

Accounting for Sustainable Energy: A Systematic Review of the literature on Energy Use Reporting and Management

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ABSTRACT

The increase in global population and economic growth have led to a significant increase in energy demand. This has an impact on increasing greenhouse gas emissions and environmental damage. Greenhouse gas emissions caused by burning fossil fuels have led to significant climate change, such as rising global temperatures and an increase in the frequency of natural disasters. TahapThe initial stage in SLR is to formulate a clear and focused research question. The research question should be well structured and direct the literature search process. In this SLR, research questions are focused on the role of accounting in supporting sustainable energy, with a particular focus on reporting and managing energy use. Sustainable energy management plays an important role in maintaining the environment. By reducing excessive energy consumption and switching to renewable energy sources, we can minimize greenhouse gas emissions that cause climate change, such as global warming. This helps preserve the quality of air, water, and soil for future generations. This study confirms the important role of accounting in supporting sustainable energy use, particularly through effective energy reporting and management. Through a systematic review of the literature, it was found that increased transparency and accountability in energy reporting not only helps companies measure and manage energy consumption, but also encourages broader sustainability practices. The role of sustainable energy accounting provides critical information that allows companies to track energy use and assess the environmental impact of their activities.

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INTRODUCTION

The increase in global population and economic growth have led to a significant increase in energy demand. This has an impact on increasing greenhouse gas emissions and environmental damage. Greenhouse gas emissions caused by the burning of fossil fuels have caused significant climate change, such as rising global temperatures and an increase in the frequency of natural disasters.

Energy sustainability is becoming important to ensure that energy resources are accessible and utilized fairly and sustainably for future generations. Sustainable energy accounting plays an important role in monitoring and managing energy use, identifying efficiency opportunities, and measuring the environmental impact of business activities (Saputra, 2023). This systematic review of the literature (SLR) demonstrates the important role of accounting in supporting sustainable energy. Accounting provides accurate and transparent information, helping organizations measure, track, and manage their energy use, as well as make more informed decisions about their investments and operations (Zarkasih et al., 2024).

Pelaporan penggunaan energi merupakan aspek penting dalam mendorong transparansi dan akuntabilitas terkait konsumsi energi (Ulkhayq et al., 2022). Consistent reporting standards, such as GRI and CDP, improve stakeholders' ability to understand and compare a company's environmental performance fairly, driving wider adoption of sustainability practices.

Effective energy management strategies, such as energy efficiency and renewable energy, can reduce dependence on fossil fuels, reduce greenhouse gas emissions, and improve energy security. Integrasi sistem manajemen energi (EMS) yang terstruktur dapat membantu organisasi mengidentifikasi area penggunaan energi yang tinggi, mengoptimalkan sistem energi, dan membuat keputusan yang lebih terinformasi (Praditya & Utomo, 2022).

Recommendations to improve energy accounting and management include the development of harmonized reporting standards, the development of effective reporting methodologies and tools, increased awareness and commitment on the part of management regarding the importance of energy use reporting, and investment in sustainable energy technologies.

Energy usage reporting includes a variety of practices aimed at improving transparency and accountability regarding energy consumption (Gautama et al., 2023). Salah satu praktik yang umum adalah penerapan kerangka kerja pelaporan yang komprehensif seperti Global Reporting Initiative (GRI) dan Carbon Disclosure Project (CDP) (Sandy Eko Syahputra et al., 2024). The framework provides standards and guidelines for the disclosure of structured and comparable Energy Information. Companies implementing this framework disclose more detailed information about their energy use, carbon emissions, and sustainability strategies, allowing stakeholders to more fairly assess a company's environmental performance (Febrianti, 2024).

In addition, the practice of reporting energy use also involves the development and use of sophisticated energy tracking systems. Sistem ini memungkinkan perusahaan untuk mengumpulkan data yang akurat tentang penggunaan energi mereka dan melacak perubahan penggunaan energi secara real-time (Andreini & Bettinelli, 2017). Informasi ini sangat penting untuk mengidentifikasi area penggunaan energi yang tinggi, mengukur efektivitas program efisiensi energi, dan membuat keputusan yang lebih terinformasi tentang strategi energi (Taufiq & Silaturahmi, 2022).

