

ENTREPRENEURSHIP IN GREEN ENERGY: A REVIEW**Agung Purnomo, Nur Afia, Elsa Rosyidah**¹Entrepreneurship Department, Bina Nusantara University^{2,3}Institute for Research and Community Services, Universitas Nahdlatul Ulama
SidoarjoEmail: agung.purnomo@binus.ac.id**Abstract**

Entrepreneurship in green energy is highly required to ensure everyone can access energy, energy efficiency improvements, renewable energy sources, and increased public and private awareness. This paper attempts to review the body of knowledge and research on entrepreneurship in green energy. Using a systematic literature review of the PRISMA guidelines for conducting and reporting systematic reviews. Several peer-reviewed publications were included following a thorough search of the Scopus databases. The findings demonstrate several publications on entrepreneurship in green energy from the quantitative analysis and perspective analysis. The number of research-related publications each year on entrepreneurship in green energy has been an upward trend. The United States was the top research nation. The most intensive topics of green energy and entrepreneurial industry sectors were bioenergy and financial. This research provides information that has opportunities to be carried out, including research on entrepreneurship in the field of green energy, with the topic of marine energy, geothermal energy, and the health industry sector.

Keywords: Entrepreneurship, Energy, Green Energy, Green Business, Systematic Review

INTRODUCTION

Green energy is forcing the energy sector to meet new standards, such as managing a significantly less predictable energy flow through the system than traditional energy sources (Hviid et al., 2019). Future sustainability of green energy production and assessment of economic, environmental, and social analyses are guidelines for improving manufacturing operations' quantity and quality (Rhofita et al., 2022). Green growth in 'green appropriation' is a complex interaction between neoliberal and disciplinary environments (Siamanta, 2017). Energy is the primary driver of economic growth and is essential for the survival of a modern economy (Ram & Selvaraj, 2012). Entrepreneurship plays a highly significant contribution to the development of green energy.

Entrepreneurship in green energy is highly required to ensure that everyone has access to energy, renewable energy sources, and energy efficiency improvements

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(Mohazzam et al., 2020), increased public and private awareness of technology-based and green entrepreneurship in wind energy conversion systems, for example, has fueled renewable energy growth (Purnomo et al., 2023; Ram & Selvaraj, 2012). Entrepreneurial effectiveness is an extraverted trait. Because independent contractors and SME owners mostly carry out the final stage of green energy implementation, the main research findings are essential for the sustainable energy industry (Janowski & Szczepańska-Przekota, 2022). However, prior research on entrepreneurship in green energy was often limited and has not used a systematic literature review approach (Polas et al., 2022).

A trustworthy, scholarly examination of the body of work on a particular subject or field is known as a systematic literature review (SLR) (Petticrew & Roberts, 2008). A straightforward, repeatable process must be used to find, assess, and synthesize all pertinent studies (Nathaniela et al., 2022). An accounting of the methods used for the document search, document exclusion, document inclusion, and document analysis is provided by protocols, which are described (Jones et al., 2011). An SLR seeks to assemble as much recent, evidence-based research related to the topic under investigation as feasible, regardless of how it was produced (Thorpe et al., 2005). SLRs are renowned for producing rigorous evidence reviews because they urge the adoption of particular strategies that can lower accuracy and bias (Tranfield et al., 2003). This review proposes research questions, what is the status of existing literature and research on entrepreneurship in green energy? From a systematic literature review perspective, this study aims to review existing literature and study entrepreneurship in green energy.

RESEARCH METHOD

This study adhered to the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) standards (PRISMA, 2022) to conduct a thorough literature review. A significant database of the literature was thoroughly reviewed for this investigation. This study searched and annotated relevant documents in the Scopus worldwide database using appropriate keywords linked to entrepreneurship in green energy research. Because academics regard Scopus, it served as the primary source of information due to its reputation as a trustworthy repository for academic works and literature sources in this study (Purnomo et al., 2022). Inclusion criteria (IC) and exclusion criteria (EC) are criteria used to decide which articles or studies to include or exclude in a systematic analysis, as illustrated in Table 1.

Table 1
Inclusion and Exclusion Criteria

No	Inclusion Criteria	Exclusion Criteria
1	Articles on the topic of entrepreneurship and green energy.	Articles outside the topic of entrepreneurship and green energy.
2	Full-text articles can be accessed and read.	Full-text articles cannot be accessed and read.

