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Research Trends on the Sustainability of Renewable Electricity in Scopus Indexed Journals: from Research Design to Data Analysis

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ABSTRACT

Objectives*: Sustainable electrical energy is electrical energy generated from natural resources that can be continuously renewed and used continuously. This study analyzes the content of several articles published in Scopus-indexed journals between 2022 and 2025 with sustainable renewable electricity as the main focus of the research.*
Methodology*: Adheres to the principle of content analysis, which is focused on the findings of various studies that have been published in scientific journals indexed by Scopus*
Findings*: Current studies have found that in the last three years, the number of publications focused on renewable electrical energy has increased. Among such publications, the most dominant research designed was quantitative. Questionnaires and trend percentages in series are the most commonly used data analysis instruments and methods.*
Conclusion*: In connection with the findings of this study, several recommendations have been proposed for future research that support renewable electrical energy research. Some of these recommendations include increasing the diversity of research types and choosing more appropriate data analysis techniques*

Keywords*: Renewable Energy; Electrical Energy; Energy Efficiency; Sustainability of Electrical Energy.*

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INTRODUCTION

Electrical energy is the backbone of modern economic development (Thaler & Hofmann, 2022a) , However, reliance on fossil energy sources for power generation has contributed significantly to greenhouse gas emissions and environmental degradation (Paraschiv & Paraschiv, 2023) . In recent decades, renewable electrical energy such as solar, wind, hydro, and biomass has emerged as a sustainable solution to reduce these negative impacts (Lopez et al., 2024a). However, the integration of renewable energy sources into the electricity system

still face a variety of technical, economic, and regulatory challenges (Hallste Pérez et al., 2023) . Energy scarcity is the lack of reliable access to modern energy sources (Feng et al., 2023) . Access to electricity has proven to be the engine of social and economic development of many countries (Balcioglu et al., 2023) . Billions of people live without electricity around the world (Adeyemi-Kayode et al., 2023) . Most of these people live in developing countries in sub-Saharan Africa and South Asia (Chowdhury et al., 2023). In developing countries, many remote communities still lack access to affordable, reliable, and sustainable electricity (Goh et al., 2023). In developing countries, most rural areas are sparsely populated, making network expansion far from reality due to its remoteness and geographical constraints (Zebra et al., 2023).

Renewable energy technologies appear to be the most viable option for rural electrification, given the technology's benefits, costs, and the environment associated with resource availability (Alhawsawi et al., 2023a). Stand-alone renewable energy systems are intermittent and varied, which leads to instability in power generation (Tao et al., 2022). Therefore, the application of alternative energy configurations, in particular renewable energy systems with storage devices and backup power of diesel generators (Galimova et al., 2023), is seen as the most appropriate option to address the intermittent nature of renewable resources and meet energy demand in terms of affordability and reliability in developing countries (Sandaka & Kumar, 2023).

Solar, hydro, biomass, and wind power are the most widely used renewable energy technologies (Islam et al., 2023) , hybridized in most cases with diesel reserves due to its potential to increase the fraction of electricity generated by renewables and reduce dependence on diesel systems (Zhao et al., 2025). Global renewable power generation capacity needs to increase by 80% by 2050 to achieve net-zero emissions target (IRENA, 2023) . However, challenges such as intermittency (supply instability), transmission network limitations, and energy storage costs remain major obstacles (Shboul et al., 2025).

Renewable energy is energy that is abundantly available in nature and can be renewable so that it can be used in a surprising way if managed properly. Much of the literature has discussed renewable energy technologies by design and optimization, each with its features and limitations. This research aims to collect information about various studies that discuss the sustainability of renewable electrical energy. In detail, this study is intended to answer the following questions: (1) What is the trend in the number of research on renewable electrical energy from year to year? (2) What are the variations of research designs used to investigate renewable electrical energy?

(3) What are the most frequently used topics to investigate renewable electrical energy? (4) What instruments are used by researchers to investigate renewable electrical energy? (5) What are the data analysis techniques used by researchers to analyze renewable electrical energy?

In some respects, current research differs from previous ones related to the sustainability of electrical energy. First, this research is focused on all articles that have been published from 2022 to 2025; all are accredited by Elsevier Journal. Second, this research is devoted to investigating a number of articles with renewable electricity as the main focus. Third, various parameters are used as the basis for content analysis.

