Discovery Challenge: When Green Bonds Fund Deforestation

The Puzzle

- UBS and Santander sold green bonds in Brazil (2023)
- Santander raised EUR 280 million for JBS
- JBS: World's largest meat processor
- Bonds financed companies accused of deforestation, land grabbing, and slave labor
- JBS emissions increased while claiming sustainability
- 97% of JBS climate footprint excluded (Scope 3)

Questions This Raises

- How did these bonds qualify as "green"?
- Why did external reviewers approve them?
- What prevents greenwashing?
- Are voluntary standards sufficient?
- Do frameworks have enforcement mechanisms?
- What distinguishes credible from questionable green bonds?

[Discovery 1] This puzzle will be resolved by Goal 1—frameworks and external review requirements

Learning Goal 1

Understand Green Bond Frameworks and Standards

Theoretical — Foundation - Establishes regulatory and market standards

The Green Bond Standards Landscape

Why Standards Matter

Green bond standards address the fundamental challenge of *credibility* in sustainable finance:

- Prevent greenwashing through clear definitions
- Enable investor confidence and market growth
- Provide comparability across issuances
- Support regulatory alignment globally

Market Adoption

- 97% of issuers reference ICMA Principles (2024)
- 81% of corporate bonds have external review
- USD 315 billion CBI-certified cumulative

Three Dominant Frameworks

1. **ICMA Green Bond Principles (GBP)**
   - Voluntary, market-led
   - Global de facto standard
2. **Climate Bonds Standard (CBS)**
   - Science-based certification
   - Sector-specific criteria
3. **EU Green Bond Standard (EUGBS)**
   - Taxonomy-aligned (from Dec 2024)
   - ESMA-supervised reviewers

[Goal 1] Standards form the foundation of market integrity—Week 1 signaling theory in practice

ICMA Green Bond Principles: The Four Core Components

1. Use of Proceeds

Net proceeds must be allocated to eligible green projects:

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

2. Process for Project Evaluation

- Clear environmental objectives
- Eligibility criteria disclosed
- Exclusion criteria defined
- Management of E&S risks

3. Management of Proceeds

- Net proceeds tracked by issuer
- Sub-accounts or tracking system
- Periodic adjustment for allocations
- Temporary investment policy for unallocated funds

4. Reporting

- Annual reporting until full allocation
- List of projects with amounts
- Expected impact metrics
- Qualitative indicators when quantitative not feasible

External Review Recommendation

- Second Party Opinion (SPO)
- Verification, Certification, or Rating

[Goal 1] GBP voluntary nature enables flexibility while 97% adoption rate demonstrates market acceptance

Climate Bonds Standard: Science-Based Certification

Climate Bonds Initiative (CBI)
A science-based certification scheme with:

- Sector-specific taxonomy criteria
- Pre-issuance and post-issuance verification
- Annual surveillance requirements
- Approved verifier network

Certification Requirements

1. Project eligibility under sector criteria
2. Use of proceeds alignment (95%+)
3. Pre-issuance third-party verification
4. Annual post-issuance reporting
5. Board-level approval process

Sector Coverage

- Solar, Wind, Geothermal energy
- Low-carbon buildings
- Low-carbon transport
- Water infrastructure
- Waste management
- Land use and forestry

Market Impact

- USD 315 billion certified (Q1 2024)
- USD 20 billion Q1 2024 issuance alone
- Certification premium: +8 bps in Asia
- Self-labeled bonds penalized: +12 bps

Fee Structure

- 0.1 bps of issue value
- Minimum: USD 2,000 (DM) / USD 1,000 (EM)

[Goal 1] CBI certification demonstrates commitment to science-based climate alignment (Kapraun et al. 2021)

EU Green Bond Standard: The New Regulatory Benchmark

Key Features (Effective Dec 2024)

- **Voluntary** designation "European Green Bond"
- 100% taxonomy-aligned proceeds required
- **15% flexibility pocket** for sectors without criteria
- ESMA-registered external reviewers
- Standardized allocation and impact reporting

Taxonomy Alignment

- Substantial contribution to 1 of 6 objectives
- Do No Significant Harm (DNSH) to others
- Minimum social safeguards
- Technical screening criteria compliance

External Reviewer Regime

- ESMA registration required
- 24 reviewers authorized (April 2025)
- Professional indemnity requirements
- Transitional regime until June 2026

