, and construction sectors, as well as the transportation, oil, residential, commercial, and public services sectors, and other sectors, were analyzed, as well as the per capita indicator	The result shows that renewable energy consumption does not have a favorable impact on the environmental quality of the agricultural sector, manufacturing, and construction and oil sectors	Clean energy, Environment Sectors Institution Nigeria	1	Cleaner Environmental Systems
21	2019	Lin B.	On Nigeria's renewable energy program	Data analysis	The economic impact, output elasticity, and the substitution possibilities of both renewable and non-renewable energies	Based on Nigeria's economic and industrialization agenda, this study agrees with the respective strategies enshrined in the renewable energy program but recommends that its implementation should be gradual and in accordance with Nigeria's economic goals	Economic growth, renewable energy, and translog production function	14	Energy
22	2022	Wang J.	Aggregated and disaggregated renewable and non-renewable energy consumption on GDP per capita in Pakistan	The ARDL bounds test using annual time series data from 1980 to 2019	Renewable energy consumption on GDP per capita	The empirical results disclose that the linear terms of fossil fuel energy consumption and electricity production using oil sources significantly enhance economic growth while the squared terms of both significantly deteriorate economic growth both in the long- and short-run in Pakistan	Electricity production from oil and hydroelectric sources and export value index	1	Energy Strategy Reviews

(Continued on following page)

TABLE 10 | (*Continued*) Main results of literature review according to PRISMA guidelines of Next-11 Countries.

	Year	Authors	Theories	Methods	Predictors	Outcomes	Keywords	Citations	Journal
23	2015	Shahbaz M.	Renewable energy consumption add in economic growth	Autoregressive-distributed lag (ARDL) model and rolling window approach	The causality analysis applied through VECM Granger causality and innovative accounting approaches	The results reveal that all the variables in the study are co-integrated that shows the long run relationship between the variables. Furthermore, renewable energy consumption, capital, and labor boost economic growth	Renewable energy and economic growth	183	Renewable and Sustainable Energy Reviews
24	2020	Bertheau P.	100% renewable energy-based micro-grids	Data analysis	Geospatial and techno-economic analysis	Geospatial analysis, cluster analysis, and energy system modeling are all used together in this approach: To begin, we locate islands that are not electrified. Second, we use cluster analysis to recognize patterns. Third, we simulate energy systems that are entirely made up of renewable energy sources	Hybrid energy system, geospatial analysis, and cluster analysis	16	Energy
25	2018	Sim J.	R&D investment in a renewable energy sector in South Korea	Monte Carlo simulation	Economic and environmental values	The results indicate that the renewable energy production amount has a relatively large influence on both the R&D investment value and the carbon emission reduction amount	Carbon emission reduction, real option, renewable energy, and system dynamics	18	Journal of Cleaner Production
26	2021	Yurtkuran S.	Effect of agriculture, renewable energy production, and globalization on CO2 emissions in Turkey	The Gregory–Hansen co-integration test, bootstrap autoregressive-distributed lag (ARDL) approach	The political, social, and economic KOF indices are used as explanatory variables	The positive economic globalization coefficient indicates that the scale effect is valid in Turkey. In addition, the crisis in 2001 slowed the economic growth rate in the country, which decreased environmental pollution	Bootstrap, ARDL, agriculture, renewable energy production, and KOF index	6	Renewable Energy
27	2020	Kul C.	Renewable energy investment risk factors	Multi-criteria decision methodology	The first stage is the identification of risk factors of REI using the Delphi method. The second stage is the assessment of identified risk factors of REI by using the analytical hierarchy process (AHP). The third stage is the evaluation and prioritization of strategies to overcome risk factors of REI projects by using fuzzy weighted aggregated sum product assessment (FWASPAS)	The FWASPAS analysis concluded a comprehensive and explicit explanation of the RET choices to be the most suitable of six strategies to deal with the investment risk factors for sustainable development in Turkey	Investment risk factors, sustainable development, and Delphi AHP	16	Journal of Cleaner Production

