

## **Sectoral structure and corporate climate strategy: A typology of adaptation, mitigation and ambidextrous configurations in emerging economies**

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### **Abstract**

Research on corporate climate strategy usually explains differences in decarbonisation through managerial cognition, leadership, capabilities or institutional pressure. This paper develops a complementary meso-level explanation: sectoral structural attributes, namely risk exposure profile, asset-cycle longevity and institutional context, filter macro-level climate pressures and condition the feasible set of firm-level responses. Using an integrative review that combines 52 peer-reviewed studies identified through Scopus and Web of Science, 12 institutional reports and 22 corporate disclosures (2021–2024), the study compares agribusiness, renewable energy and heavy manufacturing, with India as the principal context. It develops three ideal types. The Resilient Adapter is shaped by immediate physical risk and favours adaptation. The Transformative Mitigator is shaped by transition opportunity and climate-aligned capital and favours mitigation-led growth. The Ambidextrous Navigator is shaped by long-lived carbon-intensive assets and contested institutional pressure, and sustains legacy operations while investing selectively in low-carbon alternatives. Structural contingency theory supplies the fit logic, socio-technical transitions and institutional theory explain meso-level conditions, dynamic capabilities explain variation in execution, and configuration theory guides ideal-type construction. The paper proposes that the gap between climate disclosure and action varies with how closely verified climate performance is tied to finance, market opportunity, regulation and legitimacy, and it outlines Socio-Technical Transition Effectiveness as a provisional outcome framework. The study does not test causal relationships. It offers a context-sensitive typology, a set of propositions and an agenda for empirical research on corporate decarbonisation in emerging economies.

**Keywords:** Corporate Climate Strategy, Sectoral Typology, Decarbonisation, Sustainability Transitions, Disclosure–Action Gap, Dynamic Capabilities, Emerging Economies, India

**JEL Classification:** Q54, Q56, L52

## 1. Introduction

Climate change has become a strategic issue for firms across sectors, affecting physical assets, supply chains, finance, technology, regulatory exposure, labour markets, and long-term business viability (Dietz et al., 2016; Intergovernmental Panel on Climate Change [IPCC], 2022). Yet firms exposed to broadly comparable national climate commitments, investor expectations, and international market pressures often pursue markedly different decarbonisation pathways: renewable-energy firms may expand rapidly toward low-carbon generation and storage, firms in steel, cement, chemicals, or petrochemicals may pursue incremental efficiency improvements alongside longer-term technology bets, and agribusiness firms may instead prioritise resilience and supply-chain adaptation over direct emissions reduction. These differences cannot be explained adequately by variation in managerial commitment, ESG ambition, or reporting infrastructure alone. This variation is especially consequential in India, which combines major economic-development ambitions with high climate vulnerability, rapid renewable-energy expansion, and a large industrial base dependent on carbon-intensive infrastructure (Ministry of Environment, Forest and Climate Change, 2022; World Bank Group, 2024). Indian firms increasingly confront national climate-policy commitments, sustainability reporting expectations, investor scrutiny, and international trade-related transition pressures; the Business Responsibility and Sustainability Reporting framework has increased the visibility of sustainability governance among major listed firms, while climate-related financial risks have become more salient in policy discussions (Reserve Bank of India, 2023; Securities and Exchange Board of India, 2021). The effects of climate change are nonetheless experienced unevenly across sectors, depending on exposure to physical hazards, asset characteristics, and institutional conditions.

The empirical puzzle motivating this study is straightforward: why do firms facing broadly comparable macro-level climate pressures respond to decarbonisation in fundamentally different ways? A renewable-energy developer may treat climate action as a core growth opportunity, restructuring investment portfolios around renewable generation, storage, green hydrogen, and climate-aligned finance. A steel, cement, chemical, or petrochemical firm may face mounting carbon exposure and trade-related transition risks while remaining embedded in long-lived, capital-intensive production systems that cannot be replaced rapidly without substantial financial, technological, and organisational disruption (Caldecott, 2017; Mercure et al., 2018). An agribusiness firm may instead confront immediate and localised physical risks—heat stress, erratic rainfall, water scarcity, crop-yield instability, and smallholder vulnerability—making resilience and adaptation strategically urgent (Birthal et al., 2014; Challinor et al., 2014; IPCC, 2022; Lobell & Gourdji, 2012). These differences are not merely variations in the intensity of the same climate strategy; they often concern the strategic orientation of the response itself. In agriculture, the dominant concern is typically adaptation to physical climate risk, supported through precision agronomy, climate-resilient inputs, digital advisory systems, and supply-chain resilience (ITC Limited, 2023; UPL Limited, 2023; Wolfert et al., 2017). In renewable energy, the climate

transition generates direct commercial opportunity through renewable deployment, falling technology costs, and expanding access to green finance (International Energy Agency, 2023; International Renewable Energy Agency, 2023; Ministry of New and Renewable Energy, 2024). In heavy manufacturing, firms face the simultaneous challenge of reducing emissions, managing stranded-asset risk, and investing selectively in uncertain low-carbon technologies such as green hydrogen, electric arc furnaces, and carbon capture (Caldecott, 2017; Mercure et al., 2018; O'Reilly & Tushman, 2013).

Existing corporate climate-strategy research has often explained such variation through firm-level factors, including executive cognition, managerial discretion, organisational capabilities, and stakeholder pressure (Hambrick & Finkelstein, 1987; Hambrick & Mason, 1984; Ocasio, 1997; Teece et al., 1997). These perspectives matter, but they do not fully explain why some sectors appear structurally positioned to pursue mitigation-led transformation while others are more likely to prioritise adaptation or ambidextrous combinations of legacy-asset management and exploratory low-carbon investment. The puzzle, then, is not whether managerial agency matters—it clearly does—but why it is exercised under such different technological, financial, institutional, and risk conditions across sectors: why do similar macro-level pressures translate into different feasible sets of firm-level strategy?

Several literatures provide partial answers. Research on corporate climate strategy shows that firms vary in how they interpret and respond to environmental pressures (Hoffman, 2018; Kolk & Pinkse, 2005; Porter & van der Linde, 1995). The dynamic-capabilities perspective explains how organisations sense changing conditions, seize emerging opportunities, and reconfigure resource bases and routines in response to environmental change (Teece et al., 1997). Upper-echelons theory, managerial-discretion research, and the attention-based view show that executive cognition, values, attention allocation, and decision latitude shape strategic responses to complex environmental issues (Bansal, 2003; Hambrick & Finkelstein, 1987; Hambrick & Mason, 1984; Ocasio, 1997). Institutional theory explains how coercive, normative, and mimetic pressures shape corporate practices, legitimacy, and disclosure behaviour (DiMaggio & Powell, 1983; Meyer & Rowan, 1977).

Sustainability-transitions scholarship extends the analysis beyond the firm, emphasising that technological and organisational change unfolds within socio-technical systems shaped by regimes, niches, institutions, infrastructure, markets, policy, and user practices (Geels, 2002; Köhler et al., 2019; Markard et al., 2012). This literature directs attention to the meso-level conditions within which firms operate, highlighting the role of institutional alignment, niche protection, and regime stability in enabling or constraining low-carbon transitions (Geels et al., 2017; Raven et al., 2016). An important theoretical gap nonetheless remains. Climate-strategy research has concentrated chiefly on macro-level pressures—regulation, investor expectations, climate science, international market dynamics—or on firm-level strategic choice and capability.

Sustainability-transitions research offers a rich account of socio-technical systems but has less often specified how particular sectoral attributes systematically shape the translation of macro-level pressure into firm-level response, especially across multiple sectors in emerging-economy settings (Geels et al., 2017; Köhler et al., 2019; Markard et al., 2012).

This study addresses that meso-level gap by conceptualising three sectoral structural attributes. Risk exposure profile refers to the relative salience and interaction of physical and transition risks for firms in a sector, consistent with broader climate-risk frameworks distinguishing hazards, exposure, vulnerability, and transition-related disruption (IPCC, 2022). Asset-cycle longevity captures the extent to which firms are embedded in long-lived, capital-intensive production systems, creating technological, economic, and organisational lock-in as well as stranded-asset exposure (Caldecott, 2017). Institutional context refers to the configuration of policy support, regulation, financial incentives, market infrastructure, and stakeholder expectations that shape legitimacy costs and resource availability for different strategic pathways (DiMaggio & Powell, 1983; Geels, 2002; Markard et al., 2012).

Together, these attributes shape the feasible set of corporate climate responses. They do not eliminate the relevance of executive leadership, dynamic capabilities, or organisational agency, but condition the costs, opportunities, time horizons, and trade-offs within which such agency is exercised—consistent with the wider structure–agency literature, which recognises that organisational actors can reproduce, negotiate, and sometimes transform institutional arrangements even while their action remains shaped by historically developed structures (Giddens, 1984; Seo & Creed, 2002). Firms such as Ørsted and Reliance Industries may therefore be understood as potential boundary cases or regime-shifting actors rather than as evidence that sectoral structure is irrelevant (DiMaggio, 1988; Seo & Creed, 2002).

The objective of this study is to develop a theory-generating typology of corporate decarbonisation strategy grounded in sectoral structural attributes, examining how risk exposure profile, asset-cycle longevity, and institutional context shape the translation of macro-level climate pressures into firm-level strategic responses across agribusiness, renewable energy, and heavy manufacturing. The study is guided by the following central research question:

How do sectoral structural attributes shape the ways in which macro-level climate pressures are translated into firm-level decarbonisation strategies?

Three subsidiary questions guide the analysis:

1. How do physical and transition-risk exposures differ across agribusiness, renewable energy, and heavy manufacturing?
2. How do asset-cycle longevity and institutional context shape the pace, orientation, and feasibility of corporate climate strategies within these sectors?

3. What ideal-type decarbonisation configurations can be derived from the interaction among sectoral structural attributes, organisational capabilities, and firm-level strategic responses?

Drawing on typological and configuration-based theorising, the study develops three proposed ideal types (Doty & Glick, 1994; Fiss, 2011): the Resilient Adapter, characterising sectors where immediate physical risk, fragmented value chains, and short operational cycles make adaptation and resilience-building central; the Transformative Mitigator, characterising sectors where transition opportunity, technological change, and climate-aligned capital favour mitigation-led business-model transformation; and the Ambidextrous Navigator, characterising sectors where long-lived carbon-intensive assets and contested institutional pressures require firms to sustain legacy operations while selectively investing in exploratory low-carbon alternatives.

