ACROSS MARKETS AND BORDERS

Enterprise, Trade and Leadership with Purpose and Integrity

PART VI | TECHNOLOGY, STEWARDSHIP AND THE SUSTAINABLE FUTURE

CHAPTER 21

STEWARDSHIP, SUSTAINABLE BUSINESS AND RESPONSIBLE TRADE

Climate, Circularity, ESG and Human Flourishing

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CHAPTER 21 | STEWARDSHIP, SUSTAINABLE BUSINESS AND RESPONSIBLE TRADE

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Abstract

Sustainability becomes a business discipline when claims about climate, resources, people and trade are translated into testable responsibilities, measurable impacts and defensible choices. This chapter treats sustainable business as a strategic, scientific, moral and cross-border problem rather than as an ESG scorecard. It develops competing theories of sustainability; trade-growth-environment relationships; financial, impact and moral materiality; climate and nature risk; responsible sourcing and human-rights due diligence; circular economy and life-cycle reasoning; greenhouse-gas accounting, targets, carbon pricing and border measures; reporting, assurance and greenwashing controls; and the links to sustainable finance and procurement. Sasol anchors the African analysis, illustrating the tensions among industrial production, emissions, energy security, jobs, technology and offsets, while Maersk provides a global comparison of efficiency gains and rising absolute emissions. African energy access, AfCFTA, green industrialization and policy sovereignty are treated as central development questions. Christian moral reasoning frames creation care as stewardship ordered to truth, neighbour-love, justice, responsible freedom and human flourishing.

Keywords: sustainable business; stewardship; climate risk; circular economy; ESG; responsible trade; carbon accounting; responsible sourcing; AfCFTA; human flourishing

Learning Outcomes

Table 21.1. Learning outcomes for Chapter 21.

No.	Learning outcome
1	Distinguish sustainability, sustainable development, stewardship, corporate responsibility, ESG, impact, resilience and human flourishing, and explain why none of these terms should be treated as interchangeable.
2	Compare weak and strong sustainability, the triple-bottom-line tradition, stakeholder and legitimacy perspectives, the natural-resource-based view, Porter-type innovation arguments, intergenerational and planetary-boundary perspectives, identifying assumptions, contributions and limitations.
3	Analyze trade, growth and environmental externalities using scale, composition and technique effects; distinguish private cost from social cost; and evaluate distributional and development trade-offs without assuming either unrestricted trade or environmental restriction is automatically welfare-improving.
4	Distinguish physical, transition, liability, market and supply-chain climate risk; trace their transmission into operations, cash flows, asset values and strategic options; and separate scenario analysis from prediction.
5	Diagnose material sustainability issues using financial materiality, impact materiality, double materiality and explicit moral materiality, while avoiding mechanical matrix scoring.
6	Critically evaluate ESG frameworks, ratings and stakeholder expectations through decision usefulness, measurement validity, scope, incentives, ideology, comparability, sovereignty, accountability and empirical evidence.
7	Design a risk-based responsible-sourcing and human-rights due-diligence process that identifies, prevents, mitigates, tracks, communicates and remedies adverse impacts without treating supplier questionnaires as proof of responsible conduct.
8	Evaluate labour standards, traceability, chain-of-custody evidence and supply-chain transparency through data provenance, worker voice, verification, grievance and remedy, while preserving the operational-flow boundary established in Chapter 11.
9	Apply circular-economy, life-cycle and environmental-management-system reasoning to resource efficiency, product longevity, eco-design, repair, reuse, remanufacture, recycling, waste and reverse flows, and explain rebound, thermodynamic, quality, logistics and social limitations of circularity claims.
10	Construct a basic greenhouse-gas inventory using activity data and emission factors; distinguish Scope 1, Scope 2 and major Scope 3 categories; calculate emissions intensity; and explain organizational, operational and data-quality boundaries.
11	Evaluate climate targets, net-zero claims, offsets, removals and transition plans through baseline integrity, coverage, interim milestones, additionality, permanence, leakage, double counting, dependency on uncertain technologies and responsibility for real-economy reduction.
12	Calculate and interpret a marginal abatement cost and a simplified carbon-price or border-carbon exposure, recognizing that carbon markets, taxes and CBAM rules are policy instruments whose legal details and distributional effects require contextual analysis.
13	Compare IFRS S1/S2, GRI, ESRS, TNFD and related reporting architectures by audience, materiality perspective, scope and legal status, and determine what a particular enterprise actually needs to report rather than assuming that all frameworks are interchangeable.
14	Design sustainability metrics, controls and assurance arrangements that connect claims to evidence, detect selective disclosure and greenwashing, and distinguish activity, output, outcome, impact and verified performance.
15	Explain how sustainable finance, impact investment, green bonds, transition finance and green procurement connect to sustainability implementation while deferring valuation, portfolio construction and investor deal mechanics to Chapter 18.
16	Evaluate African green industrialization, energy access, AfCFTA-linked value chains, SMEs, carbon-border exposure and just-transition debates through productivity, local value addition, livelihoods, infrastructure, finance, sovereignty and environmental performance.
17	Compare an emissions-intensive African transition case with a global logistics case, distinguishing intensity improvements from absolute outcomes and company-reported progress from independent causal evidence.
18	Apply Christian moral reasoning alongside consequentialist, rights-based, justice, virtue, care, capability and communitarian perspectives, and use the Sustainable Business and Responsible Trade Stewardship Protocol to defend an evidence-based, lawful and morally responsible course of action.

Concept Map and Chapter Roadmap

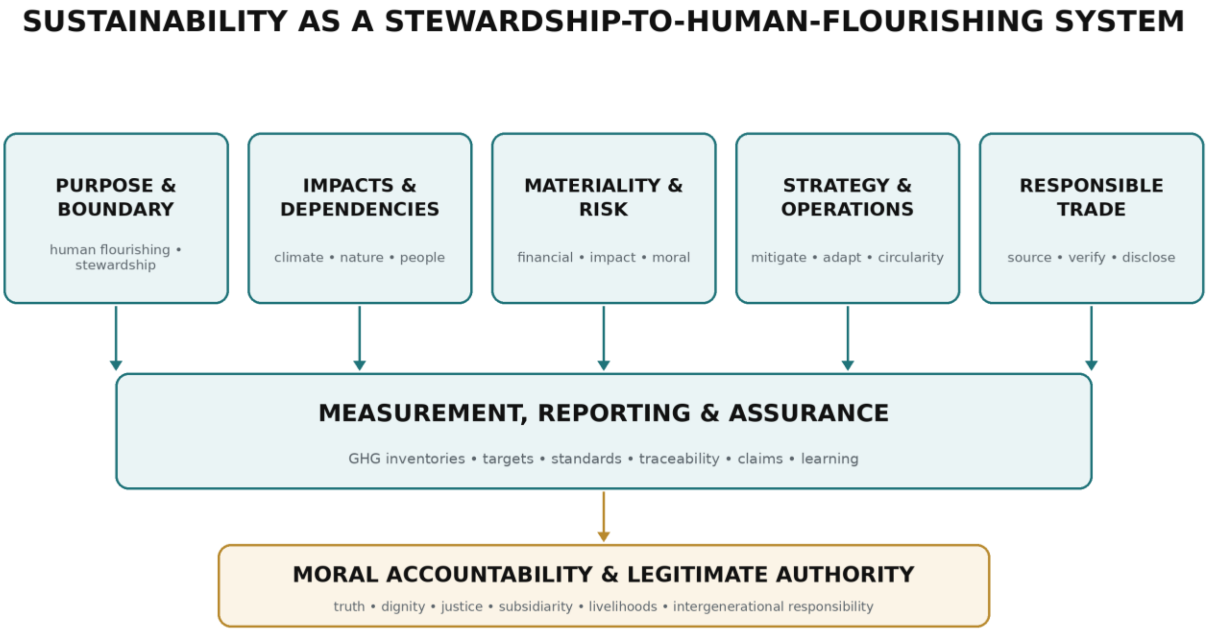

Figure 21.1. Sustainable business and responsible trade as a stewardship-to-human-flourishing system.
Source/Note: Author's synthesis, integrating sustainable-development, materiality, climate-risk, responsible-business-conduct, circular-economy, reporting and Christian stewardship perspectives.

Chapter 20 ended by distinguishing technological capability from the objective that technology is claimed to serve. Digital platforms, AI, traceability systems, data architectures and innovation portfolios can reduce resource use or improve environmental measurement, but they can also intensify consumption, surveillance, energy demand or market concentration. Chapter 21 therefore changes the governing question. It asks not what a technology can do, but what enterprises should sustain, what impacts they should prevent or remedy, how environmental and social claims can be tested, and how cross-border trade can remain productive without shifting hidden costs onto workers, communities, ecosystems or future generations. This is the second and final chapter of Part VI because technology and sustainability are closely connected but intellectually distinct.

The approved purpose is deliberately broader than environmental management and narrower than the whole field of business ethics. Chapter 13 already established the book-wide foundations of human dignity, rights, governance, corruption control, accountability and moral reasoning. Chapter 11 already developed process, procurement, logistics and reverse-flow mechanics. Chapter 14 owns the economic theory of trade, Chapter 18 investor valuation and portfolio construction, Chapter 19 formal trade-law doctrine and geoeconomics, and Chapter 20 technology strategy. Chapter 21 uses those foundations to develop sustainability-specific strategy and responsible-trade implementation: climate and nature risk, materiality, ESG, due diligence, circularity, carbon accounting, climate targets, carbon pricing, border measures, reporting, assurance, greenwashing control, green procurement, transition finance linkages and African green industrialization.

SCOPE BOUNDARY | Chapter 21 owns sustainability strategy and responsible-trade implementation. It develops environmental and climate evidence, materiality, ESG evaluation, responsible sourcing, circularity, carbon accounting, climate targets, sustainability reporting, assurance, carbon-pricing interfaces and the practical sustainability implications of trade. It does not reteach general ethics and corporate governance from Chapter 13, detailed operations and logistics from Chapter 11, international trade theory from Chapter 14, investment valuation from Chapter 18, formal trade-law doctrine from Chapter 19, or technology and AI governance from Chapter 20.

Table 21.2. Chapter architecture and scope control.

Editorial design question	Chapter 21 answer
Approved purpose	Treat sustainability as a strategic, scientific, moral and trade discipline grounded in stewardship and human flourishing, while critically assessing ESG and related frameworks rather than treating them as self-validating authorities.
Primary course alignment	Sustainable Global Business and Trade Practices; sustainability applications from Corporate Ethics and Governance and Operations.
Immediate prerequisites	Environmental and institutional foundations from Chapter 1; evidence and analytics from Chapters 3-5; operations and supply-chain flow from Chapter 11; strategy from Chapter 12; ethics and governance from Chapter 13; trade economics from Chapter 14; multinational strategy from Chapter 15; investment links from Chapter 18; trade rules and policy from Chapter 19; and enabling technologies from Chapter 20.
Principal duplication risks	Re-teaching general ethics or governance from Chapter 13; physical supply-chain mechanics from Chapter 11; trade theory from Chapter 14; investor valuation from Chapter 18; legal doctrine from Chapter 19; or digital/AI governance from Chapter 20.

Editorial design question	Chapter 21 answer
Major theory streams	Sustainable development and intergenerational equity; weak/strong sustainability; triple bottom line; natural-resource-based view; stakeholder/legitimacy and institutional perspectives; Porter-type innovation effects; business sustainability as intertemporal strategy; circular economy; life-cycle and materiality perspectives.
Main evidence streams	Climate and resource science; peer-reviewed sustainability, strategy, accounting and finance research; GHG accounting standards; labour and due-diligence instruments; corporate filings; carbon-pricing and trade-policy evidence; sustainability reporting standards and assurance requirements.
African analytical core	Sasol and South Africa's transition dilemma; African energy-access and clean-cooking gaps; AfCFTA and green industrialization; carbon-border exposure; responsible mineral and agricultural value chains; SME capacity and policy sovereignty.
Global comparison	A.P. Moller - Maersk and the difference between emissions intensity and absolute emissions; IFRS/GRI/TNFD/ESRS reporting architectures; global carbon-pricing and carbon-border developments.
Quantitative applications	GHG inventory construction; carbon intensity; marginal abatement cost; material and waste yields; simplified CBAM/carbon-price exposure; target and KPI quality diagnostics.
Core moral questions	What does stewardship require when environmental protection, jobs, energy access and affordability conflict? When is an ESG or net-zero claim truthful? Who bears transition costs? Which global standards legitimately guide firms, and when should subsidiarity, local institutions or freedom of conscience constrain external pressure?

The internal sequence moves from purpose to evidence, then from evidence to implementation. Sections 21.1-21.4 establish why sustainability is an intertemporal and distributional business problem and compare the main intellectual traditions. Sections 21.5-21.9 develop materiality, climate science, climate and nature risk, adaptation and transition strategy. Sections 21.10-21.13 critically examine ESG, ratings, responsible sourcing and traceability. Sections 21.14-21.19 build the circularity, carbon-accounting, target, carbon-pricing and border-carbon toolkit. Sections 21.20-21.22 address reporting, assurance, greenwashing, sustainable finance and procurement. Sections 21.23-21.25 place African industrialization, energy access, AfCFTA, Sasol and Maersk at the analytical center. Section 21.26 integrates Christian moral reasoning. The final sections provide the professional protocol, recurring errors, synthesis, questions, cases and evidence exercises before handing the reader to Chapter 22, where sustainability judgment becomes part of professional practice, internship learning and capstone integration.

Opening Case: Sasol and the Transition Dilemma of an Emissions-Intensive African Enterprise

Sustainability becomes difficult precisely where the trade-offs are real. Sasol, headquartered in South Africa, is a useful opening case because its industrial system sits at the intersection of energy security, chemicals, fuels, export competitiveness, employment, public policy, carbon intensity and technological transition. It is easy to state that an emissions-intensive company should reduce greenhouse-gas emissions. It is harder to determine how quickly, through which investments, against what baseline, with what treatment of offsets, and with what consequences for production, workers, customers, electricity systems and national industrial capability.

Sasol states that in 2025 it achieved roughly a 20% net reduction in Scope 1 and Scope 2 greenhouse-gas emissions from its 2017 baseline while retaining a 30% reduction target for 2030. The headline is material, but the company's own explanation makes interpretation more demanding. Lower production volumes reduced gross emissions by 13.5% relative to 2017; operational factors and methodology changes also affected the result; and 3.8 million tonnes of CO2-equivalent carbon credits were retired, contributing materially to the net reduction (Sasol, 2025a, 2025b). The same number therefore contains several mechanisms. Some reflect physical operating change, some reflect activity level, some reflect accounting methodology and some reflect an external carbon-credit instrument. A reader who reports only "20% reduction" has not yet analyzed the transition.

This distinction matters for strategy. A permanent reduction in emissions intensity through process redesign can improve the carbon competitiveness of future production. A temporary reduction caused by lower output reduces absolute emissions but may not indicate structural decarbonization. Carbon credits can finance reductions or removals elsewhere, but they are not physically identical to reducing emissions at the emitting facility and depend on additionality, permanence, leakage, measurement and claims discipline. Methodology improvements can make an inventory more accurate, but they can also complicate comparisons with prior periods unless restatements and boundaries are transparent. The manager, investor, regulator, worker and community may therefore be looking at the same headline metric while asking different questions.

The development context makes the case more complex. The International Energy Agency (IEA, 2025) reported that about 600 million Africans still lacked access to electricity and more than 1 billion lacked clean cooking. South Africa and North Africa accounted for less than one fifth of the continent's population but more than 45% of energy investment and more than 65% of installed electricity capacity. Environmental transition on the continent therefore cannot be evaluated as if affordable, reliable energy were already universal. Policies that reduce emissions while worsening electricity scarcity, household affordability or productive capacity can transfer environmental responsibility into another form of human deprivation. Conversely, invoking development needs cannot justify indefinite waste, pollution or avoidable exposure of workers and communities to harm.

Sasol also operates inside a rapidly changing trade and policy environment. South Africa has a carbon tax, the European Union's Carbon Border Adjustment Mechanism entered its definitive regime on 1 January 2026, and industrial customers increasingly request product-level emissions data. Border-carbon policies can create incentives for cleaner production and reduce carbon leakage, but they can also impose verification costs and competitiveness pressure on producers in economies with different energy systems, capital costs and administrative capacity. The correct question is not whether such policies are "green" or "anti-development." It is whether a particular instrument reduces environmental harm effectively, allocates transition burdens justly, preserves legitimate development space and creates credible incentives for cleaner productive capability.

The case gives the chapter its governing problem: **How can an enterprise distinguish genuine sustainable performance from attractive sustainability language, and then make decisions that protect long-run human and ecological flourishing without ignoring livelihoods, energy access, productivity, sovereignty and the limits of its evidence?** The answer requires scientific literacy, accounting discipline, strategic judgment, trade awareness and moral reasoning. ESG scores alone cannot supply it.

EVIDENCE CHECK | A sustainability metric is not self-interpreting. Before judging a reported reduction, ask what changed in physical activity, methodology, organizational boundary, output, emission factors, offsets or removals. Then ask whether the change is absolute or intensity-based, gross or net, independently assured or management-reported, and durable under the expected operating plan.

21.1 Why Sustainability and Responsible Trade Matter

Sustainability is often introduced through aspiration: meet present needs without harming the future, reduce emissions, protect biodiversity, respect workers, improve communities and create long-term value. Those aspirations are important, but managerial usefulness begins only when the analyst specifies the system, time horizon, affected persons, resources, impacts and decision rights. A factory can reduce emissions per unit while total emissions rise. A renewable-energy project can lower carbon intensity while displacing households or degrading a sensitive habitat. A "circular" product can use recycled material while being designed for rapid obsolescence. A supplier can pass a social audit while workers remain unable to report abusive practices safely. A company can publish an elegant ESG report while the most consequential impacts sit outside the reporting boundary.

