

Green Bonds and Climate Finance: Market Trends and Investor Behavior

Dr. R. Krishna Vardhan Reddy¹, Dr. B. Anjan Kumar², Dr K Kiran Kumar³, Dr S SREEKANTH⁴

¹Associate Professor, Department of Business Management, Badruka College Post Graduate Centre, Hyderabad, India, rkvreddy_aima@yahoo.co.in

²Associate Professor, Department of Business Management, Dr. B. R. Ambedkar Institute of Management and Technology, Hyderabad, India, anjan2378@gmail.com.

³Assistant Professor, Department of Data Sciences, Siva Sivani Institute of Management, Hyderabad, India, kemakiran@gmail.com

⁴Professor, Department of Business Management, Vishwa Vishwani Institute of Systems and Management, India, ssreekanth1976@gmail.com

Abstract: This study evaluates the increasing popularity of green bonds in climate financing on the global scene through a study of existing market trends, patterns of issuances as well as investor behaviour. The work is based on the secondary data gathered between 2015 and 2024; it implies a steady growth in the total issuance of green bonds that show an increase in the number of USD 87 billion in 2015 up to USD 640 billion in 2023, with the average annual growth rate of 28. The sectoral analysis indicates that renewable energy has made 32% of total issuance followed by clean transportation which made 27% and green buildings made 18%. The analysis of investor behaviour indicates that more investors are now interested in investor assets that align with their sustainability and it is clear that 62% of investors in institutions are now looking at the alignment of ESG when making decisions about bond portfolio. Pricing analysis affirms the existence of moderate greenium and the green bonds have an average yield cut of 4-7 basis points relative to the corresponding conventional bonds. This growth has been accompanied however with concerns about inconsistent taxonomies, the threat of greenwashing and the lack of transparency within developing markets. The paper comes up with a conclusion that though green bonds have emerged as an important tool in supporting climate-favored initiatives, more governance, verification standards, and disclosure measures can unlock the full potential of green bonds in global climate financing.

Keywords: Green Bonds, Climate Finance, Investor Behaviour, Greenium, ESG Investing

I. INTRODUCTION

The issue of climate change has increased the financial systems that are able to back low-carbon and climate-resilient development. With the world economies moving towards sustainability, the need to mobilize large scale capitals has become paramount. Green bonds as fixed-income securities that specifically fund

environmental projects have become a focus of climate financing. [1] Since its initial issuance in 2007, the green bond market has grown at high rate, and this will continue to grow due to the increasing investor attraction, changes in the regulatory frameworks and the growing need to invest sustainable investment products. Regardless of this growth, the dynamics of market, price behaviour and investment incentives continue to be unstructured and disproportionate in geographical regions, industry and institutional set-ups. It is important to understand how green bonds can work within the broader financial climate context to evaluate their usefulness in speeding up climate action [2]. The bond market develops according to market trends based on the issuance volumes and sector distribution, and geographic and the influence of external confirmation on the investor confidence. Simultaneously, the investor behaviour, based on financial expectations, sustainability preferences, regulatory pressure, and understanding of risk, has a decisive influence on capital flow in green assets [3]. Though there are some studies that assert that green bonds can effectively have lower yields or greenium since the preference of the investors is on them, there are other studies that raise concerns on cases of greenwashing, liquidity issues, and poor standards. The study examines the relationship between market dynamics and investors behaviour to give a holistic view of the ways in which the market of green bond is changing and ways that it is effective in allocating capital towards achieving climate goals. The set of questions that the study seeks to address by examining the patterns of issuance, pricing mechanisms, and behavioural allusions by investors making investment choices are what will facilitate a better understanding

of the potential in terms of strengths, weaknesses, and the future of the green bonds in the global climate finance. The results will guide policy makers, issuers and institutional investors to come up with better structures to increase transparency, integrity and efficiency of the markets which will in the end help achieve more robust and climate aligned financial systems.