Praktik pelaporan penggunaan energi yang efektif juga melibatkan komunikasi yang transparan dan terstruktur kepada stakeholder (Syach & Fajrin, 2022). Companies disclose their energy information in their sustainability reports, financial statements or websites. Keterbukaan dan transparansi meningkatkan kepercayaan stakeholder dan mendorong perusahaan untuk meningkatkan kinerja lingkungan mereka (Siahaya & Lingga, 2024).

Although the practice of reporting energy use is growing, some challenges remain. Salah satu tantangan terbesar adalah kurangnya standar pelaporan yang harmonis di seluruh dunia (Aulia et al., 2024). Diverse reporting standards can cause difficulties in comparing energy data between companies and make objective environmental performance evaluations more complicated. Companies operating in different countries with different standards may face challenges in managing energy data and meeting various reporting requirements.

Another challenge in energy use reporting is the lack of effective methodologies and tools to measure and track complex energy consumption. Perusahaan mengalami kesulitan dalam mengumpulkan data yang akurat tentang penggunaan energi mereka, terutama untuk proses dan operasi yang kompleks (Nugrahani & Rahman, 2024). Keterbatasan dalam metodologi dan alat juga mempersulit analisis penggunaan energi dan identifikasi area penghematan energi yang potensial (Prasetyo & Dewayanto, 2024).

Another challenge in reporting energy use is the lack of awareness and commitment on the part of management (Khazaini et al., 2024). Enterprise management must understand the importance of energy use reporting, developing strategies and policies that support transparent and accountable collection and disclosure of energy data.

To address the challenges and improve energy use reporting practices, several recommendations can be implemented. It is important to develop harmonized and globally applicable reporting standards to ensure transparency and fair comparison of energy data. This standard makes it easy for stakeholders to understand and assess a company's environmental performance and encourages companies to improve their sustainability practices (Latifah & Abdullah, 2022).

Selain itu, penting untuk mengembangkan metodologi dan alat pelaporan yang efektif untuk mengukur dan melacak penggunaan energi yang kompleks (Caseba & Dewayanto, 2024). This methodology makes it easy for companies to collect accurate and reliable energy data. Pengembangan alat digital juga dapat memudahkan proses

pelaporan dan meningkatkan efisiensi pelacakan penggunaan energi (Adrian & Totok Dewayanto, 2024).

It is also important to raise awareness and commitment on the part of management regarding the importance of energy use reporting (Qanita et al., 2024). Management should consider energy use reporting as an important aspect of their sustainability strategy and allocate sufficient resources to support effective reporting practices.

Effective energy use reporting has a significant positive impact on the company and stakeholders. Transparent and accountable reporting can increase stakeholder confidence in the company's environmental performance, encourage investment in more efficient energy technologies, and encourage the company to implement more ambitious sustainability strategies (Nurvita et al., 2023)

In addition, reporting on energy use can encourage companies to reduce their carbon footprint and contribute to global efforts to address climate change. Reporting on energy use can also encourage innovation and the development of new energy technologies, which benefit the economy and the environment.

It is important to note that reporting on energy use is not only the responsibility of companies. Governments also have an important role to play in supporting harmonized reporting standards, providing incentives for companies to improve their sustainability practices, and creating an environment that supports the adoption of sustainable energy.

METHODOLOGY

The initial stage in SLR is to formulate a clear and focused research question. The research question should be well structured and direct the literature search process. In this SLR, research questions are focused on the role of accounting in supporting sustainable energy, with a particular focus on reporting and managing energy use.

The second stage involves searching for literature relevant to the research question. The search process is carried out using scientific databases such as Scopus, Web of Science, and Google Scholar, as well as other sources of literature such as journals, books, and reports.

Keywords used in literature searches include "accounting," "sustainable energy," "energy reporting," "energy management," and combinations of those keywords. After the search stage, a selection and evaluation of the literature obtained is carried out. The selection process is carried out using certain criteria, such as relevance to the research question, methodological quality and year of publication.

