Lesson 8.3: Climate Finance and Sustainable Investing

Module 8: The Future Problem

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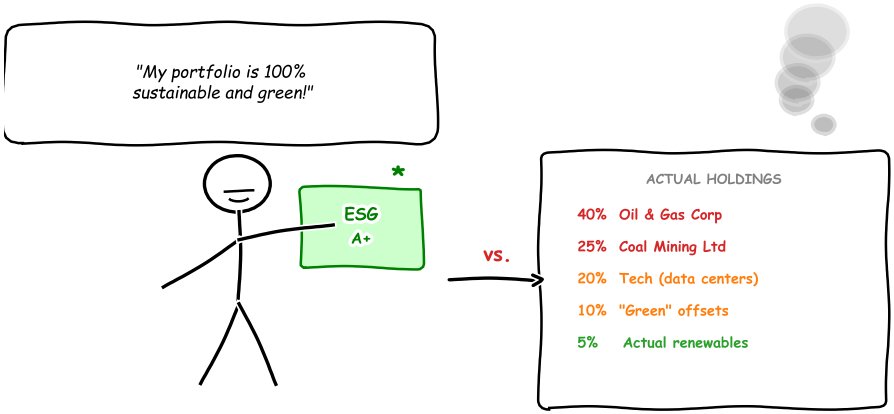
Digital Finance — BSc Course

When Finance Meets the Climate



Greenwashing: when the label is green but the portfolio is not.

Learning Objectives

After completing this lesson, you will be able to:

1. **Explain** the three pillars of ESG (Environmental, Social, Governance) and the concept of financial materiality [Understand]
2. **Classify** climate risks into physical, transition, and liability categories [Understand]
3. **Describe** how carbon markets work (compliance vs. voluntary, cap-and-trade mechanics) [Understand]
4. **Outline** the TCFD framework and ISSB disclosure standards [Apply]
5. **Distinguish** green bonds from sustainability-linked bonds [Apply]
6. **Evaluate** greenwashing risks and Scope 1/2/3 reporting challenges [Analyze]

Bloom's levels covered: Understand, Apply, Analyze

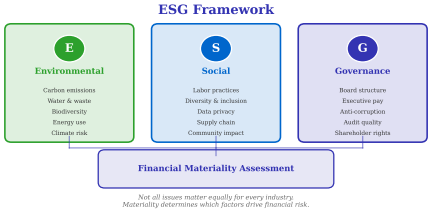
Objectives follow Bloom's taxonomy: Understand → Apply → Analyze.

Where we have been:

- Lesson 8.1: Quantum computing threats to cryptography
- Lesson 8.2: Post-quantum migration strategies

Why climate finance now?

- **Quantum threats are long-term. Climate risk is already here.**
- In 2023, climate-related disasters caused over USD 250 billion in economic losses globally
- Regulators now **mandate** climate risk disclosures for banks and asset managers
- ESG assets under management exceeded USD 35 trillion in 2024
- Climate risk is a **financial risk** — it reprices assets, creates stranded assets, and shifts capital flows



ESG integrates environmental, social, and governance factors into financial analysis.

Climate risk is not a future problem — it is repricing assets today.

ESG: Environmental, Social, Governance

Definition: ESG

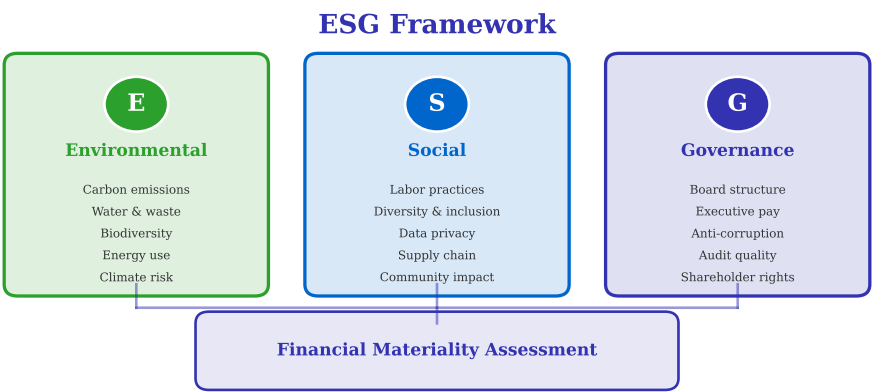
ESG stands for **Environmental, Social, Governance** — three categories of non-financial factors that investors use to evaluate companies alongside traditional financial metrics.