This research utilized the keyword "green energy" and "entrepreneurship" as illustrated in Figure 1 PRISMA Protocols, in the author's title, abstract, and keywords to obtain pertinent information from the Scopus database. The data mining was limited to yearly data to gather all published data. The following was the search option utilized in data mining TITLE-ABS-KEY ("green energ*" AND entrepreneur*) 2007-2022 as of November 2022. This criterion aims to ensure that articles that are relevant and of high quality are included in the literature review, while those that are irrelevant or of low quality are avoided. Thirty-one articles were located during this phase.

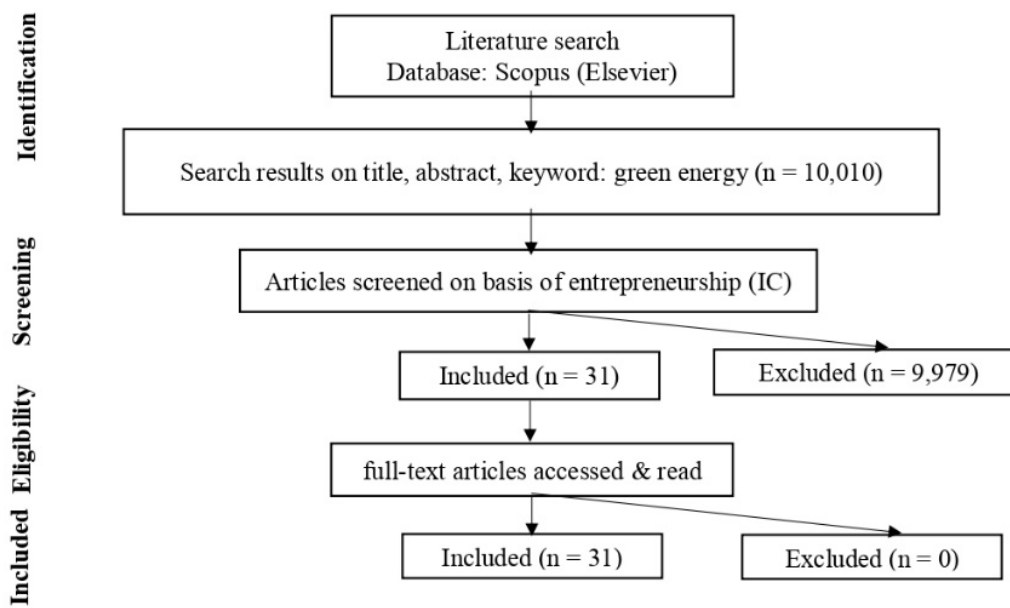


Figure 1
PRISMA Protocols

This SLR uses analysis of perspective and quantitative (Andreini & Bettinelli, 2017). Annual publications and geographic contexts comprised the quantitative analysis. The purpose of using quantitative analysis in this study is to determine the data distribution based on the location of the article publication and the year of article creation (Sanjaya et al., 2023). The perspective analysis uses the perspective of green energy type and entrepreneurship industry sector. Green energy type consists of energy sources from solar, the ocean, the wind, hydropower, geothermal energy, and bioenergy (United Nation, 2022). The entrepreneurship industry includes industrials, basic materials, oil & gas, utilities, financial, technology, telecommunications, health care, consumer services, and consumer goods (Durugbo et al., 2010).

RESULTS AND DISCUSSION

In entrepreneurship in the green energy area, this section discusses the status of existing literature and research based on quantitative and perspective analysis.

A. Yearly Research

The number of worldwide publications on entrepreneurship in green energy research published each year, in general, showed an upward trend, as shown in Figure 2. The graph shows that there have been no publications on entrepreneurship in green energy from 2008 to 2010, 2013, and 2018. The growth rate was astonishingly fast between 2016 and 2017, 2019 and 2022. The growth rate demonstrated in 2007 was two publications. Next, in 2011, the growth rate was two publications, but in 2012 was decreased to one publication. Publications in 2014, 2015, and 2016 were three, one, and two documents. After that, in 2017, it was increased to five publications. 2019 was one publication, and growth trends in 2020 and 2021 were three and four documents. And the last in 2021 and 2022 was increased with four and seven publications.

