ICE SUSTAINABLE FINANCE

“Greenium” and Impact Assessment Analysis

July 2024

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1. Executive Summary

The Japanese Government Pension Investment Fund (GPIF) is seeking to better understand the prevalence of Greenium within secondary Sustainable Bond markets and whether there is any correlation with Sustainable Bond disclosure documents. Intercontinental Exchange, Inc. (ICE) is assisting GPIF to achieve this through a detailed analysis of Greenium and Impact Assessment for a selected universe of Sustainable and non-Sustainable Bonds.

Greenium is the measure of the premium at which Sustainable Bonds trade over equivalent traditional non-sustainable bonds (or "Brown" Bonds) and has been the subject of discussion. Various research papers have drawn differing conclusions regarding the prevalence of Greenium, both in the primary and secondary markets. In this report, GPIF and ICE investigate the presence of Greenium, focusing on the secondary market, and examine whether investors react to a Sustainable Bond's disclosure publications.

To achieve this the Z-spreads for a selection of Sustainable Bonds and comparable Brown Bonds are analysed for evidence of Sustainable Bonds trading at a premium over their Brown Bond equivalent. The bonds selected for analysis were those of large and established Sustainable Bond issuers in the last three years in either Euros (EUR), Japanese Yen (JPY) or United States Dollars (USD).

Additionally, features of the Sustainable Bonds, such as independent Second Party Opinion and/or post-issuance reporting, are also reviewed to determine whether such disclosure makes any difference to the Greenium results.

Through a structured framework of standardization and normalization of numerous variables, including the reported impact objectives of individual Sustainable Bonds, GPIF and ICE also performed a detailed Impact Assessment Analysis of the selected universe chosen for the Greenium research. The objective of the Impact Assessment Analysis is to determine the overall impacts of the Sustainable Bonds in-scope, and whether such impact disclosures, or a lack thereof, correlate to Greenium.

Overall, the findings of this analysis suggest there is evidence of Greenium in the secondary Sustainable Bonds market for some individual bonds, but this is not consistent across all Sustainable Bonds, with some even trading at a discount. These variations are even observable in pools of bonds from the same issuer, where one bond could be trading at a Greenium and another at a discount. This would point to a lack of a consistent or common driver of Greenium. The lack of a general or "universal" Greenium is consistent with the mixed results of other research on the presence (or lack) of Greenium.

This analysis also found that the availability of Sustainable Bond disclosures, both pre-and post-issuance reporting, did not have a consistent correlation to Greenium. There is some (but weak) evidence to suggest recognition is given to Second-Party Opinion and Achieved Impact. However, any influence is not sufficiently large to be conclusive. This implies that at present, pre- and post-issuance information is not a major factor in investor decision-making in secondary Sustainable Bond markets. However, this is not to say this could not change in the future, especially if the global transition towards a Net Zero economy gathers momentum in the years ahead as key climate targets are approached.

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The markets are increasingly focussing on issuers transition plans; therefore, we expect that issuers will need to provide greater transparency on their ‘use of proceeds’ by more accurate and frequent reporting, and therefore investors will start to factor this in their investment decision making.

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2. Project Objective

2.1. Greenium Analysis

The need to raise capital dedicated to helping the transition of the economy to a more just and sustainable world, and the increased interest of investors in environmental and social financial instruments has led to a rise in popularity of Sustainable Bonds[1]. It has been suggested and observed that Sustainable Bonds can trade at a premium to Brown Bonds. This is often referred to as "Greenium" and is defined as the relative decrease in the yield of a Sustainable Bond with respect to an otherwise equivalent conventional (Brown) Bond[2] and is demonstrated as either the Sustainable Bond trading at a relatively higher price to the Brown Bond, or a reduced coupon offered to Sustainable Bond investors. Greenium is based on the logic that some investors may have a greater willingness to accept lower yields in favour of a sustainable impact[3].

At the point of issuance, any Greenium would lead to issuers being able to borrow funds to finance their "green" or "sustainable" projects under more favourable terms than if they were to borrow for general purposes using a Brown Bond. However, any existence of Greenium would also mean investors are effectively penalised for directing funds towards transition financing via Sustainable Bonds. This price distortion has the potential to reduce the pool of actively trading investors, leading to a lack of liquidity in secondary markets. This asks the question - do Sustainable Bonds truly extract a Greenium from investors, and are investors responding to the reported allocation of funds, or the actual impacts they've achieved?