Reporting Requirements

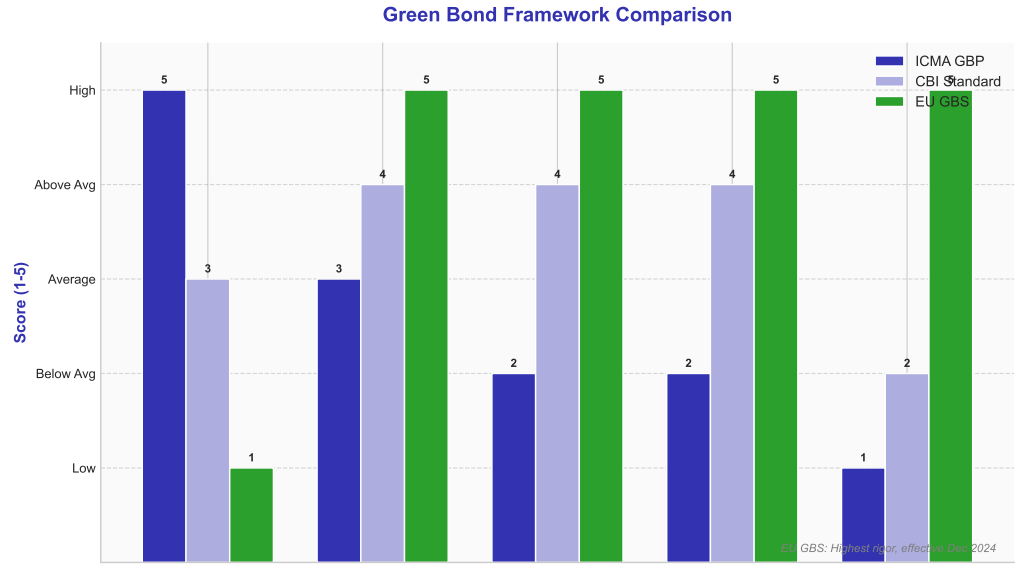
- Pre-issuance: European Green Bond Factsheet
- Annual allocation report until full allocation
- Impact report at least once during bond lifetime
- Standardized templates mandatory

Timeline

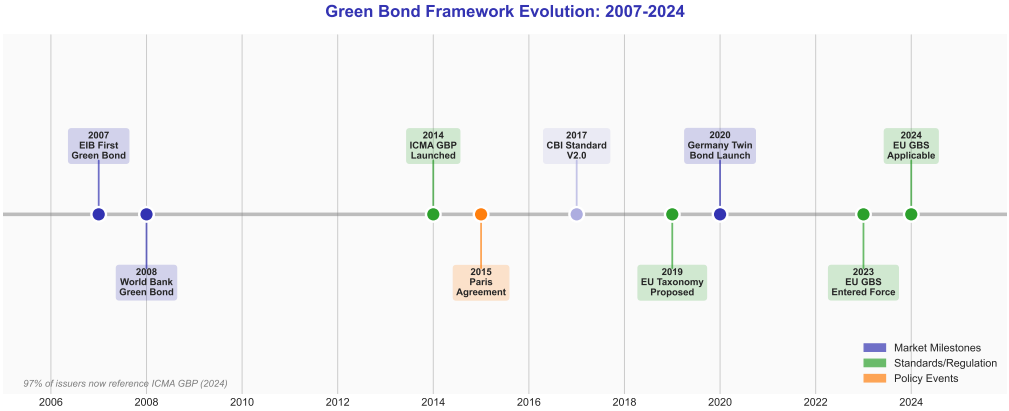
- Entered force: 20 December 2023
- Application date: 21 December 2024

[Goal 1] EUGBS represents regulatory evolution—voluntary but with highest credibility requirements

Framework Comparison: GBP vs CBI vs EUGBS



Evolution of Green Bond Standards



[Goal 1] Market growth accelerated after standardization—GBP launch in 2014 catalyzed institutional participation

Eligible Use of Proceeds: Category Breakdown

Environmental Categories (GBP)

1. **Renewable Energy** (largest share)
   - Solar, wind, hydro, geothermal
   - Grid infrastructure upgrades
2. **Energy Efficiency**
   - Building retrofits
   - Industrial efficiency
3. **Clean Transportation**
   - Electric vehicles and infrastructure
   - Public transit systems
4. **Green Buildings**
   - LEED, BREEAM certified construction
   - Net-zero building projects

Additional Categories

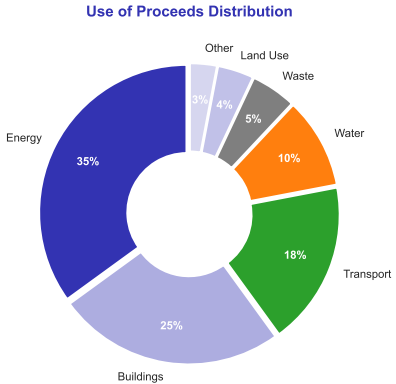
5. **Sustainable Water Management**
   - Wastewater treatment
   - Water efficiency systems
6. **Pollution Prevention**
   - Emissions reduction
   - Waste management