Pillar	Key Issues	Financial Impact
Environmental	Carbon emissions, water use, waste, biodiversity	Regulatory fines, stranded assets, resource costs
Social	Labor practices, diversity, data privacy, supply chain	Lawsuits, reputation damage, employee retention
Governance	Board structure, executive pay, corruption, audit quality	Fraud risk, shareholder dilution, mismanagement

Key insight: ESG is not charity — it identifies **risks and opportunities** that traditional financial statements miss.

ESG factors are material financial risks. A factory that pollutes faces fines; a company with poor governance faces fraud.

The ESG Framework: Three Pillars, Many Issues



Not all issues matter equally for every industry.
Materiality determines which factors drive financial risk.

Financial Materiality: Which ESG Issues Matter?

Definition: Financial Materiality

An ESG issue is **financially material** if it can reasonably be expected to affect the **financial condition, operating performance, or risk profile** of a company. Not all ESG issues matter equally for every industry.

Examples of materiality by industry:

Industry	Material ESG Issue	Why?
Oil & Gas	Carbon emissions	Transition risk, carbon taxes
Banking	Governance & risk oversight	Fraud, systemic risk
Tech	Data privacy	Fines (GDPR), user trust
Mining	Water use & biodiversity	License to operate, cleanup costs
Retail fashion	Supply chain labor	Reputation, boycotts

SASB (Sustainability Accounting Standards Board) identifies material ESG issues for 77 industries.

Materiality is the bridge between ESG and financial analysis: focus on what affects the bottom line.

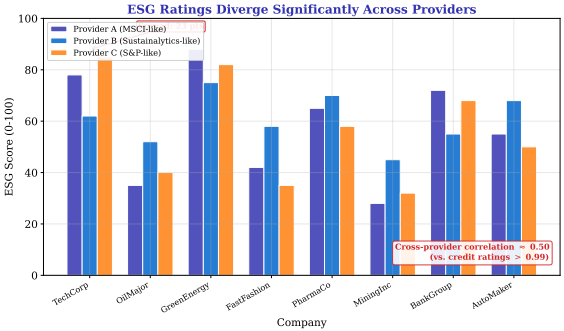
ESG Scoring: Why Ratings Disagree

The problem:

- MSCI, Sustainalytics, and S&P give the **same company** very different ESG scores
- Correlation between major ESG rating providers: only ≈ 0.50 (vs. > 0.99 for credit ratings)
- Causes: different **definitions**, different **weights**, different **data sources**

Why this matters:

- Investors cannot rely on a single ESG score
- "ESG investing" means different things to different people
- Creates room for **greenwashing**



ESG scores are not like credit ratings — they diverge significantly across providers.

Definition: Climate Risk

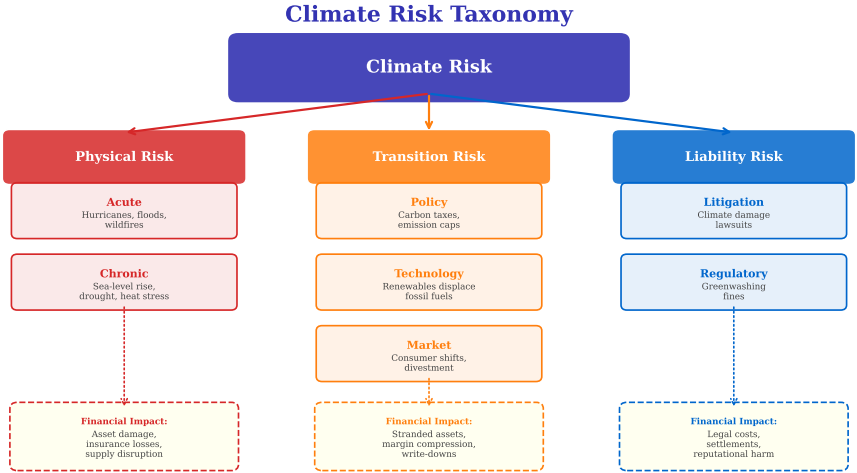
Climate risk refers to the potential for financial losses arising from climate change. It is categorized into three types: **physical risk**, **transition risk**, and **liability risk**.