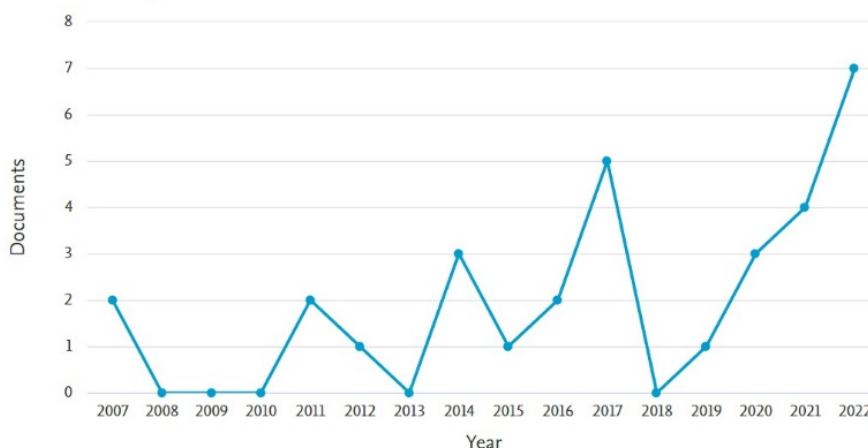


Figure 2
The Entrepreneurship in Green Energy on Sector's Yearly Publications

Research on entrepreneurship in green energy continues to grow due to the combination of environmental concerns, economic potential, and technological advances. One of the main reasons is the increasing demand for renewable energy sources as a solution to climate change and environmental degradation. As the world becomes more aware of the negative impacts of fossil fuels on the environment, there is a growing need for alternative energy sources that are sustainable and environmentally friendly. Another reason for the growth of research on entrepreneurship in green energy is the potential for economic growth and job creation. The renewable energy sector has the potential to create new jobs and stimulate economic growth, particularly in developing countries where there is a need for sustainable development. Furthermore, advances in technology and innovation have made green energy solutions more affordable and accessible, further fueling research and development in the sector. As the cost of renewable energy

technologies continues to decline, there is a growing market for green energy solutions (Polas et al., 2022).

B. Geographical Contexts

Twenty-four nations have studied entrepreneurship in green energy (can be seen in Figure 3). The United States ranked first for research publications on entrepreneurship in green energy (n = 6). Poland and the United Kingdom were next (n = 3). Canada; China; Denmark; India, and Russia Federation were the following countries to join with two publications each. The United States, Poland, and the United Kingdom were the countries with the highest levels of entrepreneurship in green energy publications. The variety of nations demonstrates the topic of entrepreneurship in green energy expanding academic importance and global appeal to contemporary researchers. Also, 58 research institutes from various countries supported research on green energy entrepreneurship.

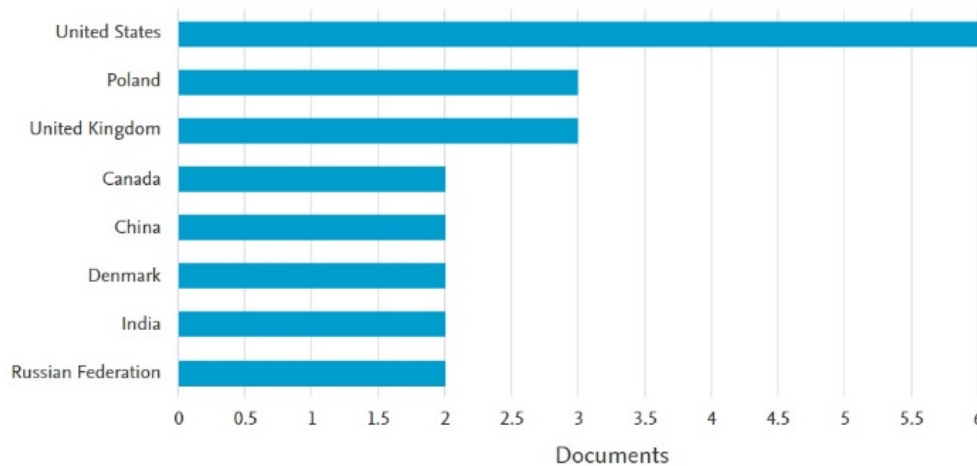


Figure 3
Nation Number of Annual Publication of Entrepreneurship in Green Energy

The United States' success in green energy entrepreneurship is likely due to government support, a strong culture of innovation, and access to capital. First, The US government has supported significant green energy research and development through funding, tax incentives, and other policies. This has helped to create a favorable environment for entrepreneurs to develop new technologies and bring them to market. Second, the United States has a strong culture of innovation and entrepreneurship, which has helped to drive the development of new green energy technologies. This culture encourages risk-taking and experimentation, which is essential for developing innovative solutions to complex problems. Third, the US has a well-developed financial system that provides entrepreneurs access to capital to fund their ventures. This has helped to fuel the growth of green energy startups and enabled them to scale up their operations more quickly. There is a growing demand for clean energy solutions in the United States, driven by concerns about climate change and the desire to reduce dependence on fossil fuels (Aiginger, 2021).

