

## Conjugation of Decarbonization & Carbon Management Systems for realization of Eco-centric Sustainability

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### ABSTRACT

Irreversible changes occurring in the biosphere & unfathomable escalation in CO<sub>2</sub> levels is leading to rampant carbonization. Apprehension among the consumers & firms over sustainability concerns & skewed ecological imbalance is causing the stakeholders to opt for decarbonization tactics. An improvised carbon management system & operational decarbonization can synergistically lead to realization of eco-centric sustainability. The objective of the paper is to qualitatively decode the mechanism by which eco-centric sustainability may be realized by conjugation (mix) of carbon management systems & techniques of decarbonization. A hybrid qualitative approach applying grounded theory to literature rich content and then subjecting it to conceptual framework analysis was used to draw inferences. Systematic data mining technique was the preferred choice for exploring the relevant literature. The inductive findings of the paper encompass the various interventions of carbon management systems & decarbonization and the mechanism by which the twin concepts may assist in attainment of sustainability. The paper is of vitality to carbon managers, sustainability engineers, social advocates of environmental change, carbon mitigation policymakers & green advertisers and opens new frontiers in the direction of holistic sustainability.

**Keywords:** Carbonization, Decarbonization, Eco-centric, Green Advertising, Sustainability.

### 1.0 Research Objective

To qualitatively decode the mechanism by which eco-centric sustainability may be realized by engaging conjugation (mix) of carbon management systems and techniques of decarbonization.

### 2.0 Introduction

The organization's ability and commitment to control the emission of greenhouse gases (GHGs) across its business interventions is called as carbon management. The coupled principles of carbon management and decarbonization fulcrum around eco-friendly corporate infrastructure, green supply chain management, proper emissions inventory and alternative fuel dependencies. For the sake of attaining eco-centric sustainable business solutions, it is imperative to engage in new carbon curtailment policies, improved energy usage and an endeavor to reduce overall carbon footprint by opting for proactive techniques of decarbonization. Strategic planning and strict carbon mitigation policies need to be in place for gaining popularity in the minds of the stakeholders by roping in green advertising as a promotional tool. Strategies of carbon management that directly affect the operationalization of eco-centric business include carbon compensation, carbon reduction and carbon independence. For the sake of curbing the double-exponential growth of carbon emissions, a plethora of decarbonization tools & techniques need to synergistically work with carbon management systems at both operational and managerial levels. The literature suggests that it is the conjugation of decarbonization techniques and carbon management systems that can catapult businesses in the direction of sustainability. Also, a trans-disciplinary approach transgressing beyond the realms of energy efficacy standards with a quintessential congruence between eco-centric innovations and the adoption of decarbonization tenets would necessitate the realization of sustainability at business horizon. This conceptual paper aims at decoding the mannerism in which a conjugated mix of

decarbonization techniques and carbon management systems can work in orchestration to achieve eco-centric sustainability.

### **3.0 Literature Review**

#### **3.1 Conceptualization of Carbon Management Systems**

Managing carbon is a strategically important concern for businesses. In the contemporary corporate context, stakeholders' awareness of climate change has increased significantly, therefore including a climate change viewpoint into cleaner company operations through carbon management (CM) initiatives is vital (Hoffman, 2007). A firm's commitment to controlling its emissions of greenhouse gases across all business processes is referred to as carbon management, which makes it easier to disclose corporate data on climate change (Kolak and Pinske, 2007). The company's commitment to control the total carbon emissions is referred to as carbon management systems (CMS), sometimes known as the company Carbon Strategy or Environmental Management Strategy (Dhanda and Malik, 2020). Firm's ability to determine the sources of its carbon dioxide emissions, monitor its emissions inventory, and subsequently investigate alternative methods to reduce emissions is enabled by a carbon management system (Wahyuni and Ratnatunga, 2015). CMS strategically affects corporate infrastructure and framework, as well as the selection of products and operations technologies, as well as the underlying control mechanism (Klassen and McLaughling, 1996). EPA Victoria (2007) outlines carbon management principles as a way to make it easier to assess the company's carbon emissions and put mitigation methods into place, which may include energy efficiency, procuring energy from renewable sources, and offsetting remaining greenhouse gas (GHG) emissions to lower its overall greenhouse effect. As per Lee (2012) by examining the activities that a firm prioritizes in terms of carbon management and the resources that are allocated to these activities, a corporate carbon strategy can be defined. Business organization's carbon management strategy is its response to possibilities and threats that it perceives, enabling a method to both safeguard itself and take advantage of its unique position (Wade et al., 2014). Effective carbon management strategies may offer the firm a roadmap for:

- (a) adapting to and complying with new carbon-curtailement policies,
- (b) save money via improved energy usage and to maintain competition in the evolving carbon-based economic environment as well as for,
- (c) reducing its overall carbon footprint (Wahyuni and Ratnatunga, 2015).

