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CLIMATE CHANGE AND ENERGY TRANSFORMATION: METHODOLOGICAL STRATEGIES FOR SUSTAINABILITY MANAGEMENT IN AN ORGANIZATIONAL CONTEXT IN THE ENERGY SECTOR

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Abstract: This article addresses the relationship between climate change and energy transformation, focusing on the need for methodological models that translate environmental, social, and governance (ESG) guidelines into management, decision-making, and monitoring routines in organizations in the energy sector. This is an applied research study with a qualitative approach, guided by action research, structured by documentary analysis and the systematization of stages for prioritizing themes, with an emphasis on the exercise of materiality as a mechanism for ranking risks, opportunities, and stakeholder expectations. The methodological proposal organizes an operational path capable of supporting the definition of guidelines, governance mechanisms, and monitoring instruments, maintaining traceability of choices and consistency between strategy, actions, and indicators. The results discussed are preliminary and focus on the implications of the methodological process, without delving into long-term performance evaluation. As a contribution, the article presents a replicable framework to guide the integration of sustainability and productive transformation in complex organizational contexts, aligning regulatory requirements, reporting standards, and climate commitments with management.

Keywords: climate change; energy transition; ESG; action research; materiality.

Introduction

Climate change has established itself as one of the main challenges of the 21st century, with profound implications for environmental, economic, social, and institutional systems. The increase in global

average temperature, associated with the intensification of greenhouse gas (GHG) emissions resulting from anthropogenic activities, has caused significant changes in climate patterns, increasing the frequency and intensity of extreme events, putting pressure on ecosystems, and deepening social and territorial vulnerabilities (IPCC, 2021; IPCC, 2023). In this context, the climate crisis goes beyond the environmental field and has become a structural problem of development, governance, and long-term planning.

Among the sectors central to addressing climate change, the energy sector occupies a strategic position. Historically responsible for a significant share of global GHG emissions, this sector is at the center of discussions on mitigation, productive transition, and the reorganization of contemporary economic systems (IPCC, 2021; IPEA, 2021). Dependence on fossil fuels, coupled with the need to ensure energy security, competitiveness, and economic growth, poses complex challenges for organizations and policymakers, especially in emerging economies such as Brazil.

The energy transition, understood as the process of transforming energy production, distribution, and consumption systems toward less carbon-intensive matrices, has been driven by international agreements, multilateral commitments, and national regulatory instruments (UNFCCC, 2015; UN, 2015). The Paris Agreement sets global mitigation and adaptation goals (), while the 2030 Agenda for

Sustainable Development reinforces the integration between climate, energy, economic development, and social justice. These international milestones have guided public policies, investments, and organizational strategies, pressuring companies and institutions to review their operating and governance models.

In Brazil, the climate and energy agenda has advanced through legal and programmatic instruments that seek to reconcile economic development and emissions reduction. Initiatives such as the National Biofuels Policy (RenovaBio), incentive programs for renewable sources, and national climate adaptation plans reflect efforts to align with international guidelines, while highlighting structural challenges related to institutional coordination, implementation, and monitoring of results (BRAZIL, 2002; BRAZIL, 2017; BRAZIL, 2024; BRAZIL, n.d.). The complexity of this scenario requires approaches that transcend isolated technological solutions and incorporate organizational, regulatory, and governance dimensions.

In this sense, there is a growing incorporation of environmental, social, and governance (ESG) criteria as benchmarks to guide corporate decisions, investment policies, and transparency mechanisms. The ESG agenda emerges as a response to the intensification of climate risks, stakeholder demands, and the need to align economic performance with socio-environmental responsibilities (LEAL; SILVA, 2023; QUARTUCCI; BRANCO, 2024). However, despite

the widespread dissemination of the concept, significant gaps remain in its operationalization in complex organizational contexts, especially with regard to translating guidelines and commitments into effective management and decision-making routines.

Several studies point out that the main difficulty does not lie in the absence of regulatory frameworks or technical references, but in the fragmentation of initiatives and the lack of clear methodological paths that integrate diagnosis, prioritization, governance, and monitoring of climate and energy actions (SILVA; CARVALHO, 2024). In organizations in the energy sector, this gap becomes even more sensitive in the face of simultaneous processes of productive transformation, technological innovation, and regulatory adaptation, which require strategic coherence and institutional capacity.