Selected articles are then evaluated to ensure their quality and credibility. The evaluation includes an analysis of the methodology, research design, and conclusions presented. After selection and evaluation, the data obtained from the literature are synthesized and analyzed. This stage involves identifying themes, patterns, and trends in the relevant literature.

Data analysis is carried out using qualitative and quantitative methods, depending on the type of data obtained. Qualitative analysis aims to understand the underlying concepts and theories, while quantitative analysis is used to identify relationships and trends in the data (W.Gulo, n.d.).

RESULTS AND DISCUSSION

A. Sustainable Energy Management In Accounting

Sustainable energy management plays an important role in maintaining the environment. By reducing excessive energy consumption and switching to renewable energy sources, we can minimize greenhouse gas emissions that cause climate change, such as global warming. This helps preserve air, water, and soil quality for future generations (Soesanto, 2022). Sustainable Energy Management encourages efforts to improve the efficiency of energy use. By applying technology and best practices, we can maximize the utilization of existing energy, reduce waste, and save costs. This means companies can increase their profits, while simultaneously contributing to environmental sustainability.

Sustainable energy management helps build energy resilience. By reducing dependence on limited fossil energy sources, we can create energy systems that are more diverse and resistant to energy price fluctuations and supply disruptions (Judijanto et al., 2024). This is important to ensure sustainable access to energy for everyone. Companies that implement sustainable energy management often enjoy a competitive advantage. Consumers are increasingly aware of the environment and tend to choose products and services from environmentally responsible companies. It can improve brand image and enhance competitiveness in the market.

One of the major challenges in sustainable energy management is the lack of awareness and motivation among individuals and organizations. Many people do not yet understand the importance of saving energy and switching to renewable energy sources. This lack of knowledge and understanding can hinder the adoption of sustainable energy management practices. Implementing sustainable energy technologies and infrastructure often requires a large initial investment. This can be an obstacle for many companies, especially small and medium-sized enterprises (SMEs), which have limited resources. High investment costs can hinder the adoption of more efficient energy technologies and practices.

Although sustainable energy technologies continue to evolve, there are still limitations in the access and availability of advanced technologies. This can hinder the implementation of sustainable energy solutions, especially in remote areas or with limited infrastructure. Strong policy support is essential to encourage the adoption of sustainable energy management. Lack of clear policies and adequate incentives may hinder investment and encourage innovation in the energy sector (Putri & Rahmanida, 2023).

B. Sustainable Energy Reporting in the Sustainability Report

Sustainable energy reporting in the sustainability report is an important element in the transparency and accountability of the company in energy sustainability efforts. By reporting energy data in detail and comprehensively, companies demonstrate their commitment to responsible energy management practices. This builds confidence for

stakeholders, including investors, customers, and the general public, that the company cares about the environment and strives to reduce its negative impacts (Surotenojo et al., 2019). In addition, sustainable energy reporting can assist companies in identifying opportunities to improve energy efficiency and save costs.

Sustainable energy reporting also plays an important role in driving innovation and adoption of sustainable energy technologies. By providing transparent information about the company's energy performance, the company can motivate stakeholders to support their efforts in developing more sustainable energy solutions. Comprehensive reporting on energy use, greenhouse gas emissions, and emission reduction efforts can encourage companies to continue to innovate and seek new ways to improve energy efficiency.

While important, sustainable energy reporting is faced with several challenges. One of the main challenges is the complexity of collecting and analyzing energy data (Christine & Meiden, 2021). Complex and fragmented energy Data across a company's various operational units can make the reporting process complicated and time-consuming. In addition, different and non-standardized Sustainable Energy Reporting Standards can make it difficult for companies to compare their performance with other companies and meet the expectations of diverse stakeholders.

Another challenge is the lack of resources and expertise in the company's accounting and reporting team. Running a comprehensive sustainable energy reporting program requires adequate human and technological resources. Lack of knowledge and expertise in the field of energy and sustainability can hinder the process of reporting sustainable energy. Companies must also face the challenge of communicating Sustainable Energy Information clearly and easily understood by stakeholders. Ini membutuhkan keahlian dalam komunikasi keberlanjutan dan strategi narasi yang efektif untuk menyampaikan pesan yang kuat dan relevan (Siregar et al., 2022).

