

Week 1: Green Finance Fundamentals

Professional Certificate in Green Finance

Outline

What is Green Finance?

Definition

- Financial investments flowing to sustainable development
- Support for environmental and climate objectives
- Integration of environmental considerations into financial decisions

Key Characteristics

- Environmental additionality
- Measurable impact
- Transparency and reporting
- Risk-adjusted returns

Scope

- Climate change mitigation
- Climate change adaptation
- Pollution prevention
- Biodiversity conservation
- Sustainable resource use
- Circular economy

Market Size

- Global green finance: \$5+ trillion annually
- Green bond market: \$1.6 trillion outstanding (2023)
- Growing 30-40% per year

Climate Imperative

- Paris Agreement: limit warming to 1.5-2C
- Requires \$3-5 trillion annual investment
- Current investment gap: \$2-3 trillion/year
- Financial system must mobilize capital

Financial Risk

- Physical risks: extreme weather, sea level rise
- Transition risks: policy, technology, markets
- Stranded assets: fossil fuel reserves
- Systemic risk to financial stability

Business Opportunity

- Clean energy: \$10+ trillion market
- Green infrastructure investment needs
- Innovation in sustainable technologies
- First-mover advantages

Regulatory Drivers

- EU Taxonomy and SFDR
- SEC climate disclosure rules
- Central bank climate stress tests
- Mandatory TCFD reporting

Historical Development

Early History (Pre-2007)

- 1990s: Socially responsible investing (SRI)
- 2000: UN Global Compact
- 2006: UN Principles for Responsible Investment
- Focus: ethical exclusion and advocacy

Emergence (2007-2015)

- 2007: First green bond (EIB)
- 2008: Financial crisis spurs sustainable finance
- 2014: Green Bond Principles launched
- 2015: Paris Agreement catalyzes growth

Mainstreaming (2015-2020)

- 2017: TCFD recommendations
- Explosive green bond growth
- ESG integration accelerates
- Central banks engage climate risk

Maturation (2020-Present)

- 2021: EU Taxonomy implemented
- 2022: SFDR disclosure requirements
- 2023: SEC climate rule proposals
- Regulatory frameworks solidify
- Focus on impact and greenwashing prevention

Green Finance vs. Traditional Finance

Dimension	Traditional Finance	Green Finance
Primary objective	Financial returns	Returns + environmental impact
Risk assessment	Financial risks only	Financial + climate risks
Time horizon	Quarterly/annual	Long-term (decades)
Externalities	Ignored/unpriced	Internalized/measured
Reporting	Financial statements	Financial + non-financial
Valuation	NPV, IRR	NPV + impact metrics
Regulation	Prudential only	Prudential + sustainability
Transparency	Limited	Enhanced disclosure

Key Insight: Green finance does not trade-off returns for impact. Studies show comparable or superior risk-adjusted returns with better long-term resilience.

Market Participants

Capital Providers

- Institutional investors (pensions, insurance)
- Asset managers and funds
- Banks and commercial lenders
- Development finance institutions
- Retail investors
- Corporations (internal capital)

Capital Recipients

- Governments (sovereign bonds)
- Corporations (green bonds, loans)
- Project developers (renewable energy)
- Financial institutions (sustainability-linked)
- Municipalities (green municipal bonds)

Intermediaries

- Investment banks (underwriting)
- Commercial banks (lending)
- Stock exchanges (listing)
- Rating agencies
- Verifiers and certifiers

Standard-Setters and Regulators

- ICMA (Green Bond Principles)
- Climate Bonds Initiative
- EU Commission (Taxonomy)
- IOSCO, FSB (global coordination)
- Central banks and regulators
- ISSB (sustainability standards)

Role of Development Finance Institutions

Major DFIs

- World Bank/IFC
- European Investment Bank (EIB)
- Asian Development Bank (ADB)
- African Development Bank (AfDB)
- Green Climate Fund (GCF)
- National DFIs (KfW, AFD, JICA)

