

Measuring What Matters: Carbon Footprints, Credits, and Real-World Impact

Arpit Darbari¹

Masters of Sciences: Mobility & Automotive Management, SRH Berlin, Germany, 10587
 Bachelor of Technology: Automobile Engineering, SRM Institute of Science and Technology, Chennai, Tamil Nadu, India, 603203
 Address: B3-1103, Mapsko Casabella, Sector 82, Gurgaon, Haryana, India, 122004

Publication Date: 2026/03/12

Abstract: Carbon footprints, credits, and markets form the backbone of corporate and policy-driven sustainability strategies amid escalating climate pressures. This paper dissects their conceptual foundations, empirical effectiveness, and governance challenges, drawing on systematic reviews, stakeholder surveys from emerging economies like India and Vietnam, and manufacturing case studies. While credits promise cost-effective mitigation and development co-benefits evidenced by 60%+ stakeholder endorsement for robust systems recent meta-analyses reveal only 16% deliver real reductions due to additionality failures and over-crediting. Reforms prioritizing verification, transparency, and a reduction hierarchy are essential for aligning markets with net-zero goals, particularly for MSMEs navigating CBAM and ESG mandates.

Keywords: Carbon Credits, Carbon Footprint, Sustainability Governance, CBAM Compliance, GHG Scope 1,2 &3, Voluntary Carbon Markets.

How to Cite: Arpit Darbari (2026) Measuring What Matters: Carbon Footprints, Credits, and Real-World Impact. *International Journal of Innovative Science and Research Technology*, 11(3), 334-338. <https://doi.org/10.38124/ijisrt/26mar260>

I. INTRODUCTION

Global climate policy has increasingly turned to market-based mechanisms and corporate sustainability strategies to address rising greenhouse gas (GHG) emissions and associated climate risks. Central to these approaches are three interconnected concepts: organizational sustainability, carbon footprints, and carbon credits.

Carbon markets now channel billions of dollars into mitigation projects, yet growing evidence questions whether these mechanisms deliver their promised emission reductions and sustainable development benefits. This paper critically examines how carbon footprint accounting underpins sustainability strategies, how carbon credits and markets are designed to operate, and what the emerging empirical record says about their real-world environmental and socio-economic impact.

➤ *The Objective is Threefold:*

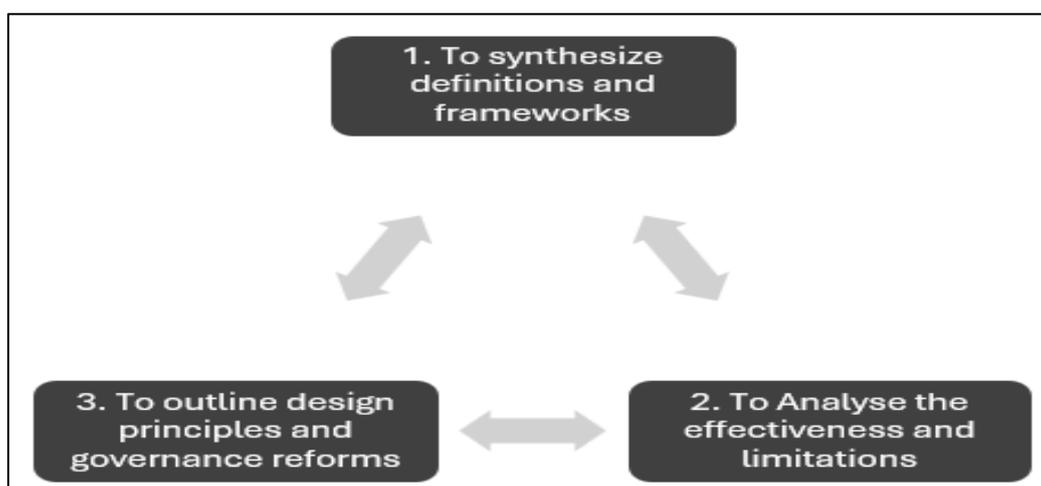


Fig 1 The Objective is Threefold

These three major principles are required for carbon credit-based approaches to contribute meaningfully to climate mitigation and broader sustainability goals.