Prior research into the question of whether Greenium exists has reached mixed conclusions. Generally, any claims of Greenium have been tentative, with results ranging from no Greenium observed[2,3] to 8 basis points (bps)[4] and in some cases even 18 bps[5] of Greenium be observed. Even though such papers agree with the existence of a Greenium, they caveat their findings with high variation in results on a per-bond basis, as well as the confounding factors that can increase or decrease Greenium.

Additionally, different papers may examine Greenium in either primary or secondary markets, or measure Greenium differently - some look at absolute yields, whilst others examine the difference in the yield between the Sustainable and Brown Bonds[6]. Others measure the difference in yield between the sustainable instrument and a benchmark, such as a government yield curve. These factors contribute to the mixed results.

Where conclusions have been drawn, Greenium is generally associated with the scale of the issuer, with larger issuers tending to extract a greater Greenium[4]. The presence of Second-Party Opinions

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[1] In this report, we define Sustainable Bonds as blue bonds, green bonds, social bonds, sustainability bonds, transition bonds, and sustainability-linked bonds that are either declared as such by the issuer or that have a second party opinion assessing alignment with sustainable bond market guidelines.

[2] O.D. Zerbib, *"The effect of pro-environmental preferences on bond prices: Evidence from green Bonds"* (2019), Journal of Banking & Finance, Vol. 98, pg. 39-60, Available at: https://doi.org/10.1016/j.jbankfin.2018.10.012.

[3] D.F. Larcker & E. Watts, *"Where's the Greenium?"* (2019). Journal of Accounting and Economics, Vol. 69, Issues 2–3, 101312, Available at: https://ssrn.com/abstract=3333847

[4] J. Caramichael & A.C. Rapp, "*The green corporate bond issuance premium*", (2024), Journal of Banking & Finance, Vol. 162, no. 107126. Available at: https://doi.org/10.1016/j.jbankfin.2024.107126.

[5] J. Kapraun et.al., "*(In)-Credibly Green: Which Bonds Trade at a Green Bond Premium?*", (2021), Kapraun, Julia and Kapraun, Julia and Latino, Carmelo and Scheins, Christopher and Schlag, Christian, (In)-Credibly Green: Which Bonds Trade at a Green Bond Premium? (April 29, 21). Proceedings of Paris December 2019 Finance Meeting EUROFIDAI - ESSEC. Available at: http://dx.doi.org/10.2139/ssrn.3347337

[6] M.B. Mohamed, T. Roncalli, and R. Semet, "*Green vs. Social Bond Premium*", (2023), Available at: https://dx.doi.org/10.2139/ssrn.4448651

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(SPO) on the value of a particular bond, as well as inclusion in Green Bond Indices, have also been associated with a more significant Greenium[4,5]. Premiums associated with Social bonds have also been examined, but results have been inconclusive[6].

The objective of the Greenium Analysis carried out by GPIF and ICE was to investigate the presence of Greenium in the secondary market, and whether investors react to a bond's disclosure publications. In particular, how the secondary market Greenium of a bond is affected by the presence of SPO (made at issuance) is examined. Post-issuance allocation and impact reports made by the issuer, and third-party verification for such post-issuance claims are also analysed for any influence on Greenium.

Analysis is conducted across bonds issued in EUR, JPY, and USD, issued in the past 3 years (2021 - 2023), selecting for the largest bonds from the most prolific Sustainable Bond issuers (as described in more detail below in section 3).

2.2. Impact Assessment

Sustainable Bond issuance has grown as companies and governments seek to finance their transition plans to achieve their sustainability goals, and investors seek ways to allocate capital towards social and environmental objectives. As a result, there is an interest in ensuring the effectiveness of investments, as well as increasing the transparency of the real-world impacts of these projects. Issuers will often publish specific performance-related metrics surrounding their Sustainable Bonds which are referred to as impact metrics.