LITERATURE REVIEW

Sustainability Electricity

The effective use of electricity by small, medium, and micro enterprises can help achieve the goals of sustainable life development and reduce poverty by creating job opportunities in the formal and non-formal sectors. This allows the community to participate in income-generating activities and improve the employability of workers (Ugembe et al., 2023) . The significant increase in global electricity demand and pollution has demonstrated the importance of thoroughly analyzing the technological and economic aspects of renewable energy technologies to achieve sustainable energy solutions (Shboul et al., 2025) . Currently, sustainable poly-generation systems are very promising as a pathway that can generate several beneficial energy outputs, such as electricity, heat, and clean water, which have the potential to improve financial competitiveness and increase higher efficiency (Alhawsawi et al., 2023a).

Renewable Energy

Fuels and renewable electricity-based chemicals are expected to play an increasingly important role in sustainable energy systems in the future, e-fuels and e-chemicals are essential to reduce dependence on fossil fuels in sectors that are difficult to reduce emissions, such as long-haul aviation and sea, as well as industrial raw materials (Galimova et al., 2023) . With the increasing demand to develop renewable energy, an assessment of the potential of these renewable energy sources is increasingly needed. For every technology that uses renewable energy sources, there are various methods that can be used to analyze its potential (Kerschbaum et al., 2025) . Reducing carbon emissions in the energy sector to address the impacts of climate change can be achieved by using more electricity from renewable sources, thereby reducing the use of fossil fuels in the energy mix, improving energy efficiency in general, and increasing energy storage capacity (Paraschiv & Paraschiv, 2023).

Electricity Energy

Electrical energy shows how important this energy is for human life and highlights problems and opportunities in developing environmentally friendly energy in the future (Ghisellini et al., 2025) . Increasing global energy demand requires efficiently and sustainably generated electrical energy, liquefied natural gas is emerging as a cleaner alternative to traditional fossil fuels. However, achieving sustainability in liquefied natural gas-based power generation is still a major challenge (Al-Kuwari et al., 2025). The rapid expansion of digital data across various sectors is expected to grow even larger in the coming years, resulting in concerns over environmental impacts, especially in terms of the large use of electricity for data operations (Castro et al., 2024).

METHOD

Research Design

This research adheres to the principle of content analysis, which is focused on the findings of various studies that have been published in scientific journals indexed by Scopus. The research methods used are similar to those used by (Kerschbaum et al., 2025).

Data Source

As a source of data for this research, article data is taken from journals listed in one of the Scopus Index journals, namely https://www.sciencedirect.com which is a journal for sharing problems, solutions, new ideas and technologies to support sustainable development, transition to the future that analyzes new technologies in relation to the existing literature and original research studies that have significant review elements, which can be in the form of criticism and comparison. Furthermore, all articles reviewing renewable electrical energy were collected from each of these journals. The articles analyzed in this study have been published online before June 2025. Of the hundreds of articles collected, there are 44 articles that research Renewable and Sustainable Energy.

Research Instrument

The instrument used in this study is an analysis guideline that covers various related aspects (Table 1). There are as many as 5 main aspects that need to be reviewed for content analysis in this study. These aspects include (1) the number of publications per year; (2) type of research; (3) the subject of the research; (4) data collection instruments; and (5) data analysis methods. Remarkably, the categories in aspects (1), (4), and (5) were not decided at first due to the absence of any prior research that might be referenced to determine what should be included in the categories and the possibility of overly general categories that might arise when the content analysis on multiple articles is performed. In addition, aspects (2) are divided into two sub-aspects, including (2a) general research types and (2b) quantitative research design.