C. Green Energy and Entrepreneurship Perspectives

Research on entrepreneurship in green energy, as seen in Table 2, can be examined using perspective analysis. The perspective analysis uses the perspective of green energy type and entrepreneurship industry sector. The five types of green energy analysis—solar, the ocean, wind, hydropower, geothermal, and bioenergy— have been the studies that have been examined's the main focus (United Nations, 2022).

Table 2
The perspective of Entrepreneurship Industry Sector and Green Energy Type

Entrepreneurship Industry Sector	Green Energy Type					
	Solar energy	Wind energy	Geothermal energy	Hydro power	Ocean energy	Bioenergy
Industrials						(Janowski & Szczepańska-Przekota, 2022) (Sheng & Wang, 2022) (Doukas et al., 2014)
Basic materials				(Jałowiec et al., 2021)		(Brandt & Svendsen, 2016)
Oil & Gas						(Pontin, 2007)
Utilities	(Wang et al., 2022) (Rao, 2011)					(Rhofita et al., 2022) (Mohazzam et al., 2020)
Financial	(Niekurzak & Kubińska-Jabcoń, 2021) (Tanifuji & Uenishi, 2021)	(Amenta & Stagnaro, 2022) (Ratner S.V & Klochko v, 2017) (Ram &				(X et al., 2021) (Car et al., 2020) (R & R, 2017)

	(Siamanta, 2017)	Selvaraj, 2012)	
Technology	(Hviid et al., 2019) (Foss et al., 2014)		(Ciocci, 2007) MENDELEY CITATION PLACEHOLDER 22 (Yakovlev, 2022) (Arslan-Ayaydin et al., 2020) (Chang & Bassue, 2017)
Telecommunications			(Heuër, 2017)
Healthcare			
Consumer services			(Irwin & Klakurka, 2015)
Consumer goods			(Solomon, 2016) (Gorrie, 2012)

In total, seven publications concentrate on solar energy. The papers specifically examine analyzing the construction of higher education innovation and entrepreneurship ecosystems and developing a scientific ecosystem based on user experience in higher education, innovation, and entrepreneurship to realize higher education, as well as presenting employing linguistic variables, a logical and clear multi-method, multi-criteria framework to assess corporate energy and environmental company policies (Wang et al., 2022) (Rao, 2011). The second group explains about presented the findings of a study on the ROI of solar collectors for single-family homes (Niekurzak & Kubińska-Jabcoń, 2021); through the collaboration of multiple organizations, initiatives that may result in new industries in the region now possible (Tanifuji & Uenishi, 2021); photovoltaic project growth based on green energy dis-course (Siamanta, 2017). The third group about Demand Response (DR) technologies can help influence consumers' energy use, but implementation is costly, often far outweighing the benefits to consumers and grid operators (Hviid et al., 2019); a rechargeable lithium-ion battery pack allows for energy storage from this power source while also maximizing energy use (Foss et al., 2014).

There was three publication that uses wind energy to analyze and discusses the mission of entrepreneurship in wind energy conversion systems to combat unemployment and improve the urban environment (Ram & Selvaraj, 2012), effective industrial policy or not (Amenta & Stagnaro, 2022); prospects for establishing and growing Russia has a wind engineering industry, focusing primarily on domestic needs (Ratner S.V & Klochkov, 2017).

Then, two publications on entrepreneurship in green energy analyze the hydropower topics. The first group has based on innovation and motivation, and Opportunities have been found for tackling global challenges, including climate change (Jałowiec et al., 2021). The second group of researchers has investigated and discovered new methods of utilizing more water resources and learning how to maximize existing water resources (Ciocci, 2007)(Polas et al., 2022).