The objective of the Impact Assessment Analysis is to determine the overall impacts of the Sustainable Bonds in-scope, and to complement the Greenium Analysis (as described in section 2.1) by providing context to impact metric disclosures and whether such disclosures, or a lack thereof, correlate to Greenium.

The metrics and impacts to be assessed as part of the analysis include the identification of key coverage metrics to understand the general make-up of the universe of bonds in-scope, the reporting status of each individual bond, and whether they have declared a methodological alignment to various reporting standards and guidelines. Additionally, the analysis examines the promised or otherwise claimed allocation of proceeds to sustainability categories as defined by the International Capital Markets Association (ICMA), and alignment to UN Sustainable Development Goals (UN SDG's)[7]. The analysis also examines the universe of bonds in-scope as an equally weighted portfolio and aggregates the metrics in order to assess the contribution towards metrics and identify the most commonly reported impact metrics for the bonds in-scope.

[7] For more information on the UN SDGs, please see **https://www.un.org/sustainabledevelopment**.

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3. Screening: Selecting the Green Bond Universe

Screening of the ICE bond universe was carried out to identify the bonds in scope for both the Greenium and Impact Assessment Analysis. Bonds were screened using the ICE Sustainable Bond Classification Service to identify which bonds were Sustainable Bonds and the classification of each individual bond. The ICE Sustainable Bond Classification predominantly follows the ICMA framework whereby Sustainable Bonds are classified in several different categories - Green (aimed at financing projects with pro-environmental targets, and projects consistent with a transition to a net-zero and nature-positive economy), Social (aimed at financing projects that achieve greater social benefits), Blue (green bonds that focus on the health of the hydrosphere and the blue economy), Sustainability (aimed at financing a combination of both environmental and social projects) and Sustainability Linked Bonds (any type of bond instrument for which the financial and/or structural characteristics can vary depending on whether the issuer achieves pre-defined sustainability/environmental, social, and governance objectives). ICE's Data Pricing and Reference Data[8] database was also leveraged to match core characteristics, determine a bond's liquidity, and check for recent price evaluations.

The following criteria were determined to screen the ICE bond universe and arrive at the 'Selected Universe'. For the purposes of this report, the Sustainable Bonds that were deemed in-scope will be referred to as "Green Bond/s" throughout, regardless of whether they are classified as a Blue, Green, or Sustainability bond. The report uses "Sustainable Bonds" to refer to the wider Sustainable Bond market, regardless of classification.

Figure 1: Screening Criteria

Criteria	Definition	Requirement
Green Bond	A Sustainable Bond with a classification of Blue, Green or Sustainability, regardless of whether it is certified or not by a third party. Social, Transition and Sustainability-Linked bonds were excluded from scope.	Mandatory
Issuance Date	Date must be within the past three full calendar years, that is: issued between and including 1 January to 31 December in 2023, 2022 or 2021.	Mandatory
Issuance Amount Currency	Currency must be in EUR, JPY, or USD.	Mandatory
Top Issuers by Count	The number of Sustainable bonds issued across all Issuance Date years for an issuer.	Mandatory
Top Issuers by Value	The Issue amount value of the issued Sustainable bond.	Mandatory
Liquidity	Sustainable bonds with the most market makers, that is, Sustainable bonds that are being actively traded by financial entities, with publicly declared bid and ask prices, ensuring there is enough liquidity in the market.	Not mandatory
Evaluations	Sustainable bonds with regular and recent price evaluations from ICE Data Services.	Not mandatory
Other Bonds	The following bonds to be excluded from selection: ▪ Duplicate Listings ▪ Floating Rate ▪ Perpetual Bonds ▪ Strip Bonds	Exclude

[8] ICE Data Pricing & Reference Data has been in business since 1968, is a Delaware Limited Liability Company, and is an indirect, wholly owned subsidiary of Intercontinental Exchange, Inc (ICE).

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The selection process started by filtering the ICE bond universe for Green Bonds issued within the year and currency of interest, for example, Green Bonds issued in EUR and issued between and including 1 January 2021 to 31 December 2021. The issuers of this screened cohort were then sorted largest to smallest by count, such that we select the issuers with the largest number of Green Bond issuances in 2021 for each currency (EUR, JPY, USD). The bonds issued by the top 20 of these issuers are then selected and sorted largest to smallest by the issue amount. Of this cohort, the bonds were checked for evaluations and sorted again by the largest to smallest number of market makers, to check for liquidity. No specific number or threshold of market makers could be defined as the availability of market makers varied depending on the market, for example, the Japanese market had fewer market makers when compared with the European market.