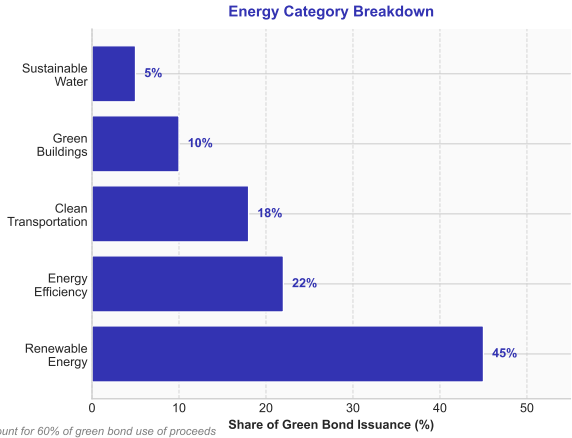
Exclusions (Common)

- Fossil fuel power generation
- Nuclear energy (varies by framework)
- Large-scale hydropower (¿25 MW in some)
- Gambling, weapons, tobacco

[Goal 1] Clear category definitions enable investor due diligence and portfolio construction

Use of Proceeds Distribution (2024)





Energy and Buildings account for 60% of green bond use of proceeds

[Goal 1] Renewable energy dominates, reflecting global decarbonization priorities and capital requirements

Learning Goal 1: Summary

What We Achieved

- ✓ Understood the three major frameworks (GBP, CBI, EUGBS)
- ✓ Learned GBP four core components
- ✓ Analyzed CBI science-based certification
- ✓ Examined EU GBS taxonomy alignment
- ✓ Compared framework requirements
- ✓ Reviewed use of proceeds categories

Can You Now...

- Explain why 97% of issuers adopt GBP?
- Describe CBI certification benefits (+8 bps premium)?
- Identify EU GBS 15% flexibility pocket purpose?
- Compare voluntary vs regulated frameworks?
- Select appropriate framework for issuer type?
- Define eligible green project categories?

Key Statistics to Remember

- 97% ICMA adoption rate — 81% corporate external review — USD 315B CBI certified
- EU GBS: 100% taxonomy + 15% flexibility — 24 ESMA-registered reviewers

[Goal 1] Achieved—frameworks establish credibility; now Goal 2 quantifies the pricing benefit

Discovery Challenge: The Disappearing Greenium

The Puzzle

- 2015: Green bonds paid 6 bps lower yields
- 2020: Greenium nearly vanished (statistically negligible)
- 2024: Greenium turned positive (issuers pay more)
- India RBI cancelled green bond auction (May 2024)
- Reason: Investors demanded higher yields than conventional bonds
- Yet oversubscription rates remain high (5-13x)

Questions This Raises

- Why did the green premium disappear?
- If greenium vanished, why still issue green?
- Why cancel auction if demand appears strong?
- Does positive greenium mean green bonds failed?
- What drives pricing dynamics over time?
- Is greenium reversal temporary or permanent?

[Discovery 2] This puzzle will be resolved by Goal 2—supply-demand equilibration and market maturation

Learning Goal 2

Quantify Greenium Dynamics and Pricing Mechanisms

Quantitative — Build - Develops analytical pricing skills

Understanding Greenium: Definition and Theory

Greenium Definition
The **greenium** (green premium) is the yield differential between green bonds and comparable conventional bonds:

$$\text{Greenium} = Y_{\text{conventional}} - Y_{\text{green}}$$

A **positive greenium** means:

- Green bonds trade at lower yields
- Investors accept lower returns
- Issuers benefit from cheaper financing

Theoretical Foundations (Week 1)

- Signaling theory: Green label as signal
- Market segmentation: Dedicated ESG demand
- Non-pecuniary preferences: Investor values

Why Greenium Exists

1. **Supply-Demand Imbalance**
   - ESG mandates create dedicated demand
   - Green supply historically constrained
2. **Risk Premium Adjustment**
   - Lower transition risk for green assets
   - Climate-aligned portfolio benefits
3. **Credibility Premium**
   - Third-party verification adds value
   - Framework quality matters

Key Finding (Zerbib 2019)
Average greenium of **-2 basis points** across matched pairs (2013-2017), more pronounced for financial and low-rated issuers.