Table 1. Aspects and categories used in content analysis in this study

Aspects	Category	
Type of research (2a)	A.1-R and D A.2-Quantitatif	A.3-Qualitative
Types of quantitative research(2b)	B.1-Observation Studies (OS) B.2-Correlational Research (CR) B.3- Survey Research (SR) B.4-Pre-Experimental Designs (PED)	B.5-True Experimental Designs (TED) B.6-Quasi-Experimental Designs (QED) B.7-Ex Post Facto Designs (EPFD)
Research subjects	C.1-Lithium-ion Battery C.2-Bioenergy C.3-Renewable energy C.4-Liquefied Natural Gas C.5-Gas ko-pyrolysis C.6-Electrical energy consumption	C.7-Waste heat C.8-Hydrosteam power plant C.9-Ethylene and chem cal production C.10-Wind turbines
Data collectioninstruments	D.1-questionnaire sheetD.2-observation sheet D.3-test sheet	D.4-interview sheetD.5-unidentified
Data Analysis	E.1-Mean E.2-Percentage E.3-N-gain E.4-T-test E.5-ANOVA	E.6-ANCOVA E.7-Correlation E.8-Unidentified E.9-Others

Data Analysis

Each article is placed in a specific category based on aspects that fit the criteria of that category. The classification decision is based on the information presented by the author in the abstract,

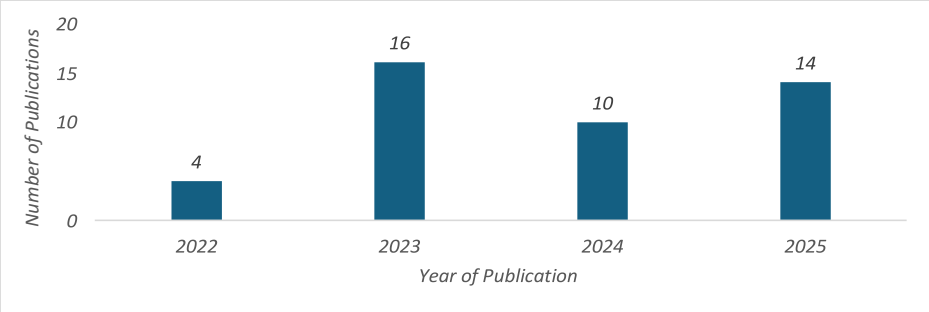
method, and discussion sections. After that, the data that has been collected is displayed in the form of a bar chart.

RESULTS AND DISCUSSION

Number of Publications

The number of article publications indicates how often research was conducted in a given period. Referring to the graph shown in Figure 1, articles reviewing renewable electrical energy can be found as early as 2022. There is no specific pattern of shifts occurring in the number of publications from year to year. Nonetheless, referring to Figure 1, the number of publications since 2023 has increased higher than the previous year. The increasing trend in the number of publications on renewable electrical energy suggests that there is a significant increase in the number of researchers who are passionate about investigating renewable electrical energy.

Figure 1. Trend of increasing the number of journal publications on renewable electrical energy



Most studies come about because researchers are paying attention to common problems that often occur around them. The number of journal publications on renewable electricity continues to increase along with increasing awareness of the importance of clean and sustainable energy. A search in scientific journal databases reveals many published studies regarding various aspects of renewable energy, including potential, technology, and environmental impact.

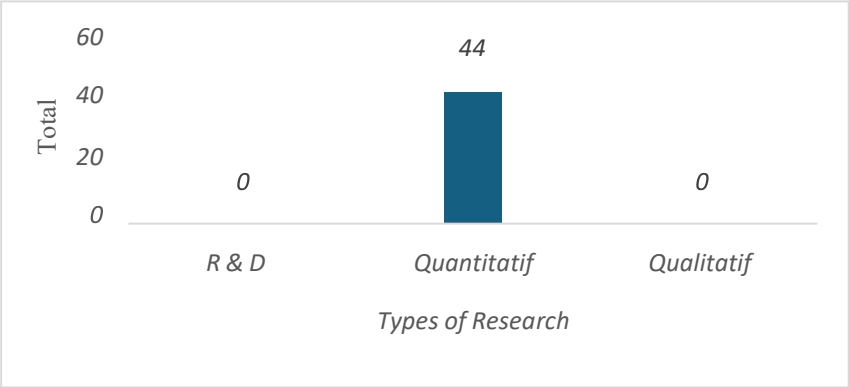
The number of journal publications on renewable electrical energy shows that this field is an active and important area of research. With increasing awareness of climate change and the limitations of fossil energy, renewable energy research will continue to evolve and provide solutions for a sustainable future. Furthermore, a study will influence future researchers for various reasons, namely: (1) the findings can be referred to as credible information that can be implemented by researchers; (2) can be the basic basis for decision-making, in governmental, local, or specific agencies; and (3) the findings may influence the way researchers think further.