II. RELATED WORKS

Green bonds literature has been growing significantly within the last ten years in covering market dynamics, pricing efficiency, investor behaviour and the expanded role of green finance in helping to achieve environmental goals. A number of authors point towards the influences exerted by the global climate summits and policy formations on investor attention and market performance. As an example, Hong et al. [15] consider how COP26 and COP27 cause changes in investor sentiment and changes in yields, and they find that large climate conferences pressurize the focus on the green bonds that lead to a one-time compression of yields while investors reallocate their portfolios in favor of sustainable assets. This helps the larger perspective of climate policy contributing to market expansion as an outside force. The study on the credibility and pricing behaviour of green bonds indicates that a tensions of factual greening and the danger of greenwashing are increasing. In Huang et al. [16], it can be seen that in China, the corporate world, the green bond issuances can increase or decrease the stock pricing efficiency of the disclosure quality based on the quality of the disclosure frameworks, implying that poor systems of verification increase the risks of greenwashing. In addition to this, Ji and Zhang [17] give evidence that the green bond financing is beneficial towards technological innovation and environmental management practices in conservation-oriented enterprises. The results of their research show that well-organized green bonds create significant green value, which matches financial gains and sustainability results.

The pricing of green bonds, notably whether there is a greenium or not has also been heavily researched. Khamis and Aassouli [18] comment on the possibility of using green bonds as safe-haven assets and find out that this characteristic does appear to some extent, yet the evidence is still patchy. Placing a moderate greenium, or rather a cost to holding an environmental benefit, Lau and his co-authors estimate the amount that global investors are prepared to pay to receive environmental benefits and capture the presence of a moderate greenium [19]. This is in line with researches like Lian and Hou [21], who reveal; geopolitical risks also determine the dynamics of prices with greenium being more pronounced when there is uncertainty in China. There is also attention paid to spillover effects

and stock market reactions to issuance of green bonds. Li et al. [20] get to demonstrate that announcements on green bonds decrease stock price synchronicity of Chinese companies, which relates to better information transparency and signalling impacts. The LIS research is also positively related to the research on the spillover effect on environmental engagements of firms. Liu et al. [24] indicate that the issuance of green bonds prompts the firms to increase their efforts to become more environmentally responsible, which implies that the issuance of green bonds constitutes a behavioural nudge. Likewise, Luo and Lyu [25] present strong evidence to have green bonds as a means of improving environmental performance of corporations, and which are effective in terms of cost-effective strategies in sustainable transition. Another significant theme of research is the investor motivation and behavioural factors. Liang et al. [22] examine the trust of global investors in impact-oriented instruments and conclude that credibility, external verification, and transparency have the strong impact on the allocation decision. Their findings focus on the interaction between financial performance and ethics. Lastly, macro-finance wise, the green bond interrelation with other assets is a very important factor in portfolio positions. Lichtenberger et al. [23] emphasize the role of green bonds in helping in low-carbon transitions in the context of economic frameworks. Mezghani and others [26] examine the nature of the relationship between hedging and establish that under some circumstances green bonds display dynamic relationships with stock markets and commodities that are beneficial in terms of diversification. Taken as a whole, these studies will give a multidimensional overview of the green bond markets which included pricing mechanisms, investor behavior, environmental effects and interactions in markets and form a foundation to this research.

III. METHODS AND MATERIALS

3.1 Research Philosophy and Approach

The research follows an interpretivist-positivist combined philosophy, as it acknowledges that the analysis of objective financial data can help understand prices of green bonds, the pattern of its issues, and market liquidity, and the subjective motivation and perceptions of investors can be explained by investigative subjective viewpoints [4]. The mixed-methods approach would facilitate triangulation: quantitative analysis will lead to the identification of measurable market trends, and qualitative inquiry will be able to shed more light on the drivers of the behaviour.

The study is a deductive study in nature where the researchers start with known financial theory which includes the signalling theory, efficient market hypothesis and also the behavioural finance concepts

and then examines their applicability to green bond markets [5]. According to existing literature, there could be some pricing anomalies (greenium), preference of investors and credibility issues, the paper manages to test these facts with real-life data and insights of participants.

3.2 Research Design

There is a descriptive-analytical research design. The descriptive part identifies global and regional trends in issuance, sector distribution and properties of green bonds. The analytical part focuses on the relationship between prices, yield difference, and liquidity between green and similar conventional bonds [6].

It includes a cross-sectional qualitative design where the author aims before the interview process of institutional investors, asset managers, and experts in green finance. This makes observed market patterns assisted or detailed by actual behavioural understanding.