The distinctive feature of sustainability is its intertemporal structure. Bansal and DesJardine (2014) argue that sustainability requires explicit attention to time because present decisions can preserve or erode the conditions under which future economic and social activity remains possible. This is not merely a longer financial forecast. It concerns path dependence, thresholds, depletion, irreversible loss, long-lived capital and the distribution of consequences across people who may not participate in the transaction that creates those consequences. A mining project can generate cash flow, wages and tax revenue today while leaving long-lived tailings liabilities; a poorly designed transition can avoid future emissions while destroying current livelihoods without a credible replacement. Sustainability therefore makes the time structure of responsibility visible.

Responsible trade adds a spatial dimension. Cross-border exchange separates production, consumption, regulation and impact. A consumer may enjoy a low-cost product in one country while pollution, unsafe work or resource depletion occurs in another. Conversely, stringent environmental or social conditions imposed by a large importing market can improve practices but can also externalize compliance costs onto smaller suppliers or function as de facto barriers when financing and verification capacity are unequal. Chapter 14 showed that trade can increase aggregate gains while distributing adjustment costs unevenly; Chapter 21 asks how sustainability requirements alter those distributions and how enterprises can avoid shifting harm through geography rather than reducing it.

The field is also vulnerable to category errors. ESG is not a synonym for sustainability; it is a family of information categories and market practices. Climate risk is not identical to climate impact: a firm can impose large emissions on society while facing limited immediate financial risk, or face severe climate risk despite having a small direct carbon footprint. Compliance is not the same as legitimacy; a legal threshold may be insufficient to prevent serious harm, while a voluntary standard may be commercially influential without possessing democratic or legal authority. Environmental efficiency is not necessarily justice, and a morally attractive objective does not excuse weak evidence about whether a policy actually works.

For managers, sustainability is therefore a problem of disciplined integration. The enterprise must identify impacts and dependencies, determine which are material under different lenses, understand scientific and regulatory evidence, design feasible options, quantify what can be quantified, expose what cannot be reduced to one metric, assign accountability, measure outcomes and correct claims when reality differs from intention. The chapter's central discipline is not compliance with a favored framework. It is stewardship under evidence and constraint.

21.2 Core Concepts: Sustainability, Stewardship, ESG and Human Flourishing

Terminology matters because different concepts answer different questions. Sustainable development gained its most influential modern formulation through the World Commission on Environment and Development (1987), which linked present development to the capacity of future generations to meet their needs. The definition was intentionally broad. Its strength is that it refuses the false choice between development and environmental protection; its weakness is that it does not specify how to resolve conflicts among present poverty reduction, future risk, ecological thresholds, national sovereignty and competing development pathways.

Business sustainability translates that intergenerational question into enterprise choices. It asks whether a firm's strategy and operations can remain economically viable while preserving or improving the social, institutional and ecological conditions on which the enterprise and its stakeholders depend. This definition does not require that every company maximize every environmental or social outcome. It requires that the company identify material dependencies and harms, avoid treating future costs as somebody else's problem, and make claims proportionate to evidence.

Stewardship provides the chapter's Christian moral orientation. Stewardship means accountable use of entrusted resources and authority, not absolute discretionary ownership and not passive preservation. A steward may cultivate land, transform materials, build infrastructure and earn legitimate profit, but cannot treat people, land, water or future consequences as morally irrelevant merely because a legal title permits use. Human flourishing provides the evaluative end: economic activity should contribute to conditions in which persons and communities can live, work, form families, exercise responsibility and pursue legitimate goods within an inhabitable creation. That framing resists both an economy that treats nature as costless inventory and an environmentalism that treats human development as an intrinsic problem.

ESG occupies a narrower place. Environmental, social and governance categories can organize information about emissions, labour, safety, corruption, boards, privacy, supply chains and other issues. They can help investors and managers identify long-horizon risks or impacts. Yet "ESG performance" depends on the selected provider, variables, weights, scope and purpose. A composite score can obscure severe weakness in one dimension through strength in another. It can also mix financially material risks, corporate impacts and governance practices into one number that lacks a single causal interpretation. The professional rule is therefore to disaggregate ESG into specific issues before drawing conclusions.

Table 21.3. Distinguishing sustainability concepts that are often collapsed.

Concept	Working meaning	What it does not prove
Sustainability	The capacity of human and organizational systems to meet present purposes without undermining the ecological, social and institutional conditions required for future flourishing.	It does not specify one universal policy package, metric or institutional authority.
Sustainable development	Development that integrates present human needs with the ability of future generations to meet their own needs, requiring attention to both development and ecological constraints.	It does not imply that every project labeled "green" improves welfare or justice.
Stewardship	Accountable care and use of entrusted resources, authority and capabilities for legitimate purposes rather than absolute discretionary ownership.	It does not mean passive preservation or refusal to use natural resources.
ESG	A family of environmental, social and governance information categories used in corporate, investment, risk and reporting practice.	A high ESG score does not by itself establish sustainability, ethics, impact, legal compliance or superior returns.
CSR / corporate responsibility	Responsibility for the consequences of corporate power, conduct and relationships, including duties toward affected stakeholders.	Responsible conduct is broader than environmental sustainability and cannot be reduced to philanthropy.
Impact	A change in people, society or the environment attributable or plausibly contributed to by an activity, product, policy or investment.	Outputs such as training hours, trees planted or reports issued are not automatically impacts.
Resilience	The capacity to anticipate, absorb, adapt to and recover from disruption while preserving essential functions.	Resilience can preserve a harmful system; it is not automatically morally desirable.

MANAGERIAL INSIGHT | Do not begin a sustainability project by asking which ESG framework to adopt. Begin by defining the business decision, affected persons, environmental system, time horizon, legal duties and evidence required. Framework selection should follow the decision architecture, not substitute for it.

21.3 Historical and Theoretical Foundations of Sustainable Enterprise

The modern sustainable-business field draws from economics, ecology, strategy, ethics, accounting, operations and public policy. No single theory explains all of it. The classical economic starting point is the externality: a cost or benefit created by an economic activity that is not fully reflected in the private transaction price. Pollution, congestion, ecosystem degradation and greenhouse-gas emissions can create external costs. A simple formulation is that the social marginal cost of an activity equals its private marginal cost plus the marginal external cost imposed on others. Where the external cost is substantial, a market price can signal profitable exchange without signalling socially efficient or morally legitimate resource use.

Social marginal cost = Private marginal cost + Marginal external cost

The external cost may be uncertain, distributed across places and generations, and difficult to monetize. The equation is an analytical reminder, not a claim that every moral consequence can be priced.

Policy responses include taxes, cap-and-trade systems, standards, property-rights arrangements, liability, information disclosure and public investment. Each instrument changes incentives differently. A carbon tax prices emissions directly; a performance standard constrains a technology or outcome; a tradable allowance system fixes an aggregate cap and allows price discovery; disclosure changes information but does not automatically change the harmful activity. The choice among instruments depends on measurement, enforcement, market structure, innovation, administrative capability, distributional effects and political legitimacy. Chapter 19 owns the formal legal analysis; here the concern is how those instruments alter enterprise sustainability choices.

A second tradition concerns substitutability between natural and produced capital. Weak-sustainability perspectives permit substantial substitution if total productive capacity or welfare can be maintained. This supports technological optimism and cost-benefit approaches: depleted natural resources may be acceptable if innovation, infrastructure, knowledge or other capital compensates future generations. Strong-sustainability perspectives reply that some ecosystem functions, biodiversity, climate stability or irreversible losses may not be meaningfully substitutable. The practical implication is not that all natural stocks must be frozen. It is that managers should identify thresholds, irreversibility and dependence before assuming money or technology can compensate for ecological loss.

The triple-bottom-line tradition popularized attention to economic, social and environmental dimensions (Elkington, 1997). Its enduring contribution is to reject financial performance as the only outcome worth observing. Its analytical weakness is aggregation. Profit, injuries, water depletion, wages, carbon emissions and community trust do not share a natural unit. A dashboard can display them side by side, but a single composite score requires weights that embed value judgments. The more heterogeneous the dimensions, the more dangerous it is to treat arithmetic aggregation as objective.

Strategy research adds several mechanisms. Hart's (1995) natural-resource-based view argues that pollution prevention, product stewardship and sustainable development can become capability-based sources of competitive advantage. Porter and van der Linde (1995) further challenged a purely static view of environmental regulation by arguing that well-designed standards can stimulate resource-productivity innovation that partly offsets compliance cost. The argument should not be converted into the slogan that regulation always pays. Innovation offsets are contingent on design, competitive conditions, managerial capability, technology and timing. Some rules are costly, poorly targeted or administratively burdensome; others accelerate learning and create first-mover advantage. The empirical question is which mechanism operates in the specific setting.

Institutional and legitimacy perspectives explain why firms respond to norms, investors, regulators, customers, communities and peers even when short-term cash-flow effects are unclear. These perspectives help explain the diffusion of sustainability reporting, supplier codes, net-zero commitments and ESG governance. They also expose a danger: organizations may adopt visible structures to appear legitimate without changing material outcomes. Greenwashing and symbolic compliance are therefore not accidental side issues but predictable risks when external audiences reward policies, scores and narratives that are easier to observe than underlying environmental or social performance.

Planetary-boundary research adds biophysical context. Richardson et al. (2023) concluded that six of nine assessed planetary boundaries had been transgressed in their framework. Such research is valuable because environmental systems can be nonlinear and globally cumulative. Yet a global boundary does not tell a manager how much of a resource one company is morally or legally entitled to use, nor how burden should be divided among rich and poor countries. Translating Earth-system science into firm-level targets necessarily adds economic, legal, technological and distributive judgments. Scientific limits are relevant constraints; allocation remains a human governance problem.

Table 21.4. Major sustainable-enterprise perspectives and their limits.

Perspective	Core mechanism	Managerial contribution	Principal limitation
Weak sustainability	Different forms of capital can substitute for one another if aggregate productive capacity is preserved.	Supports cost-benefit reasoning, innovation and substitution where credible substitutes exist.	Can understate ecological thresholds, irreversibility and non-substitutable ecosystem functions.
Strong sustainability	Critical natural capital and ecological functions cannot always be replaced by produced or financial capital.	Makes thresholds, irreversibility and precaution explicit.	Determining which stocks are "critical" and allocating constraints across firms and countries is contested.
Triple bottom line	Economic, social and environmental performance should be considered together.	Broadens attention beyond short-term financial results.	The three dimensions are not naturally commensurable; aggregation can hide trade-offs.
Natural-resource-based view	Pollution prevention, product stewardship and sustainable development can become capability-based sources of advantage.	Links environmental strategy to resources, innovation and competitive capability.	Not every environmental investment creates advantage, and imitation, regulation or weak demand can alter returns.
Porter-type innovation hypothesis	Well-designed environmental regulation may induce innovation that partly or more than offsets compliance cost.	Prevents static cost analysis from ignoring productivity and innovation responses.	Innovation offsets are contingent, not guaranteed; poorly designed rules can still destroy value or shift activity.
Stakeholder / legitimacy perspectives	Firms depend on relationships, social acceptance and institutional legitimacy, not only contracts with capital providers.	Makes externalities, voice, trust and social licence visible.	"Stakeholder interest" can become vague, politically manipulable or insufficiently accountable without decision rules.
Intertemporal business sustainability	Long-run viability requires explicit trade-offs across time and generations.	Corrects short-termism and forces target horizons and path dependence into strategy.	Long horizons increase uncertainty and can invite unfalsifiable promises unless interim evidence is specified.
Planetary-boundary perspective	Earth-system processes can have biophysical thresholds and nonlinear risk.	Provides scientific context for cumulative environmental pressure.	Global thresholds do not mechanically determine fair national allocations, firm quotas or particular technologies.

21.3.1 Sustainability as intertemporal strategy rather than reputation management

The most durable theoretical insight is that sustainability changes the time structure of strategy. Investments in resilience, worker capability, pollution prevention or supplier development may impose current cost for future reliability. Conversely, under-maintenance, resource depletion or risky externalization can create current margins by borrowing from future stakeholders. The relevant managerial comparison is therefore not "sustainability cost" versus "profit." It is the full stream of value, risk, capability and external effects across time, including consequences that current accounting systems may not recognize as liabilities.

This intertemporal framing also disciplines corporate promises. A 2050 target with no 2030 milestone can postpone accountability beyond the tenure of current executives. A circularity commitment with no product-design change can depend on recycling systems that do not exist. A biodiversity pledge without location-specific dependency mapping can remain disconnected from operating choices. Credible sustainability strategy converts long-horizon aspiration into near-term decisions that can fail, be measured and be corrected.

21.3.2 Sustainability, competitive advantage and the conditions for value creation

Sustainability can contribute to competitive advantage, but the mechanism must be specified rather than assumed. The principal value channels are resource productivity, reliability and risk reduction, innovation and product differentiation, market access, relational legitimacy, workforce capability, and financing or insurance conditions. An energy-efficiency project can lower operating cost; verified product emissions can preserve access to a carbon-constrained export market; safer working conditions can reduce disruption and retain scarce skills; and credible environmental performance can support customer trust. These are causal propositions that require evidence. The label "sustainable" creates no economic rent by itself.

The business case can also be negative, incomplete or socially misaligned. Some pollution controls impose genuine private cost because the benefit is enjoyed mainly by communities or future generations rather than captured by the firm. Early investment in an immature technology can destroy value if infrastructure, customer demand or complementary standards do not develop. A firm may therefore have a moral or legal duty to act even when the initiative does not produce a positive private net present value. Conversely, a financially attractive "green" project is not automatically responsible if it shifts harm to workers, landholders or another stage of the life cycle.

African conditions make the contingency especially visible. Resource efficiency can be strategically valuable where electricity, fuel, water or imported inputs are costly or unreliable. Cleaner production and credible traceability can protect access to demanding export markets and reduce exposure to border-carbon measures. Yet product-level carbon accounting, verification and certification also create fixed costs that can exclude capable small and medium-sized enterprises. The relevant calculation therefore includes price and cost effects, avoided disruption, market-access value, capability spillovers, financing constraints and the distribution of compliance costs.

Chapter 12 remains the intellectual owner of competitive-strategy tools such as VRIO, activity-system fit and dynamic capabilities. The sustainability-specific contribution here is a stricter four-part test. An initiative should show a credible environmental or social mechanism, economic feasibility, capability to implement and appropriate the benefits where private value is claimed, and moral legitimacy for the burdens it creates. Where these conditions do not hold, management should redesign the initiative, explain why a non-financial duty still justifies it, or stop presenting sustainability as a guaranteed source of superior performance.

21.4 Trade, Growth, Externalities and Development Trade-offs

International trade affects the environment through several mechanisms. Copeland and Taylor (2004) organize the relationship around scale, composition and technique effects. The **scale effect** arises when more economic activity increases resource use or emissions, holding production methods constant. The **composition effect** arises when trade changes which sectors expand in each country. The **technique effect** arises when income, technology, regulation or learning changes emissions per unit of output. The net environmental outcome depends on the relative strength of these channels. Trade can increase total pollution through scale while reducing intensity through technology and specialization, or shift pollution toward jurisdictions with weaker regulation.

This framework helps avoid two errors. The first is assuming that trade volume is a sufficient indicator of development or sustainability. A larger export sector can create jobs and foreign exchange while depleting soil, water or forests if the production system is poorly governed. The second is assuming that environmental regulation necessarily destroys trade competitiveness. Cleaner technologies can reduce energy and material cost, open premium markets or satisfy border standards, although those benefits are neither universal nor immediate. Firms need product- and process-level evidence rather than ideological conclusions about "free trade" or "green protectionism."

Environmental requirements also have distributional consequences across countries. High-income importing markets often possess deeper capital markets, stronger laboratories, experienced verifiers and established data systems. A traceability or carbon-footprint rule that appears technologically neutral can therefore impose proportionally higher fixed costs on small exporters from lower-income economies. Those costs may still be justified if they prevent serious harm, but the design question becomes whether the requirement is proportionate, whether transition assistance exists, whether local standards can be recognized, and whether the measure inadvertently concentrates market access among large firms.

The same distributive logic applies inside countries. Closing an obsolete, highly polluting facility may create long-run health and environmental benefits but impose immediate income losses on workers, municipalities and suppliers. A "just transition" is an attempt to make those adjustment costs explicit through retraining, income support, local investment, social dialogue and alternative productive activity. The term should not become a veto against necessary change or a rhetorical guarantee that no one will lose. Structural transitions generate real losses. The responsible question is which losses are unavoidable, which can be reduced, who should bear them and what credible replacement pathway exists.

Africa makes the development trade-off especially visible. The IEA's 2025 evidence on electricity and clean-cooking gaps means that reducing energy poverty is itself a human-flourishing priority. At the same time, many African economies are highly exposed to climate hazards and resource-dependent livelihoods. Policy that blocks reliable energy expansion without a feasible alternative can be unjust; policy that locks countries into unnecessarily polluting, high-cost assets can also be unjust if it leaves future consumers with stranded infrastructure and health damages. Sustainable development therefore requires sequencing, investment and local institutional capacity rather than imported slogans.

> **AFRICAN CONTEXT |** For African policymakers and firms, "green" and "development" should not be treated as opposing identities. The decision problem is to build productive capability that is increasingly resource-efficient, climate-resilient and internationally competitive while expanding affordable energy, jobs and local value addition. The timing and technology mix will differ by country because resource endowments, grids, fiscal space, industrial structure and access gaps differ.