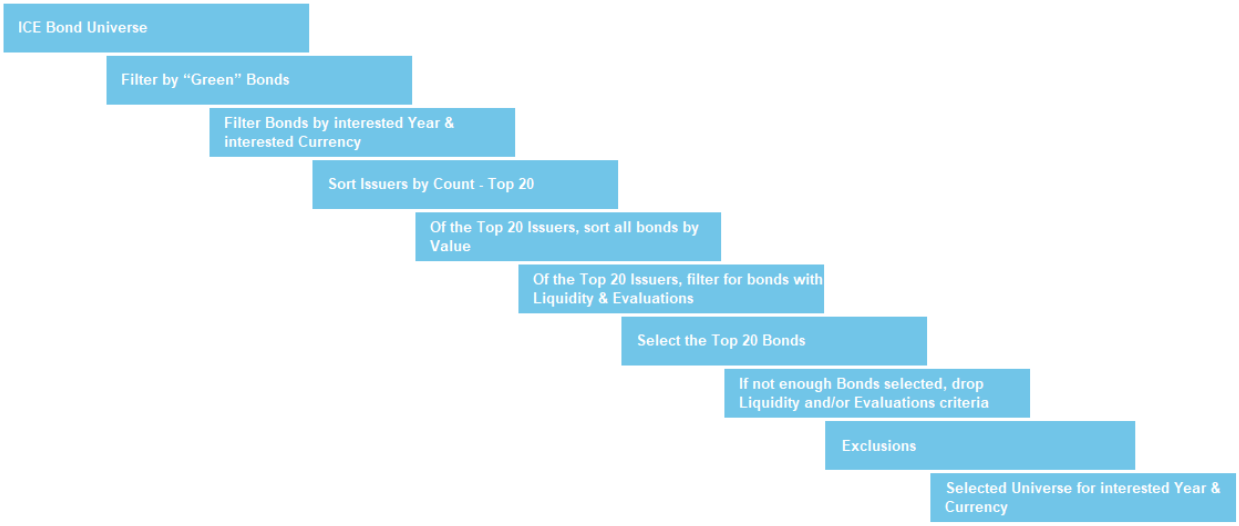
Having followed this screening process, where possible, the top 20 bonds were selected using the following criteria - bonds of issuers that had issued the greatest number of bonds, with the highest values (or issue amounts), and bonds that had liquidity and regular and recent evaluations. If 20 bonds were unable to be selected, then the liquidity and evaluated pricing criteria were loosened. If loosening these criteria still didn't allow for a large enough selection of bonds, then the top 20 Issuers by count and volume were expanded to the next top 20 issuers (i.e. top 40 issuers) until 20 bonds could be selected for the relevant year and currency.

Finally, bonds for which Z-Spreads would have been inappropriate, such as perpetual, floating rate and/or strip bonds, were excluded, along with duplicate listings such as those arising from dual 144A/REG S bond issuance. By screening for the largest bonds by count and volume, the selected bonds covered a significant part of the market and are a representative reflection of market activity.

This selection process was repeated for each of the three currencies and years to form the 'Selected Universe'.

The figure below demonstrates the high-level process that was followed to form the Selected Universe and selection of bonds considered to be in-scope for the purposes of Greenium and Impact Assessment Analysis (Figure 2).

Figure 2: High-Level Green Bond Selection Process



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4. Greenium Analysis

4.1. Data Sources

Several databases were used to form the basis of the Greenium Analysis. As described above in section 3, ICE's Sustainable Bond database and Sustainable Bond Classification Service was used to identify Sustainable Bonds. This dataset was enhanced with ICE's Pricing & Reference Data database. ICE's Pricing & Reference Data provides global securities, evaluations, reference data, and analytics designed to support financial institutions' and investment funds' valuation activities, securities operations, research, and portfolio management.