Type	Description	Example
Physical	Damage from climate events (acute: storms, floods; chronic: sea-level rise, drought)	Coastal real estate loses value; crop insurance payouts spike
Transition	Costs of moving to a low-carbon economy (policy, technology, market shifts)	Carbon tax makes coal plants unprofitable; EV adoption strands oil assets
Liability	Legal claims from climate damage or misleading disclosures	Oil company sued for damages; fund sued for greenwashing

Key insight: Climate risk is a **financial risk** — it affects asset values, credit risk, and insurance.

Physical, transition, liability — three channels through which climate change becomes a portfolio problem.

Climate Risk Taxonomy: Visual Overview



All three risk types interact: physical damage triggers insurance claims (liability) and policy responses (transition).

Physical Risk: When Climate Hits the Balance Sheet

Acute physical risk (event-driven):

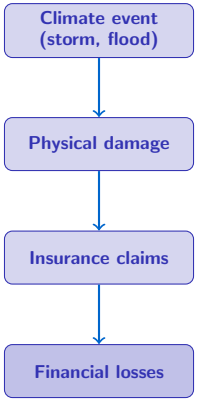
- Hurricanes, wildfires, floods
- Damage to facilities, supply chain disruptions
- Insurance losses: Hurricane Ian (2022) caused USD 60+ billion in insured losses

Chronic physical risk (gradual):

- Rising sea levels, prolonged droughts, heat stress
- Agricultural yield declines, water scarcity
- Coastal property devaluation ("climate stranded assets")

Financial channels:

- Lower asset values (property, infrastructure)
- Higher insurance premiums or **uninsurability**
- Reduced revenue (agriculture, tourism)



Physical risk is not hypothetical — Hurricane Ian alone cost insurers more than the GDP of many countries.

Transition Risk: The Cost of Going Green

Policy and regulation:

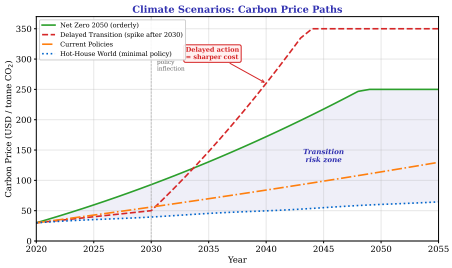
- Carbon taxes (EU ETS carbon price rose from EUR 5 in 2017 to EUR 90+ in 2023)
- Phase-out mandates (e.g., EU ban on new ICE vehicles by 2035)
- Mandatory climate disclosures (CSRD, SEC proposals)

Technology disruption:

- Renewable energy costs fell 90% in a decade (solar PV)
- Electric vehicles displacing internal combustion
- Green hydrogen and carbon capture emerging

Market and reputation shifts:

- Consumer preferences shifting to sustainable products
- Institutional investors divesting from fossil fuels
- "Stranded assets": reserves that cannot be burned



Different climate scenarios imply different levels of transition risk for high-carbon sectors.

Transition risk is the financial cost of the shift to a low-carbon economy — it creates winners and losers.

Stranded Assets: The Carbon Bubble

Definition: Stranded Assets

Stranded assets are resources (oil reserves, coal mines, gas infrastructure) that lose value or become **unburnable** due to climate policy, technology shifts, or market changes before the end of their expected economic life.