21.5 Materiality: Financial, Impact, Double and Moral

Sustainability decision making requires a rule for attention. No enterprise can measure every conceivable environmental and social variable with equal depth. Materiality is the discipline used to identify which issues deserve decision-quality evidence, governance and disclosure. The difficulty is that “material” has more than one legitimate meaning.

Financial materiality asks whether information could reasonably affect the enterprise’s prospects, including cash flows, financing access or cost of capital. IFRS S1 adopts this investor-focused orientation for sustainability-related risks and opportunities. A water shortage can be financially material because it constrains production; labour unrest because it raises cost and disrupts service; a carbon border measure because it affects export margins. This lens is essential for corporate strategy and capital markets, but it can miss serious harms that have not yet been translated into prices, lawsuits, regulation or reputation.

Impact materiality reverses the direction of analysis. Instead of asking how the world affects the firm, it asks how the firm affects people and the environment. A pesticide may create health or biodiversity effects even before investors consider them financially relevant. Excessive working hours may violate dignity even where labour is abundant and customer prices are unaffected. Impact materiality is therefore indispensable for responsibility, but impact assessments can become vague if severity, scale, scope, likelihood and reversibility are not specified.

Double materiality combines both directions and is central to the European sustainability-reporting tradition. It is conceptually attractive because enterprise and society influence one another. Yet “double” should not mean “everything matters.” A defensible assessment identifies causal mechanisms, affected groups, evidence quality and thresholds. A color-coded matrix based on workshop votes can be a useful starting conversation, but it should not convert subjective scores into pseudo-precision.

This chapter adds an explicit **moral materiality** lens. Moral materiality asks whether an issue engages a duty, right or prohibition that decision makers ought to respect even if current financial impact is small and formal reporting standards do not require disclosure. Fraudulent green claims, forced labour, knowingly unsafe conditions or deliberate pollution of a community’s water supply are not rendered morally trivial by immateriality to enterprise value. Moral materiality does not replace financial or impact analysis; it prevents them from becoming moral escape routes.

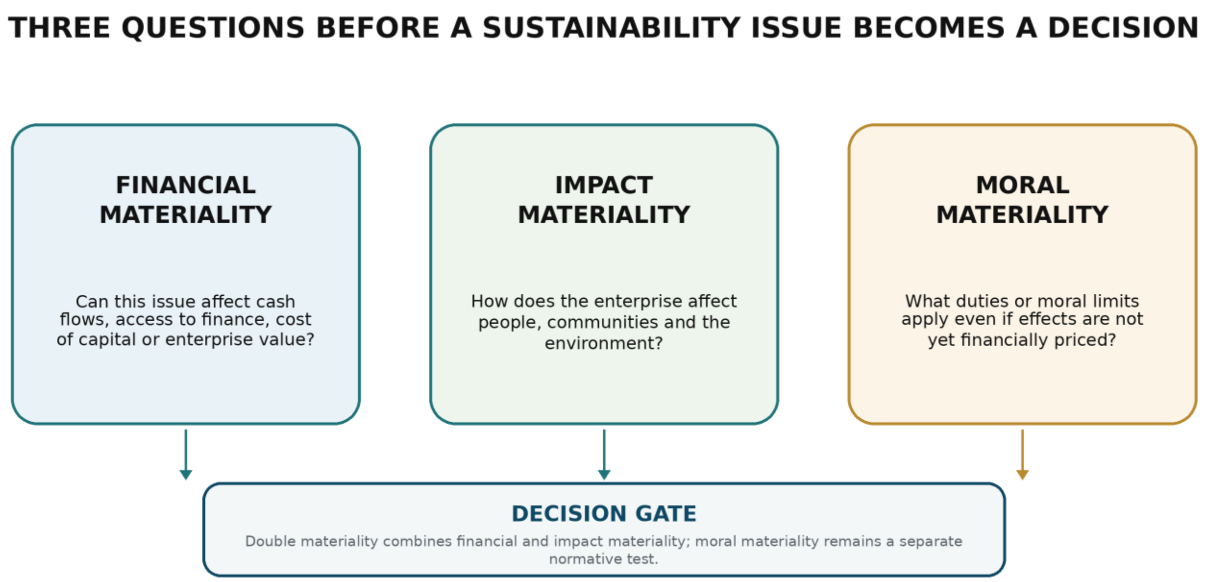

Figure 21.2. Financial, impact and moral materiality as distinct but interacting questions.
Source/Note: Author's synthesis. Double materiality combines the first two lenses; moral materiality is retained as a separate normative test rather than a reporting category.

Table 21.5. Materiality perspectives for sustainability decisions.

Lens	Primary question	Typical user	Decision risk if used alone
Financial materiality	Could the sustainability issue reasonably affect cash flows, access to finance, cost of capital or enterprise prospects?	Investors, lenders, boards, management.	Important harms may be ignored until they become financially priced.
Impact materiality	Does the enterprise cause, contribute to or become directly linked to significant effects on people or the environment?	Affected stakeholders, regulators, civil society, management.	Impact significance can be difficult to compare and may not indicate enterprise-value exposure.
Double materiality	Is the issue material from either the financial or impact perspective, including their interaction?	Broad-reporting users and regulators using double-materiality systems.	Assessment may become bureaucratic if scoring replaces causal analysis and evidence.
Moral materiality	Does the issue engage a duty, right, prohibition or serious foreseeable harm that remains relevant regardless of current financial pricing?	Decision makers exercising moral responsibility.	Without disciplined reasoning, moral language can become subjective assertion or ideological capture.

A strong materiality process therefore proceeds from evidence to judgment. It identifies the enterprise boundary and value chain; maps dependencies and impacts; screens legal and contractual duties; estimates financial transmission; examines severity for affected persons and ecosystems; considers vulnerable groups and irreversible harm; tests alternative viewpoints; documents assumptions; and assigns governance. The resulting list should be revisited when technology, operations, markets, science or regulation changes. Materiality is a decision process, not a permanent label attached to an issue.

21.6 Climate Science as Decision Input: Evidence, Scenarios and Uncertainty

Business sustainability must distinguish scientific evidence from corporate policy preference. The Intergovernmental Panel on Climate Change's Sixth Assessment synthesis concluded that human activities, principally through greenhouse-gas emissions, have unequivocally caused global warming and that continued emissions increase climate-related risks (IPCC, 2023). The World Meteorological Organization reported that 2025 was the second or third warmest year in the observational record, about 1.43°C above the 1850-1900 average, and that 2015-2025 were the eleven warmest years on record. It also reported record ocean heat content in 2025 (WMO, 2026). These are evidence statements about the climate system, not corporate instructions about which technology, tax or disclosure regime should be chosen.

The distinction matters because scientific conclusions operate at different scales from business decisions. A global mean-temperature projection does not forecast the exact financial loss for a particular warehouse in Mombasa, a coffee farm in Rwanda or a data center in Lagos. Enterprise analysis requires translation through location, asset design, supply chains, insurance, adaptive capacity, customer behavior and regulation. A climate-risk assessment that merely reproduces global scenarios without mapping those transmission channels creates the appearance of sophistication without decision relevance.

Scenarios are especially prone to misuse. A scenario is a coherent conditional description of how the future might develop under specified assumptions. It is not necessarily a probability forecast. A company can examine a higher-warming scenario to test physical resilience and a faster-transition scenario to test policy, technology and demand exposure without claiming that either will occur with a stated probability. The discipline is to identify decisions that remain robust across plausible futures and to name signposts that would justify changing course.

UNEP's *Emissions Gap Report 2025* estimated that full implementation of then-available nationally determined contributions would imply roughly 2.3-2.5°C of warming over the century, while current policies pointed to about 2.8°C (UNEP, 2025). Such estimates are not arguments for fatalism and should not be converted into precise firm-level forecasts. They are evidence that transition and physical-risk planning should not assume universal delivery of political commitments. A company whose resilience plan works only if every government meets an ambitious pledge has built a fragile plan.

Climate uncertainty therefore cuts both ways. It is wrong to manufacture certainty about exact local outcomes decades ahead; it is equally wrong to treat uncertainty as evidence that risk is zero. Managers routinely act under uncertain demand, interest rates, commodity prices and technology. Climate risk should be governed with the same discipline: explicit assumptions, ranges, scenario tests, sensitivity, decision thresholds and revision rules.

21.7 Climate Risk: Physical, Transition, Liability, Market and Supply-Chain Exposure

Climate risk enters the enterprise through causal pathways. **Physical risk** includes acute events such as floods, cyclones, wildfires and extreme heat, and chronic shifts such as sea-level rise, water stress or changing temperature patterns. The loss mechanism may involve damaged assets, worker heat stress, crop yield, power interruption, transport disruption or insurance withdrawal. The appropriate evidence is therefore more granular than a corporate carbon footprint. A low-emitting company can be highly exposed to physical climate risk.

Transition risk arises from economic adjustment toward lower-emission systems. Policy can change through carbon prices, product standards, disclosure rules, permitting, subsidies or phase-outs. Technology can change relative cost, rendering existing assets less competitive. Customer procurement standards can shift demand. Finance providers can reprice credit. Transition risk is not proof that a transition policy is socially desirable or undesirable; it is the enterprise exposure created by change in the operating environment.

Liability risk includes litigation, contractual disputes and claims arising from alleged environmental damage, inadequate disclosure or misleading sustainability representations. It can also arise when boards or managers fail to integrate known risks into governance. Liability risk is partly legal and therefore jurisdiction-specific. Chapter 19 provides the wider legal reasoning; here the managerial lesson is that sustainability claims create evidence obligations. A company that advertises a product as "carbon neutral," "deforestation free" or "responsibly sourced" should be able to reconstruct the data and assumptions supporting that statement.

Market risk includes changes in willingness to pay, product substitution, customer procurement requirements and the loss of access to markets that condition participation on environmental performance. **Supply-chain risk** arises when physical or transition shocks propagate through suppliers and infrastructure. A flood at a tier-two component maker can stop a manufacturer that never identified the site; a carbon border rule can affect the cost of an input even if the focal firm is not the importer of record.

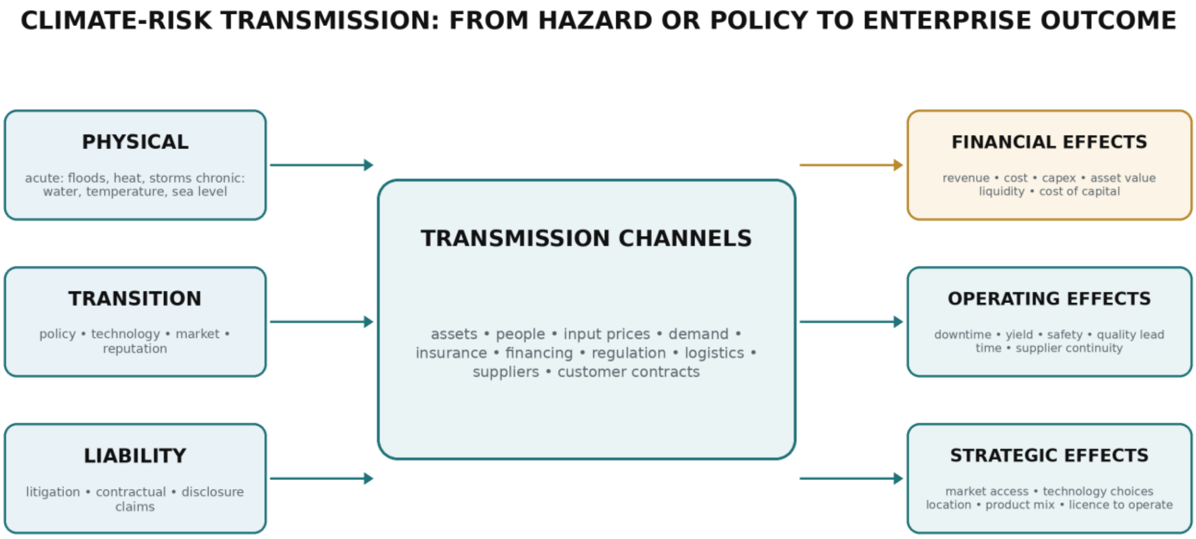

Figure 21.3. Climate-risk transmission from hazard or policy to operating, financial and strategic effects.
Source/Note: Author's synthesis, informed by IFRS S2, TCFD-derived risk architecture and enterprise risk-management logic.

Table 21.6. Climate-risk categories and enterprise evidence.

Risk type	Mechanism	Examples of evidence	Typical response
Acute physical	Event-driven hazards interrupt assets, labour, logistics or communities.	Facility hazard maps, loss history, supplier locations, heat/flood/wildfire exposure, insurance terms.	Adaptation, site protection, redundancy, continuity, worker safety, supplier diversification.
Chronic physical	Long-duration shifts alter productivity, water, agriculture, health or asset suitability.	Temperature trends, water stress, sea-level projections, crop or yield data, maintenance patterns.	Design standards, relocation options, water efficiency, heat management, product and sourcing changes.
Transition policy/legal	Taxes, standards, disclosure, phase-outs or border measures alter relative cost and market access.	Carbon-price paths, CBAM rules, product standards, permitting, litigation and enforcement.	Abatement, product redesign, verified data, contracting, technology transition, market diversification.
Transition market/technology	Customer preferences, input markets or substitute technologies change demand and asset economics.	Order patterns, competitor capex, technology cost curves, customer procurement criteria.	Portfolio renewal, innovation, asset-retirement discipline, customer transition plans.
Liability and claims	Past conduct, statements or disclosure failures create litigation, contractual or reputational exposure.	Claims register, advertising language, assurance findings, legal developments, grievance records.	Claims governance, evidence retention, legal review, correction, remediation and disclosure controls.
Supply-chain / systemic	Hazards or transitions propagate through suppliers, corridors, infrastructure and finance.	Tier mapping, concentration, critical inputs, lead times, transport routes, utility reliability, supplier climate data.	Multi-tier due diligence, buffers, substitutes, joint adaptation and scenario-linked sourcing.

A climate-risk register should therefore record at least the hazard or transition driver, exposed asset or relationship, transmission mechanism, time horizon, existing controls, residual risk, evidence source, uncertainty, owner and response trigger. The register should not duplicate the generic risk methods of Chapter 5. Its distinctive contribution is to connect climate-specific physical and transition pathways to enterprise choices.

21.8 Climate Strategy: Mitigation, Adaptation, Resilience and Transition Planning

A mature climate strategy separates four related tasks. **Mitigation** reduces greenhouse-gas emissions or increases removals. **Adaptation** changes assets, processes or behaviours to reduce harm from actual or expected climate effects. **Resilience** is the resulting capacity to continue or recover essential functions under disruption. **Transition planning** connects the current operating model to a future state through sequenced investments, retirements, capabilities, financing, milestones and governance.

Mitigation begins with the emissions hierarchy: avoid unnecessary emissions where feasible, reduce emissions at source, substitute lower-emission energy or materials, redesign products and operations, and address residual emissions with credible removals or credits only where direct reduction is not yet feasible or proportionate. This is not a universal technology order. An industrial process with difficult chemistry may require a different pathway from a building, logistics fleet or digital service. The hierarchy exists to prevent cheap credits or distant future technologies from becoming substitutes for feasible present reduction.

Adaptation is equally important because some climate change is already occurring and because mitigation outcomes depend on collective global action. Adaptation can include flood protection, heat-resistant equipment, worker-safety protocols, water storage, crop diversification, insurance, alternate suppliers, revised building standards and relocation options. Poor adaptation can create maladaptation: a defensive measure that reduces one party's risk while increasing another's, or that locks the enterprise into an unsustainable pathway. For example, groundwater extraction can protect short-term factory output during drought while depleting a shared aquifer.

A transition plan makes strategy falsifiable. It should identify the baseline, target boundary, key abatement or adaptation levers, required technologies, capital needs, operating assumptions, workforce implications, dependencies on public infrastructure, policy assumptions, milestones and escalation triggers. It should distinguish committed projects from aspirations. A "net-zero by 2050" statement without near-term investments, asset-retirement decisions or quantified dependencies is an ambition, not yet a transition plan.

PRACTICE TOOL | A useful transition plan has a *pathway*, not only a destination. For each major lever, record the expected physical effect, capital and operating cost, technical readiness, infrastructure dependency, implementation owner, worker/community implications, delivery date, measurement method and what evidence would cause the organization to accelerate, redesign or stop the lever.

21.9 Nature, Water, Pollution and Ecological Dependencies

Climate change is only one dimension of environmental sustainability. Enterprises also depend on water, soils, pollination, biomass, minerals, healthy workers, functioning ecosystems and the assimilative capacity of air, land and water. These dependencies can be commercially invisible until scarcity, contamination, regulation or ecosystem decline interrupts production. A beverage plant depends directly on water quantity and quality. A food company depends on soil fertility, water, pollination and climatic stability through farms that may sit several contractual tiers away. A pharmaceutical manufacturer may depend on biological resources and specialized chemical inputs. A financial institution has comparatively small direct material throughput but can be exposed through borrowers, collateral, financed projects and regional economic dependence.

Nature-related analysis should therefore distinguish **dependencies**, **impacts**, **risks** and **opportunities**. A dependency is something the enterprise requires from nature or ecosystem services. An impact is a change the enterprise causes or contributes to. Risk is the potential consequence for the enterprise or affected people when dependencies or impacts become economically, legally or socially consequential. An opportunity is a credible pathway to create legitimate value by reducing damaging impacts, restoring productive systems, improving efficiency or serving emerging needs. These categories should not be collapsed. A company may have a financially material water dependency while having a comparatively small direct water impact, or it may impose a large biodiversity impact that has not yet become financially material.