[Goal 2] Greenium quantifies the pricing benefit of green credentials—connects Week 1 theory to market data

Measuring Greenium: Methodological Approaches

1. Twin Bond Method
Used when issuer has green and conventional bonds with identical characteristics:

- Same coupon, maturity, seniority
- Same issuer credit risk
- Difference isolates green premium

Example: Germany Twin Bund

- Launched September 2020
- EUR 6.5 billion inaugural
- 1 bp tighter at issuance
- Up to 7 bps in secondary market

2. Matched Pairs Method
Compare green bonds to "similar" conventional bonds:

- Match on issuer, rating, maturity, currency
- Control for liquidity differences
- Regression-based adjustments

3. Panel Regression
Full sample with controls:

$$Y_{i,t} = \alpha + \beta \cdot \text{Green}_i + \gamma X_{i,t} + \epsilon_{i,t}$$

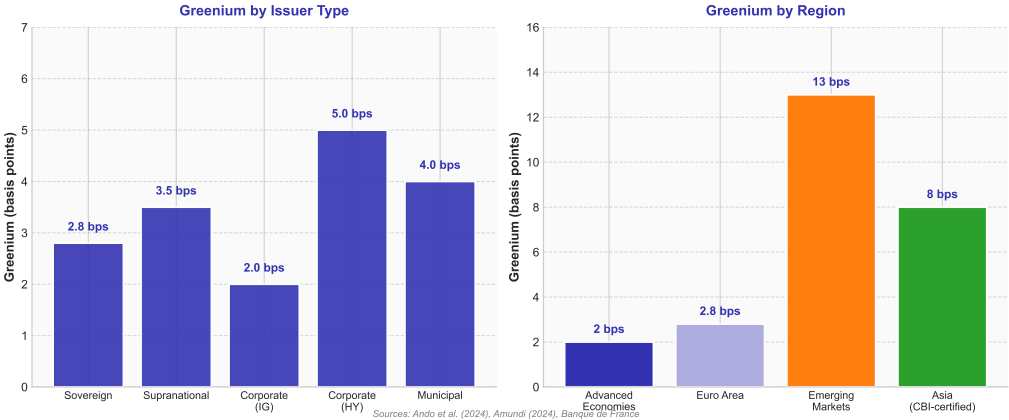
Where β captures greenium after controlling for bond characteristics X.

Measurement Challenges

- Liquidity premium contamination
- Selection bias in matching
- Time-varying market conditions

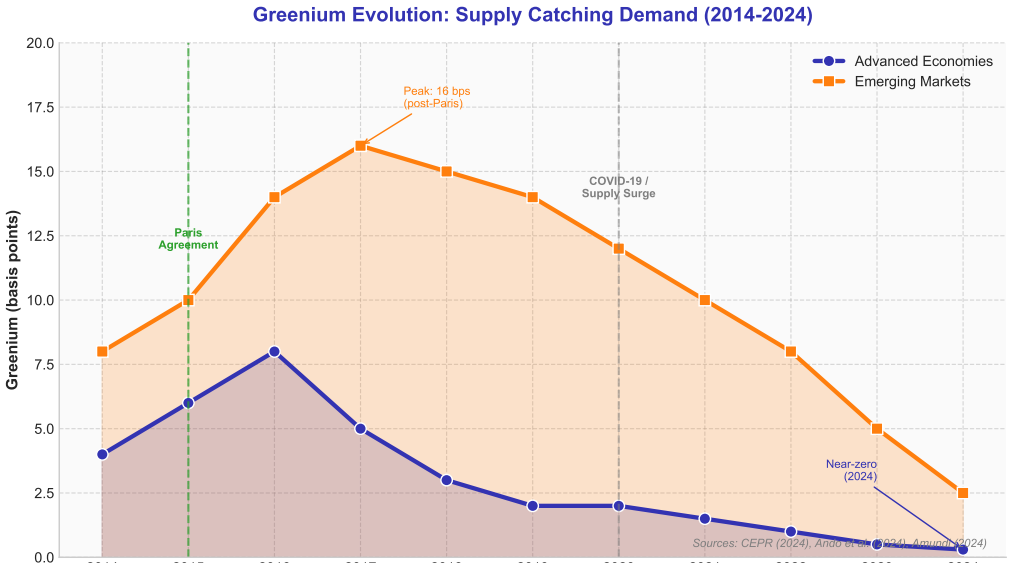
[Goal 2] Germany twin program provides cleanest greenium measurement—no matching assumptions required

Greenium Variation by Issuer Type and Region



[Goal 2] Emerging markets show larger greenium (13 bps) vs advanced economies (2 bps)—Ando et al. 2024