Types of Research

The type and design of the research determine the focus of the research. According to Alvin Surya Widiantara et al. (2024) quantitative research consists of data reduction, data presentation, and conclusion formulation. Based on Figure 2, quantitative research is the most dominant design used by researchers to investigate renewable electrical energy. Quantitative research on electrical energy sustainability focuses on the collection and analysis of numerical data to understand how electrical energy systems can operate sustainably. This research involves various aspects, including energy efficiency, use of renewable energy, environmental impacts, and related policies. In addition, the article studied also measures energy efficiency in

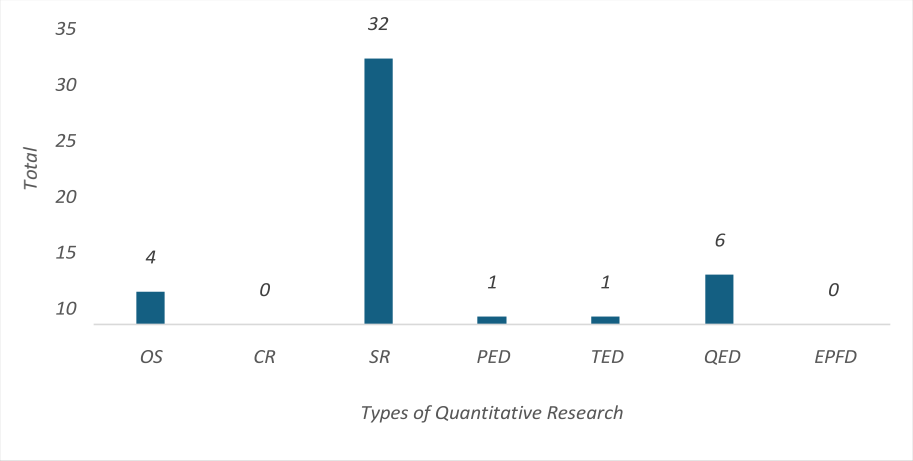
various types of buildings (household, commercial, industrial) and identifies factors that affect energy consumption.

Figure 2. Types of Research



Nevertheless, quantitative research plays an important role in providing data-driven evidence to support the transition to a more sustainable electrical energy system. By analyzing numerical data, the study can provide valuable information for policymakers, energy developers, and the general public to make more informed decisions about energy.

Figure 3. Types of Quantitative Research



In addition to the type of research, this study also aims to uncover the distribution of quantitative research that has been selected by most researchers. Based on Figure 3, survey research design (SR) is the most common research conducted by researchers on renewable electrical energy. The high frequency of use of survey research (SR) over other research designs explains that researchers must choose the one that best suits their research subject (Kerschbaum et al., 2025) . Compared to other experimental designs, pre-experimental designs are the rarest and are only found in a single publication. On the other hand, true experimental design (EPFD), which is said to be the most difficult design to apply to sustainability issues, is not found at all, in publications highlighting renewable electrical energy.

In survey research on electrical energy sustainability, researchers focused on the use of renewable energy and energy efficiency to reduce dependence on fossil fuels and carbon emissions. The survey was conducted to understand public perceptions, identify challenges in the energy transition, and evaluate the potential and impact of the implementation of various renewable energy technologies. The researchers tried to measure people's understanding and attitudes towards renewable energy, their willingness to adopt energy-efficient technologies, as well as their perceptions of the environmental impacts of various energy sources.

Survey research can examine the readiness of infrastructure, regulations, and policies that support the transition to sustainable energy, including the development of renewable energies such as solar, wind, water, and bioenergy (Taloba & Rayan, 2025) . In addition, it can evaluate the environmental impacts of various energy sources, including greenhouse gas emissions, air and water pollution, and impacts on biodiversity (Ghisellini et al., 2025). According to Río et al. (2025) Research can identify the potential of renewable energy resources in an area, such as the potential of solar, wind, water, and bioenergy, as well as the potential for geothermal and ocean waves. Meanwhile, it stated that the research can evaluate the development of renewable energy technologies, including the efficiency of solar panels, wind turbines, energy storage batteries, and other technologies that support the energy transition.