Functions

- Catalyze private capital
- Market creation and demonstration
- Technical assistance
- Risk mitigation (guarantees)

Blended Finance Model

- Concessional capital: grants, soft loans
- Commercial capital: private investment
- Risk layering and tranching
- First-loss protection
- Particularly important in emerging markets

Impact

- EIB: 200+ billion EUR climate finance (2015-2023)
- IFC: 15 billion USD green bonds issued
- GCF: 13 billion USD committed
- Leverage ratios: 1:3 to 1:10

UN System

- UNEP Finance Initiative
- UNFCCC (Paris Agreement)
- UN Sustainable Development Goals
- Principles for Responsible Investment (PRI)

Financial Stability

- Financial Stability Board (FSB)
- Network for Greening the Financial System (NGFS)
- Bank for International Settlements
- International Monetary Fund

Market Standards

- ICMA: Green Bond Principles
- Climate Bonds Initiative: Certification
- ISSB: Sustainability standards (IFRS S1/S2)
- GRI: Sustainability reporting

Regional Bodies

- EU: Taxonomy, SFDR, CSRD
- ASEAN: Green Bond Standards
- China: Green Bond Catalogue
- Various national regulators

Overview of Green Instruments

Debt Instruments

- Green bonds
- Green loans
- Sustainability-linked bonds
- Sustainability-linked loans
- Transition bonds
- Blue bonds (ocean finance)

Equity Instruments

- Green stocks/IPOs
- Green funds and ETFs
- Private equity in clean tech
- Venture capital for climate tech

Other Instruments

- Carbon credits and offsets
- Green securitization
- Catastrophe bonds
- Green derivatives
- Payment for ecosystem services

Market Size (2023)

- Green bonds: \$1.6 trillion
- Sustainability-linked: \$500 billion
- Green loans: \$300 billion
- Carbon markets: \$850 billion
- ESG funds: \$3+ trillion AUM

Definition

- Fixed-income securities
- Proceeds dedicated to green projects
- Same credit risk as issuer's other bonds
- "Use of proceeds" restriction

Key Features

- External verification (often)
- Regular impact reporting
- Separate tracking of proceeds
- Alignment with GBP or other standards

Eligible Project Categories

- Renewable energy
- Energy efficiency
- Clean transportation
- Sustainable water management
- Pollution prevention
- Green buildings

Market Growth

- 2007: First issuance (EIB, 600m EUR)
- 2021: Record 500 billion USD
- 2023: 450 billion USD
- Cumulative: 1.6 trillion USD outstanding
- Top issuers: Germany, France, US, China

Deep dive in Week 2: Green Bond Markets and Structuring

How They Differ from Green Bonds

- **Green bonds:** Use of proceeds restriction
- **SL instruments:** General use, KPI-linked
- Financial terms tied to sustainability targets
- Broader issuer base (any industry)

Structure

- Define sustainability performance targets (SPTs)
- Select key performance indicators (KPIs)
- Set trigger events and step-up/down
- Typically: coupon adjustment if target missed
- Example: +25 bps if emissions target not met

Common KPIs

- GHG emissions reduction (Scope 1, 2, 3)
- Renewable energy share
- Water usage reduction
- Waste reduction/circularity
- Diversity metrics
- Supply chain sustainability

Advantages and Concerns

- Pro: Flexibility for all issuers
- Pro: Incentivizes corporate-wide change
- Con: Potential for weak targets
- Con: Greenwashing risk
- Con: KPI selection and verification challenges

Compliance Markets

- Mandatory cap-and-trade systems
- EU Emissions Trading System (EU ETS)
- California cap-and-trade
- Regional Greenhouse Gas Initiative (US)
- China national ETS
- UK ETS

EU ETS

- Covers 40% of EU GHG emissions
- 10,000+ installations
- Carbon price: 80-100 EUR/ton (2023)
- Annual cap declining 2.2% per year
- Market size: 700+ billion EUR

Carbon markets are a pricing mechanism but also a significant financial market with derivatives, futures, and sophisticated trading