The carbon budget problem:

- To limit warming to 1.5°C, humanity can emit roughly 400 Gt CO_2 more (IPCC, 2023)
- Known fossil fuel reserves contain roughly 3,000+ Gt CO_2
- **Implication:** over 80% of known reserves **cannot be burned** if climate targets are met
- These reserves are **on company balance sheets** as assets today

Financial impact:

- Write-downs: BP wrote down USD 17.5 billion in assets in 2020
- Repricing: Coal stocks lost 90%+ of value in the 2010s in many markets
- Credit risk: Lenders exposed to fossil-fuel-dependent borrowers face default risk

If the world meets its climate goals, trillions of dollars of fossil fuel assets become worthless.

Definition: Carbon Market

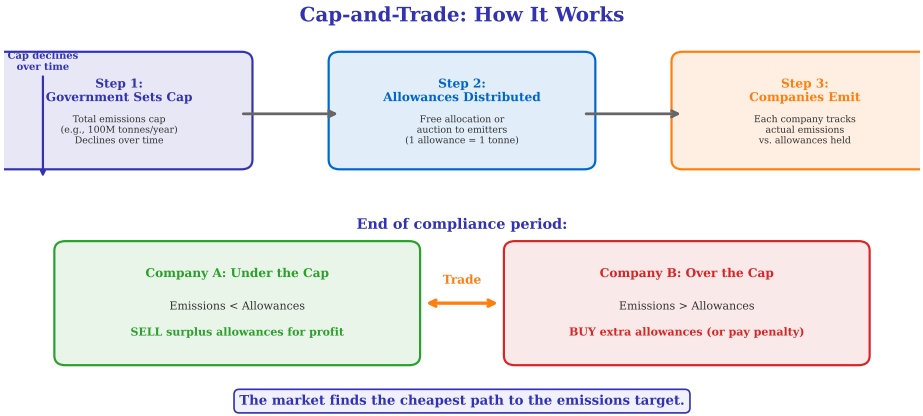
A **carbon market** is a trading system where carbon emission allowances or credits are bought and sold, creating a financial incentive to reduce greenhouse gas emissions.

	Compliance Market	**Voluntary Market**
Who?	Regulated emitters (power plants, factories)	Any company or individual
Mechanism	Government cap-and-trade; mandatory	Voluntary offset purchases
Price signal	Strong (legally binding)	Weak (variable quality)
Size (2023)	$\approx$ USD 950 billion traded	$\approx$ USD 2 billion traded
Example	EU Emissions Trading System (EU ETS)	Verra-certified offsets, Gold Standard

Key insight: Compliance markets create a **real price signal**. Voluntary markets face quality and credibility challenges.

The EU ETS is the world's largest carbon market. A tonne of CO_2 trades like a financial commodity.

Cap-and-Trade: How It Works



Cap-and-trade: the government sets the total cap; the market finds the cheapest way to get there.

Carbon Prices: From EUR 5 to EUR 100+

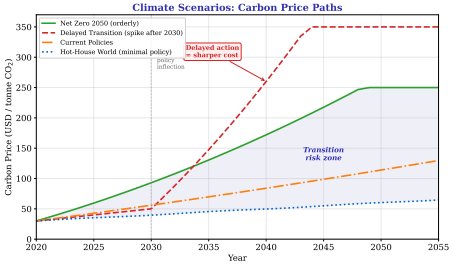
EU ETS carbon price evolution:

- 2017: EUR $\approx$ 5 per tonne CO_2
- 2021: EUR $\approx$ 50 per tonne
- 2023 peak: EUR $\approx$ 100 per tonne
- 2025: EUR $\approx$ 65–75 per tonne

Why carbon prices matter for finance:

- Higher carbon price = higher cost for carbon-intensive firms
- Affects **profitability**, **credit risk**, and **asset valuations**
- NGFS climate scenarios model carbon prices of USD 200+ by 2050 under aggressive decarbonization

For portfolio managers: Carbon price exposure is now a core risk factor.