increase. Kul et al. evaluated the renewable energy investment risk factors for Turkey's long-term development. This study uses a three-stage decision framework based on the multi-criteria decision methodology (MCDM) to assess and examine the risk factors of REIs in Turkey. The Delphi approach identifies REI risk factors in the first stage. The analytical hierarchy process is used in the second stage to examine the discovered REI risk factors (AHP). The third stage involves applying fuzzy weighted aggregated sum product assessment to evaluate and prioritize methods for overcoming risk issues in REI projects (FWASPAS). The Delphi technique discovered six primary risk variables and 23 sub-risk factors. Economic and commercial risks emerged as prominent risk factors in AHP research. The energy plan for a new era of economic development in Vietnam was examined by Nong et al. (2020). The prospective implications of such a new power strategy in Vietnam are examined in this research by extending an economic electricity-detailed model. We found that, under a 2030 target scenario, the policy will lower the prices of both fossil- and renewable-based power by 40–78%, benefiting all sectors of the economy by allowing them to replace fossil fuels. Households benefit the most, as indicated by improvements in the per capita utility of 5.64–19.19%. Overall, the Vietnamese economy benefits greatly from the various scenarios, with real GDP increasing by 5.44–24.83%, significantly greater than the results in other countries. Nguyen et al. describe the economic potential of renewable energy in the Vietnam's electrical industry. In a baseline scenario without renewables, coal provides 44% of total electricity generation from 2010 to 2030. Renewable energy has the potential to reduce that amount to 39%, as well as the sector's overall CO_2 emissions by 8%, SO_2 by 3%, and NOx by 4%. Furthermore, renewables have the potential to avoid the construction of 4.4 GW of fossil fuel generating capacity, save local coal, and minimize coal and gas imports, therefore boosting energy independence and security. Omri et al. demonstrate how renewable energy helps offset the adverse effects of environmental issues on socio-economic well-being. The findings of this article demonstrate that 1) CO_2 emissions have unconditionally adverse effects on human development and economic growth; 2) the net impact on human growth of the economy from the interaction among renewable power and carbon intensity are positive, that is, renewable energy reduces the impacts of per capita CO_2 emissions on human development and

economic growth; and 3) sustainable energy interacts with CO_2 frequency and carbon intensity from liquid fuels.

CONCLUSION AND POLICY IMPLICATIONS

Global warming, environmental pollution, and other related issues are no more country-specific problems now. For power generation and carbon dioxide sequestration, the clean development mechanism involves the massive deployment of renewable energy technologies to promote the concept of sustainable development (Latake et al., 2015). In addition to the (greenhouse gas) GHG mitigating potential of renewable energy resources, the energy security guarantee is swiftly becoming a reality with the exploitation of different renewable energy resources. The clean development mechanism is a fundamental idea of the Kyoto Protocol under the canopy of the United Nations Framework on Convention on Climate Change (UNFCCC). However, it was envisaged that the industrialized nations would finance emission reduction mechanisms whereby the fund will be given to developing countries as sponsorship for renewable energy programs. To mitigate this problem, introducing more green technologies and renewable energy sources can be a solution. But, uncertainty, input–output cost analysis, higher production and maintenance cost, skill workforce, enough financial strengths, awareness *etc*., are only a few challenges toward mass sustainable energy development. Thus, in comparison of the effects of feed-in tariff (FIT) with a renewable portfolio standard (RPS) in the developing renewable energy industry uncertainty, FIT has higher expected output and profit and lower market prices. On the other hand, the production and profit of RPS remain relatively more stable. If the cost of renewable energy is high, the incentive effect of the policy under FIT seems better. As the price goes down, the incentive effect under RPS probably continues to rise. According to the aforementioned research, it is found out that the renewable energy sector plays a very vital role in the overall growth of the country. Developing a more renewable energy system is necessary for Pakistan, Bangladesh, and Nigeria.

Renewable energy and natural resources significantly reduce emissions (Usman and Lorente, 2022). Consequently, the environmental impact of CO_2 emissions requires widespread monitoring worldwide to analyze the effects on climate change (eg., floods, landslides, droughts, and increase in global average temperature). All these effects weigh under the economic conditions of each country (Halldó rsson and Kovács, 2010). As Hao et al. (2021), green growth and eco-innovation revolutionize the industrial structure. The G7 countries must focus on a green growth strategy to achieve the SDGs.