The company's approach to managing carbon emissions includes reactive measures, such as joining emission trading systems and using various types of greenhouse gas emissions offsets and adopting proactive methods, like innovating transformations to products, marketplaces, technology, and procedures with the goal of becoming carbon neutral (Yunus et al., 2016). Kolak and Pinske (2005) created a classification of strategic alternatives determined by the strategic intent of a corporation and the level of its interconnection with other enterprises. Their research indicates that there are two areas of strategic intent:

- (a) Compensation - involves transmitting emissions or activities that cause emissions within the company to other companies and entails participating in offset initiatives, shifting high-emission sources and operations to other supply chain nodes, and purchasing emissions credits by performing emissions trading.
- (b) Innovation- entails creating novel environmental products or services that cut emissions and involve process optimization, product creation, and research into new products and emerging marketplaces.

#### **3.2 Techniques of Carbon Management Systems & Business Applications**

The formulation of a successful carbon management strategy within a volatile context is a complex endeavor (Gurkov, 2009). Acquiring pertinent information and possessing a strong knowledge base is crucial for effectively managing this complex situation (Trkman, 2009). Various carbon alleviation schemes have high up-front costs and lengthy planning periods, which makes their growth even more challenging (Sandoff & Schaad, 2009). Irrespective of the structure, businesses that use CMS can gain from increased compliance with regulation, which can improve their brand perception and boost profitability (Stapleton et al., 2001). As stated by Coglianese and Nash in 2001, although each organization's CMS has different institutional characteristics but all CMS require the following:

- (i) Developing a policy or strategy on the environment
- (ii) Conducting internal evaluations of the organization's environmental consequences
- (iii) Establishing measurable objectives
- (iv) Allocating resources, and educating staff
- (v) Systematically assessing implementation progress to make sure objectives are being met and
- (vi) Correction of goal accomplishment discrepancies and carrying out management reviews.

The development of a CMS, which bridges the gap between strategic planning and carbon mitigation, is crucial for a company to operationalize its strategy into specific actions and procedures that are generally institutionalized to develop a set of self-regulation with formalized, information-driven processes and protocols (Tang and Luo, 2014). There are several CMS options available for use by enterprises. Given that the wider population serves as the primary consumer of goods labelled with carbon information, the mechanisms by which policies aimed at mitigating the impact of carbon emissions with the assistance of carbon labels can facilitate the acceptance and acquisition of such goods (Seth, S., et al.,2023) A CMS supports procedures linked to controlling and disclosing carbon emissions over a broad range of business operations at the organizational level (Corbett, 2013).

**Table 1: Strategies for Carbon Management Systems**

No.	Carbon Management Strategies	Description
1	<b>Carbon Compensation</b>	Outlines a company's actions that balance or counteract its carbon emissions, for example purchasing carbon credits.
2	<b>Carbon Reduction</b>	Companies alter their manufacturing techniques and product in an effort to reduce carbon emissions.
3	<b>Carbon Independence</b>	To become independent from fossil fuels, businesses implement strategies that redefine how they conduct business.