According to Qin et al. (2025) Survey research can examine the financial and investment aspects of renewable energy projects, including initial investment costs, operational costs, and potential return on investment. Survey research on electrical energy sustainability has an important role in providing the information needed to plan and implement a sustainable energy transition (Alhawsawi et al., 2023) . The results of the survey can help governments, industry and society to make informed decisions in support of clean energy and reduce negative impacts on the environment (Xu et al., 2024)

Research Subject

The research subjects on renewable energy are very broad and cover various things, ranging from the type of energy source, how to convert the energy into a form that can be used, to its impact on the environment and society. Some of the main areas of research include the possibilities and ways of utilizing different types of renewable energy such as solar, wind, biomass, and geothermal. In addition, the research also focuses on developing technologies to transform the energy, improving system efficiency, and analyzing economic and policy aspects related to renewable energy.

Based on information about the type of research, survey research design is the most commonly used design by researchers. This suggests that, in general, the researchers are trying to compare some of the best instructional designs in survey research on electrical energy sustainability. In conducting research, researchers need research subjects to examine their hypotheses. Based on Figure 4, the research subjects that the researchers chose the most were renewable energy, followed by electrical energy consumption and bio energy. These findings are in line with research conducted by (Paudel et al., 2023).

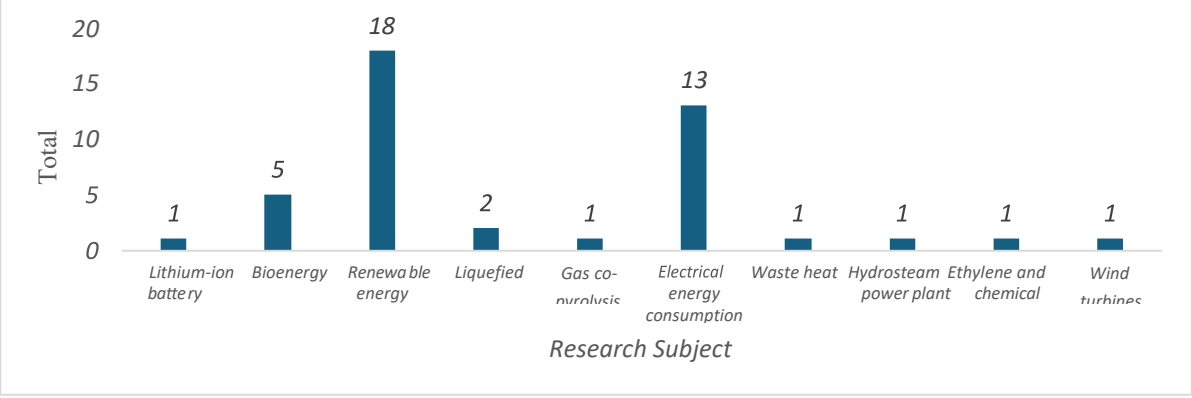
The dominance of research on renewable energy is also shown in the research Hafez et al. (2023) which states that renewable energy shows enormous potential and an urgent need to switch to these energy sources to address climate change and dependence on fossil fuels. Renewable energy, such as solar, wind, water, and geothermal, is a sustainable solution that is environmentally friendly, but it also requires technological innovation, investment, and

supportive policies to maximize its use (Mahmood et al., 2022) . However, it is different from the opinion Salem et al. (2023) which states that some of the challenges faced in developing renewable energy include considerable initial costs, technology that is still in the development stage, and uncertain changes in energy availability.

Figure 4 also shows that the more renewable energy is used, the better the impact on the environment and the economy. From an environmental perspective, renewable energy reduces air pollution and greenhouse gas emissions, and maintains water quality and biodiversity (Lebepe & Mathaba, 2024). Renewable energy, such as solar and wind, does not emit exhaust gases that can damage the air, in contrast to burning fossil fuels (Farghali et al., 2023) . Switching to renewable energy sources could significantly reduce greenhouse gas emissions, thus helping to tackle climate change (Arku et al., 2024). Using renewable energy can reduce the need to explore and take natural resources that damage the natural environment (Otsuka, 2023).