These configurations are analytical ideal types rather than exhaustive empirical categories. Firms may vary within sectors, diversified firms may display more than one configuration, and sectoral conditions may change over time; the typology is intended to guide comparative inquiry and future empirical testing rather than impose fixed classifications. This study makes three contributions to research on corporate climate strategy, sustainability transitions, and responsible business. First, it advances a meso-level explanation of corporate climate strategy. Existing research has generated substantial insight into macro-level climate governance and firm-level strategic choice, but the sectoral structural conditions connecting these levels remain comparatively under-specified. By identifying risk exposure profile, asset-cycle longevity, and institutional context as sectoral structural attributes, the paper provides a framework for explaining how broad climate pressures may be filtered into different organisational opportunities, constraints, and strategic orientations (Geels, 2002; Hambrick & Finkelstein, 1987; Markard et al., 2012).

Second, the study develops a typology of sectoral decarbonisation configurations. The Resilient Adapter, Transformative Mitigator, and Ambidextrous Navigator specify how combinations of structural attributes may be associated with adaptation-led, mitigation-led, and ambidextrous strategic orientations, extending configuration-based theory-building by suggesting that corporate climate strategy should not be assessed solely through universal indicators of ESG ambition, disclosure quality, or emissions reduction, but interpreted in relation to sector-specific exposure, technological lock-in, capital requirements, and institutional alignment (Caldecott, 2017; Doty & Glick, 1994; Fiss, 2011).

Third, the study develops a structural proposition concerning the relationship between ESG disclosure and substantive climate action. Research on symbolic compliance, organisational decoupling, greenwashing, and ESG-information divergence has documented that disclosure commitments do not always translate into operational environmental change (Berg et al., 2022; Bingler et al., 2024; Christensen et al., 2021; Hawn & Ioannou, 2016; Lyon & Maxwell, 2011; Marquis et al., 2016; Meyer & Rowan, 1977). Building on this literature, the study proposes that ESG integration is shaped partly by how materially verified climate performance connects to a

sector's primary channels of capital access, commercial opportunity, and regulatory compliance: where climate performance ties closely to financial returns and green capital, firms face stronger incentives to align disclosure with operational transformation, whereas firms dependent on fragmented supply chains or long-lived carbon-intensive assets may see disclosure advance faster than substantive asset reconfiguration. This proposition is theory-generating and requires future empirical examination.

Together, these contributions shift attention from whether firms exhibit sufficient climate ambition to the sectoral conditions that shape what forms of climate action are feasible, credible, and strategically consequential. The framework has implications for corporate boards, investors, policy makers, and development-finance institutions, suggesting that uniform climate mandates, ESG benchmarks, disclosure systems, and financing mechanisms may be poorly aligned with sectorally differentiated transition conditions.

This study is an integrative theoretical review, informed by PRISMA 2020 reporting principles, that synthesises peer-reviewed literature, institutional reports, and publicly available corporate disclosures into a sectoral typology of corporate decarbonisation strategy (Page et al., 2021; Torraco, 2016; Whitemore & Knafl, 2005). It is not a firm-level causal test, a meta-analysis, or a statistical estimation of the effects of leadership, firm resources, or sector membership on decarbonisation outcomes. The empirical focus is India, an emerging-economy context combining high climate vulnerability, agricultural dependence, rapid renewable-energy growth, and industrial expansion (Ministry of Environment, Forest and Climate Change, 2022; Ministry of New and Renewable Energy, 2024; World Bank Group, 2024), where agribusiness, renewable energy, and heavy manufacturing occupy analytically distinct positions on physical exposure, transition opportunity, and institutional support. China, Brazil, South Africa, and selected global firms appear only as illustrative comparators, not independent cases.

The three sectoral domains—agribusiness, renewable energy, and heavy manufacturing—and the composition of the academic, institutional, and corporate-disclosure evidence base are defined in full in Section 2.2 and Section 2.4; corporate disclosures are treated throughout as illustrative and triangulatory material rather than as verified measures of environmental performance (Lyon & Maxwell, 2011; Marquis et al., 2016; Meyer & Rowan, 1977). The study is bounded in scope: it focuses on large firms with visible sustainability reporting, does not assume sectoral attributes are fixed, and does not claim the configurations apply unchanged across all emerging economies; rather, it identifies structural attributes that can be adapted and tested in other national contexts (DiMaggio, 1988; Giddens, 1984; Seo & Creed, 2002). The framework follows a single conceptual sequence: macro climate pressures are filtered through three sectoral structural attributes—risk-exposure profile, asset-cycle longevity, and institutional context—into the Resilient Adapter, Transformative Mitigator, and Ambidextrous Navigator configurations, within which dynamic capabilities and managerial agency shape the quality and speed of implementation without

removing the underlying structural bounds. The outcome component, Socio-Technical Transition Effectiveness (STTE), is introduced as a provisional framework for future empirical assessment. The remainder of the paper proceeds as follows. Section 2 details the review design, search protocol, and analytical approach; Section 3 synthesises sectoral evidence; Section 4 compares sectors structurally; Section 5 develops cross-sectoral propositions; Section 6 discusses theoretical contributions; Sections 7 and 8 address implications and future research; Section 9 concludes.

## 2. Methodology

This study employed an integrative theoretical review, synthesising peer-reviewed scholarship, institutional reports, and corporate sustainability disclosures to identify recurring cross-sectoral patterns and develop theoretically grounded ideal types. The PRISMA flow diagram (Figure 1) reports the identification, screening, and inclusion of the peer-reviewed academic literature only; institutional reports and corporate disclosures were assembled separately for contextual triangulation.

### 2.1 Research Design

An integrative review methodology was adopted because the research objective was to synthesise heterogeneous forms of evidence into a theoretically coherent explanation of sectoral variation in corporate climate strategy (Torraco, 2016; Whittemore & Knafl, 2005). Integrative reviews are appropriate when a problem spans multiple conceptual traditions and includes qualitative, quantitative, theoretical, and practice-based evidence that cannot be meaningfully combined through meta-analysis. The study differs from a conventional systematic review, which answers a tightly specified question using predefined eligibility criteria and aggregates empirical findings, and from a scoping review, whose purpose is to map the breadth and gaps of an evidence base (Arksey & O'Malley, 2005; Munn et al., 2018). It instead sought to identify how sectoral conditions shape the translation of macro-level climate pressures into firm-level strategic responses, using a structured and transparent selection process while retaining the iterative, theory-building orientation of an integrative review.

The analytical process proceeded in three stages. First, the peer-reviewed academic literature was synthesised thematically within each focal sector. Second, institutional reports and corporate sustainability disclosures were used to triangulate the sectoral patterns identified in the academic corpus and to provide contemporary contextual illustrations. Third, cross-sectoral findings were compared through a structured analytical matrix spanning eight dimensions: climate-risk exposure; strategic orientation; technology adoption; ESG integration and disclosure depth; adaptation–mitigation balance; expected pace of transformation; workforce and just-transition implications; and investment orientation. These dimensions supported development of the three proposed decarbonisation configurations.



The analysis was informed by thematic synthesis procedures, particularly the movement from descriptive coding to higher-order analytical themes (Thomas & Harden, 2008), and by structured, focused comparison across sectors while maintaining attention to contextual differences (George & Bennett, 2005). The review was not intended to test causal hypotheses or compare firm-level performance statistically; rather, it identifies theoretically plausible structural conditions and strategic configurations for subsequent empirical investigation. The analytical process was guided by the study's integrated theoretical framework. Structural contingency theory provided the general logic that strategic effectiveness depends on fit between organisational response and sectoral conditions. Socio-technical transitions and institutional theory informed analysis of the meso-level structures through which macro climate pressures are filtered. Dynamic capabilities informed analysis of how firms sense, seize, and reconfigure within sectorally defined opportunity sets. Configuration theory guided the development of ideal types from recurring combinations of sectoral attributes and strategic orientations (DiMaggio & Powell, 1983; Doty & Glick, 1994; Fiss, 2011; Geels, 2002; Teece et al., 1997), used as a sensitising structure rather than a set of pre-specified causal variables.

## 2.2 Sectoral Scope and Analytical Unit

The study focused on three sectoral domains: agribusiness, renewable energy, and heavy manufacturing. These sectors were selected because they display meaningful variation in relation to two conditions central to corporate decarbonisation strategy: the relative salience of physical and transition climate risks, and the longevity and capital intensity of their core assets. Agribusiness represents a sectoral domain in which physical climate risks are especially salient: production systems and supply chains are affected by heat stress, drought, rainfall variability, water scarcity, crop-yield instability, and smallholder vulnerability, and the sector spans agricultural-input firms, food-system firms, and digital agriculture platforms. Renewable energy represents a sector in which decarbonisation-related policy, technology development, and climate-aligned capital create major commercial opportunities. Renewable generation typically involves infrastructure investments with long project lifetimes. Heavy manufacturing is characterised by capital-intensive assets, technological lock-in, carbon exposure, large workforces, and complex trade, regulatory, and industrial-policy pressures, spanning steel, cement, chemicals, petrochemicals, and related industrial activities. The selection follows a structured, focused comparison logic: sectors were chosen not as statistically representative categories of the wider economy, but as theoretically informative cases that maximise variation in risk exposure, asset-cycle characteristics, institutional alignment, and anticipated strategic response (George & Bennett, 2005). Transportation, real estate, financial services, and consumer retail fall outside the present scope; their exclusion permits concentrated development of the typology across three analytically contrasting domains. The principal analytical unit is the sectoral configuration rather than the individual firm. Firms are treated as illustrative organisational actors embedded in sector-specific risk, technological, institutional, and capital-access conditions; the study does not claim

that every firm within a sector exhibits the same strategic orientation, but examines whether recurrent sectoral patterns support the development of ideal-type configurations, consistent with typological theory-building (Doty & Glick, 1994; Fiss, 2011).