(Source: Weinhofer and Hoffmann, 2010)

Some of the carbon reduction techniques suggested by Cadez and Czerny in 2015 are:

1. Changes in the product mix - Products made from carbon-intensive materials can be replaced with those made of non-carbon materials, such as wood replacing plastic (Boiral, 2006).
2. Supply chain modifications - This practice encompasses all methods pertaining to the mitigation of carbon dioxide (CO<sub>2</sub>) emissions across the supply chain (Zhai et al.,2014). Examples encompass the procurement of environmentally friendly suppliers, initiatives aimed at mitigating emissions stemming from product utilization, and enhancements in supply chain and distribution efficacy.
3. Relocating production facilities - This action transfers carbon-intensive manufacturing to a different nation, often one with flexible carbon regulations. Although this action would lower emissions, it might have the reverse impact on emissions globally (Kuik and Hofkes, 2010).
4. Energy Saving - This action entails an overall decrease in energy consumption. Examples include using LED lights, reducing unnecessary travel, and reducing air conditioning and heating during idle time (Jeswani et al., 2008). Without requiring substantial investments, this strategy may be used across various industrial sectors.
5. Combined Heat and Power - also known as cogeneration, is a highly efficient method of generating electricity and useful heat simultaneously from the same energy source. So, entities can derive advantages from enhancing energy efficiency and diminishing business costs through substantial reduction of their carbon dioxide (CO<sub>2</sub>) footprint (Oliver, 2008).

### 3.3 Decarbonization: Backdrop, Concept and Essence

Anthropogenic activities, especially, the rampant usage of fossil fuels and organic chemicals are causing perpetual carbonization (Rockstrom et al., 2017). Several irretrievable changes are continuing to occur every year in the biosphere due to mass deforestation and unfathomable increase in CO<sub>2</sub> level thereby causing rampant carbonization (Fox et al., 2019; Rudan, 2018). Carbon emissions are experiencing the phenomena of double exponential growth (Meadows, Meadows & Behrens, 1971). In people inhabiting industrial areas, a plethora of chronic diseases like immune disorders, leukemia and chronic obstructive pulmonary disease have been observed which are attributed to carbon and carbon-origin organic chemical pollutants (Onyije et al., 2022). Therefore, decarbonization has become imperative.

In an age marked by heightened environmental consciousness and the integration of CO<sub>2</sub> objectives into corporate practices, it is necessary to reevaluate the relationship between competitive tactics and company success. The shift towards environmentally-friendly consumer attitudes, advancements in low-carbon technology, and the growing stricture of environmental regulations have the potential to cause disruptions in markets, upset the equilibrium among market participants, and ultimately alter the factors that contribute to a company's competitive edge (Sartal et al., 2023). The incorporation of decarbonization into strategic decisions is crucial for enterprises to attain or sustain their competitive advantage, regardless of the overarching business plan. The environmental change emerged as a highly disruptive phenomenon that has been consistently highlighted (Howard-Grenville et al., 2014).

Decarbonization encompasses a range of commercial endeavors aimed at mitigating anthropogenic climate change, including strategies such as energy consumption, reduction, resource optimization in the development of products and industrial processes, and effective handling of supply chains (Grubert & Hastings Simon, 2022). Organizations have the ability to reduce carbon emissions in their operations via the use of management techniques and procedures, as well as through the adoption of technical initiatives aimed at decarbonization. It comprises a range of tools, including (i). life cycle assessments (LCA), (ii). environmental certifications such as ISO 14000, (iii). cradle-to-cradle analysis (C2C), (iv). carbon calculator tools, (v). supply chain management (SCM) analysis, and eco-design (Lopez-Manuel et al., 2023; Olatunji et al., 2019; Sam & Song, 2022). The process of decarbonization, which encompasses the adoption of various technologies and organizational efforts, necessitates a range of expenditures. However, it also presents opportunities for cost savings and marketing advantages, which may influence the connection between the competitive approach taken by a business and its performance (Franca A et al., 2023). Decarbonization and digital technologies help in achieving long term value for the engaging sector (Foss & Saebi, 2018; Del Giudice et al., 2022).

In the incumbent century, climate change issues can be addressed via world's energy system through:

- (i) Decarbonization
- (ii) Carbon management by reducing CO<sub>2</sub> emissions by 50-90% (Loftus et al., 2015).

For realizing sustainable development, advanced business models should necessarily follow international climate policies that fall in line with decarbonization-oriented green technologies (Rockstrom et al., 2017). This should entail a trans-disciplinary approach that goes beyond the realms of energy efficiency (Vakili et al., 2022). There should be significant congruence between the existing standards of innovation & adoption of decarbonization technologies (Pelle & Reber, 2015). Meeting carbon emission goals and the ability to attain decarbonization is feasible through implementation of practices of law (Christodoulou et al., 2021; Inal et al., 2022; Reuter, 2022; Sachs et al., 2019; Fox et al., 2019; Rudan, 2018).