Greenium Evolution: 2015-2024



Supply-Demand Dynamics in Green Bond Markets

Demand Drivers

- **ESG Mandates**
  - Institutional asset allocation rules
  - Net-zero portfolio commitments
- **Regulatory Push**
  - EU SFDR Article 8/9 fund requirements
  - Central bank green collateral frameworks
- **Retail Investor Growth**
  - Green retail products expanding
  - Younger demographics driving demand

Demand Evidence

- EIB EuGBS: 13x oversubscribed
- Piraeus green bond: 7x oversubscribed
- Veolia hybrid: 5x oversubscribed

Supply Response

- USD 670-685 billion issuance in 2024
- 5% growth from 2023
- USD 5.7 trillion cumulative GSS+
- 53 sovereign issuers globally

Greenium Compression Mechanism

As supply expands to meet demand:

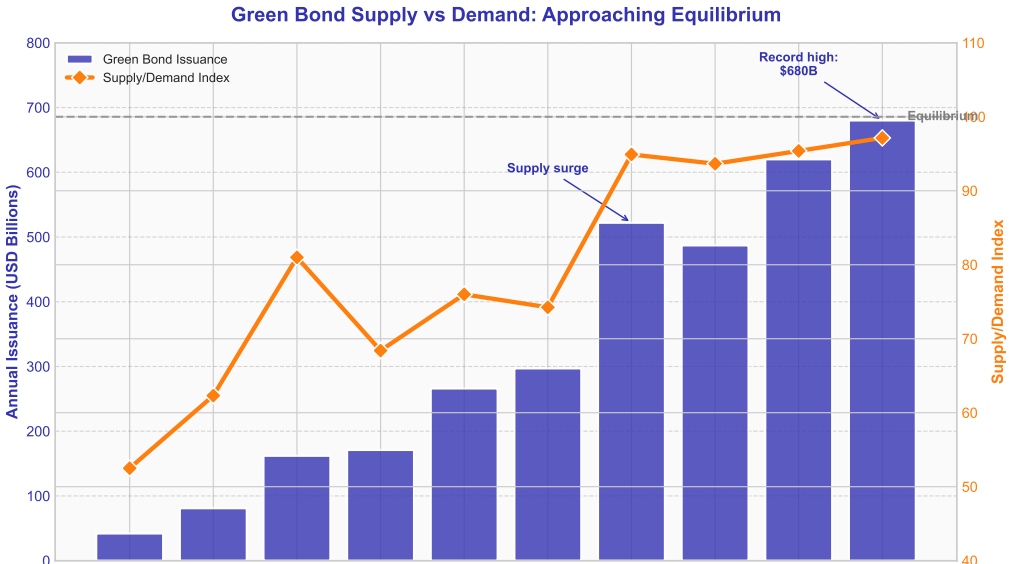
1. Scarcity premium erodes
2. Market becomes more efficient
3. Greenium approaches zero in mature segments

2024 EM Greenium (Amundi)

- 2023: 2.5 basis points
- 2024: 1.2 basis points
- "Greenium effectively disappeared"

[Goal 2] Supply-demand equilibration explains greenium compression—not loss of green value proposition

Supply vs Demand: Market Equilibrium Dynamics



Liquidity Premium and Green Bond Trading

The Liquidity Question
Does observed greenium reflect:

- True green premium? or
- Liquidity premium differences?

Empirical Findings

- Bid-ask spreads: Similar overall (0.38 bps average)
- Sector variation exists:
  - Lower green liquidity: Energy, Financials
  - Higher green liquidity: Most other sectors

China Evidence

- Green liquidity premium: 28.14 bps
- Conventional premium: 19.4 bps
- Green bonds less liquid in China

Germany Twin Analysis
Clean test without matching noise:

- Same issuer, same characteristics
- Green twin trades at lower yield
- Green twin shows *lower volatility*

