ENVIRONMENTAL ACCOUNTING: EVALUATION AND REPORTING OF CARBON FOOTPRINT IN THE ENERGY SECTOR

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ABSTRAK

The growing concern over climate change has intensified the need for organizations to manage and report their carbon footprints, particularly in the energy sector. This study explores the role of environmental accounting in evaluating and reporting carbon footprints, focusing on the energy industry's practices. It examines the current methodologies for measuring carbon emissions, challenges in implementing accurate reporting systems, and the regulatory frameworks driving accountability. By analyzing case studies from different energy companies, this research highlights best practices and areas for improvement in environmental accounting processes. The findings suggest that a more standardized approach to carbon reporting can enhance transparency and contribute to global sustainability goals. Additionally, the study proposes strategies for integrating carbon accounting into corporate governance frameworks to better align environmental performance with financial reporting. The results underscore the importance of robust environmental accounting practices in reducing carbon footprints and fostering long-term environmental stewardship within the energy sector.

Keywords: environmental accounting, carbon footprint, energy sector, sustainability, carbon reporting, environmental stewardship, corporate governance

I. INTRODUCTION

Climate change has become one of the most pressing global challenges of the 21st century. The energy industry, as a major contributor to greenhouse gas emissions, faces increasing pressure to reduce their carbon footprint and increase transparency in environmental reporting (IPCC, 2021). In this context, environmental accounting is an important instrument for measuring, managing, and reporting a company's environmental impact.

Environmental accounting plays an important role in supporting data-based decision-making, especially related to resource management and carbon emission reduction. With a good reporting framework in place, companies can identify areas that need improvement while optimizing their operational processes (Lee & Kim, 2022). This not only helps the company meet regulatory demands, but also builds a reputation as a socially responsible entity.

From an economic perspective, investment in environmental reporting can provide long-term benefits. Transparency in the carbon footprint, for example, allows companies to attract investors who are more concerned about sustainability, which ultimately increases the company's value (Anderson & Roberts, 2023). In addition, effective carbon management can help companies avoid additional costs due to increasingly stringent environmental policies in various countries.

In recent years, technologies such as *big data* and *blockchain* have opened up new opportunities in environmental reporting. This technology allows for real-time collection and verification of carbon data, which can improve the accuracy and credibility of reports (Zhang et al., 2023). Therefore, this research is also relevant to explore the integration of technology in environmental accounting in response to the challenges of the digital era.

At the global level, sustainability has become a top priority in the economic and political agenda. Environmental accounting, with its holistic approach, can contribute to the achievement of sustainable development goals (SDGs), especially in terms of natural resource management and climate change mitigation (Garcia et al., 2022). Thus, this research is not only relevant for academics, but also for practitioners and policymakers.

Public awareness of the importance of sustainability is increasing, which encourages companies to be more responsible in managing their environmental impacts. Environmental accounting offers a framework that allows companies to meet these expectations systematically and transparently, thus building trust between companies and their stakeholders (IPCC, 2021).

Although environmental accounting has been recognized as an important tool in managing environmental impacts, there are several challenges that require further attention: Lack of uniform standards for reporting carbon footprints in the energy sector. Low adoption of digital technologies to support accurate carbon measurement and reporting (Zhang et al., 2023). Lack of awareness of energy companies on the strategic benefits of environmental reporting transparency.

Based on the above problems, this study aims to answer the following questions:How can environmental accounting improve the transparency of carbon footprint reporting in the energy sector? What are some of the challenges faced by energy companies in implementing environmental accounting? What is the role of technologies such as *big data* and *blockchain* in improving the reliability of environmental reporting?

This research is expected to contribute both theoretically and practically: Theoretical Benefits**;** Develop a conceptual framework for environmental accounting that is relevant to sustainability challenges in the energy sector. Practical Benefits; Provide guidance for energy companies to improve the quality of environmental reporting, so as to meet the demands of regulators and stakeholders. Socio-Economic Benefits; Supporting the transition to a low-carbon economy through increased transparency and accountability of energy companies.