Unmanaged and limitless CO<sub>2</sub> emissions are posing itself as an evil and threat not only for homo sapiens, the society but also for the entire biosphere at large (Legach & Sharov, 2021). For reducing political and social pressures in context to CO<sub>2</sub> emissions and keeping it in congruence with sustainability; decarbonization and digitalization have been stressed upon (Agarwala et al., 2021). There is a need to highlight the relationship between Corporate Social Responsibility (CSR), government initiatives, decarbonization education & technology & public environmental awareness (Wong et al., 2013).

### **3.4 Strategizing Sectoral-level Decarbonization**

Decarbonization of specific industry sectors with certain limitations is feasible (Schiffer & Manthiram, 2017). However, this may not permit decarbonization of the entire energy system because mostly in such cases, a shift in carbon emission from one industry to another is observed. Implementation of decarbonization practices can be brought about in the shipping industry by focusing on clean and new technology (Pomaska & Acciaro, 2022). The concept of decarbonization management should be interjected into the transportation sector for the sake of restricting CO<sub>2</sub> emissions (Malloupas & Yfantis, 2021). The extrinsic factors that entail adoption and promotion of innovative sustainable business models can be considered as those complementary foundations that are responsible for creating impactful business solutions (Calandra et al., 2022).

To realize the objective of decarbonization, two methods are generally engaged:

1. Reinforcement of carbon sinks via:
  - (a) Artificial manner- By engaging CCUS technologies
  - (b) Natural manner- Assisted through reforestation and afforestation
2. Efficiency improvisation for carbon- intensive areas and mitigation of carbon sources.

The carbon economics based on top to bottom approach does not contain detailing on the technological aspects of the carbon flow systems (Spaargaren & Mol, 2013). Attainment of net- zero emissions by 2050 can be attained via:

- (i) Scientific community approved public policies (Hamilton et al., 2021)
- (ii) Interventions pertaining to business activities and social approvals (Cosma, Principale & Venturelli, 2022).

Attainment of specific costing of a decarbonized energy system is unpredictable but is a function of:

- (a) Operational costs
- (b) Specific investments in technologies & resources (Moret et al., 2017; Li et al., 2019)

Green logistics can be carried out in a sustainable environment by emphasizing on reduced greenhouse gas (GHG) emissions within the ambit of shipping interventions (Zhou et al., 2023). The financial sector needs to be engaged for attaining a decarbonized economy. Promotion of sustainable finance is pivotal as the attainment of the objectives of a decarbonized economy needs goods pumping of finances (Lagoarde & Martinez, 2021; Cortez, Andrade & Silva, 2022). Decarbonization objectives are embedded in designing & policy implementation with respect to strategic planning & incumbent sustainability preferences (Di Vaio et al., 2021).

### **3.5 Green advertising as a precursor of Decarbonization**

There has been a noticeable rise in the level of apprehension among both consumers and corporations in recent years over sustainability concerns and the adoption of environmentally friendly practices. Green advertising is a term used to describe any kind of promotional activity that highlights the connection between a product/service and the biological surroundings (Banerjee et.al, 1995). While marketing is widely recognised as being closely linked to social welfare, there are worries over the potential accessibility of consumers to unlawful promotional practices due to the consumer-centric focus and occasionally reckless strategies employed in the field. The global surge in ecological consciousness has led to increased concern among consumers safeguarding the environment (Yadav. P, et al., 2023). Green advertising is an emerging advertising term that centers around environmental preservation and human well-being. It focuses on promoting green products and advocating for green consumption practices as the primary means of communication. The environmentally conscious approaches for green marketing strategies, when implemented via Green Advertising, experience widespread acceptance, enhanced solidity, and improved trust among consumers (Mahato, M.K, et al., 2023). The objective of green advertising is to deliver environment-friendly information to consumers, emphasizing the significance of safeguarding the environment and preserving natural resources (Kilbourne, W. E., 1995). According to scholarly literature, green advertising encompasses advertising claims that specifically cater to the requirements and wants of environmentally conscious customers (Zinkhan & Carlson, 1995). In the research conducted by Zhu et al., in the year 2020, the key factors of information quality were found to be adequacy, dependability, applicability,