Water illustrates why aggregate corporate ratios are often insufficient. A cubic metre of water withdrawn from a water-abundant basin is not equivalent to a cubic metre withdrawn during severe local scarcity. Useful management therefore combines quantity with location, season, source, competing human needs, water quality and return flows. The same principle applies to land and biodiversity. Location-specific dependencies matter because ecosystems are not perfectly substitutable. A hectare of restored vegetation in one region does not automatically compensate for destruction of an ecologically distinct habitat elsewhere.

The Taskforce on Nature-related Financial Disclosures published its final recommendations in 2023 and organizes recommended disclosures around governance, strategy, risk and impact management, and metrics and targets. Its LEAP approach, Locate, Evaluate, Assess and Prepare, is useful because it forces analysis toward place-specific dependencies and impacts rather than a generic nature score (TNFD, 2023). The framework is voluntary unless incorporated into another requirement. It should therefore be treated as a diagnostic architecture, not as a source of moral authority.

Pollution requires similarly concrete analysis. Air emissions, effluent, hazardous substances, plastic leakage, persistent chemicals, noise and waste can create health, ecosystem and liability consequences. Pollution prevention is often more reliable than end-of-pipe treatment because it changes the production mechanism itself. Yet substitution can create burden shifting. Replacing one solvent with another may reduce workplace toxicity while increasing water contamination; replacing a lightweight material with a heavier recyclable material can raise transport emissions. Life-cycle reasoning, developed in Section 21.15, is therefore necessary whenever an intervention shifts impacts across stages or categories.

UNEP's *Global Resources Outlook 2024* reports that global extraction of natural resources tripled over the preceding five decades and, without substantial changes in how resources are used, could rise about 60% from 2020 levels by 2060 (UNEP International Resource Panel, 2024). The same report emphasizes large distributional differences in resource use and environmental impacts across income groups. For business education, the implication is not that all material use is morally suspect. Housing, transport, energy systems, food production and industrialization require physical resources. The decision question is whether resources are converted into genuine human benefit with progressively lower waste, avoidable harm and dependency risk.

EVIDENCE CHECK | Nature metrics can become misleading when they erase location. A company-wide water-intensity improvement can coexist with worsening withdrawals in a water-stressed basin. A biodiversity credit can represent a quantified transaction without proving ecological equivalence. Always ask what is being measured, where, against which baseline, with what ecological mechanism and for whose benefit.

21.10 ESG: Useful Information Architecture or Overloaded Label?

The acronym **ESG**, environmental, social and governance, entered mainstream investment and corporate practice as a way of organizing nontraditional information that could affect enterprise risk, opportunity and conduct. The categories are broad. Environmental topics may include climate, pollution, water, biodiversity and resource use. Social topics can include worker safety, labour rights, product impacts, community relations and human capital. Governance can include board oversight, control systems, incentives, corruption, ownership and disclosure. Because these issues differ in causal mechanism, measurement quality and moral significance, an aggregate ESG label is convenient but analytically dangerous.

ESG can be useful in at least four legitimate roles. First, it can function as a **risk-information architecture**, helping investors and managers identify financially relevant exposures not well captured by conventional financial statements. Second, it can function as a **reporting taxonomy**, organizing disclosures about environmental, social and governance matters. Third, it can support **screening or stewardship mandates** for investors whose beneficiaries have explicit constraints or objectives. Fourth, it can support **operational accountability** when specific indicators are tied to concrete decisions, controls and outcomes. None of these roles requires believing that one composite ESG score captures the moral quality or sustainability of a company.

The limitations are substantial. ESG dimensions are heterogeneous and sometimes conflicting. A firm can have strong occupational safety and weak climate performance, excellent governance and a contested product, or low direct emissions because emissions sit in its suppliers. Aggregation requires choices about scope, measurement and weights. Those choices embed judgments. A numerical score can therefore look objective while concealing methodological discretion.

Ratings divergence makes the problem visible. Berg, Kölbel and Rigobon (2022) compared major ESG rating agencies and decomposed disagreement into measurement, scope and weighting differences. They attributed the largest share of divergence to measurement choices, followed by scope differences and then weights. The central lesson is not that ratings are useless. It is that an ESG score should be treated as the output of a measurement model whose definitions need inspection. Two raters can observe the same company and produce different conclusions because they ask different questions, select different indicators or interpret incomplete data differently.

The empirical relationship between ESG and financial performance also resists slogans. Earlier work such as Khan, Serafeim and Yoon (2016) found that firms performing better on sustainability issues classified as financially material exhibited stronger subsequent accounting and market performance in their sample, while performance on immaterial issues was not similarly associated. Meta-analytic and review literature has often found non-negative average associations between many sustainability practices and financial performance, but results are heterogeneous and vulnerable to differences in measures, sectors, time periods and research design. Correlation does not establish that buying a higher ESG score will cause excess return. Edmans (2023) argues that responsible business should be analyzed through long-term value creation and trade-offs rather than treating ESG as a special category exempt from ordinary economic reasoning.

Ideological risk enters when ESG ceases to be an information architecture and becomes a mechanism through which disputed political or social objectives are presented as technically mandatory without transparent authorization. The opposite error is to dismiss all ESG information as ideological because some objectives are contested. Climate exposure, worker fatalities, corruption, water scarcity, litigation and board control are real business and moral issues regardless of the acronym used. Intellectual independence requires issue-by-issue evaluation.

A sound critique therefore asks six questions. What specific issue is being measured? What causal mechanism connects it to enterprise prospects or human impact? Who selected the metric and threshold? What evidence supports the measure? Which stakeholders bear the consequences of acting or not acting? What legitimate authority, contractual mandate or moral duty governs the decision? This approach avoids both ESG maximalism and reflexive ESG rejection.

Table 21.7. Sustainability frameworks: different purposes, different materiality logics.

Framework / instrument	Primary orientation	Materiality / scope	Status and managerial use
IFRS S1	Investor-focused sustainability-related financial information.	Risks and opportunities reasonably expected to affect cash flows, access to finance or cost of capital.	ISSB standard, effective from 1 January 2024; adoption depends on jurisdiction.
IFRS S2	Climate-related financial disclosures using governance, strategy, risk management, metrics and targets.	Climate risks and opportunities affecting enterprise prospects.	ISSB climate standard, effective from 1 January 2024; incorporates the TCFD architecture.
GRI Standards	Reporting an organization’s impacts on economy, environment and people.	Impact materiality; topic and sector standards support detailed disclosure.	Voluntary unless incorporated into law or other requirements; GRI 102 Climate Change 2025 is effective for reports from 1 January 2027.
ESRS / CSRD	EU sustainability reporting covering risks and impacts.	Double materiality.	Legal reporting system for entities within scope. As of 28 August 2026, the Commission’s 3 July 2026 revised ESRS delegated act had been adopted but was still subject to scrutiny and publication before taking effect.
TNFD	Nature-related dependencies, impacts, risks and opportunities.	Can support financial and impact perspectives; 14 recommended disclosures across four pillars.	Voluntary framework; useful for location-specific nature assessment and LEAP analysis.

Framework / instrument	Primary orientation	Materiality / scope	Status and managerial use
GHG Protocol	Corporate and value-chain greenhouse-gas accounting.	Organizational and operational inventory boundaries; Scope 1, 2 and 3 categories.	Accounting methodology, not a moral rating or transition plan.
OECD Guidelines / due diligence	Responsible business conduct across human rights, labour, environment, bribery and other areas.	Adverse impacts in operations, products, services and business relationships.	Government-backed recommendations; due-diligence logic is widely influential and may interact with law.

21.11 Materiality, Ratings and the Evidence Problem in ESG Performance

ESG performance claims become most useful when the unit of analysis is narrowed from the acronym to a specific exposure or practice. Occupational injury frequency, methane leakage, board independence, corruption incidents, product recalls and employee turnover differ in how they are measured and how they affect value. Combining them into one score can be useful for screening, but management requires disaggregation.

Three forms of measurement error deserve special attention. **Construct error** occurs when the indicator does not adequately represent the underlying concept. Measuring environmental responsibility by policy adoption alone, for example, can reward documentation rather than performance. **Boundary error** occurs when significant activities are outside the measurement scope. A retailer's direct emissions can appear small while purchased goods dominate its climate footprint. **Attribution error** occurs when a favorable outcome is credited to management without a credible counterfactual. Emissions may fall because a plant operated less, not because efficiency improved.

Data availability creates a further bias. Large listed companies often disclose more than smaller firms, and firms operating in countries with demanding disclosure rules can receive more measurable ESG profiles. More disclosure can reveal more controversies and paradoxically worsen a rating relative to a less transparent peer. Missing data should not automatically be coded as zero risk, average performance or poor performance. The appropriate treatment depends on the decision and should be documented.

The same cautions apply to **ESG-linked executive pay**. Linking remuneration to environmental or social targets can focus management attention, but badly designed metrics invite gaming. A target to reduce workplace incidents may discourage reporting. A target to increase renewable-energy share may be achieved by contracting changes without reducing absolute energy demand. A carbon-intensity target can improve while total emissions rise. Compensation committees therefore need metric definitions, baselines, adjustment rules, verification, anti-gaming controls and an explanation of why the target is strategically and morally material.

CRITICAL DEBATE | Should ESG be abandoned as a category? One position argues that the label is too broad, politically contested and methodologically inconsistent to guide investment or corporate strategy. A second position argues that abandoning the label would not remove the underlying environmental, social and governance risks. The more defensible managerial response is disaggregation: evaluate each material issue with appropriate evidence, authority and moral reasoning, then use composite scores only for limited purposes that survive methodological scrutiny.

21.12 Responsible Sourcing and Human-Rights Due Diligence

Responsible trade begins before a border crossing. It begins with what the enterprise buys, from whom, under which commercial terms, and what impacts are created in the process. Chapter 11 developed supplier selection, procurement, logistics and traceability as operational systems. Chapter 13 developed business and human rights, grievance and governance. Chapter 21 owns the sustainability implementation question: how should environmental and human-rights expectations be integrated into sourcing without turning due diligence into a questionnaire exercise?

The OECD Due Diligence Guidance for Responsible Business Conduct and the 2023 OECD Guidelines for Multinational Enterprises on Responsible Business Conduct use a risk-based logic: embed responsible conduct in policy and management systems; identify and assess actual and potential adverse impacts; cease, prevent or mitigate impacts; track implementation and results; communicate how impacts are addressed; and provide for or cooperate in remediation where appropriate (OECD, 2018, 2023). This architecture is valuable because it is iterative. It does not pretend that a global buyer can guarantee zero risk in every tier.

Severity should drive priority where resources are limited. Human-rights due diligence commonly considers the **scale**, **scope** and **irremediable character** of potential harm. A low-probability risk of catastrophic injury can deserve more attention than a frequent but minor paperwork defect. Environmental due diligence similarly needs severity, geographic sensitivity, persistence and reversibility. Risk prioritization should not become an excuse for indefinite neglect of lower-priority impacts, but it protects against spending scarce compliance resources on easy-to-measure issues while severe harms remain unmanaged.

Supplier codes of conduct are only the beginning. Contracts can establish requirements, audit rights, data duties and remediation expectations, but contracts do not change factory conditions by themselves. Purchasing practices can undermine the standards buyers claim to demand. Unrealistic lead times, last-minute order changes, below-cost pricing or punitive chargebacks can create incentives for unauthorized subcontracting, excessive overtime or safety shortcuts. A responsible buyer therefore examines its own commercial behavior as part of due diligence.

Disengagement is similarly complex. Immediate termination may be appropriate for severe, deliberate or unremediable misconduct, especially where continuing the relationship contributes directly to harm. In other cases, responsible disengagement can require a staged approach that considers whether exit would worsen conditions for workers or communities. The objective is not supplier retention at any cost. It is prevention and remediation of harm rather than reputational distance alone.

Table 21.8. Responsible-sourcing due diligence as an evidence-and-remedy cycle.

Stage	Managerial question	Evidence that strengthens confidence	Failure mode
1. Embed	Who owns the policy, decision rights, supplier terms and escalation?	Board/management accountability, procurement criteria, contract clauses, training, incentives.	Policy exists but commercial incentives reward contrary behaviour.
2. Identify & assess	Where are the most severe or likely adverse impacts and dependencies?	Risk mapping, worker/community input, facility and commodity data, country/sector evidence.	Screening only first-tier suppliers or relying on self-declarations.
3. Cease, prevent, mitigate	What action reduces the harm at source?	Corrective plans, purchasing-practice changes, engineering controls, supplier development.	Immediate disengagement shifts harm to workers or hides the problem without remedy.
4. Track	Did the intervention change conditions?	Outcome indicators, repeat visits, worker voice, grievance data, incident trends, traceable transactions.	Audit closure is treated as proof of real improvement.
5. Communicate	Can the enterprise explain methods, limitations and unresolved risks truthfully?	Bounded claims, methodology notes, disclosure of uncertainty and corrective action.	Selective success stories conceal material failures.
6. Remedy	If harm occurred, how will affected persons be restored or compensated where appropriate?	Accessible grievance, non-retaliation, investigation, remedy agreements, follow-up.	Compensation replaces prevention or remedy is designed without affected persons.

21.13 Labour Standards, Worker Voice, Traceability and Supply-Chain Transparency

The International Labour Organization identifies five categories of fundamental principles and rights at work: freedom of association and effective recognition of collective bargaining; elimination of forced or compulsory labour; abolition of child labour; elimination of discrimination in employment and occupation; and a safe and healthy working environment (ILO, 2022). These principles establish a global reference point, but implementation depends on national law, enforcement, workplace institutions and commercial relationships.

Worker voice is an evidentiary issue as well as a moral one. Management interviews, document reviews and announced audits can miss coercion, discrimination, unsafe shortcuts or unauthorized subcontracting. Workers may fear retaliation or may be coached before an audit. Stronger systems therefore use multiple channels, including confidential interviews, grievance mechanisms, trusted worker representatives, incident data, turnover patterns and follow-up verification. Voice mechanisms are not infallible, but an assessment of labour conditions that excludes workers themselves has a predictable blind spot.

Traceability answers a different question: can the enterprise reconstruct the origin, transformation and custody of a product or input to the degree required for the claim or risk? The appropriate model varies. **Identity preserved** systems keep material from one source separate. **Segregated** systems combine compliant sources but keep them separate from noncompliant material. **Mass-balance** systems allow controlled mixing while maintaining quantity accounting. **Book-and-claim** systems separate the environmental or social attribute from physical delivery. Each can be legitimate for a defined purpose, but the claim must match the chain-of-custody model. A book-and-claim certificate cannot truthfully be presented as proof that the physical molecules or fibres in a specific product came from one certified source.

Digital ledgers, satellite imagery, product passports, remote sensing and AI can improve visibility, but Chapter 20's warning applies: technical traceability is not equivalent to truthful provenance. A blockchain can preserve an inaccurate input immutably. Satellite evidence can identify land-use change but not necessarily establish who caused it or whether labour rights were respected. Data should therefore be triangulated, and exceptions need accountable human investigation.

Transparency also has limits. Publishing supplier names can support accountability, but disclosure can expose commercially sensitive information or create security risks. Publishing raw grievance allegations without due process can harm innocent parties. Responsible transparency therefore combines disclosure with proportionality, privacy, evidentiary standards and correction mechanisms. The objective is verifiability, not indiscriminate publicity.

21.14 Circular Economy, Resource Productivity and Sustainable Operations

A linear production model is often summarized as take, make, use and dispose. Circular-economy thinking asks whether economic value can be delivered with less virgin extraction, longer product life, higher utilization, recovery of components and safer recirculation of materials. Kirchherr, Reike and Hekkert's (2017) review of 114 circular-economy definitions found substantial conceptual diversity, which is itself a warning: a company should state what it means by circularity rather than relying on the positive connotations of the term.

The most defensible hierarchy preserves the highest-value function before recovering lower-value material. Avoiding unnecessary material demand is usually more resource-efficient than recycling it after one use. Repair preserves more embedded manufacturing value than shredding a product into secondary raw material. Remanufacturing can preserve components, labor and engineering. Recycling remains important, but it should not become a license for disposable design where higher-value loops are feasible.

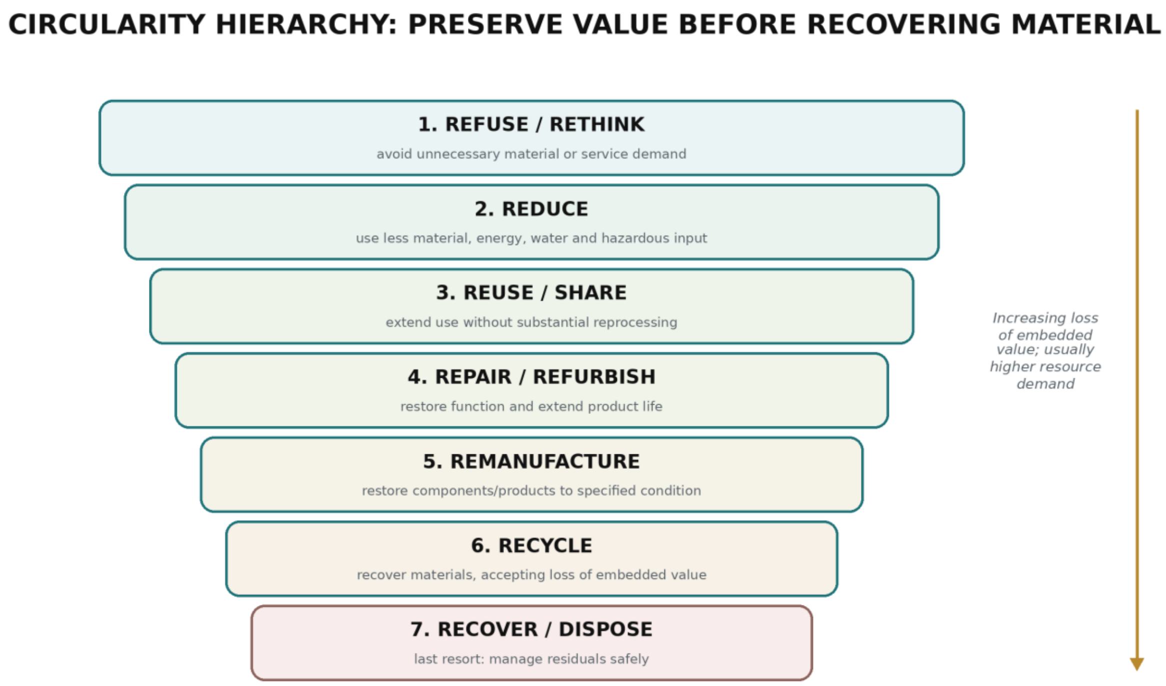

Figure 21.4. Circularity hierarchy: preserve value before recovering material.
Source/Note: Author's synthesis informed by circular-economy literature and waste-hierarchy logic.