In the renewable energy capacity in Bangladesh, Egypt, Indonesia, Iran, Mexico, Nigeria, Pakistan, Philippines, South Korea, Turkey, and Vietnam, it is found that Indonesia plays a vital role using the renewable energy system in the country's economic growth. The installed capacity of the renewable energy system in Indonesia is 14,690,000 MW. On the other hand, the Pakistan study looked at how different types of energy, such as renewables, fossil fuels, oil-based electrical generation, and hydroelectric power, can affect the output level in Pakistan. Our study concludes that while using fossil fuels to boost economic growth may be beneficial in the early stages of production, it is not helpful in the later stages of production. Whereas using clean energy may not be beneficial in the early stages of production in expanding production activities in developing countries, it is beneficial in the later stages of production not only for production but also for the environment. Policy makers should speed up the deep reforms regarding renewable energy to mitigate environmental degradation (Koengkan et al., 2020b). It has been proven that globalization can stimulate renewable energy sources for Latin American countries (Koengkan et al., 2020a). This will be beneficial in the region and at the world stage, developing green energy technologies. Thus, it is suggested that policy makers take advantage of globalization to reduce the costs of RE technologies and develop policies encouraging the access of these technologies by households with low income.

This is to note that the study has some limitations. For example, in this article, we have considered mainly G7 and N-11 countries which reflect primarily developed and developing countries. Meanwhile, many underdeveloped countries were not considered in the study. In addition, we have taken the last 10 years (2010–2021) of published articles for this systematic review. But the world economic conditions have been changing rapidly among nations. If we would consider the recent 5 years, the outcome of the review process may vary.

Furthermore, we have only analyzed English language articles. But there may be other critically related articles published in local languages such as Mandarin Chinese, Russians, and Spanish. Thus, we believe there is scope for more research on this topic area.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/Supplementary Material, further inquiries can be directed to the corresponding author.

AUTHOR CONTRIBUTIONS

MB: conceptualization, methodology, resources and software, writing—original draft, and supervision. VK: original draft. AM: investigation, methodology, writing—original draft, supervision, and formal analysis. GP: data curation, validation, writing—original draft, and writing—review and editing. QZ: Revise, Proofread. XH: Proofread.

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GLOSSARY

AHP analytical hierarchy process

ARDL autoregressive-distributed lag

Brics Brazil, Russia, India, China, South Africa

CAES computer-assisted execution system

CO_2 carbon dioxide

COVID-19 coronavirus disease variant

CSARDL cross sectionally augmented autoregressive distributed lag

CSP concentrated solar power

DEA data envelopment analysis

EDI economic development indicators

ET environmental taxes

FDI foreign direct investment

FIT feed-in tariff

FWASPAS fuzzy weighted aggregated sum product assessment

G7 Group of Seven

GDP gross domestic product

GG green growth

GHG greenhouse gas

GMM generalized method of moments

HC human capital

HRES hybrid renewable energy systems renewable energy

KOF Konjunkturforschungsstelle

MCDM multi-criteria decision methodology

MLA Modern Language Association

N-11 Next-11

NARDL non-linear autoregressive-distributed lagged model

NOX nitric oxide

NPV net present value

OECD Organization for Economic Co-Operation and Development

PHCN Power Holding Company of Nigeria

PMG Pooled Mean Group

PRISMA preferred reporting items for systematic reviews and meta-analyses

PV photovoltaic

PVAR panel vector autoregression

R&D research and development

RE renewable energy

REC renewble energy consumption

RECAI Company's Renewable Energy Country Attractiveness Index

REI renewble energy investment

RES renewable energy sources

RPS renewable portfolio standard

RWA rolling window approach

SCI/SSCI science citation index/social sciences citation index

SDGs sustainable development goals

SO_2 sulfur dioxide

UNFCCC United Nations Framework Convention on Climate Change