comprehensibility, fullness, correctness, and factuality. In terms of broad dimensions, Jiang et al. in the year 2021, observe information quality as a variable with three parts: the quality of the information's content, how it's presented, and how useful it is. The scope of this phenomenon extends beyond the mere positioning of ecologically sustainable goods (Kangis P, 1992). Additionally, it fosters and advocates for an environmentally conscious way of living while cultivating a perception of accountability. In addition to the promotion of the products/services, green advertising places equal focus on the manufacturing technique (Papadopoulos et.al, 2010). Lee and Cho studied in the year 2022 the effects of constructing messages, image valence information, and issue engagement on green consumers' perceptions of advertisements and their intentions to make purchases. This research demonstrated that the attitudes of consumers were affected by the congruence between the framing of messages and the valences assigned to images.

### **3.6 Green advertising of decarbonization interventions for attaining Sustainability**

To begin with, participating in activities aimed at reducing CO<sub>2</sub> emissions has the potential to enhance the generation of value. The incorporation of environmental considerations into consumer choices is becoming more prevalent among consumers (Holmes et al., 2021; Brower & Dacin, 2020). Firms that engage in differentiation strategies and emphasize the reduction of CO<sub>2</sub> emissions have the potential to enhance their existing differentiation by including an ecological component and fostering a good quality perception. According to previous studies (Khanra et al., 2022; Duanmu et al., 2018), it has been suggested that this practice has the potential to enhance the reputation of the organization, improve its brand image, and foster client loyalty. According to Hafner et al. in 2022 and Olatunji et al. in 2019 stated that the implementation of various initiatives, such as the use of green products, products that are recyclable and eco-friendly packaging, sustainable manufacturing techniques, and reductions in energy consumption, can play a significant role in establishing competitive advantages by enhancing the perception of a business as sustainable in nature. Furthermore, the adoption of environmentally-friendly client preferences may result in a decrease in price sensitivity towards low-carbon items. This would enable corporations to impose a higher price on their products, transfer the expenses of decarbonization to customers, enhance their profit margins, and finally, attain better financial outcomes (Shea & Hawn, 2019; Awaysheh et al., 2020). There are reasons that support the notion that prioritizing carbon reduction in a firm's strategy choices might amplify the beneficial impact of differentiation strategies on company performance (Russo et al., 2021; Khanra et al., 2022).

### **4.0 Research Methodology**

Since this research was exploratory in character, therefore the research methods used were mixed. Using a systematic search and extraction technique, the content was mined from a database of credible secondary sources (by employing topic-specific keywords). This qualitative investigation classified the whole canon of segregated literature into five groups, each representing a different level of overlap across the many works included. Conceptual framework analysis embedded grounded theory, a kind of qualitative study was engaged to explain the continuity throughout all five eras. Because the findings are given sequentially, from more particular to more generalized conclusions based on the author's and the audience's assumptions, this conceptual paper made use of inductive reasoning.

### **5.0 Findings**

Based on the application of mixed qualitative approach as discussed in research methodology above, the following probable inferences may be drawn:

- Carbon management is pivotal to ensuring climate change is erratic & offering sustainable solutions in all paradigms.
- Carbon management system encompasses the following interventions aiming at sustainability:
  - (a) Reduction of industrial & household CO<sub>2</sub> emissions
  - (b) Monitoring of emissions inventory
  - (c) Finding alternative methodologies to reduce CO<sub>2</sub> emissions
  - (d) Assortment of corporate infrastructure & operational technologies for mitigating CO<sub>2</sub> emissions
  - (e) Offsetting greenhouse gas (GHG) emissions & resorting to energy-efficient renewable sources alternatives
  - (f) Compliance with new carbon- curtailment policies

- (g) Reduction of carbon footprint
- The three-fold carbon management system strategies inclined towards sustainability are:
  - (i) Carbon compensation
  - (ii) Carbon reduction
  - (iii) Carbon independence
- Sustainable business-oriented decarbonization (carbon management) techniques are:
  - a. Changes in the product mix
  - b. Supply chain modifications
  - c. Relocating production facilities
  - d. Energy saving tactics
- Tools & techniques of decarbonization aimed at sustainable business development include:
  - (i) Life-cycle assessments (LCA)
  - (ii) Cradle-to-cradle analysis (C2C)
  - (iii) Carbon calculator tools
  - (iv) Environment certification bodies
  - (v) Eco-designing
  - (vi) Green supply chain management
- For strategizing sectoral-level decarbonization, the following two methods need to be engaged:
  - (a) Reinforcement of carbon sinks by artificial or natural ways
  - (b) Improving energy efficacy for carbon-intensive areas & by scientific approval of public policies
- Green advertising bears the full potential to popularize decarbonization and carbon management endeavors in the eyes of the general public thereby advocating an eco-centric sustainable way of living.