### 2.3 Academic Literature Search and PRISMA Process

The academic literature corpus was identified through structured searches of Scopus and Web of Science Core Collection conducted in January 2025. The reporting of the academic search, screening, eligibility assessment, and final inclusion process was informed by PRISMA 2020 guidance (Page et al., 2021). PRISMA is used here as a reporting framework to enhance transparency in the academic literature-selection process; the overall methodological approach remains an integrative, theory-building review rather than a systematic review or meta-analysis. The Scopus search used the following Boolean search string: *TITLE-ABS-KEY (“climate change” OR “climate risk” OR “decarbonization” OR “stranded assets” OR “net zero” OR “carbon disclosure”) AND TITLE-ABS-KEY (“corporate strategy” OR “ESG” OR “sustainability transition” OR “organisational response”) AND TITLE-ABS-KEY (“agriculture” OR “renewable energy” OR “manufacturing”)*

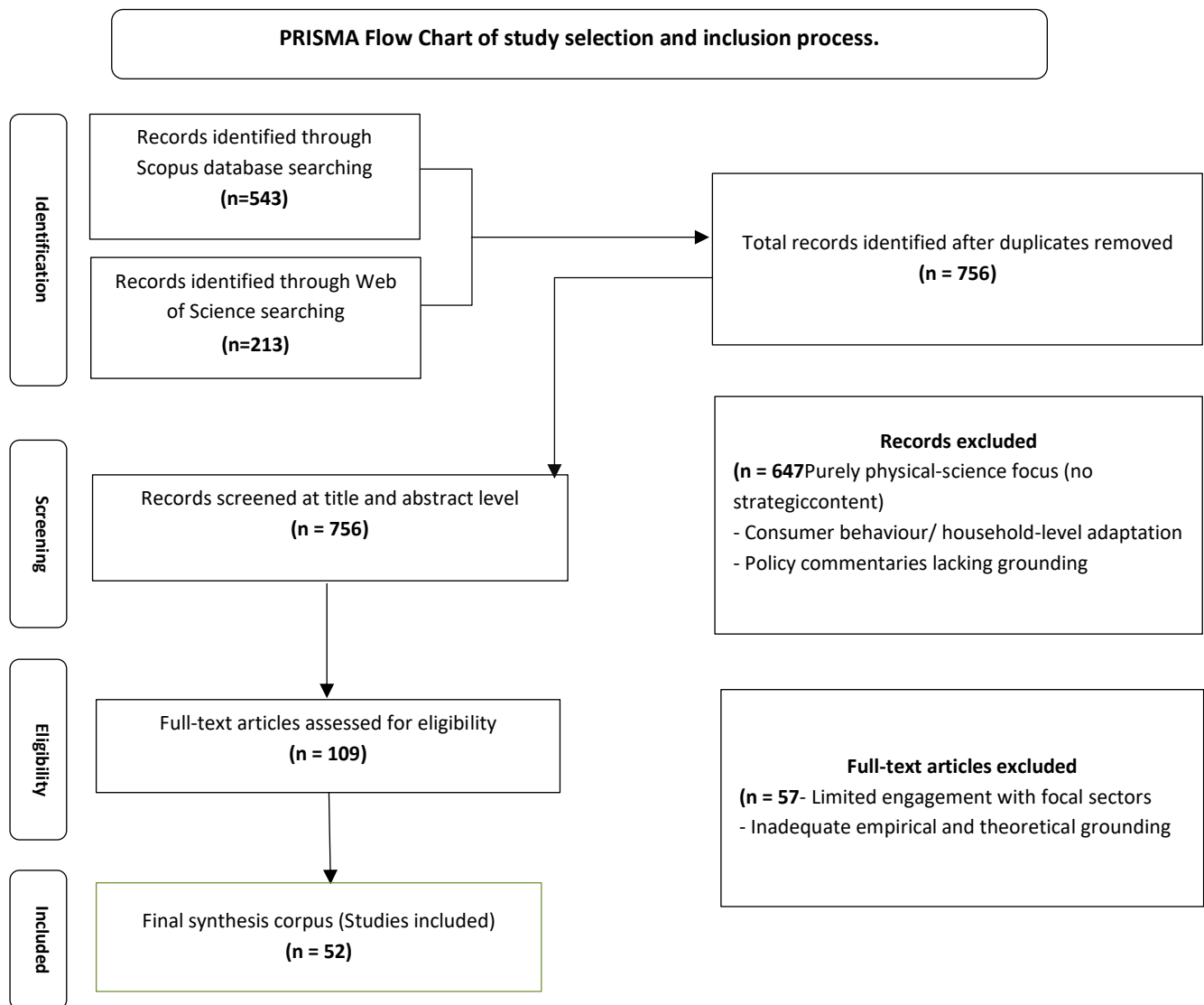
Parallel searches were conducted in Web of Science Core Collection using equivalent search concepts and Boolean logic. After de-duplication, the final academic screening pool comprised 756 unique records: 543 from Scopus and a further 213 unique, non-duplicate records from Web of Science Core Collection. The inclusion criteria for the academic corpus were:

- Publications dated 2010–2025, while retaining foundational pre-2010 theoretical works where they were necessary to establish the conceptual basis of the review.
- English-language publications.
- Peer-reviewed journal articles or scholarly book chapters.
- Substantive engagement with corporate climate strategy, organisational response, ESG integration, sustainability transitions, climate-risk management, or decarbonisation in at least one focal sector.

The exclusion criteria were:

- Studies with an exclusively physical-science focus and no substantive organisational, strategic, institutional, or managerial content.
- Studies centred primarily on consumer behaviour, household-level adaptation, or individual-level decision-making.
- Policy commentaries lacking sufficient empirical evidence or theoretical grounding.
- Studies without substantive relevance to agribusiness, renewable energy, or heavy manufacturing.

**Figure 1. PRISMA 2020 Flow Diagram of Literature Selection Process**



Source: Authors' own construction based on PRISMA 2020 guidelines; data from Scopus and Web of Science (January 2025).

All 756 unique records were screened at the title-and-abstract stage. A total of 647 records were excluded because they did not meet the eligibility criteria, principally a purely physical-science orientation, a focus on household or consumer behaviour, insufficient organisational or strategic content, a lack of substantive engagement with the focal sectors, or a publication type outside the defined eligibility criteria.

The remaining 109 full-text articles were assessed for eligibility. Fifty-seven were excluded because they had limited substantive engagement with the focal sectors, lacked adequate empirical or theoretical grounding, or did not materially address corporate climate strategy, organisational response, ESG integration, or sustainability transitions. The final academic synthesis corpus therefore comprised 52 peer-reviewed studies, including relevant seminal theoretical contributions published before 2010.

To strengthen screening reliability, a random sub-sample of 60 records was independently double-screened. Agreement was reached for 55 of the 60 records (91.7% raw agreement; Cohen's kappa = 0.83, indicating almost perfect agreement). The five disagreements were resolved through structured re-review against the predefined inclusion and exclusion criteria. The full-text synthesis and theoretical coding were conducted as an interpretive integrative-review exercise, so the double-screening procedure should not be represented as full double-coding of all included studies.

## 2.4 Contextual Triangulation Sources

The 12 institutional sources comprised reports and policy documents from bodies relevant to climate risk, renewable-energy transition, just-transition dynamics, sustainability reporting, and the Indian policy environment—including the IPCC, International Energy Agency, International Renewable Energy Agency, International Labour Organization, Food and Agriculture Organization, World Bank Group, India's Ministry of Environment, Forest and Climate Change, Ministry of New and Renewable Energy, Ministry of Statistics and Programme Implementation, SEBI, RBI, and The Energy and Resources Institute—included because they provide sector-specific benchmarks and current institutional evidence that peer-reviewed literature alone may not capture.

The corporate-disclosure corpus comprised 22 firms listed in Table A1 in Appendix A, selected purposively to provide illustrative coverage of the three focal domains and to capture visible corporate actors with publicly available sustainability, annual, ESG, integrated, impact, or regulatory disclosure materials covering 2021–2024. The final firm set included agribusiness and agricultural-technology firms; renewable-energy firms; and firms in steel, petrochemicals, engineering, construction, and related manufacturing.

The disclosures were selected using three guiding criteria:

- Public availability of relevant sustainability, ESG, annual, integrated, impact, or regulatory reporting materials.
- Substantive operational presence, market visibility, or strategic relevance within one of the focal sectoral domains.
- Availability of reporting materials across at least part of the 2021–2024 period, with variation in reporting coverage transparently recorded in Appendix A.

The corporate materials were used as illustrative and triangulatory evidence, not as a representative firm-level sample or as independently verified measures of emissions reduction, ESG quality, or decarbonisation performance—a distinction that matters because corporate reporting may communicate material commitments while also reflecting reputational and symbolic-compliance incentives (Lyon & Maxwell, 2011; Marquis et al., 2016; Meyer & Rowan, 1977). The purpose was therefore to identify stated strategic priorities, investment directions, risk framing, governance practices, and transition narratives relevant to the proposed configurations. In total, the study drew on 86 sources—52 peer-reviewed academic studies, 12 institutional reports, and 22 corporate disclosure sources; the PRISMA diagram (Figure 1) reports only the 52 academic studies identified through the Scopus and Web of Science process.

## 2.5 Data Extraction and Analytical Procedure

Data extraction and analysis followed a hybrid deductive–inductive approach. Deductive coding was guided by the study’s theoretical foundations—climate-risk exposure, asset-cycle longevity and capital lock-in, institutional context, dynamic capabilities, managerial attention, organisational ambidexterity, ESG integration, and just-transition considerations—informed by research on socio-technical transitions, institutional theory, dynamic capabilities, managerial discretion, and organisational ambidexterity (DiMaggio & Powell, 1983; Geels, 2002; Hambrick & Finkelstein, 1987; Ocasio, 1997; O’Reilly & Tushman, 2013; Teece et al., 1997).

Inductive coding then identified themes not fully captured by the initial framework, informed by constant comparison across studies, sectors, and source types as themes developed (Glaser & Strauss, 1967). Inductively developed themes included smallholder fragmentation in agribusiness adaptation, the alignment between climate performance and green-capital access in renewable energy, the strategic role of asset lock-in in heavy manufacturing, and the disclosure–action gap.

For each source, data were extracted into a structured matrix comprising:

- Sector and subsector.
- Geographic and institutional setting.
- Form of climate exposure, including physical, transition, or combined risk.
- Asset characteristics, including capital intensity and expected asset-cycle longevity.
- Institutional context, including policy support, market rules, finance, disclosure expectations, and stakeholder pressures.
- Reported strategic response, including adaptation, mitigation, digitalisation, portfolio reconfiguration, process efficiency, or exploratory low-carbon investment.
- Dynamic-capability indicators, including sensing, seizing, and reconfiguring activities.
- ESG integration and disclosure characteristics.

- Workforce and just-transition implications.
- Evidence relevant to the proposed typological configuration.

The analytic matrix supported within-sector thematic synthesis and cross-sectoral comparison. The comparison did not treat individual sources or firms as equivalent observations, but assessed whether convergent patterns across the evidence base supported the proposed relationship between sectoral structural attributes and strategic response orientations.