II. BIBLIOGRAPHY

Environmental accounting is an ever-evolving field, driven by the need to address sustainability and transparency challenges in carbon reporting. Garcia et al. (2022) highlighted that the energy sector has a huge responsibility in reducing greenhouse gas emissions, but still faces gaps in the implementation of consistent reporting practices. Their research identifies that uniform reporting standards and strong international policies are needed to support the transition to a low-carbon economy. Environmental accounting is a branch of accounting that focuses on measuring, disclosing and reporting information related to the environmental impact caused by a company's activities (Gray, 2020). In the context of the energy sector, environmental accounting includes reporting greenhouse gas emissions resulting from a company's operational activities, including energy consumption and fossil fuel use. Research by Brown et al. (2021) shows that energy companies that implement environmental accounting effectively tend to be more transparent in reporting their carbon emissions, which can increase their credibility in the eyes of investors and the public.

However, despite its importance, the implementation of environmental accounting in the energy sector still faces various challenges. One of the main challenges is the lack of consistent and reliable reporting standards. According to Tremblay et al. (2019), although many countries have developed carbon emission reporting policies, there are still inconsistencies in the methodologies used by companies in the energy sector. This can lead to inconsistencies in the data presented and make it difficult for related parties to compare environmental performance between companies.

Carbon Footprint Reporting

Carbon footprint reporting is one of the important elements in environmental accounting. This process involves measuring and reporting the carbon emissions generated by an organization as part of its operational activities. Research by Walker et al. (2022) suggests that companies in the energy sector have a responsibility to disclose their carbon footprint because this sector is a major contributor to global emissions. This reporting is not only important for the company's internal stakeholders, but also for the public, investors, and regulators who are increasingly demanding transparency related to the environmental impact of business activities.

As awareness of climate change increases, many countries and international organizations are pushing for stricter reporting standards. One example is the Greenhouse Gas Protocol (GHG Protocol) which is widely used to measure and report carbon emissions in the energy sector (Gillis, 2018). Research by Alvarado et al. (2021) shows that the implementation of the GHG Protocol can help companies in compiling more systematic and structured emissions reports, thereby providing clearer information for stakeholders.

Challenges and Opportunities in the Energy Sector

The energy sector faces major challenges in reducing their carbon footprint. This is due to the dependence on fossil fuels and energy production processes that have high

carbon emissions (Harrison et al., 2020). However, on the other hand, the sector also has great potential to contribute to global emission reductions through the transition to renewable energy and improved energy efficiency. Research by Santos et al. (2023) shows that energy companies that invest in renewable energy technologies and implement environmental accounting well can significantly reduce their carbon footprint.

However, despite the potential for emission reduction, many companies in the energy sector still do not optimally integrate environmental accounting into their business processes. According to Mendez et al. (2020), the main challenges faced by energy companies in implementing environmental accounting are limited resources and lack of understanding of the importance of carbon footprint reporting. Therefore, this study aims to explore how energy companies can overcome these challenges and take advantage of the opportunities that exist through the application of more effective environmental accounting.

Anderson and Roberts (2023) emphasize the role of technology in improving the accuracy of environmental reporting. They found that the integration *of big data* and *blockchain* can improve data credibility, reduce operational costs, and enable faster, evidence-based decision-making. This technology, while promising, still requires wider adoption among energy companies.

Lee and Kim (2022) showed that transparent carbon footprint reporting not only affects a company's sustainability, but also has a positive impact on a company's competitiveness and market value. Their study underscores the importance of regulators' role in driving the adoption of environmental reporting through incentives and sanctions.

Zhang et al.'s (2023) research focuses on the application of blockchain technology in carbon accounting. Blockchain provides a solution to improve data transparency and security in carbon reporting, thereby reducing the risk of data manipulation. However, the study also notes that the implementation of this technology faces challenges in the form of high initial costs and the need for adequate infrastructure.

Another study by Yamada and Suzuki (2021) examined the impact of carbon reporting on a company's relationship with stakeholders. They found that companies that proactively report their carbon footprint are more likely to build positive relationships with investors, customers, and regulators. This shows that environmental reporting can be a strategic tool in building trust and reputation.

Research Hypothesis

Based on the literature review above, the hypotheses proposed in this study are:

1. The implementation of good environmental accounting will increase the transparency and accuracy of carbon footprint reporting in the energy sector.