The above-mentioned probable deductions were represented by a framework depicted in figure 1.

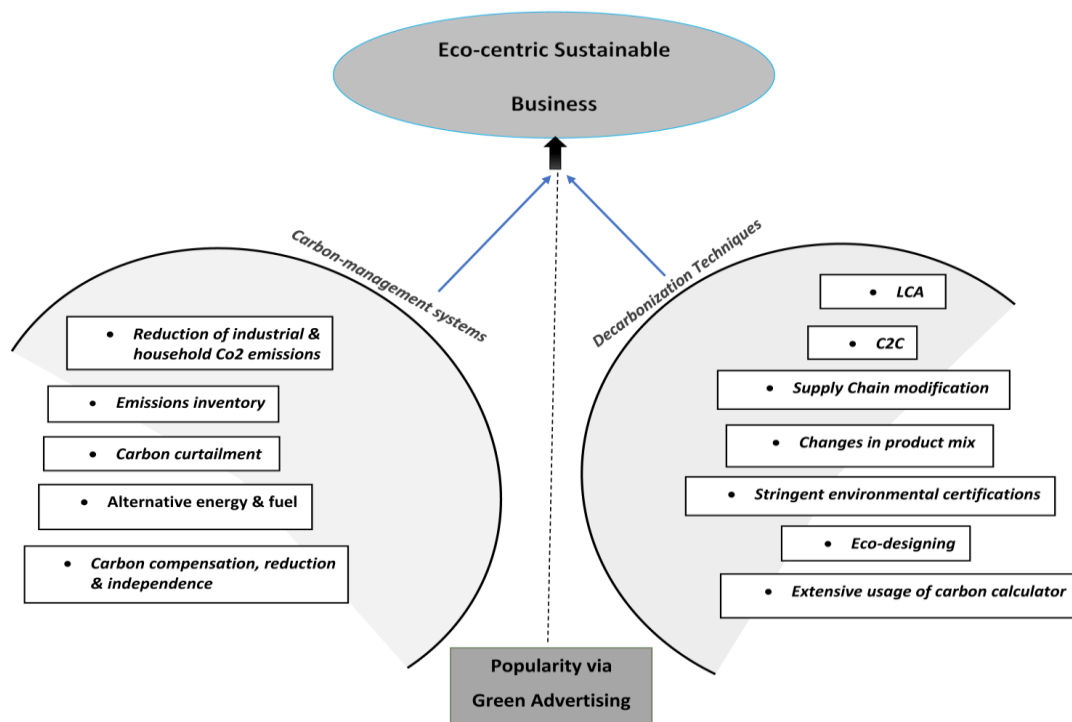


Fig1: Framework building between eco-centric sustainability and decarbonization slated carbon management system assisted via Green Advertising

## **6.0 Conclusion**

As corporations confront significant climate change challenges, managerial success and strategic acumen necessitate a demonstration of knowledge and reverence for the ramifications of their operations on global warming. Nonetheless, identifying the most efficacious facets and integrating them can often pose a challenge, thereby impeding the translation of strategic objectives into tangible outcomes. So, we endeavored to investigate a nascent corporate strategy, namely the Carbon Management Systems (CMS), and decarbonization techniques and their contribution in achieving eco-centric sustainability. Our study provides convincing evidence of the advantages, requirements, and efficacy of the CMS. This study holds significance within the realm of global warming and carbon emissions since its findings are anticipated to attract attention from corporations and policymakers. We address the demand for investigation and theoretical knowledge as well as the necessity for an efficient CMS in light of the increased focus on this topic by environmentalists. The implications of our research are significant for several stakeholders, including investors, executives, and regulatory agencies.

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