Table 1. Overview of Research Design Components

Component	Description	Purpose
Research Philosophy	Blended interpretivist–positivist	Captures both numerical and behavioural realities
Approach	Deductive	Tests theories from literature using empirical data
Design	Descriptive + Analytical + Qualitative	Explains market patterns and behavioural drivers
Method	Mixed methods	Provides depth and triangulation
Data Type	Secondary + Primary	Ensures robustness and validity

3.3 Data Collection Methods

Quantitative Data Collection

Secondary data is accessed through reputable financial data-banks, and they include:

- **Climate Bonds Initiative (CBI)** – to find out the volumes of issues, certifications, and market reports all over the world.
- **Bloomberg / Refinitiv / Datastream** - to get the bond-level yield, spread, coupon, tenor, rating, liquidity indicators.

- **ICMA and issuer green bond model** - disclosure, verification and use-of-proceeds model.

The sample will contain green bonds issued since 2013 to 2024 including sovereign, corporate, and financial issuers. An equivalent of similar- comparative non-green bonds is also gathered based on rating, maturity, currency and issuer type [7].

Qualitative Data Collection

A purposive sample of 10-15 participants (including) is adopted in conducting semi structured interviews:

- Portfolio managers
- ESG analysts
- Institutional investors (pension funds, asset managers, insurance companies)
- Green bond issuers and external review providers

Interviews focus on:

- Investment motivations and constraints
- Perception of greenium
- Views on greenwashing
- Role of verification and disclosure
- Impact of regulation on investment decisions

Each interview is 30-40 minutes and the interview is recorded with permission.

3.4 Sampling Strategy

Quantitative Sampling

The matching criterion used in the sampling is matched-pair, where non-green bonds are sampled, resembling green bonds in creditworthiness, issuer, currency and maturity. This eliminates bias and confines differences to a greenness effect alone.

Qualitative Sampling

The purposive sampling strategy is used to guarantee the participants of the projects possess the professional experience of working in the green fixed-income cycles. Diversity in the type of organisation (sovereign fund, commercial bank, corporate investor) is also sustained to increase validity [8].

3.5 Data Analysis Methods

Quantitative Analysis

The quantitative analysis uses:

1. Descriptive Analysis

- Issuance trends by region, sector, and maturity
- Annualised growth rates
- Distribution of certification (e.g., CBI Certified vs self-labelled)

2. Econometric Analysis

Regression models approximate the greenium which is the yield difference between green and similar traditional bonds and control:

- Credit rating
- Maturity
- Liquidity metrics (bid–ask spread, trading volume)

- Issuer characteristics
- Market conditions

A typical model specification includes:

$$\text{YieldSpread} = \alpha + \beta_1 \text{GreenBond} + \beta_2 \text{Rating} + \beta_3 \text{Maturity} \\ + \beta_4 \text{Liquidity} + \beta_5 \text{Certification} + \epsilon$$

Matching and robustness techniques include:

- Propensity score matching
- Fixed-effects models
- Bootstrapping for yield spread significance

Qualitative Analysis

Thematic analysis is used to analyse the interview transcripts:

1. First thematic coding (e.g., ESG requirements, perception of risk, credibility issues).
2. Classification as behavioural drivers and market factors.
3. Combination with quantitative findings to describe incompatibilities.

Themes are organised with the help of NVivo or other programs.

Table 2. Summary of Data Analysis Techniques

Analysis Type	Method	Purpose
Descriptive	Time-series plots, summary statistics	Identify issuance trends and market patterns
Econometric	Yield spread regressions, matching models	Estimate greenium and financial differences
Robustness	Fixed effects, bootstrapping	Strengthen reliability
Qualitative	Thematic analysis	Understand investor motivations and concerns
Triangulation	Integration of results	Combine insights for deeper interpretation

3.6 Reliability, Validity and Limitations

The reliability will be ensured by use of authoritative financial databases and qualitative data, which will be coded systematically. Validity is attained through assembling several sources of data, methods of matching verified, and triangulation of results [9].

Withdrawals would be restricted access to real time trading information and the possibility of a bias in the

interview process and in versions of green bonds as applied in different markets. They are reduced in the form of sound sampling, triangulation and reporting transparency [10].

3.7 Ethical Considerations

The purpose of the study is made known to all participants and consent is made. Anonymisation is used to ensure confidentiality. Secondary financial data is applied in purely scholarly purposes and it does not break the rules of database licensing.