II. MATERIALS AND METHODS

➤ Conceptual Foundations:

- *Sustainability and Climate Mitigation*

Sustainability is commonly framed through the “triple bottom line” of environmental integrity, social equity, and economic viability, with climate mitigation integral to the environmental pillar. From a climate perspective, sustainable development implies structurally decarbonizing energy

✓ Organizational Footprints Include:

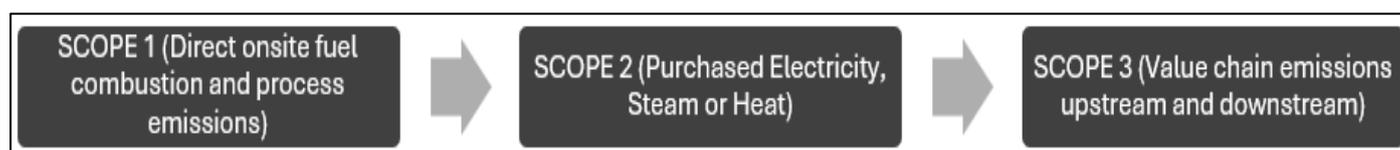


Fig 2 Organizational footprints include

Which in line with widely used GHG accounting standards nowadays.

Carbon foot printing has become the quantitative backbone of corporate climate strategies, enabling baseline setting, target formulation, performance tracking, and disclosure in frameworks such as ESG reporting and net-zero commitments. However, methodological choices: system boundaries, emission factors, allocation rules and data quality introduce uncertainty, especially for complex supply chains and embodied emissions in materials and infrastructure.

- *Carbon Credits and Markets*

A carbon credit typically denotes a verified unit representing one tonne of CO₂ (or CO₂e) reduced, avoided or removed relative to a defined baseline scenario. Credits are generated by mitigation projects such as renewable energy installations, energy-efficiency upgrades, methane capture, reforestation, or avoided deforestation, provided these projects meet criteria of additionality, measurability, permanence and independent verification. Once issued, credits can be sold in carbon markets and ultimately “retired” by buyers to claim compensation for their own emissions.

✓ Carbon Markets are Institutional Arrangements Where these Credits are Traded. Two Broad Types Exist:

- ❖ Compliance markets created by regulation (e.g., emissions trading systems) where entities must surrender allowances or credits to meet legally binding caps or performance standards.
- ❖ Voluntary carbon markets where companies or individuals without formal obligations purchase credits to support mitigation projects or to substantiate climate-related claims.

systems, industrial processes, transport, and land-use while safeguarding ecosystems and enabling inclusive growth. This shifts the focus from marginal, project level interventions to systemic changes in technology, infrastructure, and behaviour.

- *Carbon Footprints*

A carbon footprint represents the total GHG emissions caused directly and indirectly by an activity, organization, product, or individual over a defined boundary and period, expressed in tonnes of carbon dioxide equivalent (tCO₂e). It typically aggregates carbon dioxide, methane, nitrous oxide and other gases, using global warming potentials to convert to a common metric.

The theoretical rationale is that carbon pricing and trading reveal least-cost abatement options, incentivize innovation, and mobilize private capital toward low-carbon activities, while crediting extends mitigation beyond capped sectors.

III. CARBON CREDITS AS INSTRUMENTS OF SUSTAINABILITY

➤ Role in Corporate Climate Strategies

Corporates increasingly integrate carbon credits into net-zero and “carbon-neutral” strategies, often using them to offset residual emissions that are costly or technologically difficult to abate in the short term. A growing body of literature reviews how companies structure these claims, distinguishing between reduction-based and offset-based components, and emphasizing the need for transparent, science-aligned pathways where credits supplement, rather than replace, internal decarbonization efforts. Many guidance documents now insist that credits should only be used for residual emissions after aggressive on-site and value-chain reductions, and that claims such as “carbon neutral” must be supported by robust accounting and disclosure.

➤ Potential Benefits

Properly designed carbon crediting mechanisms can, in principle, support sustainability in several ways:

- *Environmental Benefits:*

Directing finance to projects that reduce emissions, restore ecosystems, and enhance carbon sinks, leading to improvements in air quality, biodiversity and land resilience.

- *Economic Benefits:*

Creating revenue streams for low-carbon technologies and land stewards, incentivizing energy-efficiency measures, and enabling cost-effective compliance with regulatory caps.