Given this scenario, this article aims to systematize a methodological approach to sustainability management, guided by ESG criteria, applied in an organizational context in the energy sector. The focus is on the methodological scope and preliminary results associated with the structuring, prioritization, and governance process, without delving into long-term performance evaluation. We have chosen to preserve the institutional confidentiality of the case analyzed, emphasizing the replicability of the method and its relevance to organizational contexts with similar challenges.

By adopting an applied research approach based on action research, the study seeks to contribute to the advancement of discussions on energy transition and climate governance from a practical and operational perspective. The proposal dialogues with the literature on climate change, public policy, ESG, and corporate sustainability, offering methodological support for the integration of climate commitments, regulatory requirements, and organizational decision-making processes. Thus, the introduction delimits the research problem, contextualizes the debate, and substantiates the relevance of the methodological path, which will be detailed in subsequent actions.

Theoretical Framework

Climate change, global risks, and socioeconomic implications

Climate change is widely recognized as a predominantly anthropogenic phenomenon, associated with increased atmospheric concentrations of greenhouse gases and intensified global warming since the Industrial Revolution. The Sixth Assessment Report of the Intergovernmental Panel on Climate Change reinforces that the climate impacts already observed, such as heat waves, extreme precipitation events, prolonged droughts, and sea level rise, tend to intensify in the coming decades, amplifying environmental, economic, and social risks (IPCC, 2021; IPCC, 2023).

These impacts are not distributed evenly across territories and social groups. Studies indicate that the most vulnerable

populations, developing countries, and regions with less adaptive capacity are more exposed to the adverse effects of climate change, deepening preexisting inequalities and structural weaknesses (ARTAXO, 2020; BLANK, 2015). Thus, the climate crisis takes on a multidimensional character, going beyond the environmental field and directly affecting economic, social, and institutional dynamics.

Contemporary literature also highlights that planetary boundaries associated with climate, biodiversity, and natural resource use impose increasing constraints on traditional development models. The notion of a “safe operating space” for humanity reinforces the urgency of structural transformations in production and consumption patterns, requiring integrated responses from public policies, markets, and organizations (ROCKSTRÖM et al, 2009).

Public policies, international agreements, and climate governance

Global climate governance is structured around multilateral agreements and international commitments that guide national and subnational policies. The Paris Agreement represents the main contemporary milestone in this field, establishing mitigation, adaptation, and climate finance targets, as well as mechanisms for transparency and periodic review of the commitments made by signatory countries (UNFCCC, 2015).

Complementarily, the 2030 Agenda for Sustainable Development reinforces the integration between climate, energy, economic development, and social justice, recognizing the cross-cutting nature of the

climate agenda in achieving the Sustainable Development Goals (UN, 2015). These instruments increase pressure on states, companies, and financial institutions to align strategies, investments, and management practices with trajectories compatible with a low-carbon economy.

In the Brazilian context, these international commitments are internalized through legal and programmatic instruments aimed at diversifying the energy matrix, stimulating renewable sources, and reducing emissions associated with the energy sector. Noteworthy initiatives include the Incentive Program for Alternative Sources of Electric Energy and the National Biofuels Policy, in addition to national plans aimed at adapting to climate change (BRAZIL, 2002; BRAZIL, 2017). Despite these advances, the literature points to recurring challenges related to implementation, institutional coordination, and monitoring of results, especially in complex organizational contexts.

Energy transition, biofuels, and energy geopolitics.

Energy transition is understood as a long-term process that involves the reconfiguration of energy production, distribution, and consumption systems toward less carbon-intensive sources. It is a multifaceted phenomenon that incorporates technological, economic, political, and geopolitical dimensions, influenced by strategic interests, energy security, and the institutional capacities of countries (DELGADO; WEISS DE ABREU; SILVA, 2018; COSTA, 2024). In the field of biofuels, Brazil occupies a strategic position on the international stage, due to its productive base, regulatory experience, and potential for expansion. Technical reports and sector studies indicate growth

in the sector and an expansion of the debate on advanced fuels, especially in the context of aviation and cargo transport (EPE, 2024; ERSE, 2021; ALBERTIN; DUTRA; PONTES, 2023). However, the consolidation of these energy alternatives depends on stable regulatory frameworks, continuous investment in innovation, and coordination between public policies and business strategies.

In addition, the literature shows that the energy transition redefines power and dependency relationships between countries and regions, altering trade flows, production chains, and geopolitical dynamics. In this sense, organizational decisions in the energy sector need to consider, in addition to technical and economic feasibility, regulatory, reputational, and strategic risks associated with the global context (IPEA, 2021).

Corporate sustainability, environmental, social, and governance criteria, and international standards.