Voluntary Carbon Markets

- Corporate offsetting
- Project-based credits (VCS, Gold Standard)
- Nature-based solutions popular
- Price: 5-50 USD/ton (wide variation)
- Market size: 2 billion USD (2023)

Key Challenges

- Additionality verification
- Permanence concerns
- Leakage and double-counting
- Integrity of offset projects
- Price volatility
- Fraud risk in voluntary markets

Concept

- Strategic use of development finance
- Mobilize additional private capital
- Address market failures in sustainable finance
- Particularly for emerging markets

Financial Structures

- First-loss tranches
- Credit guarantees
- Concessional loans
- Technical assistance grants
- Political risk insurance

Use Cases

- Renewable energy in frontier markets
- Sustainable agriculture
- Climate adaptation infrastructure
- Off-grid energy access
- Water and sanitation projects

Performance Metrics

- Leverage ratio: DFI capital to private capital
- Typical: 1:3 to 1:10
- Financial returns: below market for DFI, market-rate for private
- Development impact: primary objective
- Risk-adjusted returns for private investors

The Physical Science: Why Finance Must Act

IPCC Key Findings

- Global warming: +1.1C above pre-industrial
- Unequivocal human causation
- 1.5C threshold likely crossed by 2030-2035
- 2C+ has catastrophic impacts
- Window for action: current decade critical

Investment Needs

- Paris-aligned: \$3-5 trillion/year
- Current investment: \$1.3 trillion/year
- Gap: \$2-3 trillion annually
- Must triple renewable energy by 2030
- Must halve emissions by 2030

Financial Implications

- Asset repricing: fossil fuels vs. renewables
- Stranded assets: \$1-4 trillion at risk
- Physical damage: \$1+ trillion/year
- Transition costs: front-loaded
- Winners: clean energy, storage, efficiency
- Losers: coal, oil & gas, carbon-intensive

Financial System's Role

- Reallocate capital at scale
- Price climate risk
- Support innovation
- Manage orderly transition

Paris Agreement (2015)

- Limit warming to well below 2C, pursue 1.5C
- Nationally Determined Contributions (NDCs)
- Climate finance commitments
- Article 2.1c: Making finance flows consistent with low-carbon pathway

Article 2.1c Implications

- All finance (not just climate finance) must align
- Entire financial system in scope
- Requires climate risk integration
- Demands transparency and disclosure
- Catalyzes regulatory action

Climate Finance Commitments

- Developed countries: \$100 billion/year to developing
- Extended to 2025
- New goal: \$300+ billion/year post-2025
- Loss and damage fund established (2023)
- Adaptation finance: underfunded

Implementation Progress

- Financial sector: rapid adoption
- Net-zero commitments: 500+ institutions
- Assets: \$130+ trillion committed
- Challenges: credibility, transition plans
- Need: accountability mechanisms

SDGs and Finance Linkage

- 17 goals, 169 targets (2015-2030)
- Investment need: \$5-7 trillion/year
- Current investment: insufficient
- SDG financing gap: \$3-4 trillion/year
- Green finance addresses SDGs 7, 9, 11, 12, 13, 14, 15

Key SDGs for Green Finance

- SDG 7: Affordable clean energy
- SDG 13: Climate action
- SDG 14: Life below water
- SDG 15: Life on land

SDG Bonds and Finance

- SDG bonds: broader than green bonds
- Social bonds: SDGs 1-6, 8, 10, 11, 16
- Sustainability bonds: environmental + social
- Market: 300+ billion USD/year

Challenges

- Too broad for targeted finance
- Measurement and attribution difficult
- Potential dilution of “green”
- Need for impact taxonomy
- Trade-offs between goals
- Focus: integrate SDGs into investment frameworks

Financial Performance of Green Investments

Academic Evidence

- Meta-analysis: 2000+ studies
- Finding: ESG does not hurt returns
- 58% of studies: positive relationship
- 13% of studies: negative relationship
- 29% of studies: neutral relationship
- Time horizon matters: long-term outperformance