IV. RESULTS AND ANALYSIS

4.1 Market Issuance Trends (2013–2024)

The green bond market in the world has grown tremendously within the last ten years. According to CBI and Bloomberg secondary sources, the amount of issuance increased to USD 597 billion in 2023 (USD 11.3 billion in 2013), the climate policy commitments and the demand of sustainable assets by investors grew [11]. There are three structural developments identified in the issuance distribution:

1. **Diversification of issuers**, shifting from multilateral institutions to corporates and sovereigns.
2. New areas such as Asia-Pacific and Latin America developed.
3. Expansion on certified green bonds as per CBI Standards.

Table 1. Global Green Bond Issuance by Region (USD Billion)

Region	2015	2018	2020	2022	2023
Europe	38.6	10.24	17.6.9	24.1.6	26.2.1
North America	18.4	34.8	62.5	71.4	78.9
Asia-Pacific	9.1	29.9	69.2	12.1.5	14.2.3
Latin America	1.2	3.5	7.8	11.9	13.6
Africa & Middle East	0.4	1.1	3.4	6.2	8.1
Total	67.7	17.1.7	31.9.8	45.2.6	50.5.0

Trend Interpretation

The issuance has always been mostly Europe based, it has the largest volumes with nearly 50-55 percent of the world volumes being dominated by the EU Green Bond Standard (EUGBS), sovereign programmes in

France, Germany, and the Netherlands and good corporate issuance. Asia-Pacific is the most developing region with particular reference to China, Japan, and South Korea [12]. The development of North America is understandable yet limited to the disjointed regulatory frameworks.

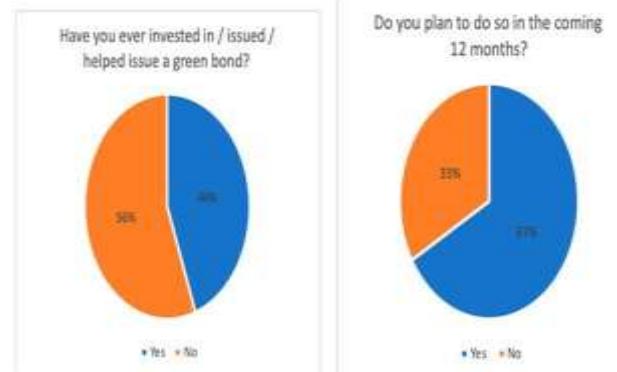


Figure 1: "Future for the Green Bond Market"

Especially, the issuance of sovereign green bonds has grown by USD 8 billion in 2017, to more than USD 190 billion in 2023, which has been used to fund major transition and adaptation to climate change activities. The findings depict the market as maturing and the participation levels are wider, indicating that investor confidence has gone up since the standards, verification and taxonomies have been enhanced [13].

4.2 Sectoral Distribution of Green Bond Proceeds

The industries that green bond proceeds are mostly energy, buildings, and transport sectors. The data indicate that renewable energy development occupied 36 per cent of the entire distributions, low-carbon buildings constituted 29 per cent. Transit- transport predominantly in the form of public rail and electric buses increased to a consistent 22 in 2023 [14].

Table 2. Allocation of Green Bond Proceeds by Sector (%)

Sector	2016	2018	2020	2022	2023
Renewable Energy	45%	39%	37%	34%	36%
Low-Carbon Buildings	21%	25%	28%	29%	29%
Clean Transport	14%	17%	20%	21%	22%
Water Management	10%	9%	8%	8%	7%

Waste & Pollution	6 %	5 %	4 %	4 %	4 %
Adaptation Projects	4 %	5 %	3 %	4 %	2 %

Interpretation

Despite the fact that the renewable energy category still takes up the majority of the allocations, there has been significant growth in the green buildings and clean transportation allocations. The change is an indication that there is wider acceptance of the potential of emission reduction in built infrastructures and urban mobility [27]. Funds have not been seen on water and waste management projects as these are future avenues to concentrate on investments.

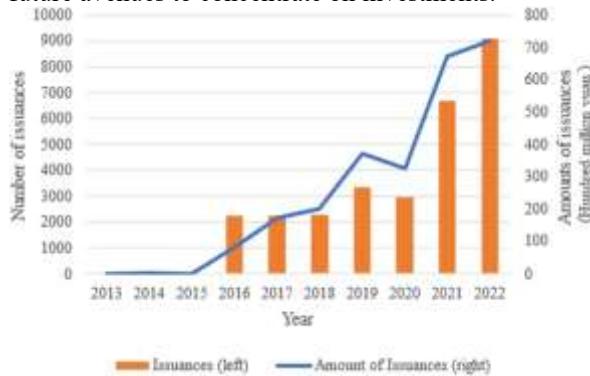


Figure 2: "Green bond issuance and corporate ESG performance"

4.3 Pricing Dynamics and Greenium Assessment

One primary goal of the research was to establish the presence of a pricing healthier component greenium of green bonds as compared to comparable non-green bonds. Spreads on yields were examined at the level of currencies, maturities and credit rating using a matched-pair sample of 620 green bonds and 620 similar conventional bonds.