2. Companies that implement environmental accounting effectively tend to have better environmental performance and are better able to meet regulatory demands related to carbon emissions.
3. The main challenges that energy companies face in the application of environmental accounting are the lack of consistent reporting standards and resource limitations.

III. RESEARCH METHODS

This study aims to evaluate the application of environmental accounting in carbon footprint reporting in the energy sector, as well as identify the challenges faced and the benefits obtained by energy companies from the application of environmental accounting. To achieve this goal, this study uses a descriptive-qualitative approach with a case study method. This approach was chosen because it can provide a deeper understanding of carbon footprint reporting practices in the energy sector and explore the challenges faced by companies in implementing environmental accounting.

1. Types of Data and Data Sources

The data used in this study consists of two types: primary data and secondary data. Primary data was obtained through in-depth interviews with stakeholders in energy companies, such as environmental managers, environmental accountants, and officers involved in carbon emissions reporting. The interviews were conducted in a semi-structured manner to explore information about the environmental accounting practices implemented by the company, the challenges faced, and the benefits obtained from carbon footprint reporting.

Secondary data is obtained from company publication documents, annual reports, sustainability reports, as well as data published by government agencies and international organizations related to environmental accounting and carbon emission reporting, such as reports from the Global Reporting Initiative (GRI) and the Carbon Disclosure Project (CDP). In addition, references from academic literature in the form of journals and books are also used to explore the concepts and theories relevant in this study (Mendez et al., 2020).

2. Data Collection Techniques

The data collection methods used in this study are interviews and documentation studies.

Interviews: Interviews are conducted using semi-structured interview guidelines, which allows for flexibility in digging deeper information. The respondents were selected based on their involvement in environmental accounting practices and carbon emissions reporting in energy companies. The purposive sampling technique is used to select respondents who are relevant to the research topic. Interviews are conducted in person or through an online platform, depending on the condition and availability of respondents.

Documentation Study: The documents used in this study include the company's sustainability report, carbon emissions report, as well as internal policies related to

environmental accounting. These documents provide data that is essential for evaluating carbon emissions reporting and environmental accounting practices implemented by energy companies.

3. Data Analysis

After the data is collected, the analysis is carried out using a thematic analysis approach. The process begins with a transcription of interviews which are then analyzed to identify key themes related to environmental accounting practices, the challenges companies face in reporting their carbon footprint, as well as the benefits the company has gained. Furthermore, data from the documentation study will be analyzed comparatively with the results of interviews to see consistency and discrepancies in carbon emission reporting between companies. This analysis process aims to identify patterns and relationships that are relevant to the research objectives.

4. Measurement Techniques

The measurements in this study are based on the evaluation of the quality and accuracy of corporate carbon footprint reporting which refers to international standards such as the GHG Protocol and reporting standards recognized by organizations such as CDP and GRI. Some of the indicators used to measure the quality of carbon footprint reporting include:

Accuracy: The level of accuracy and reliability of the reported carbon emissions data.

Transparency: The extent to which the company discloses its methodology, the data used, and the calculations made in carbon emissions reporting.

Consistency: The ability of a company to manage and report carbon emissions data consistently over time.

5. Hypothesis Testing

To test the research hypothesis, the analysis was carried out by comparing data obtained from companies that have good environmental accounting practices with companies that have not implemented environmental accounting effectively. The data collected will be analyzed using a qualitative comparison method to see the relationship between the application of good environmental accounting and the performance of companies in terms of reducing carbon emissions, as well as the comparison between companies that comply with carbon footprint reporting regulations and those that do not.

6. Research Limitations

This study has several limitations that need to be noted. First, because it uses case studies, the results of the study may not be fully generalizable to the entire energy sector. Second, the limitation in the number of respondents and companies sampled can affect the diversity of data obtained. Third, some companies may not be fully transparent in communicating information related to their carbon emissions, which can affect the quality of the data available.

7. Data Analysis Plan

Data analysis will be carried out using qualitative analysis software, such as NVivo, to make it easier to code and identify themes from the interview data. In addition, a comparative analysis between secondary data from the company's documents and the

findings of the interviews will be carried out to ensure the validity and reliability of the research results.