The incorporation of environmental, social, and governance criteria has gained centrality in the debate on corporate sustainability and risk management, especially in carbon-intensive sectors. The literature points out that such practices are associated with improved transparency, enhanced dialogue with stakeholders, and the integration of climate risks into strategic decisions, influencing access to financing and the evaluation of organizational performance (LEAL; SILVA, 2023; SILVA; CARVALHO, 2024).

In this context, international standards and benchmarks play an important role in providing parameters for structuring management and reporting systems. Of particular note are guidelines focused on social respon-

sibility, the quantification and reporting of greenhouse gas emissions, and energy management, which help organizations translate climate commitments into operational practices. However, the effectiveness of these instruments depends on the institutional capacity and internal governance of organizations (ISO, 2010; ISO, 2018).

Governance, materiality, and operationalization of sustainability.

Recent literature emphasizes that governance is a central element for the operationalization of sustainability in complex organizations. The definition of clear decision-making structures, institutional responsibilities, monitoring mechanisms, and accountability is essential to ensure consistency between climate commitments, public policies, and management practices.

In this sense, the materiality exercise stands out as a methodological tool capable of prioritizing relevant issues based on the analysis of risks, impacts, and stakeholder expectations. This process contributes to the strategic prioritization of actions and the more efficient allocation of resources, strengthening the integration between sustainability and organizational strategy (QUARUCCI; BRANCO, 2024).

From an institutional perspective, effective governance arrangements depend on clear rules, monitoring mechanisms, and possibilities for adjustment over time. Ostrom (1990) emphasizes that these elements are fundamental to the management of common goods and are equally applicable to climate and energy governance in organizational contexts. Thus, the articulation between governance, materiality, and international standards provides the theoretical

basis for proposing methodological paths capable of reducing the fragmentation of initiatives and strengthening the coherence between commitments, decisions, and results.

Methodology

This study is characterized as applied research, with a qualitative approach, guided by the action research method. The choice of this methodological approach is justified by the nature of the problem investigated, which simultaneously involves the production of scientific knowledge and intervention in a real organizational context, marked by processes of productive transformation and adaptation to climate and energy requirements. Action research allows for the articulation of analysis and practice, incorporating the participation of the actors involved and continuous cycles of planning, action, observation, and reflection (THIOLLENT, 2011).

From an epistemological point of view, the research is based on interpretive assumptions, recognizing that phenomena related to sustainability, climate governance, and energy transition are socially constructed and dependent on the institutional context. Thus, priority is given to an in-depth understanding of processes, decisions, and organizational arrangements, rather than statistical generalizations.

Research design and application context

The investigation was developed in an organizational context in the energy sector, selected because it is undergoing a process of productive transformation aimed at reducing greenhouse gas emissions and in-

corporating environmental, social, and governance criteria. It was decided to preserve institutional confidentiality, avoiding the identification of the organization, its geographical location, and specific operational characteristics, in order to focus the analysis on the methodological approach adopted.

The research design combines documentary analysis, systematization of institutional information, and the application of methodological instruments aimed at prioritizing relevant topics. This combination enabled the construction of a structured diagnosis, aligned with regulatory frameworks, public policies, and international benchmarks widely recognized in the field of sustainability and climate management.

Data collection and analysis procedures.

Data collection initially focused on the documentary analysis of legislation, public policies, technical reports, standards, and guidelines related to climate change, energy transition, and corporate sustainability. Among other things, national legal instruments, climate plans and strategies, as well as international regulatory benchmarks associated with emissions management, energy, and social responsibility were considered.

In a complementary stage, topics, risks, and opportunities associated with the energy transition process in the analyzed organizational context were mapped. This mapping sought to identify critical aspects related to environmental, social, and governance dimensions, considering both regulatory requirements and stakeholder expectations and sector trends.

Data analysis followed qualitative procedures, with thematic categorization and

interpretation in light of the theoretical framework adopted. This process allowed the information collected to be organized systematically, supporting the subsequent stages of the research.

Materiality exercise and prioritization of themes

One of the central axes of the methodology adopted was the materiality exercise, understood as a tool for prioritizing relevant themes based on the analysis of impacts, risks, and expectations of stakeholders. This exercise aimed to support strategic decision-making, guiding the definition of priorities and the allocation of resources in the context of sustainability management.

Materiality was structured based on the identification and classification of topics associated with environmental, social, and governance dimensions, considering criteria such as strategic relevance, potential impact, and alignment with public policies and climate commitments. The result of this process was the organization of a prioritized set of topics, which served as the basis for proposing governance guidelines and mechanisms.