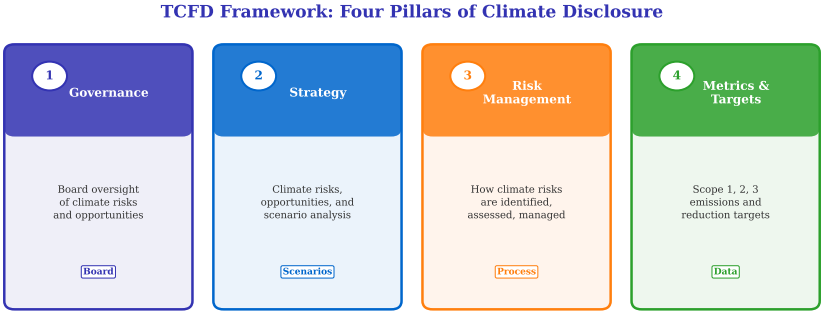


A rising carbon price is a direct tax on high-emitting companies — it reprices entire sectors.

TCFD: The Global Disclosure Standard

Definition: TCFD

The **Task Force on Climate-related Financial Disclosures** (TCFD), created by the Financial Stability Board in 2017, recommends that companies disclose climate risks across four pillars: **Governance, Strategy, Risk Management, Metrics & Targets**.



TCFD: What Companies Must Disclose

Pillar	Key Disclosure Questions
Governance	How does the board oversee climate risks? Who is responsible?
Strategy	What climate risks and opportunities has the company identified? How do they affect the business model under different scenarios (1.5°C, 2°C, 4°C)?
Risk Management	How does the company identify, assess, and manage climate risks? Are they integrated into overall risk management?
Metrics & Targets	What metrics does the company use? What are its Scope 1, 2, 3 emissions? What are its reduction targets?

Scenario analysis is the centerpiece: companies must show how their strategy holds up under different warming pathways (e.g., orderly transition vs. delayed action vs. hot-house world).

TCFD turned climate from a "nice to have" into a boardroom-level governance issue.

ISSB: The New Global Baseline for Sustainability Reporting

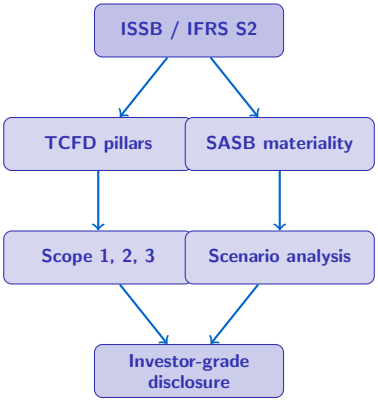
What is the ISSB?

- International Sustainability Standards Board (created 2021, under IFRS Foundation)
- Published **IFRS S1** (general sustainability) and **IFRS S2** (climate) in June 2023
- Builds on TCFD; designed to become the **global baseline**

Key features of IFRS S2:

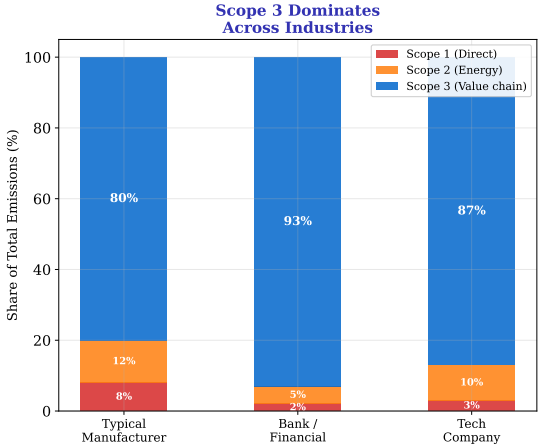
- Mandatory disclosure of **Scope 1, 2, and 3** emissions
- **Scenario analysis** required
- Transition plans and climate targets must be disclosed
- Designed for **investors** (enterprise value focus)

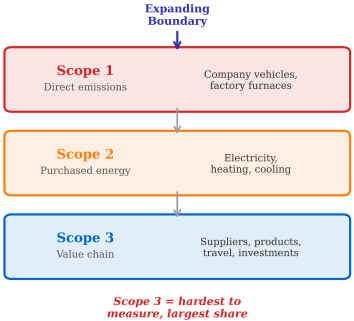
Adoption: UK, Australia, Canada, Japan, Nigeria, Singapore have announced plans to adopt ISSB standards.