Adjusted Greenium Estimates

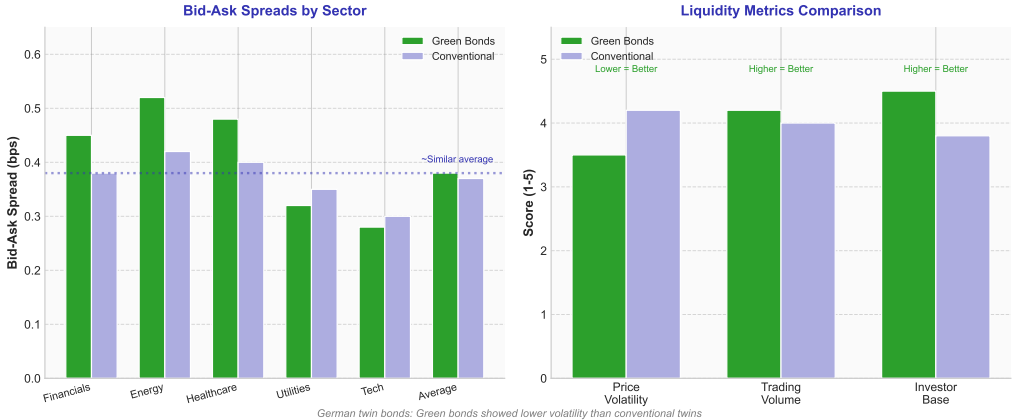
- Raw greenium: 4 bps (advanced economies)
- Liquidity-adjusted: 68-81 bps
- Suggests true green value is higher

Implications for Investors

- Buy-and-hold: Greenium beneficial
- Active trading: Consider liquidity costs
- Portfolio construction: Sector variation matters

[Goal 2] Liquidity-adjusted greenium suggests green bonds more valuable than raw spreads indicate

Liquidity Comparison: Green vs Conventional Bonds



[Goal 2] Green bonds achieve comparable liquidity while maintaining pricing advantage

Learning Goal 2: Summary

What We Achieved

- ✓ Defined greenium and its components
- ✓ Mastered measurement methodologies
- ✓ Analyzed cross-sectional variation
- ✓ Traced greenium evolution 2015-2024
- ✓ Understood supply-demand dynamics
- ✓ Examined liquidity premium effects

Can You Now...

- Calculate greenium from yield data?
- Explain why EM greenium (13 bps) exceeds DM (2 bps)?
- Describe greenium compression causes?
- Interpret oversubscription as demand signal?
- Adjust greenium for liquidity effects?
- Predict greenium trends for 2025?

Key Statistics to Remember

- Advanced economies: 2 bps average — Emerging markets: 13 bps average (Ando 2024)
- Peak: 16 bps post-Paris — 2024: Near-zero (supply meets demand)
- External review premium: +5.3 bps — CBI certification premium: +8 bps (Asia)

[Goal 2] Achieved—greenium quantified; now Goal 3 applies knowledge to issuance process

Discovery Challenge: When USD 1.2 Billion Vanishes

The Puzzle

- Adani Green Energy planned USD 1.2 billion bond (Oct 2024)
- Targeted sustainability-focused investors
- Had issued green bonds successfully before
- Bond offering suddenly withdrawn
- Insufficient investor interest despite ESG focus
- Followed Hindenburg Research allegations
- Green bond issuance cancelations increased in 2024

Questions This Raises

- Why do some green bonds fail to attract investors?
- What due diligence do investors perform?
- How does issuer reputation affect green bonds?
- What timing factors matter for issuance?
- Can past green issuance guarantee future success?
- What makes the difference between success and failure?

[Discovery 3] This puzzle will be resolved by Goal 3—framework quality, external review, and market conditions

Learning Goal 3

Apply Green Bond Structuring and Issuance Principles

Applied — Apply - Demonstrates practical implementation

Pre-Issuance: Framework Development and Preparation

Framework Development

Key components to establish:

1. **Use of Proceeds**
   - Define eligible project categories
   - Specify exclusion criteria
   - Align with GBP/CBI/EUGBS
2. **Project Selection Process**
   - Governance structure
   - Evaluation criteria
   - Environmental objectives
3. **Management of Proceeds**
   - Tracking methodology
   - Temporary investment policy
   - Look-back period (if refinancing)

Timeline Estimates

First-time issuers: 4-6+ months

- Framework development: 1-3 months
- External review (SPO): 6 weeks
- Management preparation: 1 month
- Marketing and roadshow: 2-4 weeks

Experienced issuers: 2-4 months

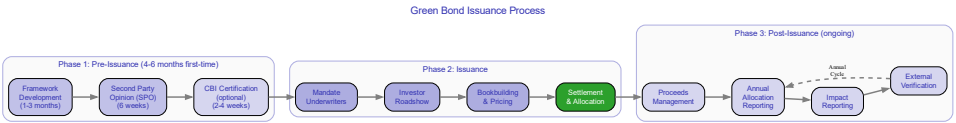
- Framework update: 2-4 weeks
- SPO refresh: 3-4 weeks
- Execution: 2-4 weeks

Cost Considerations

- SPO cost: USD 10,000-50,000
- CBI certification: 0.1 bps + minimum
- Internal resources: Significant

[Goal 3] Framework quality drives investor confidence—time investment yields greenium benefits