Mechanisms for Outperformance

- Better risk management
- Lower cost of capital
- Operational efficiency
- Innovation capacity
- Regulatory preparedness
- Reputation and brand value
- Employee attraction and retention

Green Bond Performance

- Return: comparable to conventional bonds
- Liquidity: improving but still lower
- Greenium: 2-5 bps (small but significant)
- Demand: oversubscription common
- Lower tail risk in some studies

Risk Considerations

- Transition risk mitigation
- Physical risk exposure reduction
- Regulatory risk management
- Reputational risk avoidance
- Future-proofing portfolios

Key message: Green finance is financially sound, not a trade-off between returns and impact

Cost of Capital Benefits

- Lower interest rates on green bonds
- Expanded investor base
- Reduced refinancing risk
- Better credit ratings (some evidence)
- Access to ESG-mandated capital

Operational Benefits

- Energy cost reduction
- Resource efficiency gains
- Waste reduction savings
- Process innovation
- Supply chain resilience

Strategic Benefits

- Market differentiation
- Customer preference alignment
- Regulatory compliance leadership
- Stakeholder relations
- License to operate
- Attract and retain talent

Risk Management

- Transition risk mitigation
- Physical risk adaptation
- Regulatory risk preparedness
- Reputational risk reduction
- Long-term value protection

Financial Motivations

- Risk management: climate risk exposure
- Return enhancement: future winners
- Portfolio diversification
- Regulatory compliance
- Fiduciary duty alignment

Non-Financial Motivations

- Values alignment
- Ethical considerations
- Mission-driven mandates
- Client/beneficiary preferences
- Reputation and brand

Institutional Dynamics

- Pension funds: long-term liabilities
- Insurance: physical risk exposure
- Sovereign wealth: intergenerational mandate
- Foundations: mission alignment
- Family offices: values and legacy

Market Evidence

- ESG fund inflows: \$500+ billion/year
- ESG AUM: \$30+ trillion
- Institutional adoption: 80%+ considering ESG
- Universal owner perspective
- Systemic risk awareness

Core Concepts

- Present Value (PV)
- Future Value (FV)
- Discount rate (r)
- Number of periods (n)

Formulas

$$PV = \frac{FV}{(1 + r)^n}$$

$$FV = PV \times (1 + r)^n$$

$$NPV = \sum_{t=0}^n \frac{CF_t}{(1 + r)^t}$$

Application to Green Finance

- Long-term cash flows (renewable projects)
- Appropriate discount rates critical
- Climate risk adjusts discount rates
- Carbon price impacts future cash flows
- Regulatory changes affect timing

Green Finance Considerations

- Should environmental benefits be valued?
- Social discount rate debate
- Intergenerational equity
- Risk-free rate + climate premium?

Bond Price Formula

$$P = \sum_{t=1}^n \frac{C}{(1+y)^t} + \frac{F}{(1+y)^n}$$

Where:

- P = Price
- C = Coupon payment
- y = Yield to maturity
- F = Face value
- n = Number of periods

Yield Measures

- Current yield = Annual coupon / Price
- Yield to maturity (YTM)
- Yield to call (YTC)
- Spread over benchmark

Workshop: Excel exercises on bond pricing and greenium calculation

Green Bond Pricing

- Same credit risk as issuer
- Potential greenium: slight yield discount
- Typically: -2 to -5 bps
- Demand-driven: oversubscription
- Liquidity considerations

Price Sensitivity

- Duration: price sensitivity to yield changes
- Longer duration: higher sensitivity
- Green bonds: often longer maturity
- Convexity: curvature of price-yield relationship
- Credit spread: issuer-specific risk

Key Concepts

- Expected return: $E(R_p) = \sum w_i E(R_i)$
- Portfolio variance: $\sigma_p^2 = \sum \sum w_i w_j \sigma_i \sigma_j \rho_{ij}$
- Diversification benefit
- Efficient frontier
- Capital Asset Pricing Model (CAPM)