ISSB aims to do for sustainability what IFRS did for financial reporting: create one global language.

Scope 1, 2, 3: Measuring a Company's Carbon Footprint





Scope 3 is by far the largest for most companies (often 80–90% of total emissions) — and the hardest to measure.

Scope 1, 2, 3: Definitions and Challenges

Scope	Definition	Example	Data Quality
Scope 1	Direct emissions from owned sources	Factory smokestacks, company vehicles	High (measured)
Scope 2	Indirect emissions from purchased energy	Electricity, heating	Medium (utility data)
Scope 3	All other indirect emissions (supply chain + product use)	Business travel, purchased goods, customer use of products	Low (estimated)

The Scope 3 challenge:

- For an automaker, most emissions are **Scope 3**: customers driving their cars
- For a bank, Scope 3 includes **financed emissions**: the emissions of companies it lends to
- Scope 3 data relies on **estimates and proxies** — very hard to verify

Paradox: Scope 3 is the most important category but the least reliable.

One company's Scope 1 is another's Scope 3 — emissions are counted multiple times across the value chain.

Definition: Green Bond

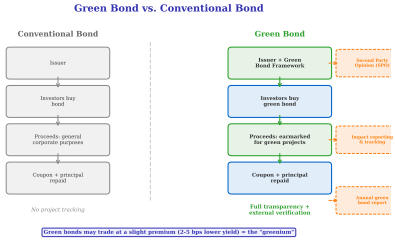
A **green bond** is a fixed-income instrument whose proceeds are **exclusively** used to finance environmentally beneficial projects (renewable energy, clean transport, green buildings, etc.).

Key characteristics:

- "Use of proceeds" model: money is earmarked for green projects
- Same credit risk as the issuer's regular bonds
- Often certified by a third party (Climate Bonds Initiative, Second Party Opinion)
- Market size: USD 500+ billion issued in 2023 alone

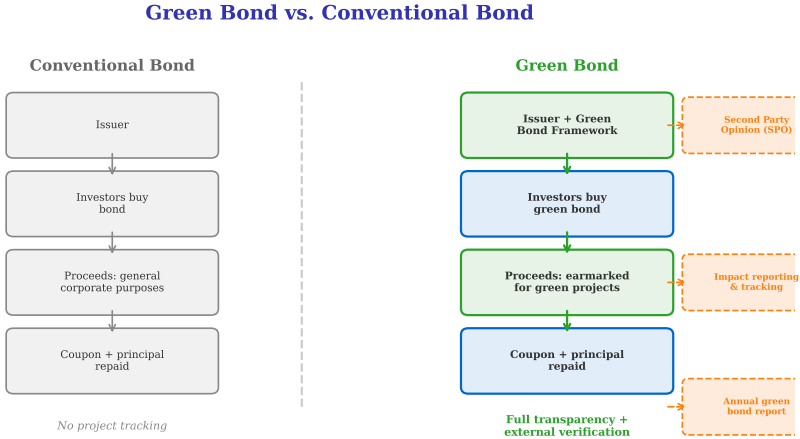
The "greenium":

- Green bonds sometimes trade at a slight premium (lower yield) vs. conventional bonds
- This "greenium" is typically 2–5 basis points
- It represents the market's willingness to accept slightly lower returns for green projects



Green bonds link capital markets to climate action. The EU Green Bond Standard (2024) tightens rules on what qualifies.

Green Bond vs. Conventional Bond: Key Differences



A green bond adds transparency layers (use-of-proceeds reporting, external review) on top of a standard bond.

Definition: Sustainability-Linked Bond (SLB)

A **sustainability-linked bond** ties the **coupon rate** to whether the issuer meets pre-defined **sustainability performance targets** (SPTs). If the target is missed, the coupon **steps up** (penalty).