- *Social Co-Benefits:*

Supporting community-level projects (e.g., clean cooking, rural renewable energy, agroforestry) that can deliver health, livelihood, and resilience gains when well-governed.

Empirical work on regulated carbon markets shows that, under stable pricing and credible enforcement, such systems can reduce carbon intensity more quickly than in comparable non-market regions and prompt firms to upgrade technologies and invest in low-carbon innovation. Survey-based evidence from emerging economies suggests that stakeholders view carbon markets as a viable mechanism for aligning economic development with environmental sustainability when governance is robust.

- *Key Survey Evidence are as follows:*

- A 2021 CEEW survey of 250+ professionals across Indian think tanks, industry, government, academia, and finance found strong support for carbon pricing tools like taxes or trading to decarbonize sectors. Over 60% viewed them as key for low-carbon transitions, especially renewables and efficiency, while stressing transparent governance to avoid economic shocks.
- In Vietnam, a 2025 NS-DEMATEL study of experts highlighted stakeholder priorities: 70%+ emphasized regulatory clarity, price stability, and verification for carbon credit systems (CCS). Private firms and banks flagged financial incentives as vital, seeing markets viable for net-zero if aligned with Article 6.
- World Bank's 2024 carbon markets report, drawing on policymaker surveys in developing nations, notes political buy-in grows when markets promise tech transfer and finance e.g., halving NDC costs but falters without enforcement against leakage or weak baselines.

- *Why Governance Matters?*

Robust setups address core concerns:

- Transparency: Public registries and audits build trust (Vietnam experts ranked it top).
- Equity: Benefit-sharing with communities prevents backlash (e.g., Mozambique forestry).
- Stability: Price floors/ceilings aid investment (India ETS pilots).

IV. EFFECTIVENESS AND IMPACT: EMERGING EVIDENCE

- *Environmental Effectiveness of Carbon Credits*

Recent systematic assessments raise serious questions about the environmental integrity of a large share of carbon credits, especially in voluntary markets. A meta-analysis covering 2,346 mitigation projects and nearly one billion tonnes of issued credits estimates that less than 16% of credits correspond to real emission reductions, implying that the climate impact of many projects is substantially overestimated. A related review of crediting projects finds pervasive issues with additionality (whether projects would

have happened anyway), baseline inflation, permanence, and leakage, particularly in forestry and land-use interventions.

These findings suggest that for many projects, one credited tonne does not actually represent one tonne of avoided or removed emissions, undermining the core premise of carbon offsetting. If buyers rely on such credits to meet voluntary targets or to justify slower internal reductions, global emissions may end up higher than claimed, a phenomenon sometimes described as “paper decarbonization.”

- *Carbon Markets as a “Double-Edged Sword”*

Studies of regulated carbon markets highlight a nuanced picture in which emissions are reduced but at non-trivial economic and financial costs. For example, empirical analyses of regional carbon trading schemes indicate that these policies significantly lower carbon intensity sometimes at annual rates notably higher than in non-covered regions while also tightening firms’ financing conditions and slightly reducing returns on assets. At the same time, carbon pricing appears to induce higher research and development spending, patenting activity, and equipment upgrades, signalling that emissions pressure can catalyse technological innovation and energy-structure optimization.

- *Perceptions and Governance Challenges*

Stakeholder surveys in developing-country contexts show strong perceived potential for carbon markets to mitigate climate change, incentivize greener industrial practices, and balance economic growth with environmental responsibility. Yet these same studies emphasize persistent barriers: weak policy enforcement, limited monitoring and verification infrastructure, inadequate technical capacity, and concerns over transparency and equity in benefit-sharing.

Civil society analyses and NGO reports echo these governance concerns, arguing that low-quality credits, opaque methodologies, and conflicts of interest in standard-setting bodies undermine trust and risk “cooking the climate books.” The gap between formal standards and practical enforcement emerges as a central determinant of whether carbon crediting supports or distorts sustainability objectives.