C. Energy Efficiency Measurement In Accounting

Energy efficiency measurement is an important step in sustainable energy management. By measuring energy consumption, companies can identify areas of waste and develop strategies to improve efficiency. This process is very important in accounting because it relates energy consumption to the financial performance of the company. By tracking and analyzing energy data, companies can evaluate the financial impact of energy saving efforts and measure the return on investment (ROI) of energy efficiency projects.

Energy efficiency measurements are also important in order to meet sustainability reporting requirements. Standar pelaporan keberlanjutan, seperti GRI (Global Reporting Initiative) dan SASB (Sustainability Accounting Standards Board), mengharuskan perusahaan untuk mengungkapkan informasi tentang konsumsi energi, emisi gas rumah kaca, dan upaya penghematan energi. By taking accurate measurements, companies can ensure that they can report transparent and reliable information to stakeholders. This information can give stakeholders awareness and confidence that the company is committed to responsible energy practices (Hakim & Bahri, 2022).

Aspects Of Energy Efficiency Measurement

Energy efficiency measurement involves two main aspects:

- **Energy consumption measurement:** the first step is to accurately measure energy consumption. It involves collecting data regarding the type of energy used, the amount of energy consumed, and the time of consumption. This Data can be collected from various sources, such as energy meters, building management systems and energy invoices.
- **Energy efficiency evaluation:** once energy consumption data has been collected, the next step is to evaluate energy efficiency. It involves comparing energy consumption with the resulting output. For example, the energy intensity in a plant can be calculated by dividing the total energy consumption by the number of products produced. The lower the energy intensity, the more efficient the use of energy. Energy efficiency evaluation can also involve comparing energy consumption to industry standards or best practices.

By measuring energy consumption and evaluating energy efficiency on an ongoing basis, companies can develop effective energy saving programs and measure the financial impact of sustainable energy investments.

D. Role of Standards and regulations in sustainable energy accounting

a) Standardization and consistency

A robust sustainable energy accounting framework is essential to ensure standardization and consistency in the collection, processing, and reporting of energy data. Hal ini memungkinkan perusahaan untuk membandingkan kinerja mereka dengan standar industri dan melacak kemajuan mereka dalam mencapai tujuan keberlanjutan energi mereka (Breliastiti, 2011).

b) Transparency and accountability

A clear and defined framework helps improve transparency and accountability in energy-related decision (Fara Brygita Ramadhani & Cholis Hidayati, 2024). Investors, stakeholders and other external parties can more easily understand a company's energy strategy and assess their performance in terms of efficiency and sustainability.

c) Improved Energy Efficiency

By accurately tracking and measuring energy consumption, companies can identify areas with energy saving potential. The accounting framework allows companies to optimize their energy use and reduce overall energy costs, supporting the sustainability and profitability (Arifianti & Widianingsih, 2023).

d) Better decision making

The information obtained through sustainable energy accounting provides a solid basis for strategic decision-making. Companies can identify sustainable investment opportunities, determine investment priorities in energy efficiency, and track the impact of their sustainability programs (Apriliyanti & Rizki, 2023).

E. Challenges In Accounting For Sustainable Energy

a) Data Availability

One of the main challenges in sustainable energy accounting is the availability of accurate and comprehensive data. Companies often face difficulties in collecting energy consumption data from various sources, both internal and external (Himmah et al., 2024). Incomplete, inaccurate, or non-standardized Data can hinder the process of tracking and measuring energy performance, making analysis and decision-making ineffective.

b) Methodological Complexity

Sustainable energy accounting methodologies can be very complex, especially when it comes to measuring and reporting greenhouse gas emissions, renewable energy use, and other environmental impacts. The selection of the right methodology and its consistent application can be a challenge for companies, especially for those who are not yet well versed in sustainable energy accounting.

c) Implementation Costs

The implementation of a sustainable energy accounting system can require significant investments, both in terms of hardware and software, staff training, and the development of a data collection system (Nuha & Nastiti, 2020). For small and medium-sized companies, these costs can be a major barrier to implementing a comprehensive sustainable energy accounting system.

d) Lack of expertise and competence

The success of sustainable energy accounting depends on the expertise and competence of the company's staff in understanding the methodologies, standards and tools involved. Lack of expertise and competence in the field of sustainable energy accounting can be a challenge, especially when it comes to implementing effective accounting systems and interpreting the resulting data.