The final stage involved developing and refining the three ideal-type configurations: the Resilient Adapter, associated with adaptation and supply-chain resilience under acute physical risk and fragmented value chains; the Transformative Mitigator, associated with mitigation-led expansion where technology, policy, and climate-aligned capital create opportunity; and the Ambidextrous Navigator, associated with sectors managing legacy operations alongside exploratory low-carbon investment. These configurations are theory-building abstractions, not deterministic labels or validated classifications.

## 2.6 Reflexivity, Quality Considerations, and Limitations

In line with reflexive practice in integrative research, the study recognises that sector selection, evidence interpretation, and the construction of typological categories are not value-neutral processes (Lather, 1986). Centring India was a deliberate choice: India combines physical climate vulnerability, rapid low-carbon investment, industrial expansion, developmental priorities, and institutional complexity. The study does not claim the resulting configurations apply unchanged to all emerging economies.

Several procedures improved analytical quality: the academic literature was identified through transparent database searches with PRISMA-style reporting; a random sub-sample underwent independent double-screening; the analysis triangulated peer-reviewed scholarship with institutional benchmarks and corporate disclosures; corporate disclosures were treated cautiously as strategic signals rather than verified evidence; and the analysis explicitly considered boundary conditions, including within-sector heterogeneity and changing institutional environments.

The methodology nevertheless has limitations. The academic search was restricted to Scopus, Web of Science, English-language publications, and the stated search terms; relevant studies indexed elsewhere may not have been captured. The integrative design does not support causal inference or statistical generalisation. The corporate-disclosure corpus is purposive and emphasises visible firms with developed reporting practices, creating possible selection bias, and disclosures may overstate commitments or omit implementation challenges. Accordingly, the findings should be interpreted as a theory-generating account of how sectoral structural attributes may shape corporate decarbonisation strategy. They provide a structured basis for future qualitative, comparative, longitudinal, and quantitative research rather than definitive causal evidence.

### 3. Sectoral Findings

#### 3.1 Agribusiness: The Resilient Adapter Configuration

Agriculture bears the most direct exposure to physical climate risk of the three sectors studied here. The IPCC (2022) projects yield declines of 2–6% per decade globally under current emissions trajectories, with South Asia facing above-average losses from heat stress, erratic rainfall, and intensifying drought. The stakes in India are especially high: agriculture employs roughly 42% of the workforce and contributes about 18% of GDP (Ministry of Statistics and Programme Implementation, 2023). Challinor et al. (2014) and Lobell and Gourdji (2012) document substantial yield reductions for staple crops under warming scenarios, and Birthal et al. (2014) add a structural wrinkle: smallholder fragmentation severely limits how much adaptation any individual farmer can manage alone. Smallholder fragmentation is, organisationally speaking, an extreme case: decentralised network governance combined with real behavioural resistance to change. Agribusiness firms have responded mainly through technology—drone-based crop monitoring, AI-driven agronomy advisory, IoT field sensors, and satellite remote sensing, increasingly deployed to raise resource efficiency and climate resilience (Wolfert et al., 2017). For firms such as ITC (through e-Choupal) and UPL (through OpenAg), these platforms are cognitive interventions meant to reshape routines across otherwise decentralised ecosystems (Cohen & Levinthal, 1990). DeHaat, Ninjacart, and AgroStar illustrate the same strategy at smaller scale; global majors Syngenta, Corteva Agriscience, and Bayer CropScience invest instead in climate-resilient seed technology and biological crop protection.

One micro-foundational element deserves attention: gendered absorptive capacity. Women make up roughly 33% of India's agricultural workforce and carry disproportionate responsibility for water collection, food preparation, and subsistence farming (Food and Agriculture Organization, 2023). Rao et al. (2019) and Goh (2012) find that women smallholders face compounded disadvantage—greater climate risk exposure, fewer adaptation resources, and structural exclusion from digital agri-platforms. Most agribusiness ESG frameworks still fail to disaggregate climate impact by gender, both a data gap and an equity risk given institutional investors' due-diligence expectations (Dankelman, 2010).

#### 3.2 Renewable Energy: The Transformative Mitigator Configuration

Renewable energy occupies an unusual position: climate change is not a constraint to be managed, but rather the primary strategic rationale, growth driver, and competitive opportunity. Firms in this sector share the attributes that place them in the Transformative Mitigator configuration—low physical climate risk, high transition opportunity, and close alignment with green capital markets. Renewables now account for the largest share of new global electricity capacity, and solar PV costs fell by 89% between 2010 and 2022 (International Energy Agency, 2023; International Renewable Energy Agency, 2023). India's installed non-hydro renewable capacity passed 180 GW by 2024 (Ministry of New and Renewable Energy, 2024), driven by the Production Linked

Incentive scheme, Renewable Purchase Obligations, and competitive reverse auctions. Indian majors—Tata Power Renewable, ReNew Power, Adani Green Energy—have scaled quickly into solar, wind, storage, and green hydrogen. Global peers Ørsted, Vestas, and NextEra Energy show what deep mitigation-dominant integration looks like: their financial performance is structurally tied to renewable deployment, so commercial incentive and climate action align—unique among the three sectors. The multi-level perspective and strategic niche management need real adaptation before they travel to emerging-economy contexts: both assume steady-state institutional capacity and deep capital markets sheltering emerging technologies inside stable niches, an assumption that does not hold where volatile regulation and capital constraints push firms to lean on the micro-foundations of dynamic capabilities instead (Teece et al., 1997). SNM further assumes policy entrepreneurs sustaining protective niches; India’s federal, multi-party landscape offers no such guarantee (Raven et al., 2016).

### 3.3 Heavy Manufacturing: The Ambidextrous Navigator Configuration

Heavy manufacturing carries both kinds of risk at once: physical exposure through supply-chain disruption, water stress, and extreme weather, and mounting transition risk through carbon pricing, the EU Carbon Border Adjustment Mechanism (CBAM, applicable from 2026), and mandatory ESG disclosure. Core production assets amortise over 20–30 years, building powerful economic inertia against rapid decarbonisation—a structural fact that generates a deep stranded-asset problem (Caldecott, 2017) as firms balance existing carbon-intensive business models against growing regulatory and investor pressure.

Heavy industry is not monolithic: steel, cement, chemicals, and petrochemicals differ substantially in their decarbonisation profiles. But the same structural logic—long asset lives, dual risk exposure, complex institutional context—runs through all four subsectors, reliably placing them within the Ambidextrous Navigator configuration even as specific pathways differ; Section 5.5 treats this within-sector heterogeneity as a boundary condition.

Organisational ambidexterity theory (O’Reilly & Tushman, 2013) holds that firms facing simultaneous exploitation and exploration pressures develop both structural and contextual mechanisms to manage them. Structural ambidexterity separates exploratory low-carbon units—hydrogen R&D divisions, new-energy subsidiaries—from the legacy cash-flow assets that fund them; contextual ambidexterity instead builds systems and cultures letting individual managers balance exploitation and exploration within one structure. Heavy manufacturing shows both at once.

This carries real implications for upper-echelon behaviour too (Hambrick & Finkelstein, 1987; Hambrick & Mason, 1984; Ocasio, 1997). Asset-cycle longevity is not just a financial switching-cost parameter; it constrains what executives are cognitively predisposed to notice. Executives whose careers are built around 25-year amortisation cycles tend to read short-horizon regulatory signals—a new carbon price, a CBAM announcement—as manageable incremental risk rather

than an existential threat. Call this “asset-cycle cognitive lock-in”: it compounds the financial lock-in already documented in the stranded-assets literature (Caldecott, 2017), producing a dual inertia ordinary ESG incentive redesign is unlikely to fix alone.

Leading manufacturers have converged on an incremental-and-ambidextrous strategy, pairing gradual operational adaptation with selective, long-term technological bets: JSW Steel’s H-DRI pilot at Vijayanagar, Tata Steel’s electric arc furnace transition, L&T’s net-zero pledge, and Reliance Industries’ ₹75,000 crore New Energy programme all illustrate the same signalling dynamic, read as strategic signals reducing information asymmetry in global capital markets even while firms navigate domestic pro-growth mandates (Wright & Nyberg, 2017). Mercure et al. (2018) give this added urgency: the case for accelerating transition is macroeconomic, not just environmental.

#### 4. Cross-Sectoral Comparative Analysis

The cross-sectoral comparison is structured around six dimensions, mapped onto the three-level framework in Figure 2. Three meso-level dimensions capture the sectoral structural attributes that bound firm-level choice: risk exposure profile, drawing on the IPCC’s (2022) hazard-vulnerability-exposure framework; asset cycle longevity, drawing on the stranded-assets and capital-lock-in literature (Caldecott, 2017); and institutional context, drawing on the multi-level perspective (Geels, 2002; Markard et al., 2012) and institutional theory (DiMaggio & Powell, 1983). Three firm-level dimensions capture how firms respond within those bounds: dynamic-capabilities configuration (sensing, seizing, and reconfiguring routines; Teece et al., 1997); strategic leadership and change approach (Hambrick & Mason, 1984; Ocasio, 1997); and ESG integration and disclosure depth (Eccles & Klimenko, 2019). Table 1 sets out the full configuration specifications for the three ideal types across all six dimensions, showing how risk exposure profile, asset-cycle longevity, and institutional context combine to produce a distinct dynamic-capabilities configuration, strategic-leadership style, and predicted STTE outcome for each configuration. Table 2, in Section 6.1, then synthesises these same structural attributes at the sector level to validate the typology against the evidence reviewed in Section 3.