Meanwhile, from an economic perspective, renewable energy encourages local economic growth, opens up job opportunities, and minimizes dependence on fossil fuels which are limited in number (Rashid & Majed, 2023). The construction and management of renewable energy projects opens up new job opportunities in various fields, such as manufacturing goods, buildings, and maintenance (Ameer et al., 2023). While the initial cost of investing may be a bit expensive, the cost of running a renewable energy source is usually cheaper, so it can reduce energy expenditure in a sustainable manner (Thaler & Hofmann, 2022b). With more stable and affordable energy prices, people can get better access to energy and improve their quality of life (Lopez et al., 2024b). An analysis of the literature shows that with energy resources such as solar and wind, the potential of physical resources is often distinguished from the theoretical potential, whereas with biomass and geothermal, this is usually not the case. One reason may be a fundamental difference in the availability of local resources. However, the literature review process has shown that the distinction between physical resources and theoretical potential can be useful because it provides a better picture for the allocation of limiting potentials.

Figure 4. Research Subject



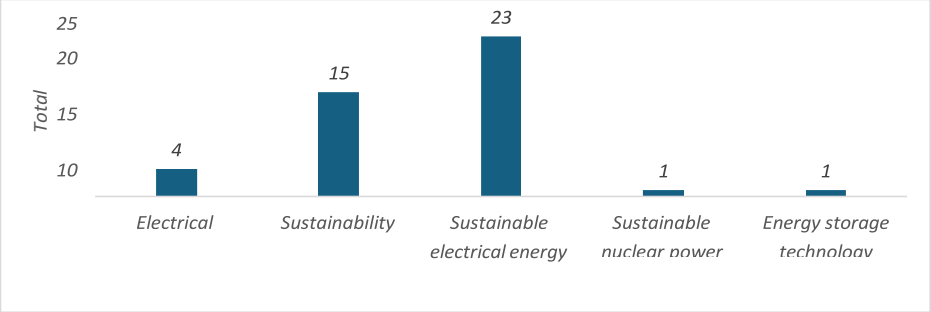
Sustainability Topics Chosen When Conducting Studies

The sustainability topics discussed in various studies cover various aspects of life related to how humans meet current needs without interfering with the ability of future generations to meet their needs. This involves three main pillars, namely environmental, economic, and social.

Sustainable electrical energy, also known as renewable energy, comes from natural resources that can be recovered naturally in a short period of time, such as solar, wind, water, geothermal, and organic matter. In contrast to fossil energy such as petroleum, coal, and natural gas, which are limited in number and have a bad Impact on the environment (Saqib et al., 2023).

Based on this analysis, there are some publications that only discuss one specific topic, while there are also those that emphasize several topics at the same time. Based on figure 5, several topics were selected by the researchers to test their research. In particular, sustainable electrical energy and sustainable efficiency are the most commonly chosen topics to conduct research. From journal publications, researchers with the topic of sustainable electrical energy mostly discuss the potential and challenges in obtaining sustainable electrical energy, renewable energy sources, and environmental impacts of electricity generation. These journals will explain various aspects related to renewable energy, such as solar, wind, water, and geothermal, as well as discuss efforts to reduce dependence on fossil fuels.

Figure 5. Research Topics

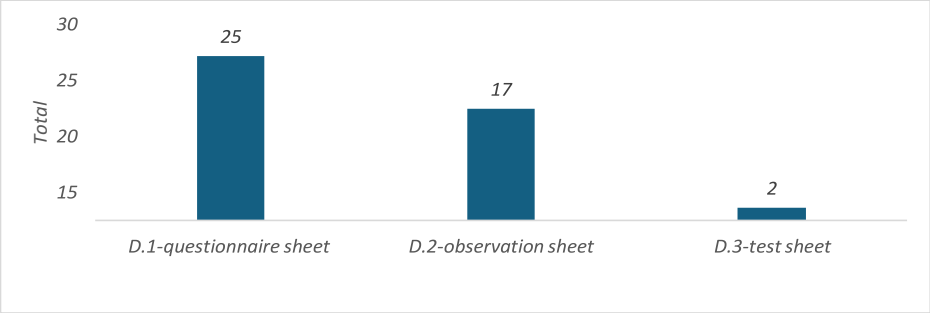


Data Collection Instruments

In conducting research, researchers need instruments to facilitate data collection. Renewable electrical energy research can be assessed using various tools that have been developed by previous researchers. Based on the graph shown in Figure 5, questionnaires have become the most commonly used instrument for collecting data on renewable electrical energy. Data collection in this study was carried out using a questionnaire method consisting of a closed questionnaire about determining criteria, a semi-open questionnaire about a questionnaire that determines subcriteria and the relationship of influence between criteria. In addition, data collection through questionnaires is considered more objective than observation and test methods.