F. Benefits Of Sustainable Energy Management For Companies

One of the main benefits of sustainable energy management is energy cost savings. By implementing various energy efficiency strategies such as the use of energy-saving equipment, the implementation of intelligent technology, and the optimization of production processes, enterprises can reduce their energy consumption, thereby significantly lowering energy costs. This has a positive impact on the profitability of the enterprise, increases competitiveness and provides long-term financial benefits.

Sustainable energy management promotes increased operational efficiency. By optimizing energy use, companies can increase productivity, reduce downtime, and improve the efficiency of production processes. This can be achieved through process improvement, optimization of equipment usage, and implementation of technologies that can automate processes and reduce energy waste (Soraya & Sari, 2023).

As awareness of climate change and sustainability increases, companies committed to sustainable energy management are gaining positive reputations in the eyes of consumers, investors and other stakeholders. This can increase customer loyalty, attract environmentally conscious investors, and improve the company's brand image. Improving a company's image and reputation can have a positive impact on the company's value and business opportunities.

The implementation of Sustainable Energy Management encourages innovation and adoption of new technologies in the field of energy efficiency. Companies committed to energy sustainability are often pioneers in developing and implementing innovative technologies, such as renewable energy systems, intelligent technologies, and integrated energy management systems (et al., 2022) this opens up new opportunities to improve energy efficiency, reduce emissions and improve operational performance.

Companies that have a strong sustainable energy management program can gain a competitive advantage in an increasingly competitive market. They can attract environmentally conscious customers, reduce operating costs and increase profitability. Keunggulan kompetitif ini dapat membantu perusahaan tumbuh dan berkembang dalam jangka panjang (Nugroho et al., 2024).

G. Case Studies And Best Practices In Sustainable Energy Accounting

Manufacturing Company A

Manufacturing Company A, operating in the field of electronic production, has successfully implemented a comprehensive sustainable energy accounting system. They invested in integrated energy management software to collect real-time energy consumption data from various sources, such as production equipment, lighting systems, and HVAC (Windhy Puspitasari, 2016). This Data is then analyzed to identify areas with potential energy savings, such as inefficient equipment, excessive energy use during non-operating hours, and energy-wasteful production processes.

Company A also implements educational programs for employees on the importance of energy conservation, provides training on the use of energy-efficient equipment, and encourages the adoption of energy-saving behaviors in the workplace. These educational programs help raise employee awareness about energy consumption and encourage them to make small, impactful changes. Company A also implements periodic energy audit programs to evaluate their systems and processes, identify hidden energy saving opportunities, and create implementation plans to improve overall energy efficiency.

Results from sustainable energy accounting efforts at company A show significant energy cost savings, reduced greenhouse gas emissions, and improved operational efficiency. These energy cost savings have helped companies improve profitability and competitiveness, while reduced greenhouse gas emissions have helped them achieve their energy sustainability targets. Keberhasilan perusahaan A menjadi contoh yang baik bagaimana akuntansi energi berkelanjutan dapat diimplementasikan secara efektif untuk mencapai tujuan bisnis dan keberlanjutan (Sudirman, 2023).

Hospitality Company B

Hospitality company B, which manages a chain of five-star hotels around the world, has implemented an innovative approach in sustainable energy accounting. They invest in integrated energy measurement and monitoring systems to track energy consumption in every hotel room, restaurant and public area. This energy consumption Data is then linked to room occupancy data, room temperature, and other factors to identify trends and patterns in energy consumption.