**Table 1. Ideal-Type Structural Attributes and Configuration Specifications**

| Typological Dimension        | Ideal Type A: The Resilient Adapter                                 | Ideal Type B: The Transformative Mitigator                        | Ideal Type C: The Ambidextrous Navigator                                     |
|------------------------------|---------------------------------------------------------------------|-------------------------------------------------------------------|------------------------------------------------------------------------------|
| <b>Risk Exposure Profile</b> | High physical hazard; immediate vulnerability to resource scarcity. | High transition opportunity; market growth paired with technology | Dual exposure: simultaneous physical supply shocks and regulatory penalties. |

|                                                                |                                                                                                                                                                                                          |                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                           |
|----------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                |                                                                                                                                                                                                          | obsolescence.                                                                                                                                                                                                                          |                                                                                                                                                                                                                                           |
| <b>Asset Cycle Longevity</b>                                   | Short-cycle, low capital intensity; high operational flexibility.                                                                                                                                        | Long-cycle infrastructure capital; rapidly declining technology cost curves.                                                                                                                                                           | Extreme capital intensity; 20–30-year asset lives creating deep technological lock-in.                                                                                                                                                    |
| <b>Institutional Context</b>                                   | Fragmented niche network; dependent on state subsidy frameworks.                                                                                                                                         | Aligned niche-regime convergence; tight integration with green capital markets.                                                                                                                                                        | Mature, locked-in incumbent regime; constrained by legacy industrial policies.                                                                                                                                                            |
| <b>Dynamic Capabilities Configuration (Teece et al., 1997)</b> | Sense agro-climatic hazard data and smallholder vulnerability; deploy precision agronomy platforms and climate-resilient inputs; restructure supply chain governance for smallholder climate resilience. | Scan policy pipelines, green capital markets, and technology cost curves; rapidly commit capital to renewable auctions and green bond issuance; divest fossil-fuel assets and reconfigure portfolios toward low-carbon infrastructure. | Track carbon pricing, CBAM applicability, and technology readiness; selectively invest in H-DRI pilots, EAF transitions, and carbon capture and storage (CCS) studies; separate exploratory decarbonisation units from legacy operations. |
| <b>Strategic Leadership &amp; Change Approach</b>              | Eco-centric stewardship across decentralised actors; distributed incrementalism through continuous behavioural adaptation.                                                                               | Entrepreneurial eco-innovation with high risk tolerance; radical reconfiguration through top-down structural transformation and asset divestment.                                                                                      | Bureaucratic adaptive planning focused on compliance and political negotiation; segmented ambidexterity separating exploratory units from legacy assets.                                                                                  |
| <b>ESG Integration &amp; Predicted STTE</b>                    | Optimises localised climate resilience and supply chain survival under shocks.                                                                                                                           | Maximises rapid market capture and equity valuation in green capital markets.                                                                                                                                                          | Minimises financial penalties of stranded assets while reducing carbon exposure.                                                                                                                                                          |

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*Note: STTE = Socio-Technical Transition Effectiveness. The six dimensions map onto the three-level framework in Figure 2: the first three rows capture meso-level sectoral structural attributes; the remaining three capture firm-level strategic response within those bounds.*

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Source: Authors' own creation.

Three patterns stand out. The variation in strategic orientation—adaptation-dominance in agriculture, mitigation-dominance in renewable energy, ambidexterity in manufacturing—reflects differences in structural attributes, not in ESG ambition or leadership commitment. Digital technology functions as a universal enabler that each sector configures differently. And the just-transition dimension cuts across all three sectors as a concern none has adequately addressed.

## 5. Emergent Themes and Cross-Sectoral Synthesis

### 5.1 Structural Determinism of Climate Response Orientation

Among the patterns emerging from the cross-sectoral synthesis, the clearest is that variation in climate response orientation aligns more closely with the meso-level sectoral structural attributes identified here than with the firm-level managerial-discretion factors (Hambrick & Finkelstein, 1987) that dominate existing climate-strategy literature. We frame this as a central proposition: in the medium term (a 5–10-year horizon, consistent with the asset-cycle logic distinguishing short-cycle agribusiness from long-cycle capital assets), sectoral structural attributes constrain the feasible set of climate response orientations more tightly than firm-level discretionary factors. Section 8 outlines directions for future empirical inquiry. Three sub-propositions unpack this logic. Proposition 1a: risk exposure profile shapes strategic attention allocation (Bansal, 2003; Ocasio, 1997), shaping the adaptation-mitigation balance. Proposition 1b: asset-cycle length shapes switching costs and therefore the degree of ambidexterity required (Caldecott, 2017; O'Reilly & Tushman, 2013). Proposition 1c: institutional context, through coercive, normative, and mimetic isomorphic pressures (DiMaggio & Powell, 1983), shapes the legitimacy costs and resource availability associated with different climate response orientations. This structural-pattern argument must be qualified. Institutional theory has been criticised for over-emphasising constraint at the expense of agency (Seo & Creed, 2002). Ørsted's business-model transformation and Reliance Industries' New Energy commitment show that outlier firms can act as “regime-shifters,” transforming their sector's structural attributes over long time horizons through sustained investment and political negotiation—consistent with structuration theory (Giddens, 1984; Seo & Creed, 2002), and a priority for future longitudinal research.

### 5.2 Digital Technology as a Sectorally Differentiated Enabler

Digital technology acts as a universal mediating capability across all three sectors, but each configures it differently to fit its own climate response needs. In agriculture, the critical capabilities are AI-driven agronomy advisory, IoT-based field sensing, satellite data interpretation, and mobile

platform management—visible in ITC’s e-Choupal network and UPL’s OpenAg platform. In renewable energy, they are project finance analytics, grid integration software, energy storage management, and predictive maintenance AI. In manufacturing, they are process engineering optimisation, supply chain carbon accounting, and green technology R&D management, as seen in JSW Steel’s H-DRI programme and Reliance’s New Energy strategy. This capability-based framework extends the dynamic capabilities literature (Teece et al., 1997) into climate change management, sector by sector.

### 5.3 Just Transition as a Cross-Sectoral Strategic Imperative

The just transition dimension remains under-addressed across all three sectors despite being strategically consequential. In agriculture, farmers without digital access are excluded from precision agronomy platforms. In renewable energy, coal-dependent communities face displacement, particularly in Jharkhand, Odisha, and Chhattisgarh. In manufacturing, process automation and capacity rationalisation create transition risk for large unionised workforces. The International Labour Organization’s (2018) framework is a starting point, but firms need context-specific approaches for each sector’s most vulnerable stakeholders (The Energy and Resources Institute, 2023).

### 5.4 ESG Integration Depth and the Disclosure-Action Gap

A disclosure-action gap shows up across all three sectors: companies build sophisticated ESG reporting frameworks, TCFD-aligned climate-risk disclosures, and ambitious net-zero commitments, while operational transformation moves more slowly than stated timelines suggest. This lines up with the symbolic-compliance literature (Berg et al., 2022; Bingler et al., 2024; Christensen et al., 2021; Lyon & Maxwell, 2011; Marquis et al., 2016). What is striking is that the depth of genuine ESG integration tracks the financial materiality of climate metrics to a firm’s primary resource channels—this paper’s third theoretical contribution. In the Transformative Mitigator configuration, access to green bonds and international development finance depends explicitly on verifiable carbon-mitigation metrics, so decoupling is rare—compliance is built into the commercial logic. In the Ambidextrous Navigator configuration, heavy manufacturers face conflicting demands (pro-growth domestic mandates versus pro-decarbonisation trade rules like CBAM), and strategic decoupling works as a deliberate cushion letting the upper echelon negotiate long-term transitions without triggering catastrophic asset write-downs (Hawn & Ioannou, 2016; Meyer & Rowan, 1977). In the Resilient Adapter configuration, where ESG metrics barely connect to capital access, the gap is at its widest. This sectoral pattern adds a structural explanation for why disclosure and action diverge: the gap reflects how tightly a sector’s capital channels reward climate performance, not solely corporate bad faith. It also points to a policy lever—regulatory interventions raising the financial materiality of ESG performance, such as mandatory climate risk stress-testing (Reserve Bank of India, 2023) and the BRSR mandate (Securities and Exchange Board of India, 2021), may close the gap more than disclosure-quality rules alone.

## 5.5 Scope Conditions and Boundary Cases

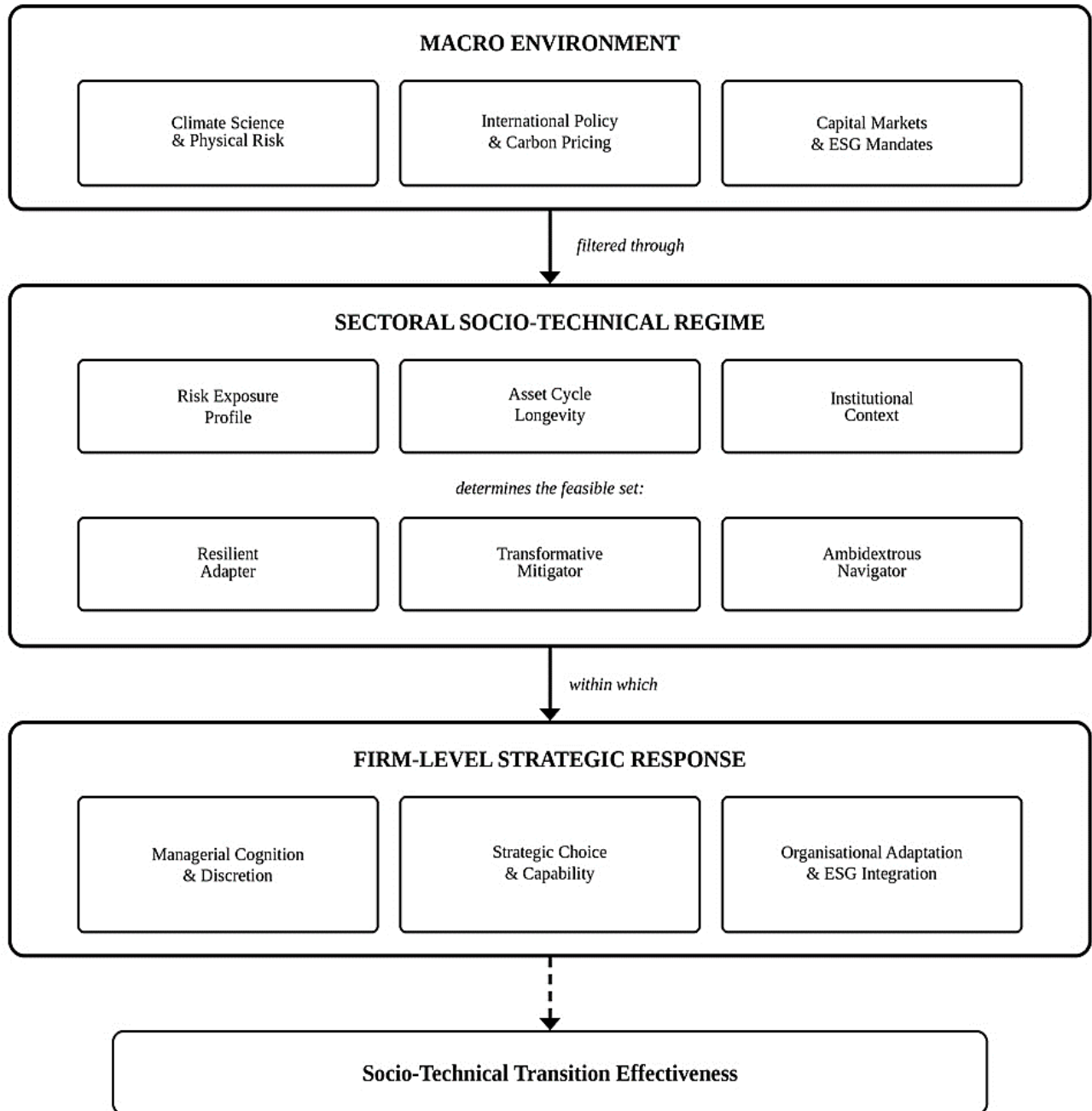
The structural-attributes argument works best under institutional stability and medium-term time horizons, and applies most clearly to large, listed firms with established sustainability reporting infrastructure. Four scope conditions call for further empirical work: sectors with rapidly shifting institutional environments, where regulatory discontinuities could compress the medium-term timeframe; smaller, unlisted firms, which make up the majority of economic activity in all three sectors; emerging economies other than India, where the precise configuration of structural attributes will differ even within the same sectors; and longer time horizons, over which structural attributes themselves may be transformed by sustained institutional entrepreneurship.