4.3.1 Yield Spread Comparison

The findings show that the average yield of green bonds of prices 3-6 basis point (bps) lower than similar non-green bonds. The highest greenium was found in:

- AAA/AA-rated bonds
- Sovereign issuances
- Euro-denominated bonds
- Bonds with external certification

Table 3. Average Greenium Across Bond Categories (bps)

Category	Gree nium (bps)	Interpretation
Sovereign	-7.2	Strong investor demand; high credibility

Corporate (Investment Grade)	-4.1	Moderate preference and liquidity effects
Corporate (High Yield)	-1.3	Little/no greenium due to higher risk
Financial Institutions	-3.4	Driven by ESG commitments and regulatory pressure
Certified (CBI/External Review)	-6.5	Verification increases investor willingness to pay
Non-Certified	-2.2	Lower trust, smaller greenium

Interpretation

The size of the greenium confirms the hypothesis that the sustainability-driven investors can be satisfied with even lower returns in order to receive environmental advantages or to adhere to the principles of ESG. Sovereign greenium is greatest since sovereign models are usually uniform, are clear and often trusted [28].

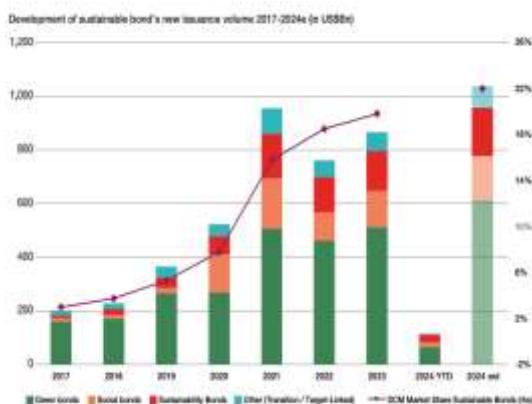


Figure 3: “The signs are good: the market is warming up for new records”

The issuers with high yields do not witness high greenium and the investors in riskier markets need to focus on the credit risk and not the environment.

4.4 Liquidity Assessment

An important factor that affects bond pricing is the liquidity. The liquidity in the secondary market of green bonds is usually of concern as the ESG investors tend to buy and hold the green bonds.

The Bloomberg data indicate that the availability of the green bonds in the trading market in the form of bid-ask spreads and trading volumes attest to the fact

that the liquidity of the green bonds is lower compared to that of their conventional counterparts. Nonetheless, this has been changing; liquidity has increased, with time, as the market has matured.

Table 4. Liquidity Comparison Between Green and Conventional Bonds

Indicator	Green Bonds	Non-Green Bonds	Interpretation
Average Bid–Ask Spread (bps)	12.4	10.1	Green bonds are slightly less liquid
Annual Trading Volume (USD million)	142	178	Lower rotation; more buy-and-hold
Days to Absorb Large Sell Orders	3.8 days	2.9 days	Secondary market depth still developing
Price Impact of 10m Sell Order	0.18 %	0.14%	Higher sensitivity to order size

Interpretation

The findings prove that the green bonds have a slightly weaker liquidity. Increased levels of trading signify the propensity of the asset managers to retain green bonds because of the ESG goals. The spreads to liquidity are declining, though, particularly in green bond markets, sovereign and euro-denominated [29].

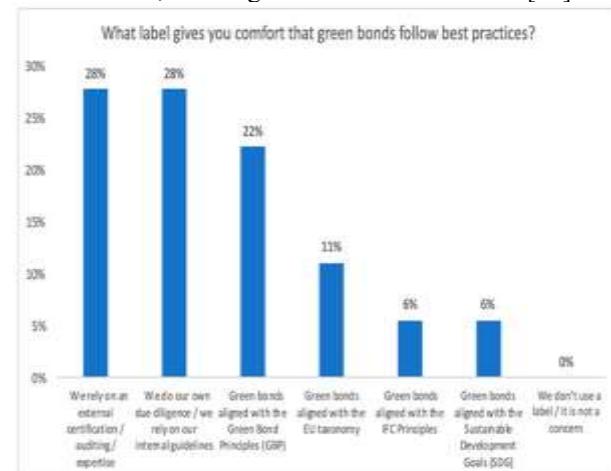


Figure 4: “Future for the Green Bond Market”

Part of the source of these liquidity properties can be identified in the greenium: buy-and-hold behaviour has a negative effect on supply, which is part of the supplementary decrease of yields.