Green Bond Issuance Process: End-to-End Flow



[Goal 3] Process requires coordination across finance, sustainability, legal, and external parties

External Review: SPO, Verification, and Certification

Types of External Review

1. **Second Party Opinion (SPO)**
   - Assessment of framework alignment
   - Evaluation of green credentials
   - Most common review type
2. **Verification**
   - Assurance on specific criteria
   - Can be pre- or post-issuance
   - Focus on factual claims
3. **Certification**
   - CBI Climate Bond Certification
   - Ongoing surveillance required
   - Highest credibility signal
4. **Green Bond Rating**
   - Moody's, S&P, etc.
   - Numerical/letter scale
   - Comparable across issuers

SPO Market Structure (2024)

Top 5 providers market share:

- Sustainalytics: Market leader
- S&P Global: 17.2%
- Moody's: 12.9%
- R&I: 12.4%
- ISS-Corporate: 11.3%

Impact on Pricing

External review adds value:

- SPO premium: +5.3 bps (statistically significant)
- CBI certified: +8 bps vs traditional
- Self-labeled penalty: +12 bps higher yields

Investor Expectations

- 81% corporate bonds reviewed (2024)
- 69% official sector bonds reviewed
- Increasingly table stakes

[Goal 3] External review ROI is clear—SPO cost (USD 10-50k) vs greenium benefit (multiple bps on issuance)

Post-Issuance: Allocation and Impact Reporting

Allocation Reporting
Annual requirements until full allocation:

- List of projects funded
- Amounts allocated per project
- Share of financing vs refinancing
- Unallocated proceeds and treatment

Impact Reporting
Recommended metrics by category:

- **Renewable Energy**
  - MW capacity installed
  - MWh generated annually
  - tCO2e avoided
- **Energy Efficiency**
  - Energy saved (MWh/year)
  - % improvement vs baseline
- **Clean Transport**
  - Electric vehicles deployed
  - km of rail/transit built

Best Practice Examples
Apple Green Bond Program

- Total issued: USD 4.7 billion
- Allocated: USD 3.4 billion (FY2023)
- Projects funded: 50
- CO2 mitigated: 2,883,000 tCO2e
- Renewable capacity: Nearly 700 MW
- Third-party verification: EY attestation

Common Reporting Challenges

- Attribution methodology
- Baseline selection
- Aggregation across projects
- Third-party assurance scope

Investor Allocation (Sample)

- 56% to green/ESG investors
- Demonstrates dedicated demand

[Goal 3] Impact reporting closes the accountability loop—essential for repeat issuance and reputation

Case Study: Germany Twin Green Bund Program

Program Overview

Germany's innovative "twin" approach:

- Simultaneous green and conventional issuance
- Identical coupon, maturity, seniority
- Enables transparent greenium measurement

Inaugural Issuance (Sept 2020)

- Amount: EUR 6.5 billion
- Greenium at issuance: 1 bp tighter
- Order book: EUR 33.5 billion (5x)
- First sovereign twin program globally

Subsequent Issuances

- 2020: EUR 11.5 billion
- 2021: EUR 12.5 billion
- 2022: EUR 14.5 billion

Key Findings

Pricing Dynamics

- Secondary market: Up to 7 bps greenium
- Lower yields AND lower volatility
- Consistent green twin outperformance

Significance for Market

- Benchmark for sovereign green bonds
- Clean greenium measurement method
- Demonstrated issuer commitment
- Won Green Bond of the Year (Sovereign)