## 6. Discussion

### 6.1 Theoretical Contributions: The Typological Theory of Decarbonisation Configurations

This paper makes three theoretical contributions. First, in contexts of deep ecological disruption, “fit” between a firm and its environment is a multi-dimensional, configuration-based phenomenon (Doty & Glick, 1994; Fiss, 2011) that differs systematically by sector—a challenge to the industry-uniform paradigm built into most ESG benchmarking. The contribution is not that it extends any single prior theory, but that it identifies the sectoral socio-technical regime as a missing meso level between well-theorised macro pressures (climate science, policy, capital-market pressure) and well-theorised firm-level response (managerial cognition, strategic choice): the layer where macro pressure is filtered through risk exposure profile, asset-cycle longevity, and institutional context before it reaches any individual firm, bounding the feasible set of strategic responses available regardless of leadership quality or ambition. Figure 2 depicts this relationship. The second contribution works the dynamic-capabilities and managerial-cognition literatures from two directions. It maps the sensing, seizing, and reconfiguring micro-foundations (Teece et al., 1997) onto each ideal type, showing that the same capability categories look different depending on structural-attribute configuration. It also theorises asset-cycle longevity as a cognitive constraint on executive sensing—an “asset-cycle cognitive lock-in”—that compounds the financial switching costs already identified in the stranded-assets literature (Caldecott, 2017), and distinguishes structural from contextual ambidexterity (O’Reilly & Tushman, 2013), showing that their optimal blend in heavy manufacturing is itself an outcome of structural attributes rather than a managerial choice variable (Sine & Lee, 2009; Wright & Nyberg, 2017). The third contribution follows from a single finding: how deeply a firm’s ESG commitments take hold depends on how financially material its climate metrics are to capital access. Renewable-energy firms, whose funding depends directly on verifiable carbon mitigation, show the smallest disclosure-action gap; agricultural firms, whose capital channels barely connect to climate performance, show the widest—giving the cross-sectoral disclosure-action gap a structural explanation that complements existing behavioural accounts (Berg et al., 2022; Bingler et al., 2024).

**Figure 2. The Missing Meso Level: Sectoral Structural Attributes as the Filter between Macro Climate Pressure and Firm-Level Strategic Response**



Source: Authors' own construction.

STTE - the conceptual outcome framework introduced in Section 1—is specified along three constituent dimensions, each operationalised with concrete empirical proxies for future quantitative evaluation:

Emissions Intensity Velocity: annual percentage reduction in Scope 1–3 emissions per unit of revenue or output (e.g., tCO<sub>2</sub>e / tonne steel or tCO<sub>2</sub>e / MWh).

Capital Reallocation Velocity: ratio of low-carbon CapEx (e.g., green hydrogen R&D, renewable capacity) to legacy-asset maintenance CapEx over a rolling 5-year window.

Capability Accumulation: year-over-year growth in green-technology patents, low-carbon R&D intensity, and the share of executive hires with dedicated environmental-management expertise.

These dimensions are offered as a conceptual foundation for future research using CDP, Bloomberg ESG, Refinitiv, and company-level BRSR/TCFD data. Table 2 synthesises how the three structural attributes configure differently across agriculture, renewable energy, and manufacturing, producing the three ideal types.

**Table 2. Structural Attributes Summary by Sector (Typological Validation Matrix)**

| Structural Attribute              | Agribusiness (Resilient Adapter)                               | Renewable Energy (Transformative Mitigator)                            | Heavy Manufacturing (Ambidextrous Navigator)                          |
|-----------------------------------|----------------------------------------------------------------|------------------------------------------------------------------------|-----------------------------------------------------------------------|
| <b>Risk Exposure Profile</b>      | High physical hazard; low transition risk.                     | Low physical risk; high transition opportunity.                        | Dual exposure: physical + transition risk.                            |
| <b>Asset Cycle Longevity</b>      | Short-cycle, low capital intensity; rapid adaptation feasible. | Capital-intensive; cost-competitive and declining; long project life.  | Highest capital intensity; 20–30-year asset life; deep lock-in.       |
| <b>Institutional Context</b>      | Smallholder dominance; fragmented; state support-dependent.    | Policy-aligned; green capital markets; international climate mandates. | Most complex: industrial policy, labour law, CBAM, carbon regulation. |
| <b>Typological Classification</b> | Adaptation-Dominant                                            | Mitigation-Dominant                                                    | Contested Transition (Ambidextrous)                                   |

Source: Authors' own creation.

## 6.2 Sectoral Differences in Climate Response: Three Structural Sources

Agricultural firms face physical climate risk that is immediate, spatially specific, and cannot be deferred. Their asset structure is low-capital and short-cycle, and an institutional context built

around smallholder dominance and heavy government-policy dependence pushes them toward resilience rather than transformation. Renewable-energy companies sit differently: their opportunities are mostly transition-related, their asset structure is capital-intensive but increasingly cost-competitive, and policy mandates, green capital markets, and international climate commitments actively favour rapid scaling—falling technology costs and ESG investor mandates converge to make mitigation-dominance economically necessary, not just ethically desirable (Sine & Lee, 2009). Manufacturing firms face both kinds of risk in roughly equal measure, with the most capital-intensive, longest-lived assets and the most contested institutional context of the three; the stranded-asset problem (Caldecott, 2017) bites hardest here, producing an incremental-and-ambidextrous orientation that is less a preference than a rational response to a structural environment where transformative decarbonisation is not yet economically viable.

### **6.3 The India Context and Comparative Emerging Economy Positioning**

India's structural environment stands out for three reasons at once: extreme smallholder agricultural fragmentation, a renewable-energy transition accelerating faster than most, and a manufacturing base deepening even as it comes under pressure to decarbonise. India is this paper's empirical anchor; China, Brazil, and South Africa appear only as illustrative comparators. China offers one comparison: it has pushed state-directed renewable scaling further than India, but faces comparable heavy-industry lock-in, while India's federal, multi-party context makes for a more contested implementation path. Brazil offers another: its agricultural and energy sectors benefit from distinct land and hydro endowments, showing how resource endowments interact with the structural-attributes logic differently than in India. South Africa offers a third: acute coal dependence and just-transition pressure put the Ambidextrous Navigator configuration under real financial and social strain. Across all three, what stands out about India is the same tension between industrialising and decarbonising, driven by acute climate vulnerability and Paris Agreement commitments.

Institutional developments land differently across sectors. In agriculture, BRSR and RBI guidelines pressure firms to formalise adaptation practices already operationally embedded but organisationally informal. In renewable energy, these developments mostly reinforce an existing trajectory. Manufacturing is where implications matter most: RBI climate stress-testing (Reserve Bank of India, 2023) and BRSR mandatory disclosures (Securities and Exchange Board of India, 2021), converging with EU CBAM, create compounding pressure that may finally make stranded-asset risk material enough to shift capital toward accelerated technology investment.

## **7. Implications**

### **7.1 Managerial Implications**

This analysis carries several practical implications for corporate strategists. Climate risk is heterogeneous enough across sectors that firms should avoid importing best practices from

adjacent industries without contextual adaptation—the mitigation logic that works for a renewable-energy firm is structurally wrong for an agribusiness facing immediate physical risk across its smallholder supply chain. Most large firms already have governance infrastructure to act on this; the task is redirecting it by sector rather than applying it uniformly. The disclosure-action gap has a direct governance implication: boards should link sustainability commitments to capital allocation, operational KPIs, and executive incentives, rather than treating disclosure and delivery as separate workstreams.

The cross-sectoral technology analysis points to a further priority: building sector-specific digital and green-technology capabilities before they become competitive necessities, since early movers in precision-agriculture platforms (ITC's e-Choupal), renewable-energy optimisation AI (NextEra), and green-hydrogen R&D (JSW Steel) are positioned better for the low-carbon future than late adopters. The just-transition dimension also deserves an explicit place in climate strategy: recruitment and training pipelines should account for women smallholders' structural exclusion from many precision-agriculture platforms, and for the fact that women hold fewer than 15% of installation, operations, and maintenance roles in Indian renewable energy (International Renewable Energy Agency, 2023).

## 7.2 Policy Implications

Climate policy needs to be sectorally differentiated; a single carbon price cannot produce the specific investment decisions each sector needs. In agriculture, priorities are scaling digital climate advisory services, strengthening PMFBY crop insurance coverage, and building regulatory frameworks for agricultural carbon markets. In renewable energy, the priority is resolving structural bottlenecks—grid integration, land acquisition, transmission infrastructure—alongside a coherent green hydrogen framework. In manufacturing, the most consequential move is a domestic carbon pricing mechanism building on India's PAT scheme, with revenues funding just-transition support; EU CBAM makes this especially urgent for steel, aluminium, and cement exporters.

At the multilateral level, development finance institutions currently favour renewable-energy projects, where the risk-return profile looks most attractive, leaving manufacturing systematically underfinanced relative to its decarbonisation need. Redirecting some DFI climate finance toward concessional first-loss capital for industrial deep-decarbonisation projects—hydrogen-based steelmaking, electrified cement kilns, bio-based chemical feedstocks—would address a gap market-rate green bonds cannot resolve. The Green Climate Fund's Private Sector Facility and the IFC's Manufacturing Accelerator are plausible vehicles.