There are several questionnaires in research on renewable electrical energy, questionnaires can be used for various purposes, such as measuring public awareness, their perceptions, and attitudes towards renewable energy, and also to identify obstacles that exist in the process of adopting renewable energy technology. Among them is an awareness and knowledge questionnaire that measures respondents' level of understanding of various types of renewable energy, its benefits, and its potential (Sharifishourabi et al., 2025). In addition, according to Okika et al. (2025) The adoption and behavior questionnaire can measure the extent to which respondents have adopted or plan to adopt renewable energy technologies in their daily lives. In other words, information about validity and reliability is considered important for readers to trust more.

Figure 6. Data collection instruments

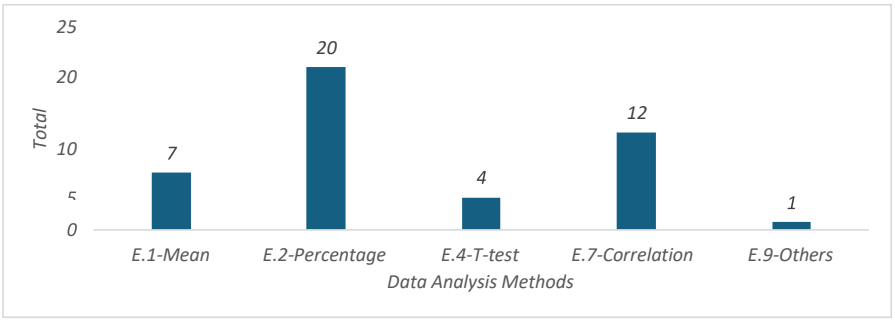


Data Analysis Methods

The accuracy of the selection of methods for data analysis will determine the degree of validity of a study. Referring to the graph shown in Figure 7, there were 25 studies that used survey research designs (Figure 3), but only four studies used t-tests as a data analysis method (Figure 7). Furthermore, Figure 7 shows that percentage is the most widely used data analysis method by researchers. These findings have clarified that researchers often use percentages to display the results of sustainable renewable electrical energy research.

Data analysis using percentages, otherwise known as percentage trend analysis, is a way to find out how data changes relatively from one time to another. This method involves calculating the percentage change between two periods to observe patterns, both up and down. Thus, this analysis helps in understanding how a variable changes in proportion to its original value.

Figure 7. Data analysis methods



The use of the trend percentage method can make it easier for researchers to make comparisons between different time periods, even though the absolute values are different, it can also show how changes occur in proportion, thus clarifying the trends that occur. In addition, the trend percentage method can also be helpful in recognizing meaningful and important trends in the data. So that by understanding and applying trend percentage analysis, users can get useful insights from the data they have, so that they can make more appropriate and profitable decisions.

CONCLUSION

In the current study, articles highlighting sustainable renewable electrical energy published in scopus-indexed journals from 2022 to 2025 have been reviewed. This trend has been found that there has been an increase in the number of publications with the theme of renewable electrical energy as a major concern in the last three years. Among hundreds of publications, quantitative research is mostly found. In addition, the research subject that the researchers chose the most was renewable energy, followed by electrical energy consumption and bio energy. Meanwhile, sustainable electrical energy materials and sustainable efficiency are the most chosen topics.

Questionnaires are the most commonly used instrument to collect data on renewable electrical energy. while the most common trend percentage is used for data analysis. Referring to the findings of this study, several recommendations have been prepared for further research. First, it is necessary to increase the frequency of conducting qualitative research in order to delve deeper into the development of research on sustainable renewable electrical energy. Second, research and development methods that aim to develop sustainable electrical energy must be targeted to increase public awareness of the importance of preserving the environment. Third, future researchers must clearly explain the research tools used, including the validity and reliability of the tools. Finally, it is recommended that researchers select the percentage of trends that are most suitable for the hypothesis and research design in conducting research related to the sustainability of environmental ecosystems.

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