	Green Bond	**Sustainability-Linked Bond**
What is green?	The *use of proceeds*	The *issuer's overall targets*
Flexibility	Money locked to specific projects	General corporate purposes
Penalty for failure	None (reputational only)	Coupon step-up (financial penalty)
Criticism	"Is the project really green?"	"Are the targets ambitious enough?"

Example: Enel issued a sustainability-linked bond with a target to increase renewable capacity. Missing the target triggers a 25-basis-point coupon increase.

SLBs align the issuer's financial cost with its sustainability ambition — but targets must be credible.

Greenwashing: The Trust Problem in ESG

Definition: Greenwashing

Greenwashing is the practice of making misleading claims about the environmental benefits of a product, service, or investment strategy to attract capital or improve reputation.

Common greenwashing patterns:

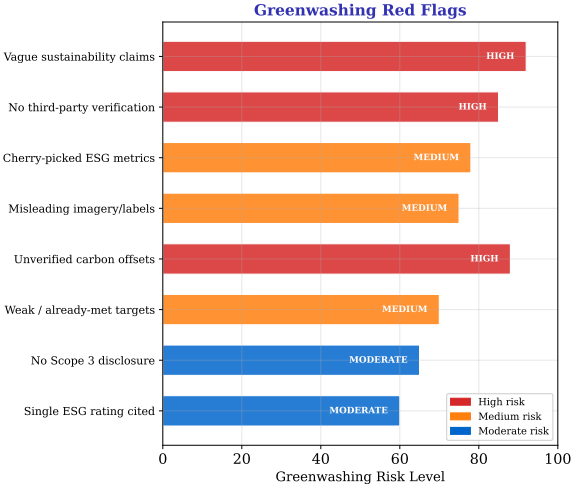
1. **Vague labels:** "eco-friendly fund" with no clear criteria
2. **Cherry-picking:** Highlighting one green project while ignoring overall emissions
3. **Weak targets:** SLB targets that are already being met (no stretch)
4. **Offset reliance:** Claiming "carbon neutral" through questionable offsets
5. **Relabeling:** Renaming existing products as "sustainable" without changes

Regulatory response:

- EU SFDR (Sustainable Finance Disclosure Regulation): classifies funds as Article 6 / 8 / 9
- SEC proposed rule on ESG fund names
- DWS (Deutsche Bank subsidiary) raided by police in 2022 over greenwashing allegations

Greenwashing erodes trust and misdirects capital. Regulation is tightening — but enforcement lags.

Greenwashing Red Flags: What to Watch For



Due Diligence Checklist

- [ ] Are claims specific and measurable?
- [ ] Is there independent third-party review?
- [ ] Are ALL material ESG metrics disclosed?
- [ ] Do targets exceed industry baseline?
- [ ] Are carbon offsets independently verified?
- [ ] Is Scope 3 reported (not just 1 & 2)?
- [ ] Are multiple ESG ratings compared?
- [ ] Is there a clear transition plan?

If 3+ boxes are unchecked, investigate further.

Due diligence on ESG claims is as important as due diligence on financial statements.

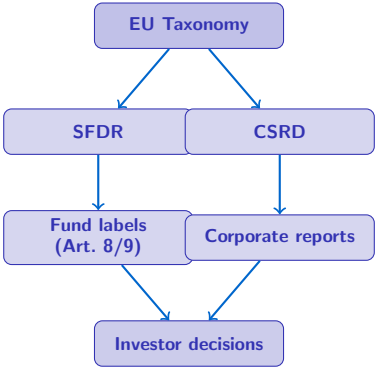
The Regulatory Landscape: EU Taxonomy and Beyond

EU Taxonomy:

- Classification system defining which economic activities are "environmentally sustainable"
- Six environmental objectives (climate mitigation, adaptation, water, circular economy, pollution, biodiversity)
- "Do No Significant Harm" (DNSH) principle

Global regulatory landscape:

- **EU:** SFDR + EU Taxonomy + CSRD (most comprehensive)
- **UK:** SDR (Sustainability Disclosure Requirements)
- **US:** SEC climate disclosure rule (contested)
- **Switzerland:** Swiss Climate Scores, FINMA guidance



The EU is leading in sustainable finance regulation. Other jurisdictions are following with varying speeds.