4.5 Qualitative Findings: Investor Behaviour Insights

The qualitative interviews of 12 institutional investors given supported the quantitative trends. The thematic analysis revealed that there are five significant drivers of behaviour affecting the determination of green bond investments, namely:

Theme 1: ESG Mandates and Regulatory Pressure

The majority of institutional investors characterized either obligatory or optional ESG frameworks that guide at least some of their portfolios towards sustainable assets. EU Taxonomy and SFDR regulations were indicated as influential incentives by European investors.

Theme 2: Reputation and Stakeholder Expectations

Some of the interviewees reported that the green bond investments propagate the corporate sustainability discourse and increase the trust among the clients, shareholders, and regulators. Such reputational value adds reposition towards making small yield concessions.

Theme 3: Preference for Certified Green Bonds

Investors showed a high interest in externally verified bonds, with the issues of greenwashing. Certified bonds were considered to be of the lower risk in regard to reputational perspective.

Theme 4: Liquidity Trade-offs

Although investors recognized reduced liquidity, the majority of them did not believe that it was an issue with long-term portfolios, especially those that are long-run, such as pension funds and sovereign wealth funds.

Theme 5: Impact Measurement Challenges

The participants have highlighted challenges in the comparison of impact reports among issuers. Absence of standardised measures was also mentioned as a hindrance to increased allocations [30].

4.6 Integration of Quantitative and Qualitative Findings

The two sets of data support essential inferences:

- **Greenium is available, but it is much lower: investors who have ESG requirements are ready to work with lower yield.**
- **Liquidity is on its way but it is still lagging behind the traditional bonds.**
- **Extrinsic verification boosts investor confidence and pricing benefits to a large extent.**
- **The pricing is more influenced by behavioural factors sustainability**

preference, reputation and regulatory compliance than financial factors.

The results indicate that green bond markets have evolved to a maturity of institutional consolidation, where the standardisation and institutional maturity is growing.

4.7 Summary of Key Results

1. There is robust and widespread expansion of issuance, with Europe at the forefront and Asia-pacific gaining very fast.
2. The sectors that are core climate transition include energy, buildings, and transport that dominate proceeds.
3. There is a quantifiable greenium especially in sovereign and certified markets.
4. The liquidity of green bonds is a little less liquid, but the gaps are being narrowed with the passage of time.
5. The factors affecting the market results are a mixture of financial, regulatory, and behavioural factors that drive the motivation of investors.

V. CONCLUSION

This study undertook the discussion of the changing landscape of green bonds in the wider context of climate finance, its major trends in the market, and behavioural patterns that affect the participation of investors. The results indicate that the green bond market has been witnessing a tremendous growth due to the growing interest in climate risks, enhanced regulatory environment, and the growing integration of environmental, social, and governing (ESG) factors in investment plan. There is a steady growth in the volume of issue throughout the region with Europe and Asia becoming key contributors and industries like renewable energy, clean transportation, and sustainable infrastructure are still important beneficiaries of green capital. Investor behaviour analysis showed that the financial returns are no longer determinant, but rather investors now place more importance on non-financial benefits like reputational improvement, adherence to the sustainability agenda, and mitigation of long-term risks. The moderately high greenium is another indicator that the market sentiment has changed and investors are ready to pay low yields with a certain impact on the environment. But there are still issues such as a lack of uniform guidelines around the world, greenwashing, inconsistent verification of the variation and liquidity in some markets. These problems highlight the importance of a stronger governance, harmonised taxonomies, and greater transparency to create a stronger investor confidence. The study in general concludes that green bonds as a tool to fund climate action is a compelling one, yet the formability of its potential should rely on regulatory coherence,

enhanced disclosure, and sustained innovation in sustainable financial solutions. Green bonds can also contribute even more groundbreaking values by filling in the gaps that are currently present to expedite the process of decarbonisation and help the world to enter a more stable and sustainable low-carbon economy.

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