Table 21.9. Circular strategies and the value they seek to preserve.

Strategy	Primary value preserved	Example	Analytical caution
Refuse / rethink	Avoided material and energy demand.	Service substitution, lightweight design, elimination of unnecessary packaging.	Demand can shift elsewhere; user welfare and access still matter.
Reduce	Resource productivity.	Lower scrap, water reuse, energy efficiency, material optimization.	Efficiency can trigger rebound if lower cost expands total volume.
Reuse / sharing	Product and component utility.	Reusable containers, shared equipment, refill systems.	Cleaning, return logistics and utilization rates determine net impact.
Repair / refurbish	Product life and embedded manufacturing value.	Repairable electronics, refurbished machinery, parts replacement.	Safety, warranty, software locks and parts availability can constrain life extension.
Remanufacture	High-value components and engineering work.	Rebuilt engines, industrial equipment.	Quality assurance and reverse-flow economics are essential.
Recycle	Material content.	Aluminium, steel, paper and selected polymers.	Downcycling, contamination, collection losses and energy use can be significant.
Recover / dispose	Residual energy or safe containment.	Controlled energy recovery or engineered disposal.	Lowest circular priority; should not be relabeled as full circularity.

Resource productivity can be expressed simply as useful output per unit of resource input. If a plant produces 10,000 units from 500 tonnes of material, its material productivity is 20 units per tonne. If process redesign produces the same output from 450 tonnes, productivity rises to 22.22 units per tonne, an 11.1% improvement. Yet the environmental conclusion still depends on the nature of the material, energy use, toxicity, scrap treatment, product durability and total production volume.

Resource productivity = Useful economic or functional output / Material, energy or water input

Material yield is another useful operational metric:

Material yield = Saleable product mass / Total material input

If 900 kg of saleable product emerges from 1,000 kg of input, yield is 90%. Raising yield to 95% can reduce procurement cost and waste simultaneously. But the chapter's moral boundary remains important. Efficiency gains do not justify unsafe exposure, excessive water extraction or production of harmful goods. The value of resource productivity depends on what is produced and at whose cost.

MANAGERIAL INSIGHT | Circularity is not a synonym for recycling. The strongest circular strategy often removes unnecessary material demand, extends useful life or preserves components before materials need to be recovered. Measure the loop, the return rate, the quality of recovered material and the net life-cycle effect rather than the percentage of marketing language that uses the word "circular."

21.15 Life-Cycle Assessment, Burden Shifting and the Limits of Circularity

Life-cycle assessment, or LCA, evaluates environmental inputs and outputs across a defined product system. ISO 14040 and ISO 14044 organize LCA around goal and scope definition, life-cycle inventory, impact assessment and interpretation (International Organization for Standardization [ISO], 2006a, 2006b). The method is useful because it makes system boundaries explicit. A packaging decision that lowers factory emissions but doubles transport mass can be evaluated across the product life rather than at one site.

The first discipline is the **functional unit**, the quantified function against which alternatives are compared. Comparing two beverage containers by kilograms of packaging alone is weak if they deliver different volumes, protection, reuse cycles or spoilage rates. A functional unit might be "delivery of 1,000 litres of beverage to customers with specified quality." The second discipline is the system boundary: cradle-to-gate, cradle-to-grave or cradle-to-cradle. The third is inventory quality, including allocation when processes produce multiple products.

A simplified life-cycle footprint is the sum of activity at each stage multiplied by the relevant impact factor:

$$\text{Life-cycle impact} = \Sigma\ (\text{Activity data at stage } j \times \text{Impact factor } j)$$

The equation is simple; the choices are not. Allocation rules, electricity mix, recycled-content assumptions, product life, return distance and end-of-life rates can change conclusions. Good LCA therefore includes sensitivity analysis and avoids presenting one point estimate as natural fact.

Circularity faces at least five structural limits. First, material quality can degrade, making closed-loop recycling technically impossible. Second, collection and reprocessing require energy and logistics. Third, stocks grow: a rapidly expanding economy can need virgin material even with high recycling because old products are not yet available for recovery. Fourth, rebound can offset efficiency gains if lower resource cost increases total consumption. Fifth, a circular flow can still be socially unjust or environmentally damaging if the underlying product or extraction is harmful. Korhonen, Honkasalo and Seppälä (2018) therefore warn that circular-economy claims need system-level boundaries rather than idealized closed loops.

These limits do not invalidate circularity. They make it a design discipline rather than a slogan. The relevant question is how much virgin extraction, waste, pollution and embedded value is avoided relative to a credible alternative, with what trade-offs and distributional effects.

21.15.1 Environmental management systems, eco-design and industrial symbiosis

Life-cycle evidence becomes operational only when it is embedded in a management system. ISO 14001:2026 provides a current international framework for an environmental management system built around organizational context, leadership, environmental aspects, obligations, objectives, operational controls, monitoring, evaluation and continual improvement (ISO, 2026). Its value lies in disciplined management architecture rather than in a logo. Certification can show that specified system requirements were assessed; it does not prove low absolute impact, legal perfection, superior sustainability performance or the moral legitimacy of every activity.

Eco-design moves intervention upstream, where many life-cycle consequences are locked in. Designers can alter material intensity, toxicity, energy demand, durability, modularity, repairability, upgradeability, disassembly and end-of-life recovery before production begins. The design objective should be functional performance with lower avoidable burden, not maximum recyclability in isolation. A heavier "recyclable" product, for example, can create greater transport and material impacts than a lighter alternative if return and recycling systems are weak. Design choices therefore require the same functional-unit and system-boundary discipline used in LCA.

Industrial symbiosis extends circular reasoning across organizational boundaries. A by-product, waste heat, water stream or residual material from one facility can become a productive input for another. The apparent circularity becomes real only when quality, continuity of supply, contamination risk, storage, transport distance, liability, price and alternative treatment are economically and environmentally credible. A long-distance exchange that consumes more energy than it saves, or that transfers hazardous material to a weaker regulator, is not improved merely because the flow has acquired a second user.

Implementation should connect environmental objectives to the operational disciplines developed in Chapter 11: process ownership, maintenance, supplier terms, quality controls, incident response, worker competence and traceable records. Digital sensors, AI, product passports and optimization tools from Chapter 20 can strengthen monitoring, but they do not replace accountable management. The professional test is whether the system produces measurable improvement in the relevant environmental mechanism and can detect and correct deterioration rather than merely documenting procedures.

21.16 Carbon Accounting: From Activity Data to Scope 1, 2 and 3 Inventories

A greenhouse-gas inventory is a measurement system. It converts activity data, such as litres of fuel, kilowatt-hours of electricity or tonnes of material, into tonnes of carbon-dioxide equivalent using emission factors and global-warming potentials. The GHG Protocol Corporate Standard remains a widely used architecture for corporate inventories, with complementary guidance for Scope 2 and Scope 3 (GHG Protocol, 2004, 2011, 2015).

For a source *i*, a basic calculation is:

GHG emissions_i = Activity data_i × Emission factor_i × Applicable GWP_i

Carbon dioxide equivalent, CO2e, allows different greenhouse gases to be aggregated using their relative warming effect over a specified time horizon. The inventory should document which global-warming-potential values are used because methodologies can change.

Scope 1 covers direct emissions from sources owned or controlled by the reporting company, such as combustion in boilers and company vehicles or process emissions. **Scope 2** covers emissions associated with purchased electricity, steam, heating or cooling. **Scope 3** covers other indirect value-chain emissions across defined upstream and downstream categories, including purchased goods, capital goods, transport, business travel, use of sold products, end-of-life treatment, franchises and investments where relevant. Scope classification is an accounting boundary, not a statement that one category matters more morally than another.

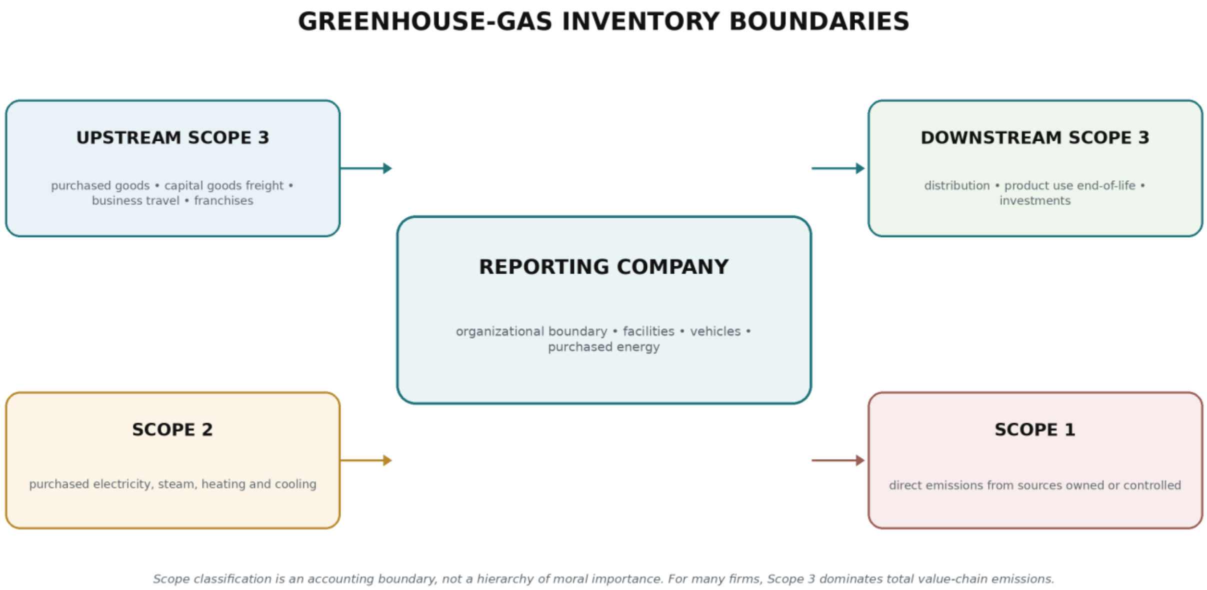

Figure 21.5. Greenhouse-gas inventory boundaries across Scope 1, Scope 2 and Scope 3.
Source/Note: Author's synthesis based on the GHG Protocol Corporate Standard, Scope 2 Guidance and Scope 3 Standard.

Table 21.10. Worked greenhouse-gas inventory for a simplified manufacturing site.

Source	Activity data	Emission factor	Calculated emissions	Scope
Natural gas combustion	500,000 m^3	2.00 kg CO2e/m^3	1,000 tCO2e	Scope 1
Diesel fleet	200,000 litres	2.68 kg CO2e/litre	536 tCO2e	Scope 1
Purchased electricity	3,000 MWh	0.40 tCO2e/MWh	1,200 tCO2e	Scope 2
Purchased steel	800 tonnes	1.60 tCO2e/tonne	1,280 tCO2e	Scope 3
Outbound freight	1,500,000 tonne-km	0.08 kg CO2e/tonne-km	120 tCO2e	Scope 3
Total			4,136 tCO2e	Inventory total

The worked site in Table 21.10 reports 4,136 tCO2e. Scope 1 is 1,536 tCO2e, Scope 2 is 1,200 tCO2e and the selected Scope 3 categories contribute 1,400 tCO2e. If the site produced 10,000 units, the reported carbon intensity would be 0.4136 tCO2e per unit for the included boundary. That intensity should never be reported without the boundary. Adding employee commuting, upstream fuel emissions or product use would change the numerator.

Scope 2 requires additional care. A **location-based** method reflects average emissions from the grids where electricity is consumed. A **market-based** method uses qualifying contractual instruments and supplier-specific information where available. The two answer different questions and can diverge materially. Reporting only the more favorable number without explaining the method can mislead readers about physical grid dependence.

Scope 3 is often the largest and most uncertain part of a corporate footprint. Supplier-specific primary data can improve precision but is expensive and uneven. Spend-based estimates are easier but can confuse price changes with physical emissions. Industry-average factors support screening but may not capture supplier performance. An enterprise should therefore distinguish **screening estimates**, adequate for prioritization, from **decision-grade estimates**, required for consequential targets, procurement decisions or product claims.

Double counting across companies is not inherently an error in Scope 3 accounting. The same physical tonne of emissions can be Scope 1 for a supplier and Scope 3 for a customer because the inventories answer different organizational questions. Double counting becomes a problem when separate claims are aggregated as if they represented distinct physical reductions, or when carbon credits or renewable attributes are claimed by multiple parties.

Avoided-emissions or "handprint" claims require a different evidentiary logic from the corporate inventory. They compare a product, project or service with a specified counterfactual and therefore depend on assumptions about what would otherwise have happened. They should not be silently netted against Scope 1, 2 or 3 inventories. A defensible claim states the comparator, functional unit, time horizon, system boundary, market assumptions and uncertainty, and distinguishes a comparative contribution claim from an observed reduction in the reporting company's own inventory.

21.17 Targets, Net-Zero Claims, Offsets and Marginal Abatement Cost

A target becomes credible when its boundary, baseline, metric, time horizon, pathway and governance are explicit. "Reduce emissions 30%" is incomplete. The reader must know whether the target is absolute or intensity-based; which scopes and entities are included; whether acquisitions and divestitures trigger base-year recalculation; which greenhouse gases are included; how market-based electricity is treated; and whether offsets are counted inside the target.

Absolute targets reduce total emissions within the defined boundary. **Intensity targets** reduce emissions per unit of output, revenue, passenger-kilometre, tonne-kilometre or another denominator. Intensity can be useful when activity is growing, but it can mask rising absolute emissions. Absolute reduction can also mislead if caused mainly by production collapse or outsourcing. The two should often be interpreted together.

A **net-zero** claim generally implies deep reduction of anthropogenic emissions and balancing of residual emissions with durable removals. The term is widely used but applied inconsistently. A professional assessment asks which scopes are covered, how much reduction is achieved before neutralization, whether residual emissions are genuinely hard to abate, what type of removal is used, how permanence is managed and whether interim targets constrain delay. A distant target without capital allocation is not yet a strategy.

Carbon credits can finance worthwhile mitigation or removals, but a credit is an accounting instrument whose environmental integrity depends on the underlying project and registry rules. Core questions include **additionality**, whether the reduction or removal would have occurred without credit revenue; **baseline integrity**; **leakage**, whether emissions shift elsewhere; **permanence** for stored carbon; **measurement uncertainty**; **double counting**; and safeguards for affected people and land rights. Retiring a credit does not make the company's own physical emissions disappear. Claims should distinguish gross emissions, direct reductions and credits used.

A marginal abatement cost, MAC, helps compare reduction options. A simplified annualized calculation is:

$$\text{MAC} = (\text{Annualized capital cost} + \text{Incremental operating cost} - \text{Annual operating savings}) / \text{Annual tCO2e reduced}$$

Suppose a heat-recovery project has annualized capital cost of \$180,000, incremental maintenance of \$25,000, annual energy savings of \$260,000 and reduces 1,100 tCO2e per year. The MAC is (\$180,000 + \$25,000 - \$260,000) / 1,100 = **-\$50/tCO2e**. A negative MAC means the option saves operating cost under the stated assumptions. A second option costing \$210,000 net per year for 3,000 tCO2e reduction has a MAC of **\$70/tCO2e**. The ranking is informative, but not automatic. Projects differ in timing, reliability, strategic dependence, capital constraints, co-benefits, safety and technology risk.

A MAC curve can also conceal interactions. Installing one efficiency measure can reduce the emissions available for a later measure to abate. The cost of renewable electricity can depend on grid upgrades. Electrification can move emissions from Scope 1 to Scope 2 if the grid is carbon-intensive. Decisions should therefore use systems analysis, not a static list of independent projects.

ETHICAL DILEMMA | A company can meet a public "net-zero operations" claim cheaply by purchasing credits while continuing a technically avoidable high-emission process. The credits may be valid under the chosen program. Is the claim truthful if customers reasonably infer that the company's own operations have largely decarbonized? The answer requires more than compliance: it requires precise language about gross emissions, actual abatement, residual emissions and the role of credits.

21.18 Carbon Pricing and Carbon Markets: Prices as Instruments, Not Moral Verdicts

Carbon pricing attempts to incorporate part of the social cost of greenhouse-gas emissions into economic decisions. A **carbon tax** sets a price per unit of emissions and allows quantities to adjust. An **emissions trading system**, ETS, sets a cap or allowance architecture and allows a market price to emerge. **Crediting mechanisms** issue credits for qualifying reductions or removals relative to defined baselines. These instruments differ economically and legally. Treating them all as "the carbon market" obscures important design choices.