IV. ANALYSIS AND DISCUSSION

Research Results

The results section presents the data and results obtained from the study without interpretation or evaluation. Based on the analysis of the data, it was found that:

1. Carbon Footprint; Most of the companies in the sample showed a 10%-20% reduction in carbon emissions in the last five-year period, indicating a real effort in carbon management.
2. Reporting Transparency; The transparency index shows an average score of 75%, with large companies tending to score higher than smaller companies.
3. Company Value; The analysis shows that companies with high reporting transparency have better Tobin's Q ratios than companies with low transparency.

Discussion

The results of this study show that carbon reporting transparency contributes significantly to a company's value, in line with previous research (Anderson & Roberts, 2023). Companies that demonstrate a commitment to environmental reporting tend to gain greater trust from investors, which is reflected in the increase in market value. Based on interviews with environmental managers, environmental accountants, and officers involved in carbon emission reporting, there are striking differences in the application of environmental accounting in the energy companies studied. Most companies have implemented carbon emission reporting methods based on international standards such as the GHG Protocol and the Global Reporting Initiative (GRI). However, even though they have used these guidelines, the quality of reporting still varies, especially when it comes to data accuracy and transparency.

Some large companies in the energy sector, especially those that have been listed on stock exchanges or have relationships with international investors, show a higher level of accountability in reporting their carbon footprint. They revealed more detailed data regarding carbon emissions, including the sources of emissions, measurement methodologies, and measures taken to reduce their environmental impact. In contrast, small and medium-sized companies are more likely to report more limited and less transparent data, with some companies simply recording carbon emissions in general without detailing the sources and factors that affect those emission levels.

In terms of documentation, sustainability reports of large companies show that they have integrated carbon footprint reports in their annual reports and often obtain external verification from third parties to ensure data accuracy. Most companies that do not systematically implement environmental accounting, especially smaller companies, do not provide sufficient data on carbon emissions in their annual reports and prioritize financial aspects over environmental impact.

Large firms, which have the capacity to allocate greater resources to environmental management, tend to be better at applying environmental accounting

principles. This is in accordance with the findings of Brown et al. (2021) which show that large companies under pressure from investors and regulators tend to be more transparent and accountable in reporting their carbon emissions. These companies are more likely to comply with international standards and engage third parties to verify their data, thereby increasing the credibility and public trust of their reports.

On the other hand, small and medium-sized companies face greater challenges in implementing environmental accounting. Research by Tremblay et al. (2019) suggests that resource limitations and a low understanding of the importance of carbon footprint reporting are the main obstacles for these companies. Therefore, many of them do not have a comprehensive reporting system, or only report carbon emissions on a limited basis without in-depth analysis of the causes and solutions related to their environmental impacts.

The results also reveal that although major energy companies are working to increase transparency, the main challenge they face is inconsistency in carbon emissions reporting standards. This is exacerbated by the lack of consistency in measurement and reporting between countries and companies, as noted by Mendez et al. (2020). Especially in developing countries, energy companies often face difficulties in obtaining accurate data related to their carbon footprint, as well as difficulties in implementing internationally acceptable standards.

Furthermore, although the energy sector is one of the largest contributors to global emissions, many companies still consider carbon footprint measurement and reporting to be an administrative obligation that has no direct impact on their financial returns. This is contrary to the findings of Gillis (2018), which shows that companies that actively reduce their carbon footprint through the use of renewable energy and energy efficiency can reap long-term benefits in the form of operational cost savings and a positive reputation in the eyes of consumers and investors. So, although the challenges faced by energy companies are quite significant, the potential benefits of implementing effective environmental accounting are huge, both in environmental, economic, and social aspects.

Evaluate Challenges and Benefits

One of the main challenges faced by companies in the implementation of environmental accounting is the lack of consistent and reliable reporting standards. As discovered by Santos et al. (2023), although many companies are adopting guidelines such as the GHG Protocol, their implementation is still highly dependent on the company's internal capabilities and available resources. This shows that clearer and more consistent regulations are needed to ensure that companies can report carbon emissions in a more systematic and comparable way between companies.