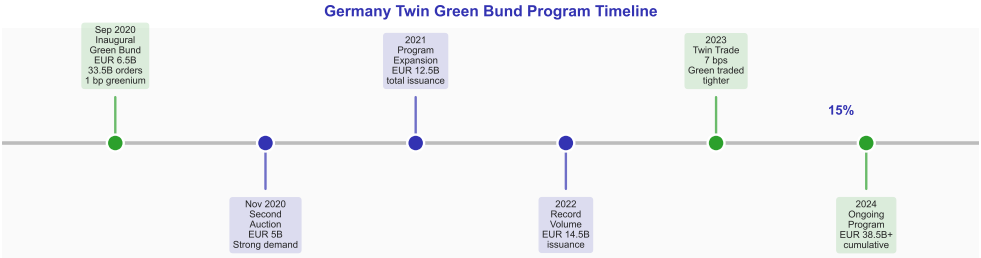
Research Implications

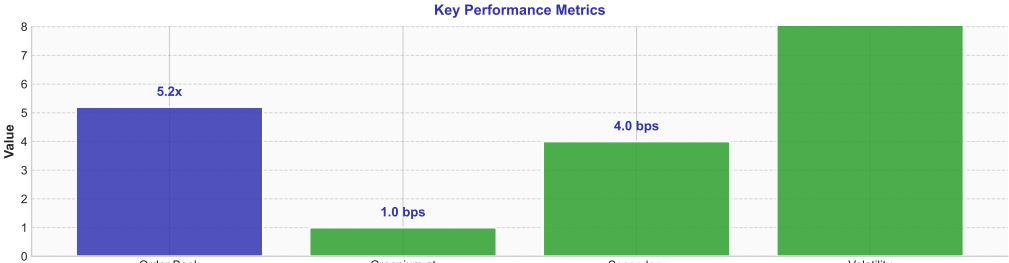
Advanced economy greenium estimates:

- Raw estimate: 4 bps
- Liquidity-adjusted: 68-81 bps
- Twin method preferred for accuracy

[Goal 3] Germany twin program provides the gold standard for greenium measurement and sovereign issuance

Case Study Timeline: Apple Green Bond Program





Sustainability-Linked Bonds vs Green Bonds

Green Bonds (Use-of-Proceeds)
Structure:

- Proceeds earmarked for green projects
- Asset-level commitment
- Project eligibility verified
- Impact reporting on projects

Advantages:

+ Clear link to green assets
+ Established market (USD 670B in 2024)
+ Strong investor understanding
+ 57.7% of sustainable bond market

Limitations:

- Requires eligible green assets
- Not suitable for all issuers

Sustainability-Linked Bonds (SLBs)
Structure:

- General corporate purposes
- Entity-level commitment
- KPI targets with coupon step-up/down
- Sustainability Performance Targets (SPTs)

Advantages:

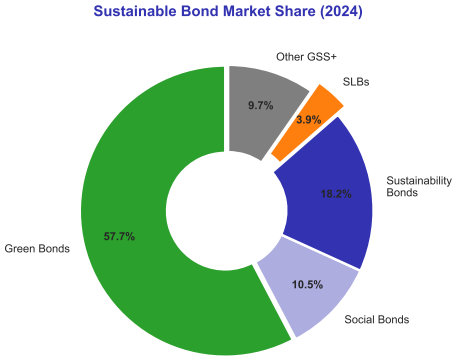
+ Flexible use of proceeds
+ Targets entity-wide transformation
+ Available to any sector

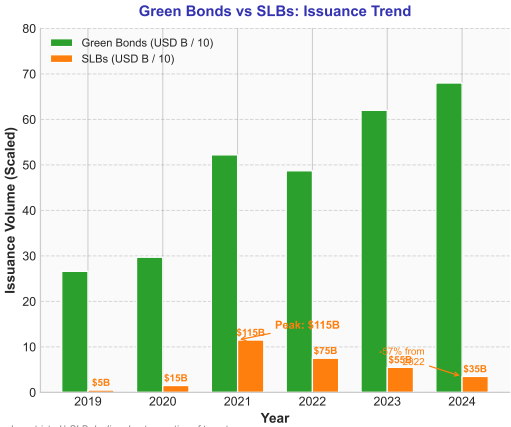
Limitations:

- Target ambition concerns
- Market share declining (3.9% in 2024)
- USD 35B issuance (down 57% from peak)

[Goal 3] SLB market contraction reflects scrutiny of target ambition—Enel step-up a "watershed moment"

SLB Market Evolution and Enel Case Study





SLBs: Coupon linked to KPIs | Green Bonds: Use-of-proceeds restricted | SLB decline due to scrutiny of targets

[Goal 3] Enel 2024 step-up triggered on 10 SLBs demonstrates SLB accountability mechanism in action

Learning Goal 3: Summary and Week Integration

What We Achieved

- ✓ Mastered pre-issuance requirements
- ✓ Understood external review options
- ✓ Learned post-issuance reporting
- ✓ Analyzed Germany twin case study
- ✓ Examined Apple green bond program
- ✓ Compared SLB vs green bond structures

Can You Now...

- Estimate timeline for first-time issuance?
- Calculate external review ROI?
- Design impact reporting metrics?
- Evaluate twin bond program benefits?
- Advise on green bond vs SLB choice?
- Structure KPI targets for SLBs?

Week 2 Integration: Framework → Pricing → Application

- Goal 1: Standards establish credibility (GBP 97% adoption, external review 81%)
- Goal 2: Credibility translates to pricing (2-13 bps greenium, certification premium +8 bps)
- Goal 3: Practical implementation captures benefits (4-6 month process, SPO USD 10-50k)

[Goal 3] Week 2 complete—deep dive into green bonds prepares for Week 3 climate risk integration