The World Bank's *State and Trends of Carbon Pricing 2026* reported 87 direct carbon-pricing policies worldwide, covering just over 29% of global greenhouse-gas emissions. It reported more than US\$107 billion in public revenue in 2025 and an average direct carbon price of nearly US\$21/tCO2e across covered systems, while prices and coverage varied substantially (World Bank, 2026). These figures show that carbon pricing has become economically consequential. They do not demonstrate that every scheme has the same effectiveness or distributional legitimacy.

Price design involves trade-offs. A predictable tax can support investment planning but does not guarantee an emissions quantity. A cap can constrain aggregate allowances but price volatility can complicate investment. Free allocation can address leakage or competitiveness during transition but can weaken the polluter-pays signal if badly designed. Revenue use matters because the same nominal carbon price can have different welfare effects if revenue is recycled to households, infrastructure, innovation or general budgets.

Carbon pricing also interacts with development. In countries with low historical emissions, large energy-access gaps and limited fiscal space, uniform high carbon prices can affect affordability differently than in mature high-income systems. This does not imply that environmental costs should be ignored. It means that policy design should consider energy access, industrial learning, household income, local pollution, technology availability and the distribution of transition costs.

An internal carbon price is a managerial tool rather than a government levy. Firms can use a shadow price to stress-test capital projects, a charge to allocate costs internally or an implicit price derived from an abatement constraint. The price should be connected to a decision. A symbolic internal price that never changes investment choices is not evidence of climate strategy.

21.19 Border Carbon Measures and the Trade-Sustainability Interface

Border carbon measures seek to address differences in carbon constraints across trading partners and the risk that production or emissions shift to jurisdictions with weaker pricing. They also create complex questions of measurement, competitiveness, development and legal design. Chapter 19 owns the full trade-law analysis. Chapter 21 focuses on implementation consequences for firms and the distributional questions created when environmental policy crosses borders.

The European Union's Carbon Border Adjustment Mechanism, CBAM, entered its definitive regime on 1 January 2026. The European Commission states that EU importers or indirect customs representatives importing more than the single mass-based threshold of 50 tonnes of CBAM goods must seek authorized CBAM declarant status and purchase CBAM certificates under the definitive regime (European Commission, 2026a). The covered architecture initially concerns emissions-intensive goods such as cement, iron and steel, aluminium, fertilizers, electricity and hydrogen. Firms should consult current official rules because product scope, calculation, reporting and certificate obligations are legally specific and can evolve.

For an exporter, the managerial exposure can be illustrated without pretending to calculate legal liability. Suppose an exporter sells 800 tonnes of steel with verified embedded emissions of 1.60 tCO2e per tonne. Embedded emissions are 1,280 tCO2e. At a purely illustrative border-carbon reference of EUR75/tCO2e, the gross carbon-value exposure would be EUR96,000 before any legally applicable adjustments, free-allocation phase-in, carbon price paid in the country of origin, default values or certificate rules.

Illustrative carbon-value exposure = Imported quantity × Embedded emissions intensity × Applicable carbon-price reference

The calculation reveals why carbon data can become a trade capability. Two exporters with the same physical product can face different commercial outcomes if one can demonstrate lower embedded emissions or credible primary data. Yet compliance capability has a fixed cost. Large firms can fund product-level emissions accounting and verification more easily than small exporters. Border measures can therefore improve incentives for cleaner production while simultaneously creating market-access burdens for producers with weak measurement infrastructure.

World Bank analysis of CBAM exposure has emphasized that aggregate macroeconomic exposure is concentrated in a limited number of developing economies but can be material for particular sectors and exporters. Countries such as Mozambique, Ukraine and Egypt have been identified as relatively exposed under modeled trade patterns, while many countries show small GDP-level exposure but can still experience firm-level effects (Maliszewska et al., 2025). The correct response is therefore sector-specific rather than rhetorical.

Trade agreements increasingly include environmental, climate, labour or sustainable-development provisions, and preferential market access can interact with product standards, procurement rules and due-diligence expectations. Their precise legal enforceability belongs to Chapter 19. For managers, the implementation lesson is narrower: commitments in trade agreements can change the evidence customers request, the standards public buyers apply, the origin and production data needed for preference, and the policy support available for cleaner production. Firms should map treaty-linked obligations to operating controls rather than treating a sustainability chapter in an agreement as either symbolic language or a self-executing corporate rule.

A responsible border measure should be evaluated through at least five lenses: environmental effectiveness, leakage prevention, administrative proportionality, development and distributional effects, and consistency with legitimate trade rules. Exporting countries likewise need credible emissions data, cleaner production options, affordable finance and negotiation capacity. The purpose of critical analysis is neither to exempt high-emission production permanently nor to presume that policy designed in a large market is automatically fair to smaller economies.

POLICY LENS | Carbon-border measures can operate simultaneously as environmental policy, industrial policy and trade policy. Analysts should identify which mechanism is doing the work. A measure may reduce leakage yet also change comparative competitiveness, redirect investment and create data-governance requirements. These effects should be measured rather than hidden behind either “green protectionism” or “climate leadership” slogans.

21.20 Sustainability Reporting, Standards, Assurance and Regulatory Status

Sustainability reporting has moved from voluntary corporate storytelling toward more formalized disclosure systems. This development can improve comparability and governance, but it also creates costs, overlapping definitions and the risk that compliance becomes a substitute for performance. The first professional question is therefore: **who is the intended user and what decision is the disclosure meant to support?**

IFRS S1 and IFRS S2, issued by the International Sustainability Standards Board, are investor-focused standards. IFRS S1 addresses sustainability-related risks and opportunities that could affect an entity's prospects, while IFRS S2 focuses specifically on climate-related risks and opportunities. Both became effective for annual reporting periods beginning on or after 1 January 2024, subject to jurisdictional adoption (IFRS Foundation, 2023a, 2023b). They use a financial-materiality orientation and are designed to connect sustainability information with general-purpose financial reporting.

GRI's standards answer a different question: how does the organization affect the economy, environment and people? This impact orientation makes GRI valuable for a wider stakeholder account. GRI 102: Climate Change 2025 is scheduled to be effective for reports published on or after 1 January 2027 (Global Reporting Initiative, 2025). Because materiality lenses differ, a company cannot assume that an ISSB-compliant investor disclosure automatically satisfies an impact-reporting objective.

The European Sustainability Reporting Standards implement the European Union's double-materiality architecture for entities within scope of the Corporate Sustainability Reporting Directive. Reporting obligations have been changing. On 3 July 2026, the European Commission adopted revised ESRS intended to reduce mandatory datapoints by more than 60% and total datapoints by more than 70%, with an expected reduction in reporting costs of more than 30% per company. As of 28 August 2026, those delegated acts were still subject to European Parliament and Council scrutiny and subsequent publication before taking effect (European Commission, 2026b). This dated status is important: textbooks should not convert a proposed, adopted or scrutinized measure into an already effective rule.

TNFD provides voluntary recommendations for nature-related dependencies, impacts, risks and opportunities. GHG Protocol provides emissions-accounting methods. OECD due-diligence guidance supports responsible-business-conduct processes. These frameworks can interact, but they are not interchangeable. A single enterprise may use several because they answer different questions.

Table 21.11. Reporting quality: what makes a sustainability claim decision-useful.

Quality test	Question	Weak practice	Stronger practice
Boundary	What entities, sites, products, value-chain stages and periods are included?	Headline metric with unclear scope.	Explicit consolidation boundary, exclusions and changes.
Method	How was the metric calculated?	Proprietary score without methodology.	Formula, source data, factors, assumptions and versioned method.
Comparability	Can users compare across time and peers?	Changing denominator or base year without restatement.	Consistent definitions, reconciliations and reason for changes.
Completeness	Are material adverse results included?	Only favorable initiatives and achievements.	Balanced disclosure of progress, misses, uncertainty and incidents.
Attribution	Does the claim exceed the evidence?	"Our project saved the climate" from activity data.	Distinguish activity, output, outcome, contribution and causal impact.
Assurance	Has material information been independently challenged?	Logo-based certification presented as universal proof.	Defined assurance scope, criteria, evidence, limitations and provider independence.
Correctability	Can errors be detected and corrected?	No restatement policy or claims owner.	Controls, data lineage, change log, grievance and public correction where material.

Assurance strengthens confidence only if users understand what was assured. **Limited assurance** provides a lower level of assurance than **reasonable assurance** and uses less extensive evidence procedures. Assurance scope matters: a provider may assure selected emissions metrics but not the full sustainability report, the transition plan or management's narrative claims. Independence, criteria, evidence quality, competence and materiality remain central. An assurance statement should never be presented as proof that the underlying strategy is environmentally or morally sound.

The assurance architecture is also evolving. The International Auditing and Assurance Standards Board published International Standard on Sustainability Assurance (ISSA) 5000 in November 2024 as a profession-agnostic standard for limited and reasonable assurance over sustainability information prepared under suitable criteria (International Auditing and Assurance Standards Board [IAASB], 2024). Unless a jurisdiction specifies otherwise, the standard is effective for assurance engagements on sustainability information reported for periods beginning on or after 15 December 2026, with early application permitted. Adoption remains jurisdiction-specific. The managerial implication is not to assume that "assured" means the same thing everywhere, but to verify the applicable criteria, practitioner competence and independence, level of assurance, scope, materiality and report wording.

Reporting systems also create behavioural risk. Managers can optimize what is disclosed rather than what matters. Complex frameworks can advantage firms with larger reporting departments. Small suppliers may receive multiple questionnaires that ask similar questions in different formats. Standardization can reduce these frictions, but central standard setting also raises questions of proportionality, local relevance and accountability. The proper standard is one that improves truthful decision-useful information at a proportionate cost without pretending to settle contested moral questions merely through technical metrics.

21.21 Sustainability Measurement, Impact, Assurance and Greenwashing Control

A sustainability metric should sit inside a causal chain. **Inputs** are resources committed, such as capital or training hours. **Activities** are actions taken. **Outputs** are immediate deliverables. **Outcomes** are changes experienced by people, operations or the environment. **Impacts** are broader changes attributable or credibly contributed to by the intervention. Chapter 8 introduced theory of change and impact evaluation from the venture perspective; Chapter 21 applies the distinction to environmental and social sustainability claims.

Consider tree planting. The number of seedlings planted is an activity or output, not yet carbon removal, biodiversity restoration or community benefit. Survival, growth, species composition, land tenure, leakage and counterfactual land use determine outcomes. A claim of "10,000 trees planted" can be true and still be a poor measure of impact. Similarly, the number of suppliers trained in responsible sourcing does not establish that forced-labour risk declined.

A strong sustainability dashboard therefore mixes leading and lagging indicators. Leading indicators might include percentage of high-risk suppliers with corrective plans, percentage of capital expenditure screened for physical climate risk, maintenance of pollution controls or percentage of products designed for repair. Lagging indicators include injuries, actual emissions, effluent exceedances, waste generated, verified grievance outcomes or energy intensity. The dashboard should be small enough to govern and broad enough to prevent local optimization.

Greenwashing occurs when environmental or sustainability communication creates a materially misleading impression about performance, attributes, plans or impacts. It can involve false statements, selective disclosure, vague language, unsupported superiority, hidden trade-offs, misleading labels, inappropriate offsets, unrepresentative imagery or distant targets presented without credible pathways. Greenwashing can be intentional deception or arise from weak controls and overenthusiastic marketing. Recent literature emphasizes that definitions and detection methods vary, which is why claims should be tested against explicit criteria rather than accusation by impression alone (Bernini et al., 2024; Treepongkaruna et al., 2024).

A robust claims-control process asks whether the claim is **specific**, **bounded**, **substantiated**, **comparable**, **current** and **correctable**. "Made with 80% recycled aluminium by mass in the housing, verified for 2026 production" is more testable than "planet friendly." A claim about carbon neutrality should identify the boundary, gross emissions, reduction measures, credits or removals used, standard, vintage and material exclusions. Comparative claims such as "30% greener" need a defined comparator and impact category.

> **PRACTICE TOOL |** Before publishing a sustainability claim, require a claim file containing the exact wording, intended audience, boundary, metric definition, source data, calculation, material assumptions, relevant standard, verification status, exclusions, owner and expiry/review date. Marketing should not be able to strengthen the claim beyond what the evidence file supports.

21.22 Sustainable Finance, Impact Investment, Transition Finance and Green Procurement

Finance can accelerate sustainability when capital is allocated to productive environmental and social improvements, but the label "sustainable finance" does not remove ordinary investment discipline. Chapter 18 owns valuation, portfolio construction, risk-adjusted return and investor contracting. Here the issue is how sustainability characteristics enter financing and procurement implementation.

A **green bond** typically dedicates proceeds to eligible environmental projects under stated use-of-proceeds criteria. Its environmental credibility depends on project selection, proceeds management, reporting and the actual performance of financed projects. A green label does not change the issuer's credit risk. A **sustainability-linked bond or loan** usually links financing terms to entity-level performance targets rather than segregated project proceeds. Its integrity depends on whether the target is material, ambitious, measurable and resistant to gaming. A trivial coupon step-up can turn the label into branding rather than an incentive.

Transition finance addresses activities that are economically important but not yet low-emission. The concept can be useful for steel, cement, chemicals, aviation, shipping and other hard-to-abate sectors where immediate withdrawal of capital can reduce investment in genuine transition. It can also become a loophole if "transition" merely refinances business as usual. Credible transition finance therefore needs a sector-relevant pathway, interim milestones, capital expenditure alignment, governance and disclosure of dependencies on uncertain technologies or policy.

Impact investment intentionally seeks measurable social or environmental outcomes alongside financial return. The word "impact" should be reserved for a defensible impact thesis. Additionality is especially difficult in liquid public markets, where buying a share from another investor may have less direct financing effect than primary capital, engagement or project finance. Investors should state the mechanism through which their capital or stewardship is expected to change outcomes.

Green procurement translates sustainability into buyer decisions. Purchase price alone can be expanded toward **total cost of ownership**, already introduced in Chapter 11, and then toward selected externality or risk criteria where evidence is sufficiently robust. A fleet buyer might compare purchase price, fuel, maintenance, charging infrastructure, residual value, downtime and an internal carbon price. A food buyer might incorporate water, deforestation and labour-risk controls. Procurement criteria should remain proportional, technically relevant and accessible to capable smaller suppliers rather than becoming administrative barriers unrelated to performance.

Sustainability provisions in trade agreements and market-access arrangements can reinforce these private requirements by addressing environmental cooperation, labour, climate, fisheries, forestry, subsidies, public procurement or responsible-business conduct. Their legal force varies from binding and enforceable obligations to cooperation clauses and political commitments. Chapter

19 remains the owner of treaty interpretation and dispute doctrine. The sustainability manager's task is narrower: translate the provision that actually applies into product, sourcing, measurement, documentation and remediation controls, and avoid treating a broad treaty aspiration as if it were a self-executing corporate rule.

A practical compliance architecture therefore maintains an obligations register that records the source of authority, jurisdiction, product or activity scope, threshold, evidence required, responsible owner, review date and escalation route. Legal requirements, contractual buyer standards and voluntary frameworks should be separated visibly. This prevents two opposite errors: understating a binding obligation because it looks like "ESG," and presenting a voluntary private standard as though it carried public-law authority.

The moral caution is important. Finance and procurement can become private regulatory power. Large buyers or asset owners can impose standards on firms that have little bargaining power. Such standards may improve safety or environmental performance, but legitimacy depends on transparency, evidence, proportionality, due process and respect for lawful local institutions. Private capital is influential; it is not sovereign.

21.23 Africa, AfCFTA, Energy Access and Green Industrialization

Sustainability in Africa cannot be evaluated through a framework designed only for mature high-income economies. The continent combines low historical per-capita emissions in many countries, high vulnerability to climate hazards, large infrastructure deficits, rapid population and urban growth, rich renewable and mineral resources, and an urgent need for productive employment. These conditions make environmental stewardship more important, not less, but they change the sequence and distribution of feasible choices.

Energy access is the clearest example. The International Energy Agency reported in *World Energy Investment 2025* that about 600 million people in Africa still lacked electricity access and more than 1 billion lacked access to clean cooking. It also noted severe regional concentration: South Africa and North Africa represented less than 20% of the continent's population but more than 45% of energy investment and over 65% of installed electrical capacity (IEA, 2025). Sustainability that ignores reliable and affordable energy is incomplete because electricity supports health services, refrigeration, water systems, digital participation, manufacturing and household welfare.

The relevant question is therefore not whether Africa should "choose development or climate." It is how to expand energy and productive capacity with an increasingly efficient, resilient and lower-pollution system while respecting country-specific resources and fiscal constraints. In some locations, decentralized solar and storage can expand access quickly. Elsewhere, grids, hydropower, geothermal, natural gas, transmission, regional power pools or other resources may play transitional or complementary roles. A single global template can fail because reliability, affordability, grid strength, industrial load, domestic resources and financing differ.

AfCFTA can contribute by expanding the market for African manufactured goods, energy services, agricultural processing and green technologies. UNECA's *Economic Report on Africa 2025* emphasizes AfCFTA's potential to support diversification, industrialization, energy trade and stronger regional value chains, while also recognizing implementation and investment requirements (UNECA, 2025). Manufactured goods already represent a large share of intra-African exports, which makes regional integration potentially important for scaling productive capability rather than remaining dependent on raw-commodity exports.

Green industrialization should prioritize **local value addition**, **resource productivity**, **reliable energy**, **skills**, **technology absorption**, **infrastructure** and **market access**. Critical-mineral production illustrates the opportunity and danger. Rising demand for copper, cobalt, graphite, lithium and other inputs can generate export revenue and investment, but extraction without local processing, environmental safeguards, labour protections or transparent fiscal governance can reproduce enclave structures. Conversely, local-processing mandates that ignore power reliability, scale economics or market access can create high-cost projects that do not become competitive. Stewardship requires both aspiration and feasibility.