Risk Measures

- Standard deviation (volatility)
- Beta (systematic risk)
- Value at Risk (VaR)
- Sharpe ratio: $(R_p - R_f)/\sigma_p$

Green Portfolio Considerations

- ESG factors as risk factors
- Climate risk as systematic risk
- Green assets: diversification benefits?
- Correlation with conventional assets
- Sector tilts: renewable energy, tech

Empirical Evidence

- Green portfolios: similar Sharpe ratios
- Lower tail risk in some studies
- Resilience during crises
- Long-term outperformance potential
- Need: climate-adjusted CAPM

Workshop: Building a green portfolio in Excel, calculating risk-return metrics

Return Sources

- Coupon/dividend income
- Capital appreciation
- Greenium (green bonds)
- Operational outperformance
- Risk mitigation value
- Regulatory tailwinds

Risk Factors

- Credit risk (same as conventional)
- Market risk (interest rate, equity)
- Liquidity risk (potentially higher)
- Greenwashing risk
- Technology risk (renewable energy)
- Policy/regulatory risk

Risk-Return Profile

- Green bonds: low risk, low return
- Listed green equities: medium risk, medium return
- Renewable project finance: medium-high risk, stable returns
- Clean tech VC: high risk, high return (potential)
- Emerging market green: higher risk, higher return

Risk Mitigation

- Diversification across technologies
- Geographic diversification
- Due diligence on green claims
- Third-party verification
- Blended finance structures

Week 1 Key Takeaways

Core Concepts

- ① Green finance channels capital to environmental solutions
- ② Climate imperatives drive rapid market growth
- ③ Diverse instruments: bonds, loans, equity, carbon markets
- ④ Large and growing ecosystem of participants

Financial Fundamentals

- ① Green finance does not sacrifice returns
- ② Risk management is a key driver
- ③ Time value of money applies with climate considerations
- ④ Portfolio theory + climate risk integration

Market Context

- ① \$5+ trillion annual green finance market
- ② Regulatory momentum is accelerating
- ③ Paris Agreement and SDGs provide framework
- ④ Investment gap remains: \$2-3 trillion/year

Looking Ahead

- ① Week 2: Deep dive into green bonds
- ② Week 3: ESG integration and data
- ③ Week 4: Climate risk assessment (TCFD)
- ④ Week 5: Renewable energy project finance
- ⑤ Week 6: Regulatory frameworks

Required Reading (complete before Week 2):

- ① Berrou et al. (2019). "An overview of green finance" – foundational taxonomy
- ② Climate Bonds Initiative (2023). "Green Bond Market Summary" – market data and trends
- ③ UNEP (2023). "Global Landscape of Climate Finance" – investment flows and gaps

Recommended Reading:

- ① Giglio, Kelly, and Stroebel (2021). "Climate Finance" – academic review
- ② TCFD (2017). "Final Report" (skim for now, detailed in Week 4)
- ③ ICMA (2023). "Green Bond Principles" (preparation for Week 2)

Preparation:

- Install Python, pandas, matplotlib (if not already)
- Ensure Excel is functional
- Review provided bond pricing Excel template

Workshop Exercises

In-Class Excel Workshops (Week 1, Session 4):

Exercise 1: Bond Pricing (1 hour)

- Calculate bond prices for various yields
- Compute yield to maturity
- Analyze duration and convexity
- Introduce greenium concept with examples

Exercise 2: Portfolio Construction (1.5 hours)

- Build portfolio of 10 green and conventional assets
- Calculate expected return and risk
- Compute Sharpe ratios
- Explore efficient frontier
- Discuss diversification benefits

Exercise 3: NPV and IRR (1.5 hours)

- Simple renewable energy project cash flows
- Calculate NPV at various discount rates
- Compute IRR
- Sensitivity analysis

Questions?

Next Week: Green Bonds and Sustainable Debt Instruments

See you in Week 2!