Fintech Meets Climate: Digital Tools for Sustainable Finance

Technology is enabling climate finance at scale:

Technology	Application in Climate Finance	Stage
AI / NLP	Analyzing corporate sustainability reports, detecting greenwashing	Deployed
Satellite data	Monitoring deforestation, methane leaks, physical risk	Deployed
Blockchain	Carbon credit tracking, avoiding double-counting	Pilot
Big data	Scope 3 estimation from supply-chain data	Growing
IoT sensors	Real-time emissions monitoring at industrial sites	Growing
Climate models	Scenario analysis for physical and transition risk	Deployed

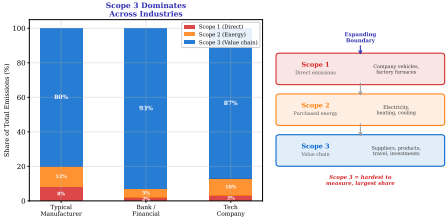
Example: Firms like Clarity AI, RepRisk, and Persefoni use NLP to scan thousands of news articles and reports for ESG controversies — faster than any human analyst.

Technology is the key to making climate finance verifiable and scalable.

Banks and Financed Emissions: Scope 3 for Finance

The unique challenge for banks:

- A bank's Scope 1 and 2 emissions are small (offices, data centers)
- Its **Scope 3 (financed emissions)** is enormous: the emissions of every company it lends to or invests in
- Partnership for Carbon Accounting Financials (PCAF) provides the methodology



Example calculation:

- Bank lends CHF 10 million to a steel company
- Steel company emits 100,000 tonnes CO_2
- Bank's share: $\frac{10M}{500M \text{ enterprise value}} \times 100{,}000 = 2{,}000$ tonnes attributed to the bank

Net-Zero Banking Alliance: 130+ banks have committed to align lending portfolios with net-zero by 2050.

For banks, climate risk is credit risk: if borrowers cannot decarbonize, they may default.

Key Takeaways

1. **ESG** = Environmental, Social, Governance — non-financial factors that are financially material
2. **Climate risk** comes in three forms: **physical** (storms, floods), **transition** (carbon taxes, tech shifts), and **liability** (lawsuits)
3. **Carbon markets** put a price on emissions — compliance markets (EU ETS) are large and growing; voluntary markets face quality issues
4. **TCFD / ISSB** provide the global framework for climate disclosure (Governance, Strategy, Risk Management, Metrics)
5. **Green bonds** earmark proceeds for green projects; **sustainability-linked bonds** tie coupons to targets
6. **Scope 1/2/3** emissions define a company's carbon footprint — Scope 3 is largest but hardest to measure
7. **Greenwashing** is a real risk: vague labels, weak targets, and questionable offsets undermine trust
8. For **banks**, financed emissions (Scope 3) turn climate risk into **credit risk**

Climate finance is where regulation, technology, and capital markets converge.

Summary / Next Lesson Preview

This lesson: We explored how climate change creates financial risk through three channels (physical, transition, liability), how carbon markets and disclosure frameworks (TCFD, ISSB) are reshaping finance, and why greenwashing is a growing concern.

Key vocabulary:

- ESG (Environmental, Social, Governance)
- Financial materiality
- Physical risk / transition risk / liability risk
- Stranded assets
- Carbon market (compliance vs. voluntary)
- Cap-and-trade
- TCFD / ISSB / IFRS S2
- Scope 1, 2, 3 emissions
- Green bond / greenium
- Sustainability-linked bond (SLB)
- Greenwashing
- EU Taxonomy / SFDR
- Financed emissions (PCAF)

Next lesson (M8L4): *Digital Identity and Decentralized Finance 2.0* — How self-sovereign identity and the next generation of DeFi protocols could reshape financial access and privacy.

Review: Can you explain the three types of climate risk? Can you distinguish a green bond from a sustainability-linked bond?