Small and medium-sized enterprises face a distinct compliance problem. Product carbon footprints, due-diligence documentation and reporting systems have fixed costs. If every large buyer imposes a unique questionnaire and audit, small suppliers can be excluded even when their actual environmental performance is good. Proportionate standards, shared digital infrastructure, sector-level data, mutual recognition and technical support can make responsible trade more inclusive.

The language of **just transition** is useful when it refers to actual distributional analysis: which workers, households, regions, taxpayers and firms bear costs, and how can adjustment preserve dignity and productive capability? It becomes weak when "just" is used as a label without measuring who gains or loses. Coal-region transition, for example, requires more than severance payments. It can require skills, infrastructure, municipal revenue replacement, enterprise development, land remediation and credible new investment.

Policy sovereignty and subsidiarity therefore belong inside sustainability analysis. International standards can reduce information asymmetry, prevent regulatory arbitrage and facilitate market access. They can also impose costs or priorities that do not fully reflect local circumstances. The answer is not isolation. It is disciplined participation: negotiate standards with evidence, build domestic measurement capability, cooperate where scale adds value and retain local decision authority where decisions are better made closer to affected communities.

AFRICAN CONTEXT | A responsible African transition should be evaluated through two simultaneous tests. First, does it reduce avoidable environmental harm and long-run vulnerability? Second, does it expand or preserve the productive capabilities required for affordable energy, decent work, food security, industrial learning and local agency? A strategy that passes only one test is incomplete.

21.24 African Case: Sasol and the Difference Between Lower Emissions and Structural Transition

The opening Sasol case can now be revisited with the chapter's full architecture. Sasol is economically important and emissions-intensive, which makes simplistic judgments especially unhelpful. Its South African operations are embedded in employment, industrial supply chains, energy systems, foreign exchange, tax revenues and local communities. At the same time, large greenhouse-gas emissions create climate, transition, financing, technology and legitimacy exposure.

Sasol's 2025 climate disclosures state that the Group achieved roughly a 20% net reduction in Scope 1 and 2 emissions from its 2017 baseline. The company attributes the change to several factors, including lower production volumes that reduced gross emissions by 13.5% relative to 2017, operational factors, methodology changes, energy-efficiency gains and the retirement of 3.8 MtCO2e of carbon credits. Sasol also states that it remains committed to a 30% reduction by 2030 (Sasol, 2025a, 2025b). These facts are useful precisely because they show why the headline number needs decomposition.

Table 21.12. Sasol: why transition metrics require causal interpretation.

Observed 2025 signal	What it can support	What it cannot establish by itself
Company reported roughly a 20% net reduction in Scope 1 and 2 emissions from its 2017 baseline.	The reported net footprint was lower than the selected baseline under the company's methodology.	It does not by itself show that structural production decarbonization accounted for the full reduction.
Sasol states that lower production volumes reduced gross emissions by 13.5% relative to 2017.	Output level materially influenced emissions performance.	Lower emissions caused by lower production are not equivalent to improved emissions intensity or transformed process chemistry.
The company states that 3.8 MtCO2e of carbon credits were retired in 2025.	Offsets materially affected the net figure.	Retired credits are not identical to on-site abatement; credit quality, additionality and permanence require separate evaluation.
The company retains a 30% Scope 1 and 2 reduction target by 2030 from the 2017 baseline.	Management has an explicit interim target and transition roadmap.	A target is not performance; credibility depends on funded projects, production assumptions, technology, energy supply and governance.

The strategic test is whether the transition increasingly changes the emissions mechanism while preserving a viable enterprise. Lower output can reduce absolute emissions, but if the objective is to preserve production and employment, structural abatement requires process changes, feedstock shifts, energy efficiency, lower-carbon electricity, alternative fuels or technologies, and eventually retirement or replacement of high-emission assets. Each lever has capital, infrastructure and timing constraints.

The offset question is equally important. Retiring credits can be legitimate under a defined system, but net metrics should remain transparent about gross emissions and the share of progress attributable to credits. This protects managers, investors, workers and communities from confusing accounting netting with physical transformation.

The case also illustrates development justice. An abrupt forced closure can reduce emissions at one facility while imposing concentrated unemployment, municipal fiscal stress and supply-chain damage. Indefinite continuation without credible transition can preserve short-term jobs while increasing future regulatory, market and environmental risk. The responsible course lies in evidence-based sequencing: identify unavoidable decline, fund feasible abatement, develop replacement capabilities, support affected workers and regions, and report honestly where technical or economic uncertainty remains.

Sasol should therefore not be reduced to either "major polluter" or "transition leader." Those labels are conclusions before analysis. The professional task is to examine emissions, production, intensity, capital commitments, offsets, technology, worker and community exposure, energy-system dependence and governance, then judge whether the pathway is becoming more sustainable in real terms.

21.25 Global Comparative Case: Maersk and the Difference Between Intensity and Absolute Emissions

A.P. Møller - Mærsk A/S provides a useful global comparison because shipping illustrates the tension between efficiency, trade growth and difficult-to-abate fuel systems. Maritime transport can move large quantities of goods with comparatively low emissions per tonne-kilometre relative to air freight, yet global shipping's absolute fuel use and emissions remain significant. A firm can improve efficiency and still see total emissions rise when activity, routing or value-chain boundaries change.

Maersk's 2025 reporting states that total market-based greenhouse-gas emissions were about 85.4 million tCO2e, above both 2024 and its 2022 baseline. The company also reported improvement in Ocean EEOI, an energy-efficiency operating indicator, from 11.1 to 10.8 gCO2 per tonne-nautical-mile, and took delivery of ten new dual-fuel methanol vessels. The annual report explains that continuing re-routing around the Cape of Good Hope extended sailing distances and increased fuel use, while Scope 3 emissions also rose (A.P. Møller - Mærsk A/S, 2026).

Table 21.13. Maersk 2025: intensity improved while absolute emissions increased.

Metric	2024	2025	Interpretation
Total GHG emissions, market-based (1,000 tCO2e)	83,528	85,449	Absolute footprint increased by approximately 2.3%.
Scope 1 (1,000 tCO2e)	33,939	33,953	Direct emissions were approximately flat despite fleet changes.

Metric	2024	2025	Interpretation
Scope 2 market-based (1,000 tCO2e)	356	313	Purchased-energy emissions declined, including renewable-electricity changes at sites.
Scope 3 (1,000 tCO2e)	49,232	51,183	Value-chain emissions increased, including capital goods and sold products.
Ocean EEOI (gCO2/t-nm)	11.1	10.8	Transport-work intensity improved even though total emissions rose.
Dual-fuel methanol vessels added	-	10	Fleet transition option expanded, but fuel availability, lifecycle emissions and utilization determine realized impact.

The case shows why an intensity metric and an absolute metric can both be correct. Efficiency improved for transport work, while total system emissions increased. Neither measure should be used to cancel the other. Intensity helps answer how efficiently a service is delivered; absolute emissions help answer the size of the physical footprint. A transition strategy needs both.

Dual-fuel vessels also illustrate option value. A vessel capable of using methanol expands the technical pathway available to the company, but lower lifecycle emissions depend on fuel production, availability, certification, price and actual use. A “methanol-capable” ship is therefore an enabling asset, not yet proof of a particular emissions reduction. The same logic applies to hydrogen-ready, carbon-capture-ready and other future-compatible technologies.

The rerouting effect adds a geopolitical dimension. Sustainability performance does not occur in a closed technical system. Conflict, security and shipping-route disruption can lengthen voyages and increase fuel use. Robust targets should therefore distinguish what management controls directly, what depends on external infrastructure or policy, and what is exposed to geopolitical shocks.

Together, Sasol and Maersk demonstrate the chapter's central empirical discipline: interpret sustainability metrics causally. Ask what physically changed, what accounting changed, what production or routing changed, what was purchased or offset, and what can be independently verified.

21.26 Faith, Ethics and Moral Reasoning: Creation Care Ordered to Human Flourishing

Christian moral reasoning begins with the identity of creation and the limits of human ownership. Psalm 24:1 declares that the earth and everything in it belong to the Lord. The implication for enterprise is not that human beings must leave creation untouched. Scripture also presents humanity as entrusted with productive responsibility. Genesis 1:26-28 gives humanity delegated dominion, while Genesis 2:15 presents the human vocation in the garden as working and watching over it. Dominion is therefore accountable rule under God's ownership, not permission for wasteful destruction.

This stewardship framework guards against two opposing errors. The first treats nature merely as raw material whose only relevant value is market price. Markets are powerful coordination mechanisms, but prices can omit pollution, ecological thresholds, common resources and effects on future generations. The second error treats human productive use of creation as intrinsically suspect. Agriculture, mining, manufacturing, housing and energy can serve legitimate human needs. Biblical stewardship asks whether use is wise, just and accountable, not whether use exists.

Truthfulness is the first sustainability duty because every other judgment depends on accurate description. Proverbs 11:1 condemns dishonest scales. The principle applies directly to carbon inventories, product claims, offsets, supplier audits and ESG scores. A technically sophisticated sustainability report that changes boundaries to conceal deterioration is a modern form of false measurement. Greenwashing is morally serious because it manipulates customers, investors, regulators and communities by manufacturing a reality that the evidence does not support.

Neighbour-love places affected persons inside the decision boundary. Jesus' command to love one's neighbour as oneself in Matthew 22:39 does not prescribe a carbon price or circular-economy metric. It does require managers to consider foreseeable effects on workers, communities and customers rather than externalizing harm simply because those affected have less bargaining power. Pollution that damages a neighbouring community, unsafe waste handling or a procurement practice that predictably drives forced overtime cannot be justified by private profitability alone.

Justice toward workers matters especially in transition. James 5:4 condemns withheld wages and exploitation. A climate or circularity strategy that celebrates environmental gains while transferring unreasonable costs to workers or vulnerable suppliers is morally incomplete. This does not grant every existing job a perpetual claim against technological or environmental change. It does require truthful consultation, fair process and serious attention to the people who bear concentrated adjustment costs.

Intergenerational responsibility follows from stewardship and neighbour-love even though Scripture does not provide a modern discount rate. Decisions about long-lived pollution, ecosystem degradation, public debt for transition infrastructure or irreversible resource depletion can impose costs on people who have no voice in today's contract. Christian prudence therefore resists both reckless present consumption and policies that sacrifice present poor households for speculative future benefits. Intergenerational justice requires proportionate evidence, not romanticism about either present or future interests.

Accountability increases with power. Luke 12:48 links greater entrustment with greater responsibility. Large firms, governments, financiers and standard setters can alter supply chains and livelihoods at scale. Their ability to impose a requirement does not prove its moral legitimacy. Power should be exercised under subsidiarity, due process, transparency and respect for conscience. Conversely, sovereignty is not a moral shield for corruption, pollution or exploitation. Local authority is accountable too.

The biblical story also refuses utopianism. Romans 8:19-23 portrays creation as subject to corruption and groaning for redemption. The passage is theological, not a climate model. It cautions Christians against expecting a regulatory framework, technology or corporate strategy to perfect the world. Stewardship is faithful responsibility within a fallen creation, not the construction of salvation through business policy.

Serious alternative ethical traditions sharpen the analysis. **Consequentialism** asks which course produces the best aggregate outcomes, making avoided climate damage, health benefits, jobs, energy access and transition costs comparable in principle. Its strength is attention to effects; its weakness is that aggregate welfare can permit severe burdens on minorities. **Rights-based and deontological approaches** protect persons from being used merely as means and emphasize duties such as non-deception and non-coercion, but they can struggle when legitimate rights conflict. **Justice approaches** ask who receives benefits and bears burdens, including across generations. **Virtue ethics** asks what prudence, temperance, courage and justice require of decision makers. **Care ethics** emphasizes relationships and vulnerability. **Capability approaches** ask whether people retain substantive freedoms to live and work well. **Communitarian and subsidiarity perspectives** emphasize the authority and knowledge embedded in local institutions.

Christian moral reasoning can learn from these analytical insights without treating them as equivalent to Scripture. It adds a distinctive account of creation as God's possession, persons as bearers of God-given dignity, work as vocation, authority as stewardship, truth as moral obligation, and neighbour-love as a boundary on externalization. The resulting judgment should be technically rigorous precisely because careless evidence can harm people.

A disciplined Christian sustainability judgment therefore asks: What are the facts and uncertainties? What duties and prohibitions apply? Who is affected, especially the less powerful? What consequences are reasonably foreseeable? Which resources and authority have been entrusted? What level of decision should act? Are claims truthful? Is profit legitimate rather than extracted through hidden harm? Can the decision be explained openly before God, those affected and a competent reviewer?

FAITH AND VOCATION | Creation care is not achieved by attaching a Bible verse to an ESG report. It is demonstrated when managers measure truthfully, refuse deceptive claims, reduce avoidable harm, use resources productively, protect workers and neighbours, respect legitimate authority and local agency, and remain accountable for the consequences of the power entrusted to them.

21.27 Professional Toolkit: The Sustainable Business and Responsible Trade Stewardship Protocol

The Sustainable Business and Responsible Trade Stewardship Protocol, SBRTS, converts the chapter into a repeatable professional workflow. It is deliberately not an ESG score. It begins with the decision and ends with learning, because sustainability problems are context-dependent and evidence changes.

Figure 21.6. Sustainable Business and Responsible Trade Stewardship Protocol.
Source/Note: Author's synthesis integrating materiality, enterprise risk, due diligence, circularity, measurement, reporting and Christian stewardship.

Table 21.14. SBRTS professional decision record.

Protocol step	Required decision record
1. Boundary	State the decision, purpose, relevant products/sites/countries, time horizon, affected groups, legal regimes and what is excluded.
2. Evidence	Record baseline data, methods, uncertainty, source reliability, climate/nature/labour impacts, dependencies and existing commitments.
3. Materiality	Separate financial, impact and moral materiality. Identify severity, likelihood, scale, reversibility, distribution and vulnerable groups.
4. Options	Generate alternatives using avoidance and reduction first; include adaptation, circularity, supplier development, redesign, relocation, technology and remedy where relevant.
5. Trade-offs	Quantify economic effects where defensible and describe non-commensurable effects explicitly, including energy access, jobs, affordability, sovereignty and community impacts.
6. Commit	Specify targets, owners, budgets, supplier terms, thresholds, interim milestones, controls, escalation and stop/revise conditions.
7. Verify	Define calculation methods, data lineage, internal controls, assurance scope, claim language and correction mechanisms.
8. Learn	Review outcomes against baseline and stakeholder experience; distinguish failure of implementation from failure of theory and remediate unintended harms.

The protocol's first discipline is **boundary**. A firm deciding whether to redesign packaging has a different system boundary from a government designing a carbon market or an investor evaluating a transition bond. Naming the decision owner, geography, time horizon and affected persons prevents frameworks from expanding indefinitely.

The second is **evidence**. Establish the physical and social baseline before setting a target. If the baseline is weak, improve measurement or use a range. Do not create a false point estimate merely because a reporting template requires a number.

The third is **materiality**. Test financial transmission, external impact and moral duty separately. An issue can be morally material before it is financially material, and financially material without being the largest environmental impact.

The fourth is **options**. Use a hierarchy: prevent severe harm where possible; reduce at source; adapt to unavoidable risk; redesign for resource productivity and circularity; remedy damage; and use offsets or compensatory mechanisms only where their role is explicitly justified.

The fifth is **trade-offs**. Compare economic cost, resilience, energy and product access, livelihoods, local capability, environmental effect, distribution and sovereignty. A trade-off is not a moral excuse. It is a fact pattern that must be made explicit so that hidden costs are not assigned to those with the least voice.

The sixth is **commitment**. Translate the preferred option into capital, contracts, owners, timelines, supplier conditions, workforce plans, control points and stopping rules. An unfunded target is not implementation.

The seventh is **verification**. Build data lineage from source to claim, obtain proportionate independent challenge and correct material errors. Assurance should focus where error or manipulation would change decisions.

The eighth is **learning**. Sustainability strategy should change when evidence falsifies assumptions. A project that underperforms should be redesigned or stopped even when senior leaders publicly endorsed it. Institutional courage includes correcting one's own green narrative.

21.28 Common Misconceptions, Analytical Errors and Professional Pitfalls

Table 21.15. Common misconceptions and professional corrections.

Misconception	Correction
Sustainability and ESG are the same.	ESG is an information and categorization architecture. Sustainability is the wider question of long-run ecological, social, economic and institutional viability and responsibility.
A high ESG rating proves a company is ethical.	Ratings measure provider-defined attributes. Providers disagree materially, and moral legitimacy cannot be outsourced to a composite score.
Net zero means zero emissions.	Most net-zero pathways allow residual emissions balanced by removals. Credibility depends on deep reductions, boundary, timing, residual definition and high-integrity removals.
Scope 3 is always “someone else’s emissions.”	Scope 3 lies outside direct operational control but can be materially influenced through design, procurement, logistics, customer use, finance and contracting. Double counting across company inventories is expected and does not make value-chain management meaningless.
Recycling is circular economy.	Recycling is usually lower in the value-preservation hierarchy than refusing, reducing, reusing, repairing or remanufacturing. Circularity must be evaluated at system level.
An intensity decline proves decarbonization.	Intensity can improve while absolute emissions rise, as Maersk’s 2025 figures illustrate. Both metrics answer different questions.