## 7.3 Implications for the Sustainable Development Goals

The typology speaks diagnostically to several SDGs: SDG 13 (Climate Action), since decarbonisation pace is bounded by sectoral structure and should be assessed sector by sector;

SDG 7 (Clean Energy) via the Transformative Mitigator; SDG 9 (Industry and Infrastructure) via the Ambidextrous Navigator's technology pathways; SDG 8 (Decent Work) via the just-transition dimension; SDG 5 and SDG 10, since a sector can decarbonise while gender equity worsens, undetected by current disclosure regimes; and SDG 17, where redirecting concessional finance toward under-financed manufacturing corrects a risk-return bias in current climate finance allocation.

## 8. Future Research Agenda

This typology points toward a structured research agenda. Four priorities stand out, ranked here by their combined theoretical and policy impact.

The most foundational priority is developing quantitative measures of proximity to each ideal type. Large-scale panel datasets from international ESG repositories—CDP, Bloomberg ESG, Refinitiv—could support this, assessing how closely a firm's structural profile matches its ideal type's multi-dimensional attributes. Fuzzy-set qualitative comparative analysis (fsQCA) offers another route: researchers could examine whether proximity to these configurations is associated with long-term performance, capital-access costs, or organisational survival under extreme ecological shocks, and whether sector membership explains climate response orientation once firm size, ownership, internationalisation, and country characteristics are accounted for.

A second, urgent priority concerns the micro-foundations of transition leadership. Longitudinal, qualitative case studies could track corporate leaders' cognitive journeys from symbolic compliance to substantive asset reconfiguration, examining how executive values interact with organisational structural history to shape the timing and velocity of change. Just-transition dynamics in emerging economies form the third priority, and arguably the most under-researched with the most direct policy stakes. A mixed-method approach—quantitative labour-market analysis alongside qualitative work with affected communities in India, such as coal-mining communities in Jharkhand, thermal power communities in Chhattisgarh, and farmers in Bihar's climate-vulnerable districts—would inform both just-transition policy and the human-resource routines that mitigate worker displacement.

The fourth priority concerns the endogenous transformation of structural attributes themselves: how regime-shifting firms such as Ørsted and Reliance Industries reshape the institutional context, asset-cycle norms, and risk exposure profiles of their sectors over long time horizons. Comparative historical analysis of sectors in which a structural attribute has already been endogenously transformed—for example, the institutional context of offshore wind—would advance both the typological theory and the institutional entrepreneurship literature (DiMaggio, 1988; Seo & Creed, 2002).

## 9. Conclusion

This paper has built a typological theory of strategic decarbonisation configurations around three fully specified ideal types: the Resilient Adapter (agribusiness), the Transformative Mitigator (renewable energy), and the Ambidextrous Navigator (heavy manufacturing). What distinguishes these archetypes is not firm-level ESG ambition but three meso-level structural attributes—risk exposure profile, asset-cycle longevity, and institutional context—that bound what firms can plausibly do far more tightly than the managerial-discretion variables strategy research usually emphasises. A second finding follows from the same synthesis: ESG integration depth tracks the financial materiality of climate metrics to capital access, giving the cross-sectoral disclosure-action gap a structural explanation—firms are not necessarily greenwashing so much as operating under conditions that reward disclosure more than delivery in some sectors and less in others.

The practical upshot is that climate strategy which ignores sectoral structure will misallocate both effort and capital, systematically. Practices that work well in renewable energy do not translate to agriculture; ambitions that drive manufacturing leadership cannot survive 30-year asset cycles without dedicated transition finance behind them. India's decarbonisation will depend on coordinated, sector-specific policy and finance instruments across all three sectors rather than treatment of climate response as one unitary problem. We read the under-financed manufacturing decarbonisation gap as among the most consequential structural financing failures this review surfaces, and one deserving urgent attention from DFIs, policymakers, and corporate strategists alike. We do not claim the configurations apply unchanged across all emerging economies; rather, we identify structural attributes that can be adapted and tested in other national contexts.

This study offers a foundation for future hypothesis-driven research, with the specific empirical extensions laid out in Section 8. Its real value may lie less in settling questions about industrial decarbonisation than in giving researchers and practitioners a vocabulary precise enough to ask those questions properly—the necessary first step toward any effective response in a domain where complexity and urgency collide as forcefully as they do in climate change.

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**Conflict of Interest:** The authors declare no conflict of interest.

**Data Availability Statement:** This is an integrative review; no new primary or proprietary data were generated. The literature corpus was assembled from Scopus and Web of Science, and the corporate disclosures analysed are publicly available on the respective companies' investor relations portals (see Appendix A). Data supporting the search protocol and coding scheme are available from the corresponding author upon reasonable request.

**Ethics Statement:** This study did not involve human participants, human data, or animal subjects, and therefore did not require ethics committee approval.

**Author Contributions:** Yasmeen Shamsi Rizvi: conceptualisation, methodology, literature synthesis, writing—original draft, writing—review and editing, supervision. Sumna Khan: literature search, data curation, writing—review and editing. Both authors approved the final manuscript.

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## References

- ABB Ltd. (2023). Sustainability report 2022–23. <https://www.abb.com>
- Adani Green Energy Limited. (2024). Annual report 2023–24. <https://www.adanigreenenergy.com>
- AgroStar. (2023). Impact report 2022–23. <https://www.agrostar.in>
- Arksey, H., & O'Malley, L. (2005). Scoping studies: Towards a methodological framework. *International Journal of Social Research Methodology*, 8(1), 19–32.
- Bansal, P. (2003). From issues to actions: The importance of individual concerns and organizational values in responding to natural environmental issues. *Organization Science*, 14(5), 510–527.
- Bayer CropScience. (2023). Sustainability report 2022–23. <https://www.bayer.com>
- Berg, F., Kölbel, J. F., & Rigobon, R. (2022). Aggregate confusion: The divergence of ESG ratings. *Review of Finance*, 26(6), 1315–1344.
- Bingler, J. A., Kraus, M., Leippold, M., & Webersinke, N. (2024). How cheap talk in climate disclosures relates to climate initiatives, corporate emissions, and reputation risk. *Journal of Banking & Finance*, 164, 107179.
- Birthal, P. S., Khan, M. T., Negi, D. S., & Agarwal, S. (2014). Impact of climate change on yields of major food crops in India: Implications for food security. *Agricultural Economics Research Review*, 27(2), 145–155.
- Caldecott, B. (2017). Introduction to special issue: Stranded assets and the environment. *Journal of Sustainable Finance & Investment*, 7(1), 1–13.
- Challinor, A. J., Watson, J., Lobell, D. B., Howden, S. M., Smith, D. R., & Chhetri, N. (2014). A meta-analysis of crop yield under climate change and adaptation. *Nature Climate Change*, 4(4), 287–291.
- Christensen, H. B., Hail, L., & Leuz, C. (2021). Mandatory CSR and sustainability reporting: Economic analysis and literature review. *Review of Accounting Studies*, 26(3), 1176–1248.

- Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly*, 35(1), 128–152.
- Corteva Agriscience. (2023). Sustainability report 2022–23. <https://www.corteva.com>
- Dankelman, I. (Ed.). (2010). *Gender and climate change: An introduction*. Earthscan.
- DeHaat. (2022). Impact report 2021–22. <https://www.dehaat.com>
- Dietz, S., Bowen, A., Dixon, C., & Gradwell, P. (2016). Climate value at risk of global financial assets. *Nature Climate Change*, 6(7), 676–679.
- DiMaggio, P. J. (1988). Interest and agency in institutional theory. In L. G. Zucker (Ed.), *Institutional patterns and organizations: Culture and environment* (pp. 3–21). Ballinger.
- DiMaggio, P. J., & Powell, W. W. (1983). The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields. *American Sociological Review*, 48(2), 147–160.
- Doty, D. H., & Glick, W. H. (1994). Typologies as a unique form of theory building: Toward improved understanding and modeling. *Academy of Management Review*, 19(2), 230–251.
- Eccles, R. G., & Klimenko, S. (2019). The investor revolution. *Harvard Business Review*, 97(3), 106–116.
- Fiss, P. C. (2011). Building better causal theories: A fuzzy set approach to typologies in organization research. *Academy of Management Journal*, 54(2), 393–420.
- Food and Agriculture Organization. (2023). The status of women in agrifood systems. FAO. <https://www.fao.org>
- Geels, F. W. (2002). Technological transitions as evolutionary reconfiguration processes: A multi-level perspective and a case study. *Research Policy*, 31(8–9), 1257–1274.
- Geels, F. W., Sovacool, B. K., Schwanen, T., & Sorrell, S. (2017). Sociotechnical transitions for deep decarbonization. *Science*, 357(6357), 1242–1244.
- George, A. L., & Bennett, A. (2005). *Case studies and theory development in the social sciences*. MIT Press.
- Giddens, A. (1984). *The constitution of society: Outline of the theory of structuration*. University of California Press.
- Glaser, B. G., & Strauss, A. L. (1967). *The discovery of grounded theory: Strategies for qualitative research*. Aldine.
- Godrej Agrovet Limited. (2023). ESG report 2022–23. <https://www.godrejagrovet.com>

- Goh, A. H. X. (2012). A literature review of the gender-differentiated impacts of climate change on women's and men's assets and well-being in developing countries. CAPRI Working Paper No. 106. International Food Policy Research Institute.
- Hambrick, D. C., & Finkelstein, S. (1987). Managerial discretion: A bridge between polar views of organizational outcomes. *Research in Organizational Behavior*, 9, 369–406.
- Hambrick, D. C., & Mason, P. A. (1984). Upper echelons: The organization as a reflection of its top managers. *Academy of Management Review*, 9(2), 193–206.
- Hawn, O., & Ioannou, I. (2016). Mind the gap: The interplay between external and internal actions in the case of corporate social responsibility. *Strategic Management Journal*, 37(13), 2569–2588.
- Hoffman, A. J. (2018). The next phase of business sustainability. *Stanford Social Innovation Review*, 16(2), 35–39.
- Intergovernmental Panel on Climate Change. (2022). Sixth assessment report: Impacts, adaptation and vulnerability (Working Group II). <https://www.ipcc.ch>
- International Energy Agency. (2023). World energy outlook 2023. <https://www.iea.org>
- International Labour Organization. (2018). World employment and social outlook 2018: Greening with jobs. <https://www.ilo.org>
- International Renewable Energy Agency. (2023). Renewable power generation costs in 2022. <https://www.irena.org>
- ITC Limited. (2023). Sustainability report 2022–23. <https://www.itcportal.com>
- JSW Steel Limited. (2024). ESG report 2023–24. <https://www.jsw.in>
- Köhler, J., Geels, F. W., Kern, F., Markard, J., Onsongo, E., Wieczorek, A., & Wells, P. (2019). An agenda for sustainability transitions research. *Environmental Innovation and Societal Transitions*, 31, 1–32.
- Kolk, A., & Pinkse, J. (2005). Business responses to climate change: Identifying emergent strategies. *California Management Review*, 47(3), 6–20.
- Larsen & Toubro Limited. (2023). Sustainability report 2022–23. <https://www.larsentoubro.com>
- Lather, P. (1986). Research as praxis. *Harvard Educational Review*, 56(3), 257–277.
- Lobell, D. B., & Gourdji, S. M. (2012). The influence of climate change on global crop productivity. *Plant Physiology*, 160(4), 1686–1697.
- Lyon, T. P., & Maxwell, J. W. (2011). Greenwash: Corporate environmental disclosure under threat of audit. *Journal of Economics & Management Strategy*, 20(1), 3–41.