Most of the publications included in this research examine green energy in the context of entrepreneurship by considering bioenergy topics. The first group has noted that the installation and upkeep of solar panels and wind turbines are typically handled by small business owners and independent contractors (Janowski & Szczepańska-Przekota, 2022); the efficiency of the system is shown by the low packet loss rate, robust fault tolerance, high data throughput, and low system power consumption of the educational environment described in this study (Sheng & Wang, 2022); and methodological multi-criteria framework that evaluates corporate energy and environmental initiatives using language variables in a straightforward and cogent manner (Doukas et al., 2014) as the second group of researchers has observed the benefits of local environmental management over potential green components (Brandt & Svendsen, 2016). Biofuel is an alternative green energy source with numerous advantages, including converting it to cellulose-based production (Pontin, 2007). As the third group of researchers has observed, the primary consideration in its development is energy production from biomass residue (Rhofita et al., 2022); the effectiveness of macro factors like institutions, regulations, and policies, as well as micro factors like access to infrastructure, inputs, and finance in influencing private sector decisions to invest in sustainable energy technologies (Mohazzam et al., 2020). A fifth group has observed a microeconomic growth factor whose critical strength is the constant drive for innovation (X et al., 2021); the Green Energy Cooperative's activities as an illustration of a cutting-edge business strategy in the green energy industry that supports the energy transition (Car et al., 2020) and gives a precise the definition of the energy efficiency (EE) and renewable energy (RE) industries (R & R, 2017). Sustainability has an impact on the uptake of green solutions that is both positive and significant, utilizing green energy technology (solar) toward a sustainable green economy (Polas et al., 2022); chances for technological awakening and digital modernization in crucial sectors of the national economy (Yakovlev, 2022); evidence from projects launching initial coin offerings (ICOs) concentrating on different facets of developing the renewable energy sector (Arslan-Ayaydin et al., 2020); and computer-aided design and technology in the modern era (Chang & Bassue, 2017). Other studies talk about understanding local challenges and

needs and having the ability to reach remote beneficiaries through their extended local network (Heuër, 2017). The potential impact of societal culture in serving as a barrier or enabler when creating conditions conducive to innovative endeavors (Irwin & Klakurka, 2015). The last group said that plants support employment and income, environmental security, and social development in addition to meeting the country's energy and food requirements (Solomon, 2016); and the development and construction of a 1.6-megawatt project to be operated under the name Seacliff Energy (Gorrie, 2012).

The entrepreneurship industry includes industrials, basic materials, oil & gas, utilities, financial, technology, telecommunications, health care, consumer services, and consumer goods (Durugbo et al., 2010). The industrial entrepreneurship sector in green energy is the subject of three publications' studies. Two documents related to basic material study in the entrepreneurship sector in green energy. The sectors of oil & gas, utilities, financial, technology, telecommunication, consumer services, and consumer goods on entrepreneurship in green energy have been studied for the number of publications, one, four, nine, seven, one, one, and two. This shows that the financial industry has been studied the most intensively in entrepreneurship in green energy research from the perspective of the entrepreneurial industry sector.

The analysis on there was significant research on entrepreneurship in green energy. Not many studies have examined entrepreneurship in green energy using geothermal energy and ocean energy topics. In addition, there is no research linking entrepreneurship in green energy with the health industry sector. The least researched green energy type for entrepreneurship in green energy was wind energy and hydropower. The least studied entrepreneurship industry sector for entrepreneurship in green energy was the industry sector of basic material, telecommunication, oil & gas, consumer services, and consumer goods. The limited amount of research on entrepreneurship in green energy in a number of these areas opens up opportunities for research gaps to be studied in the future.

CONCLUSION

Entrepreneurship in green energy is highly required to ensure everyone has access to energy, renewable energy sources, improved public awareness of energy efficiency, and private awareness. This research looks into the distribution of publications related to research on green energy, providing quantitative analyses related to entrepreneurship in green energy literature, such as annual publications and geographical contexts. With six papers published on entrepreneurship in green energy, the United States was the top research nation. The number of research-related publications each year on entrepreneurship in green energy has been an upward trend. The most productive type of energy research topic for entrepreneurship research in green energy was the bioenergy research topic, with 18 papers. The most intensive research topic for the entrepreneurial sector for entrepreneurship research in green energy was the financial industry sector, with nine documents.

This review has research limitations using only publications from the Scopus database. A future study that might be conducted, such as studies on entrepreneurship in green energy, uses the energy type topics of ocean energy and geothermal energy. Also, how does research on entrepreneurship in green energy link to the healthcare industry sector? Research on entrepreneurship in green energy on the green business, green products, and green economy is also interesting. This assessment is intended to open the door for a frontier investigation into fields that lack in-depth understanding and advanced analysis.

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