Company B also implements a centralized energy management program, which allows them to optimize HVAC temperature settings, automatically regulate lighting, and regulate more efficient energy use in equipment such as washers and dryers. This energy management Program has helped Company B significantly reduce energy consumption, improve guest comfort, and reduce operating costs. Perusahaan B juga mengintegrasikan sumber energi terbarukan, seperti panel surya, untuk mengurangi ketergantungan mereka pada energi fosil dan mengurangi jejak karbon mereka (Patricia Evelyn Laksana, I Setyaningrum, 2023).

Company B's success in implementing sustainable energy accounting in their hotel chain demonstrates that the company can achieve sustainability and profitability goals through the adoption of a holistic approach that includes energy measurement and monitoring, energy use optimization, and integration of renewable energy sources.

H. Recommendations For The Future

Awareness raising and education

The first step towards a sustainable future is to raise awareness and education about sustainable energy accounting at all levels. It involves a comprehensive educational effort targeting companies, investors, governments, and the general public. Educational campaigns can be conducted through seminars, workshops, trainings, and online programs to improve understanding of the benefits and importance of sustainable energy accounting (Sedy Eko Syahputra et al., 2024).

Development of stronger standards and regulations

The development of stronger and more integrated standards and regulations is essential to encourage the adoption of sustainable energy accounting throughout the industry (Khazaini et al., 2024). These standards should include clear reporting methodologies, standardized performance metrics, and comprehensive information disclosure requirements. Strong standards will help ensure transparency, accountability and consistent comparisons in energy performance reporting.

Government support and incentives

Governments play an important role in encouraging the adoption of sustainable energy accounting through the provision of fiscal incentives, financing programs, and policies that support investment in energy-efficient technologies and renewable energy sources. The government can provide tax incentives for companies implementing sustainable energy programs, offer financial assistance for investments in energy-efficient technologies, and set energy sustainability standards for various industrial sectors. Dukungan pemerintah dan insentif ini akan membantu mengurangi biaya implementasi dan meningkatkan pengembalian investasi (ROI) bagi perusahaan yang berinvestasi dalam akuntansi energi berkelanjutan (Adrian & Totok Dewayanto, 2024).

Increased Access To Technology

Increased access to advanced and affordable technologies, such as energy management systems, sensors, and data analytics platforms, is critical to enabling enterprises to track, analyze, and optimize their energy performance. Increased access can be achieved through investments in technology research and development, financing programs for companies that want to adopt new technologies, and cooperation between the public and private sectors to accelerate innovation and technology diffusion.

Collaboration and Exchange of knowledge

Improving collaboration and knowledge exchange between companies, research institutes and related organizations is critical to fostering innovation and sharing best practices in sustainable energy accounting. Pengembangan platform online dan forum untuk berbagi informasi, pengalaman, dan solusi dapat memfasilitasi pertukaran pengetahuan dan mendorong adopsi praktik energi berkelanjutan yang efektif (Adrian & Totok Dewayanto, 2024)

Increased investment in research and development

Continued investment in research and development is critical to driving new innovations in sustainable energy accounting, energy-saving technologies, and renewable energy sources. This research should be focused on developing more accurate accounting methodologies, new technologies for measuring and managing energy consumption, and innovative solutions to improve energy efficiency and reduce greenhouse gas emissions (Gautama et al., 2023).

Conclusion

This study confirms the important role of accounting in supporting sustainable energy use, particularly through effective energy reporting and management. Through a systematic review of the literature, it was found that increased transparency and accountability in energy reporting not only helps companies measure and manage energy consumption, but also encourages broader sustainability practices.

The role of sustainable energy accounting provides critical information that enables companies to track energy use and assess the environmental impact of their activities. Although energy use reporting is growing, challenges such as the lack of harmonized standards and effective methodologies still exist.

The development of better reporting standards, increased awareness among management, as well as policy support to encourage investment in sustainable energy technologies are needed. Effective implementation of energy accounting can improve operational efficiency, reduce costs, and improve the company's image in the eyes of consumers and investors.

Companies, governments, and other stakeholders are encouraged to collaborate in developing policies and practices that support sustainable energy accounting. Education and awareness-raising at all levels is critical to achieving more ambitious energy sustainability goals.

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