Structuring the methodological model for sustainability management

Based on the results of the documentary diagnosis and materiality exercise, a methodological model for sustainability management was structured. This model was conceived as an operational path, articulating stages of diagnosis, prioritization, definition of guidelines, governance, and monitoring.

The methodological proposal sought to integrate international benchmarks, technical standards, and public policies in order to ensure consistency between climate commitments, regulatory requirements, and organizational practices. Emphasis was placed on the replicability of the path, allowing for its adaptation to other organizational contexts in the energy sector or sectors with similar challenges.

Methodological rigor criteria and limitations.

To ensure analytical rigor and scientific consistency, quality criteria specific to qualitative research were adopted, such as credibility, transferability, dependability, and confirmability, as proposed by Guba and Lincoln (1985). These criteria guided both data collection and analysis, contributing to the transparency and reliability of the results presented.

As a methodological limitation, it should be noted that the study focuses on the procedural and methodological aspects of sustainability management, not covering quantitative performance evaluation or longitudinal analysis of results. These dimensions are recognized as relevant and constitute possibilities for further study in future stages of the research.

Preliminary results

The results presented in this article are preliminary and focus on the methodological implications arising from the application of the proposed sustainability management pathway in an organizational context in the energy sector. In line with the research design, the aim is not to evaluate operational results or final performance indicators, but

rather to analyze how the methodological instruments adopted contribute to structuring decision-making processes aligned with the energy transition and the demands associated with climate change.

Organization and systematization of strategic themes

Documentary analysis and initial mapping of institutional information allowed us to identify a broad set of themes related to environmental, social, and governance dimensions. This set reflected both regulatory requirements and climate commitments, as well as market pressures and stakeholder expectations, in line with the literature that highlights the role of organizations in the energy sector in mitigating greenhouse gas emissions and reorganizing production systems (IPCC, 2021; IPCC, 2023; IPEA, 2021).

The systematization of these themes highlighted the need for mechanisms that allow scattered information to be organized and translated into strategic priorities. In this sense, it was observed that the mere existence of policies, standards, and commitments does not guarantee their incorporation into organizational routines, reinforcing the importance of methodological instruments capable of articulating external guidelines and internal practices internal practices.

Materiality exercise and prioritization

The materiality exercise was one of the main results of the methodological process, as it enabled the prioritization of the topics mapped based on criteria of strategic relevance and potential impact. The application of this instrument made it possible to diffe-

rentiate between structural topics and those of a more operational nature, contributing to reducing the complexity inherent in sustainability management in organizational contexts that are intensive in regulatory and technical requirements.

The results of the exercise indicated the centrality of themes associated with emissions mitigation, energy efficiency, climate risk management, and corporate governance. This hierarchy was consistent with trends identified in the literature on energy transition and ESG, which highlight the need to integrate climate risks, environmental performance, and transparency into decision-making processes (LEAL; SILVA, 2023; SILVA; CARVALHO, 2024).

Integration between public policies, standards, and organizational management

Another relevant result refers to the ability of the methodological approach to promote greater alignment between public policies, technical standards, and organizational practices. The analysis showed that the articulation between national legal instruments, international commitments, and regulatory s contributes to greater consistency in strategic decisions related to sustainability and energy transition.

This alignment proved particularly relevant in the context of climate change, where energy sector organizations are simultaneously impacted by regulatory requirements and called upon to play an active role in mitigating emissions (UNFCCC, 2015; UN, 2015; BRAZIL, 2017). The methodological approach made it possible to translate these milestones into operational guide-

lines, albeit in a preliminary and procedural manner.

Methodological implications and potential for replicability

Preliminary results indicate that the main gain from the study lies in the systematization of a structured methodological approach capable of supporting sustainability management in complex organizational contexts. The combination of action research, document analysis, and materiality exercise proved adequate for integrating diagnosis, prioritization, and definition of guidelines, reinforcing findings in the literature on governance and management of common resources and collective decision-making processes (OSTROM, 1990).

In addition, the emphasis on the procedural and methodological nature of the study increases its potential for replicability, allowing the path to be adapted to other organizations in the energy sector or sectors with similar challenges. This feature is particularly relevant given the diversity of institutional and regulatory contexts associated with the energy transition, as pointed out by studies on energy geopolitics and public policy (DELGADO; WEISS DE ABREU; SILVA, 2018; COSTA, 2024).

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