- Markard, J., Raven, R., & Truffer, B. (2012). Sustainability transitions: An emerging field of research and its prospects. *Research Policy*, 41(6), 955–967.
- Marquis, C., Toffel, M. W., & Zhou, Y. (2016). Scrutiny, norms, and selective disclosure: A global study of greenwashing. *Organization Science*, 27(2), 483–504.
- Mercure, J. F., Pollitt, H., Viñuales, J. E., Edwards, N. R., Holden, P. B., Chewpreecha, U., Salas, P., Sognaes, I., Lam, A., & Knobloch, F. (2018). Macroeconomic impact of stranded fossil fuel assets. *Nature Climate Change*, 8(7), 588–593.
- Meyer, J. W., & Rowan, B. (1977). Institutionalized organizations: Formal structure as myth and ceremony. *American Journal of Sociology*, 83(2), 340–363.
- Ministry of Environment, Forest and Climate Change. (2022). India's long-term low-carbon development strategy. <https://moefcc.gov.in>
- Ministry of New and Renewable Energy. (2024). Annual report 2023–24. <https://mnre.gov.in>
- Ministry of Statistics and Programme Implementation. (2023). Annual report 2022–23: Economic statistics. <https://mospi.gov.in>
- Munn, Z., Peters, M. D. J., Stern, C., Tufanaru, C., McArthur, A., & Aromataris, E. (2018). Systematic review or scoping review? Guidance for authors when choosing between a systematic or scoping review approach. *BMC Medical Research Methodology*, 18, 143.
- NextEra Energy. (2023). Environmental, social, and governance report 2022–23. <https://www.nexteraenergy.com>
- Ninjacart. (2023). Impact report 2022–23. <https://www.ninjacart.com>
- NTPC Limited. (2023). Integrated annual report 2022–23. <https://ntpc.co.in/investors/annual-reports/2022-23>
- Ocasio, W. (1997). Towards an attention-based view of the firm. *Strategic Management Journal*, 18(S1), 187–206.
- O'Reilly, C. A., III, & Tushman, M. L. (2013). Organizational ambidexterity: Past, present, and future. *Academy of Management Perspectives*, 27(4), 324–338.
- Ørsted. (2023). Sustainability report 2022. <https://orsted.com>
- Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., . . . Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ*, 372, n71.

- Porter, M. E., & van der Linde, C. (1995). Toward a new conception of the environment-competitiveness relationship. *Journal of Economic Perspectives*, 9(4), 97–118.
- Rao, N., Lawson, E. T., Raditloaneng, W. N., Solomon, D., & Angula, M. N. (2019). Gendered vulnerabilities to climate change: Insights from the semi-arid regions of Africa and Asia. *Climate and Development*, 11(1), 14–26.
- Raven, R., Kern, F., Verhees, B., & Smith, A. (2016). Niche construction and empowerment through socio-political work. A meta-analysis of six low-carbon technology cases. *Environmental Innovation and Societal Transitions*, 18, 164–180.
- Reliance Industries Limited. (2023). Annual report 2022–23. <https://www.ril.com>
- ReNew Power Private Limited. (2023). Annual report 2022–23. <https://www.renew.com>
- Reserve Bank of India. (2023). Report on currency and finance 2022–23: Towards a greener cleaner India. <https://www.rbi.org.in>
- Securities and Exchange Board of India. (2021). Business responsibility and sustainability reporting (BRSR) framework (Circular No. SEBI/HO/CFD/CMD-2/P/CIR/2021/562). <https://www.sebi.gov.in>
- Seo, M. G., & Creed, W. E. D. (2002). Institutional contradictions, praxis, and institutional change: A dialectical perspective. *Academy of Management Review*, 27(2), 222–247.
- Siemens AG. (2023). Sustainability report 2022–23. <https://www.siemens.com>
- Sine, W. D., & Lee, B. H. (2009). Tilting at windmills? The environmental movement and the emergence of the US wind energy sector. *Administrative Science Quarterly*, 54(1), 123–155.
- Syngenta Group. (2023). Sustainability report 2022–23. <https://www.syngenta.com>
- Tata Power Company Limited. (2024). Sustainability report 2023–24. <https://www.tatapower.com>
- Tata Steel Limited. (2023). Integrated report and annual accounts 2022–23. <https://www.tatasteel.com>
- Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal*, 18(7), 509–533.
- The Energy and Resources Institute. (2023). Mapping India's transition from coal: A district-level analysis. <https://www.teriin.org>
- Thomas, J., & Harden, A. (2008). Methods for the thematic synthesis of qualitative research in systematic reviews. *BMC Medical Research Methodology*, 8, 45.



- Torraco, R. J. (2016). Writing integrative literature reviews: Using the past and present to explore the future. *Human Resource Development Review*, 15(4), 404–428.
- UPL Limited. (2023). Annual report 2022–23. <https://www.upl-ltd.com>
- Vestas Wind Systems A/S. (2023). Sustainability report 2022. <https://www.vestas.com>
- Whittemore, R., & Knafl, K. (2005). The integrative review: Updated methodology. *Journal of Advanced Nursing*, 52(5), 546–553.
- Wolfert, S., Ge, L., Verdouw, C., & Bogaardt, M. J. (2017). Big data in smart farming: A review. *Agricultural Systems*, 153, 69–80.
- World Bank Group. (2024). World development indicators 2024. <https://www.worldbank.org>
- Wright, C., & Nyberg, D. (2017). An inconvenient truth: How organizations translate climate change into business as usual. *Academy of Management Journal*, 60(5), 1633–1661.

## Appendix A

### List of 22 firms Included in the Triangulation Sample

**Table A1. Firms Included in Corporate Disclosure Triangulation**

| Firm Name                  | Country     | Sector                    | Reporting Frameworks | Years Covered |
|----------------------------|-------------|---------------------------|----------------------|---------------|
| ITC Limited                | India       | Agriculture               | GRI, BRSR, TCFD      | 2021–2024     |
| UPL Limited                | India       | Agriculture               | GRI, BRSR            | 2021–2024     |
| Godrej Agrovet Limited     | India       | Agriculture               | GRI, BRSR            | 2021–2024     |
| Syngenta Group             | Switzerland | Agriculture               | GRI, TCFD, SASB      | 2021–2024     |
| Corteva Agriscience        | USA         | Agriculture               | GRI, TCFD, SASB      | 2021–2024     |
| Bayer CropScience          | Germany     | Agriculture (Agri-inputs) | GRI, TCFD, SASB      | 2021–2024     |
| DeHaat                     | India       | Agriculture (AgTech)      | GRI (partial)        | 2022–2024     |
| Ninjacart                  | India       | Agriculture (AgTech)      | GRI (partial)        | 2022–2024     |
| AgroStar                   | India       | Agriculture (AgTech)      | Impact Report        | 2022–2024     |
| Adani Green Energy Limited | India       | Renewable Energy          | GRI, BRSR, TCFD      | 2021–2024     |
| Tata Power Company Limited | India       | Renewable Energy          | GRI, BRSR, TCFD      | 2021–2024     |
| ReNew Power                | India       | Renewable Energy          | GRI, TCFD            | 2021–2024     |
| NTPC Green Energy Limited  | India       | Renewable Energy          | GRI, BRSR            | 2021–2024     |
| Ørsted                     | Denmark     | Renewable Energy          | GRI, TCFD, SASB      | 2021–2024     |

|                             |      |             |                             |                       |           |
|-----------------------------|------|-------------|-----------------------------|-----------------------|-----------|
| Vestas Systems              | Wind | Denmark     | Renewable Energy            | GRI, TCFD, SASB       | 2021–2024 |
| NextEra Energy              |      | USA         | Renewable Energy            | GRI, TCFD, SASB       | 2021–2024 |
| Tata Steel Limited          |      | India / UK  | Steel                       | GRI, BRSR, TCFD, SASB | 2021–2024 |
| JSW Steel Limited           |      | India       | Steel                       | GRI, BRSR             | 2021–2024 |
| Larsen & Toubro Limited     |      | India       | Engineering & Construction  | GRI, BRSR, TCFD       | 2021–2024 |
| Reliance Industries Limited |      | India       | Petrochemicals / New Energy | GRI, BRSR, TCFD       | 2021–2024 |
| Siemens AG                  |      | Germany     | Industrial Manufacturing    | GRI, TCFD, SASB       | 2021–2024 |
| ABB Ltd.                    |      | Switzerland | Industrial Manufacturing    | GRI, TCFD, SASB       | 2021–2024 |

Note: Sample firms selected based on exchange listing (BSE/NSE/Global), mandatory or voluntary sustainability reporting alignment (GRI, TCFD, BRSR, SASB) for 2021–2024, and top-market capacity position within focal sectors. Sources: ITC Limited (2023); UPL Limited (2023); Godrej Agrovet Limited (2023); Syngenta Group (2023); Corteva Agriscience (2023); Bayer CropScience (2023); DeHaat (2022); Ninjacart (2023); AgroStar (2023); Adani Green Energy Limited (2024); Tata Power Company Limited (2024); ReNew Power Private Limited (2023); NTPC Limited (2023); Ørsted (2023); Vestas Wind Systems A/S (2023); NextEra Energy (2023); Tata Steel Limited (2023); JSW Steel Limited (2024); Larsen & Toubro Limited (2023); Reliance Industries Limited (2023); Siemens AG (2023); ABB Ltd. (2023).

Source: Authors' own compilation from company investor relations portals (December 2024 – February 2025).