Misconception	Correction
Carbon offsets are equivalent to internal abatement.	Offsets are separate instruments with additionality, permanence, leakage, measurement and double-counting risks. They should not conceal feasible direct reductions.
Carbon pricing always harms competitiveness.	Effects depend on design, recycling of revenue, trade exposure, innovation, market structure and foreign policy. It can also reward efficient producers.
CBAM is simply a tariff.	It is a carbon-border mechanism tied to embedded emissions and the EU ETS architecture. Its legal, administrative and distributional effects differ from an ordinary customs tariff.
Sustainability reporting guarantees sustainability.	Reporting improves information only if boundaries, data, controls and claims are credible. Organizations can report extensively while impacts deteriorate.
Global sustainability standards are morally authoritative because they are global.	Standards can improve comparability and coordination, but legitimacy still requires lawful authority, evidence, proportionality, subsidiarity, due process and attention to local consequences.
Developing economies should postpone environmental responsibility until they are rich.	Poverty and ecological degradation can reinforce each other. The relevant question is how to sequence development and protection without imposing costs that deny basic energy, livelihoods or industrial capability.

Several errors deserve special emphasis. The first is **metric substitution**, in which an indicator becomes the objective. Recycling rate can rise while total material use rises faster. Renewable-energy share can rise while energy demand and total emissions increase. ESG disclosure pages can multiply while environmental performance stagnates. Managers should preserve the causal link between metric and intended outcome.

The second is **boundary shopping**. Firms may select organizational, product or time boundaries that make performance appear favorable. Boundary changes can be legitimate after acquisition, divestiture or methodology improvement, but they should be transparent and reconciled.

The third is **outsourcing the footprint**. Selling a high-emission facility can reduce the seller's Scope 1 emissions without changing global emissions. Outsourcing manufacturing can move emissions to Scope 3. Portfolio and corporate decisions should distinguish accounting movement from real-economy effect.

The fourth is **technology solutionism**. Sensors, AI, blockchain and digital twins can improve measurement and optimization, but they do not determine the moral objective. Chapter 20 remains the owner of the technology architecture. Chapter 21 asks whether the technology actually reduces environmental harm or improves responsible trade after lifecycle effects, data quality and access are considered.

The fifth is **policy monoculture**, assuming that because one instrument works in one jurisdiction it should be exported universally. Carbon pricing, disclosure, product standards, subsidies and due-diligence rules interact with institutional capacity, energy systems, income, enforcement and trade structure. Harmonization can reduce transaction costs, but subsidiarity can preserve local knowledge and democratic accountability. The choice requires evidence.

21.29 Chapter Synthesis and Transition to Chapter 22

Chapter 21 has treated sustainability as a strategic, scientific, operational, trade and moral discipline rather than as a reputation program. The chapter began with stewardship and human flourishing, then connected sustainable development to externalities, materiality and intergenerational responsibility. It showed that climate science supplies evidence about physical systems, but enterprise decisions require translation through assets, supply chains, markets, regulation and adaptive capacity. Climate risk was therefore separated into physical, transition, liability, market and supply-chain pathways, and climate strategy into mitigation, adaptation, resilience and transition planning.

The chapter then moved from climate to the wider resource system. Nature, water, pollution and ecosystem dependencies require place-specific evidence. Circularity can preserve product, component and material value, but circular claims must survive life-cycle boundaries, rebound, quality losses and logistics. Carbon accounting provides a disciplined inventory but does not itself determine the right target. Scope 1, 2 and 3 classifications describe organizational responsibility for accounting; moral responsibility follows a broader analysis of causation, control, benefit and foreseeable harm.

ESG was deliberately disaggregated. Environmental, social and governance information can improve risk identification and accountability, but composite ratings depend on measurement choices and do not constitute moral verdicts. Reporting systems such as IFRS S1/S2, GRI, ESRS, TNFD and GHG Protocol serve different users and materiality lenses. Their authority, scope and legal status must be verified. A technically compliant sustainability report can still mislead if claims are selective, boundaries are manipulated or targets conceal dependence on offsets and distant technology.

Responsible trade extends sustainability into sourcing, labour conditions, traceability, carbon data and border measures. Due diligence is a cycle of identifying, preventing, tracking, communicating and remedying adverse impacts, not an audit certificate. Carbon pricing and CBAM can create incentives for cleaner production while also changing competitiveness and imposing fixed compliance costs. African firms and policymakers therefore need measurement capability, reliable energy, finance, infrastructure and productive upgrading, not merely imported reporting templates.

Africa has remained at the analytical core. Energy poverty and clean-cooking gaps make human development inseparable from environmental strategy. AfCFTA can create scale for regional value chains, manufacturing and clean-energy trade if infrastructure and implementation follow. Green industrialization is strongest when it raises resource productivity, local value addition, resilience and environmental performance together. Policy sovereignty and subsidiarity do not excuse poor environmental conduct; they require that authority be exercised at legitimate levels with local evidence and accountability.

The Sasol and Maersk cases demonstrated why sustainability performance needs causal interpretation. Net emissions can fall partly through lower output or credits. Emissions intensity can improve while absolute emissions rise. New technology can create future capability without yet delivering the promised environmental result. The manager's responsibility is to explain these mechanisms truthfully rather than select whichever metric supports the preferred narrative.

Christian moral reasoning gives the chapter its final orientation. Creation is entrusted rather than absolutely owned. Productive use is legitimate, but domination without accountability is not. Truthful measurement, neighbour-love, worker justice, prudent care for future generations, responsible freedom and subsidiarity constrain profit-seeking. Stewardship rejects both environmental indifference and ideological conformity. It requires competent judgment about what actually serves people and creation under real constraints.

Transition to Chapter 22. Chapter 21 completes Part VI, *Technology, Stewardship and the Sustainable Future*. Chapter 22, *Vocation, Professional Practice, Internships and Capstone Integration: Applying Business Knowledge with Integrity and Service*, changes the reader's task from mastering another discipline to integrating the whole book in professional practice. Sustainability, like finance, strategy, marketing, operations, technology and trade, becomes one evidence stream inside real workplace problems. The final chapter will show how to define a bounded professional problem, gather trustworthy evidence, exercise moral courage, integrate disciplinary tools, develop feasible recommendations, learn through internship practice and execute a capstone without confusing technical competence with vocation or service.

Key Terms

Table 21.16. Key terms.

Term	Working definition
Additionality	The extent to which an emission reduction or removal would not have occurred without the credited intervention or incentive.
Adaptation	Adjustment to actual or expected climate effects to reduce harm or exploit beneficial opportunities.
Carbon border adjustment	A border mechanism that links import obligations to embedded greenhouse-gas emissions and a domestic carbon-pricing regime.
Carbon credit	A tradable unit representing a quantified greenhouse-gas reduction or removal under a specified crediting methodology.
Carbon intensity	Greenhouse-gas emissions divided by a relevant unit of output, revenue, energy or activity.
Circular economy	A system-oriented approach seeking to reduce virgin resource use and waste by preserving product, component and material value through design, longevity, reuse, repair, remanufacture and recycling.
Climate risk	Potential adverse effects arising from physical climate hazards or the economic, legal, market and technological transition associated with climate response.
Double materiality	A reporting and decision concept that considers both effects of sustainability matters on the enterprise and the enterprise's impacts on people and the environment.
Embedded emissions	Greenhouse-gas emissions associated with producing a good, often calculated over specified processes and boundaries.
ESG	Environmental, social and governance categories used to organize information about corporate conduct, risk, performance or impact.
Financial materiality	Relevance of information to enterprise prospects, including cash flows, access to finance or cost of capital.
Greenwashing	A mismatch between sustainability-related communication and underlying performance, evidence or material context that creates an unjustifiably favorable impression.
Impact materiality	Significance of an organization's effects on people or the environment, including actual or potential positive or adverse impacts.
Just transition	An approach to economic and energy transition that explicitly addresses workers, communities, consumers and regions bearing adjustment costs.
Life-cycle assessment	A standardized method for compiling and evaluating environmental inputs, outputs and impacts across defined stages of a product or service system.
Marginal abatement cost	The net incremental cost per unit of greenhouse-gas emissions avoided or reduced by an abatement option.
Net zero	A state in which remaining anthropogenic greenhouse-gas emissions within a defined boundary are balanced by anthropogenic removals over a specified period, after substantial reductions.
Physical climate risk	Risk arising from acute events or chronic changes in climate and related environmental conditions.
Responsible sourcing	Procurement and supplier governance that identifies and addresses material human-rights, labour, environmental and integrity impacts associated with sourced goods and services.
Scope 1	Direct greenhouse-gas emissions from sources owned or controlled by the reporting organization.
Scope 2	Indirect greenhouse-gas emissions associated with purchased or acquired electricity, steam, heating and cooling.

Term	Working definition
Scope 3	Other indirect greenhouse-gas emissions occurring in the organization's value chain, across specified upstream and downstream categories.
Stewardship	Accountable care and use of entrusted resources, authority and capabilities for legitimate purposes and with responsibility for consequences.
Transition risk	Policy, legal, technology, market and reputational risk associated with the shift toward lower-emission economic systems.
Traceability	The ability to follow the history, location, transformation or chain of custody of a material, product, transaction or claim through verifiable records.
Eco-design	Integration of environmental considerations into product or service design across the life cycle, including material choice, durability, repairability, energy use, disassembly and end-of-life recovery.
Environmental management system (EMS)	A structured management system for identifying environmental aspects and obligations, setting objectives, operating controls, monitoring performance, auditing and continual improvement.
Industrial symbiosis	A cross-organizational arrangement in which by-products, residual materials, water, energy or other resources from one activity become useful inputs to another under credible economic, environmental and safety conditions.

Concept-Check Questions

1. Distinguish sustainability, sustainable development, ESG, stewardship and resilience. Why is it analytically dangerous to use them as synonyms?
2. What is the difference between weak and strong sustainability, and why does the distinction matter for irreversible ecological loss?
3. Explain scale, composition and technique effects in trade-environment analysis.
4. Distinguish financial materiality, impact materiality, double materiality and moral materiality.
5. Why can two reputable ESG rating agencies assign different scores to the same firm?
6. Distinguish physical, transition, liability, market and supply-chain climate risk using one original example for each.
7. What is the difference between climate mitigation, adaptation, resilience and a transition plan?
8. Why is reuse or repair often more circular than recycling? What conditions can reverse that conclusion?
9. Calculate emissions from 100,000 litres of diesel using an illustrative emission factor of 2.68 kgCO2e per litre. State the unit and any assumptions.
10. Distinguish Scope 1, Scope 2 and Scope 3 emissions. Why can the same physical emission appear in more than one company's inventory?
11. What does a negative marginal abatement cost mean? Why should projects not be ranked by MAC alone?
12. Why does limited assurance over selected metrics not establish that an entire sustainability strategy is sound?
13. Why does certification to an environmental management system standard not, by itself, prove low environmental impact or responsible trade performance?

Higher-Order Analytical and Critical-Thinking Questions

1. "If climate risk is financially material, markets will price it correctly without regulation." Critically evaluate the statement using externalities, information, time horizon, incentives and institutional capacity.
2. Can a company be genuinely sustainable while receiving a low ESG rating? Can a company receive a high ESG rating while causing serious harm? Build a reasoned answer rather than relying on examples alone.
3. Under what conditions can a carbon border measure improve global environmental performance, and under what conditions can it operate mainly as protection or burden shifting?
4. A low-income country has abundant domestic natural gas, severe electricity shortages and excellent solar resources but weak grid infrastructure. How should a responsible energy strategy evaluate gas, renewables, grid expansion, affordability and transition risk?
5. Critically assess whether Scope 3 targets should be mandatory for every firm. Consider control, influence, data uncertainty, supplier capacity and the risk of shifting responsibility.
6. A circular product is more expensive than a linear competitor and has lower material throughput but higher transport emissions because of return logistics. What evidence is required before calling it environmentally superior?
7. When should a multinational disengage from a supplier with severe labour violations, and when might responsible remediation be more ethical than immediate exit?
8. If a sustainability standard is legally valid in a major export market but conflicts with a producer country's development priorities, how should sovereignty, market access, subsidiarity and environmental responsibility be balanced?
9. Does the purchase of high-quality carbon removals justify continued avoidable operational emissions? Develop the strongest argument on both sides before reaching a conclusion.

10. "The true purpose of sustainability is long-term shareholder value." Evaluate this claim from financial materiality, impact materiality, Christian stewardship and at least two alternative ethical perspectives.

Applied Case Problem: Kivu Aluminium Works and the Low-Carbon Export Contract

Kivu Aluminium Works, a fictional but realistic East African manufacturer, supplies extruded aluminium profiles to regional construction companies. A European customer offers a five-year contract that could increase annual sales by 35%, but the buyer requires verified product-level embedded-emissions data, evidence of responsible bauxite and alumina sourcing, a credible reduction pathway, and supplier labour due diligence. Kivu currently purchases electricity from a grid with mixed generation, operates an older diesel backup system and imports most alumina through a trader that will not identify the smelter of origin. Its accounting team can estimate Scope 1 and 2 emissions, but purchased-material emissions are based on generic factors. The company employs 420 people and supports a network of local transporters and fabricators.

Management has four options. It can accept the contract immediately and use conservative default emissions factors while promising future improvement. It can delay the contract for twelve months to build supplier traceability and install a more efficient extrusion line. It can source certified lower-emission alumina at an 11% input premium, threatening near-term margins. Or it can decline the European contract and prioritize regional markets with fewer data requirements. A development bank has indicated that it may finance efficiency improvements if Kivu presents a credible transition plan, but the terms are not yet agreed.

Using the SBRTS Protocol, prepare a board recommendation. Your analysis should define the materiality boundary; identify data gaps; estimate which emissions categories are likely to dominate; distinguish what can be verified now from what requires supplier evidence; evaluate the four options through profitability, cash flow, workforce, market access, carbon exposure, responsible sourcing and sovereignty; identify claims that management must not make; propose a staged verification and capital plan; and state the moral red lines that should constrain the decision.

Ethical and Faith-Informed Dilemma: The Village, the Mine and the Transition Mineral

A mining company has discovered a mineral deposit required for battery and grid technologies. Developing the site could create 1,800 direct jobs, expand national export revenue and support a downstream processing industry. The deposit lies near farming communities and a wetland that supports local water supply. Environmental models indicate that engineered controls can reduce contamination risk substantially but cannot eliminate it. The government strongly supports the project. Community consultation is legally required, but the company has enough political support to obtain approvals even if local opposition remains significant.

The company could abandon the project, redesign it at 22% higher capital cost with a smaller footprint, proceed under the legal minimum, or negotiate a slower development that includes independent water monitoring, livelihood safeguards, benefit-sharing and a community grievance mechanism. The redesigned option would reduce expected return and could delay the national processing strategy.

Analyze the dilemma using Genesis 2:15, Matthew 22:39, stewardship, truthfulness, neighbour-love, justice, subsidiarity and responsible authority. Then compare the Christian analysis with consequentialist, rights-based and capability perspectives. Your recommendation should address whether legal approval is sufficient, how uncertainty should be communicated, what community consent or participation can reasonably require, what level of environmental risk is morally tolerable, and how national development benefits should be weighed against concentrated local harm.

Data and Evidence Exercise: Building a Sustainability Decision File

A manufacturer reports the following annual data: Scope 1 emissions of 12,000 tCO_2e; location-based Scope 2 emissions of 8,000 tCO_2e; market-based Scope 2 emissions of 4,500 tCO_2e; purchased-material Scope 3 emissions estimated at 45,000 tCO_2e with ±30% uncertainty; production of 100,000 tonnes; waste generation of 7,500 tonnes, of which 5,250 tonnes are recycled; water withdrawal of 900,000 m^3, of which 60% occurs in a basin classified by the company as water-stressed. A proposed efficiency project costs \$1.8 million, has annualized capital and operating cost of \$290,000, saves \$410,000 in energy and reduces 2,000 tCO_2e annually. A second project costs \$1.1 million and has annual net cost of \$140,000 while reducing 3,500 tCO_2e annually.

Calculate the location-based and market-based Scope 1+2 footprint; calculate emissions intensity under each Scope 2 method; calculate the recycling rate; calculate the MAC of each project; and identify why the corporate recycling rate is insufficient to assess waste circularity. Then prepare a one-page evidence note identifying at least five questions that should be answered before management claims that the company is "on a science-based net-zero pathway." Your note should distinguish measured data, estimated data, assumptions, missing Scope 3 categories, water-location risk, target design, assurance and the role of offsets or removals.

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Annotated Further Reading

Bansal and DesJardine (2014). A concise conceptual argument that business sustainability is fundamentally intertemporal. Particularly useful for distinguishing sustainability from broad responsibility language and for diagnosing short-termism.

Berg, Kölbel, and Rigobon (2022). The clearest empirical demonstration of why ESG ratings should not be treated as objective measures of a single underlying construct. Essential for analysts using third-party ESG scores.

IPCC (2023). The principal synthesis of assessed climate science underlying contemporary climate-risk analysis. Read the Summary for Policymakers together with sector- and region-specific evidence rather than extracting a single headline scenario.

UNEP International Resource Panel (2024). A global evidence base on material extraction, resource productivity and distribution. Particularly useful for moving circularity discussions beyond recycling slogans.

OECD (2023). A current government-backed responsible-business-conduct framework linking due diligence to human rights, labour, environment, climate, biodiversity, technology and supply chains.

IFRS Foundation (2023a, 2023b). IFRS S1 and S2 are central for investor-focused sustainability-related financial disclosure. They should be read alongside impact-oriented frameworks rather than treated as substitutes for them.

Taskforce on Nature-related Financial Disclosures (2023). A practical framework for identifying nature-related dependencies, impacts, risks and opportunities, with special value where location, water, ecosystems and supply chains matter.

World Bank (2026). State and Trends of Carbon Pricing 2026 provides current comparative evidence on carbon taxes, emissions-trading systems and carbon-crediting markets. Useful for separating carbon-pricing facts from policy rhetoric.