V. CARBON FOOTPRINTS, OFFSETTING, AND CORPORATE CLAIMS

- *Linking Footprints and Carbon Credits*

The connection between carbon footprints and carbon credits is operationalized through offsetting: organizations quantify their footprint, pursue internal reductions, and then purchase or generate credits to compensate for remaining emissions. This linkage is conceptually straightforward but practically complex. It assumes that footprint estimates are reasonably accurate, that credits represent real, additional and permanent reductions, and that the combination yields meaningful progress toward net-zero trajectories.

Literature reviewing corporate climate claims finds wide heterogeneity in how companies use credits and communicate their role. Some firms clearly separate

reductions and offsets, disclose project details, and set time-bound phase-down plans for credit use; others rely heavily on credits while making broad “carbon neutral” marketing claims with limited transparency about project quality or internal decarbonization ambition.

➤ *Risks of Over-Reliance on Offsets*

Given the evidence that a large share of voluntary credits delivers overstated climate benefits, extensive reliance on offsetting risks delaying necessary structural changes in production and consumption systems. When credits are cheap and plentiful, they may be used as a substitute for investments in energy efficiency, fuel switching, process redesign, or circular-economy strategies that address emissions at source.

• *This Creates Several Risks:*

- ✓ Environmental risk: Global emissions do not fall at the rate implied by corporate claims, jeopardizing temperature goals.
- ✓ Reputational risk: Companies face accusations of “greenwashing” or “offset washing” if their claims are underpinned by low quality credits.
- ✓ Transition risk: Firms that rely on offsets rather than real reductions may be less prepared for future regulation, carbon pricing, or customer demands for low-carbon products.

For these reasons, many recent guidance documents and reviews stress a mitigation hierarchy: prioritize deep absolute emissions reductions, then use high-quality credits only for residual emissions that are currently hard to abate.

VI. DESIGN PRINCIPLES FOR HIGH-INTEGRITY CARBON CREDIT SYSTEMS

➤ *Strengthening Environmental Integrity*

To align carbon credits with genuine sustainability outcomes, reforms are needed across the project cycle:

- Stricter additionality testing: Requiring robust financial and regulatory assessments to demonstrate that projects would not occur without credit revenue.
- Conservative baselines: Using baseline scenarios grounded in the latest scientific and policy trends, avoiding inflated assumptions about what emissions would have been absent the project.
- Monitoring and verification: Improving data collection, independent audits, and periodic re-evaluation of project performance over time.
- Permanence and leakage management: Particularly in land-use projects, addressing risks of reversal (e.g., future deforestation) and displacement of emissions to other locations.

Recent meta-studies argue that crediting programs and standard bodies bear a particular responsibility to adopt conservative quantification, update methodologies with new scientific insights, and transparently communicate uncertainty.

➤ *Governance, Transparency, and Equity*

Beyond technical integrity, governance features shape whether carbon crediting advances or undermines broader sustainability objectives:

- Transparent registries and methodologies: Open access to project documentation, methodologies, and third-party evaluations to enable independent scrutiny.
- Clear role of credits in corporate claims: Standardized guidance on how companies can reference credits in net-zero or carbon-neutral claims, including requirements for disclosure of volumes, types, and project characteristics.
- Fair benefit-sharing: Mechanisms ensuring that local communities, landowners, and workers receive equitable shares of financial and non-financial benefits, particularly in projects in the Global South.
- Policy alignment: Integration of carbon markets with national climate policies, NDCs, and just transition strategies to avoid double counting and ensure that credits complement, rather than conflict with, domestic mitigation pathways.

Where such governance elements are weak, power imbalances and information asymmetries can lead to extractive or inequitable outcomes, even when projects are technically compliant.

VII. INTEGRATING CARBON CREDITS INTO A SUSTAINABLE TRANSITION

➤ *From Project-Based Offsets to System Level Decarbonization*

Current evidence suggests that while carbon markets and credits can contribute to emission reductions and clean-technology investment, they cannot substitute for rapid, deep decarbonization of energy, industry, transport, buildings and land-use systems. Some studies emphasize that direct footprint reduction through efficiency, renewable energy adoption, process innovation, and behavioural change is more reliable for long-term mitigation than purchasing offsets, because reductions at source are inherently measurable, verifiable, and cumulative.

Consequently, integrating carbon credits into sustainability strategies requires reframing their role: from primary mitigation instrument toward a complementary tool for addressing hard-to-abate residual emissions, supporting high-impact projects in underfunded sectors, and closing near-term ambition gaps while structural transitions are underway.