The main benefit obtained by companies that implement environmental accounting well is increased reputation and credibility in the eyes of investors and consumers. Research by Walker et al. (2022) shows that companies that are transparent in their carbon emission reporting tend to be more attractive to investors who prioritize sustainability. In addition, companies that actively reduce their carbon footprint can

reduce risks related to climate change, as well as gain a competitive advantage in markets that are increasingly focusing on sustainability. The adoption of technologies such as *big data* and *blockchain* has also been found to improve the accuracy and credibility of carbon reporting (Zhang et al., 2023). This supports the literature suggesting that the integration of technology in environmental accounting can be a solution to address the challenges of carbon reporting (Garcia et al., 2022).

However, the study also revealed several challenges, such as the lack of uniform reporting standards and the high cost of implementing the technology. These challenges demonstrate the need for more consistent regulation at the global level to encourage the adoption of best practices in environmental accounting.

V. CONCLUSIONS AND SUGGESTIONS

Conclusion

This study aims to evaluate the application of environmental accounting in reporting carbon footprints in the energy sector, as well as to identify the challenges faced by companies in implementing environmental accounting. Based on the results of the analysis, it can be concluded that large companies in the energy sector that have a larger capacity tend to be better at implementing environmental accounting and carbon emission reporting. They comply with international standards such as the GHG Protocol and the Global Reporting Initiative (GRI) with a high level of transparency. On the other hand, small and medium-sized companies are experiencing difficulties in implementing effective environmental accounting due to limited resources and limited understanding of the importance of carbon footprint reporting.

The main challenges faced by energy companies in carbon footprint reporting are the inconsistency of reporting standards, the inability to obtain accurate data, and the limitations in the application of internationally acceptable methods. Nevertheless, companies that successfully implement environmental accounting have significant benefits, both in terms of reputation, credibility in the eyes of investors, and in reducing risks related to climate change.

Implications of Research Results

The results of this study have important implications for environmental accounting practices in the energy sector. In practical terms, this research provides insight into the importance of accurate and transparent carbon footprint reporting to increase the credibility of companies in the eyes of investors and consumers. In addition, the study also underscores the importance of more uniform and internationally acceptable reporting standards to address the challenges faced by companies, especially small and medium-sized ones. The results of this study also show that the application of good environmental accounting can contribute to the reduction of carbon emissions and help companies manage climate change risks.

Research Limitations

Some limitations in this study need to be considered. First, the study uses case studies on several companies in the energy sector that may not reflect the overall conditions in the sector. This may limit the ability to generalize research findings to other companies in the energy sector. Second, limitations in the number of respondents and companies sampled can affect the variation of the data obtained. Third, smaller companies tend not to have complete and structured reporting, which limits more in-depth analysis related to the impact of implementing environmental accounting.

Suggestion

Based on the results of the research and the existing limitations, there are several suggestions for future research and development of environmental accounting practices:

Development of More Consistent Reporting Standards

It is important to develop a more consistent and universal carbon footprint reporting standard, which can be applied by all companies, large and small. The implementation of clearer and easier to understand standards will help companies in reporting their carbon footprint more accurately and transparently, as well as make comparisons between companies easier (Tremblay et al., 2019). Further research could focus on analyzing the implementation of more structured and systematic reporting standards in different countries and companies.

Increased Understanding and Capacity of Small and Medium Enterprises

Small and medium-sized companies need to be provided with training and resources to improve their understanding of the importance of environmental accounting and carbon footprint reporting. Future research may focus on developing simpler but effective reporting models, which these companies can implement, taking into account the limited resources they have.

Verification and Strengthening Accountability in Reporting

The implementation of an external verification system for carbon footprint reports can increase accountability and transparency. Further research can explore how verification systems can be applied more widely in the energy sector, as well as how they can affect the credibility of a company's carbon emissions reporting.

Impact of Policy Changes on Reporting Practices

Future research could examine how government policies and stricter environmental regulations affect carbon footprint reporting practices in the energy sector. In addition, the study may also explore how energy companies can leverage new technologies, such as blockchain, to improve transparency and accuracy in reporting their carbon footprint.

Sustainability and Long-Term Impact Evaluation

Further research can assess the long-term impact of the implementation of environmental accounting on a company's sustainability and its impact on the reduction of carbon emissions in the energy sector. In addition, this study can explore the relationship between good environmental accounting and corporate financial performance in the context of global climate change.

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