➤ *Priority Areas for Future Research*

Several research gaps emerge from the literature:

- Methodological innovation in crediting: development of dynamic baselines, standardized additionality tests, and probabilistic approaches to reflect uncertainty in project performance.
- Sector-specific assessments: deeper analysis of credit effectiveness across sectors such as industrial energy

efficiency, renewable fuels, agriculture, forestry, and urban infrastructure, including interactions with regulations like border adjustment mechanisms.

- Distributional and justice dimensions: examining who benefits from carbon credit finance, whose land and resources are leveraged, and how projects intersect with local development priorities and rights.
- Corporate transition pathways: longitudinal studies tracking how companies that rely heavily on offsets compare in actual decarbonization performance and resilience to policy changes versus those prioritizing internal reductions.

VIII. CONCLUSION

Sustainability, carbon footprints, and carbon credits are tightly interwoven in contemporary climate governance, corporate strategy, and financial markets. Carbon footprint accounting provides a quantitative foundation for understanding and managing emissions, while carbon credits and markets aim to harness market forces to deliver cost-effective mitigation and support low-carbon development. Yet mounting empirical evidence reveals that many credited emission reductions are overstated, exposing serious risks when offsetting is used as a central decarbonization strategy rather than a supplementary tool.

High-integrity carbon credit systems require robust methodologies, conservative baselines, rigorous verification, transparent governance, and clear limits on how credits can be used in corporate claims, embedded within a mitigation hierarchy that prioritizes deep, direct emission reductions. Under such conditions, carbon credits can contribute to sustainable transitions by channelling finance to genuinely additional, high-impact projects and addressing residual emissions, particularly in hard-to-abate sectors. The challenge ahead lies in reshaping markets and institutional frameworks so that claims of “carbon neutrality” and “net-zero” reflect real transformations in the physical economy rather than accounting artefacts.

REFERENCES

- [1]. <https://www.sciencedirect.com/science/article/abs/pii/S0140988323005388>
- [2]. <https://www.mpg.de/23737687/climate-impact-of-carbon-crediting-projects-substantially-overestimated>
- [3]. <https://css.umich.edu/publications/factsheets/sustainability-indicators/carbon-footprint-factsheet>
- [4]. <https://pmc.ncbi.nlm.nih.gov/articles/PMC10069309/>
- [5]. <https://climatepromise.undp.org/news-and-stories/what-are-carbon-markets-and-why-are-they-important>
- [6]. <https://academic.oup.com/ce/article/9/6/137/8213641>
- [7]. <https://www.nature.com/articles/s41467-024-53645-z>
- [8]. <https://www.worldfuturecouncil.org/carbon-credit-market/>
- [9]. <https://rsisinternational.org/journals/ijriss/articles/the-potential-impact-of-carbon-market-on-climate-change-mitigation-and-the-advancement-of-sustainable-development-goals-in-anambra/>

- [10]. <https://www.ceew.in/publications/stakeholders-survey-on-net-zero-carbon-economy-vision-of-india>
- [11]. <https://openknowledge.worldbank.org/entities/publication/abf9c34f-14a6-4c4f-ac97-f07f4ebd67ff>
- [12]. <https://www.sciencedirect.com/science/article/pii/S2665972725000121>
- [13]. <https://economics.pubmedia.id/index.php/jees/article/download/1022/757/3919>
- [14]. <https://jier.org/index.php/journal/article/download/2878/2352/5150>
- [15]. <https://scholarworks.umb.edu/cgi/viewcontent.cgi?article=1848&context=nejpp>
- [16]. <https://www.sciencedirect.com/science/article/pii/S1876610211008423>
- [17]. <https://dai-global-developments.com/articles/q-a-establishing-domestic-carbon-markets-in-vietnam/>
- [18]. <https://carbonwire.org/carbon-voices/vietnam-sets-sights-on-carbon-market-leadership-as-pilot-exchange-launch-approaches/>
- [19]. <https://www.linkedin.com/pulse/case-study-reducing-carbon-footprint-manufacturing-yatish-2gmwc>
- [20]. https://www.cifor-icraf.org/publications/pdf_files/OccPapers/OP-238.pdf