ICE's reference data was utilised for the purpose of being able to search and compare Green Bonds with Brown Bonds that had similar characteristics and define a 'Matched Universe' (as described below in section 4.2.1). Pricing and evaluation data was utilised for the purpose of tracking the market demand for the selected bonds. ICE's Pricing Data incorporates market colour from a range of sources, including market makers and exchanges, and combines them with analyst sector expertise and market knowledge.

The data collected for the bonds included in the Greenium Analysis included, but not limited to, the following fields[9]:

- Identifier (ISIN)
- Primary Name (Issuer)
- Issue Date
- Maturity Date
- Debt Rank Type
- Subordination Type
- Issue Amount
- Issue Amount Currency
- Issue Pric
- Bond Indicators (Call, Put, Sink, Convertible)
- Guarantee Type
- Current Coupon Type
- Current Coupon Rate
- Sustainable Bond Type
- Quote Sources
- Price/Evaluation Date
- Z Spread

ICE's data collaborator, Luxembourg Stock Exchange's DataHub was also leveraged for the pre- and post-issuance documentation information (such as Allocation and Impact Reports).

[9] See Appendix 8.1 for the list of field name definitions as per the ICE Pricing & Reference Data Dictionary.

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4.2. Methodology

4.2.1. Matching Logic to Match Green/Brown Bonds

To establish whether Greenium exists, equivalent Brown Bonds needed to be matched with each of the Green Bonds in the selected universe to form a 'Matched Universe' that could be analysed. A matching logic was defined by using several bond characteristics and applying an equal weighting to each characteristic to find the best match. Equal weighting was applied to not over emphasize or place higher importance on individual criteria. Characteristics such as Issue Amount, Issue Date and Current Coupon Rate were not included in the criteria to match due to the use of Z-Spreads accounting for such characteristics. If the Current Coupon Rate was included in the matching logic, this would be controlling for the exact feature that is under investigation as part of this analysis.

The table below sets out the criteria and applied logic, as described above, for the matching of a Green Bond to a Brown bond equivalent (Figure 3).

Figure 3: Matching Criteria and Logic

Criteria for Matching	Rule	Value
Primary Name (Issuer)	= (must be equal)	-
Issue Amount Currency	=	-
Maturity Date	*X = green bond maturity – brown bond maturity* X ≤ 6 months	1
	X > 6 months	0
Debt Rank	=	1
Subordination Type	=	1
Call Indicator	=	1
Put Indicator	=	1
Sink Indicator	=	1
Convertible Indicator	=	1
Guarantee Type	=	1
Current Coupon Type	=	1
Maximum Matching Total		**9**

To find the 'best match' of Brown Bonds to Green Bonds, the matching logic as described above was applied to the entire ICE Brown Bond Universe. On some occasions one Brown Bond would be paired with two Green Bonds, if they were deemed to be the best match. An example of a matched Green/Brown pair can be seen in the table below (Figure 4).

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Figure 4: Germany (Federal Republic Of) Matched Pair Example

Criteria	Green Bond	Brown Bond	Match Total
ISIN	**DE0001030740**	**DE0001141869**	
Issuer	Germany (Federal Republic Of)	Germany (Federal Republic Of)	-
Issue Amount Currency	Euro	Euro	-
Maturity Date	15/10/2027	15/10/2027	1
Debt Rank	Not Applicable	Not Applicable	1
Subordination Type	Senior	Senior	1
Call Indicator	FALSE	FALSE	1
Put Indicator	FALSE	FALSE	1
Sink Indicator	FALSE	FALSE	1
Convertible Indicator	FALSE	FALSE	1
Guarantee Type	No guarantee	No guarantee	1
Current Coupon Type	Fixed rate	Fixed rate	1
Total			**9**

As a final step in the matching process and after reviewing the Z-Spread data, several bond pairs were excluded due to data availability, where consistency may have been lacking (such as, bonds that may not have regular price evaluations). After this data cleansing, we arrived at a final 'Analysed Universe' consisting of 79 Green/Brown Bond pairs (or 158 individual bonds), as set out in the table below (Figure 5).

Figure 5: Analysed Universe per selected Currency

Currency	Analysed Universe
EUR	32
JPY	36
USD	11
Total number of bond pairs	***79***

4.2.2. Matching Logic Comparison

The table below demonstrates the distribution of characteristics between the selected Green Bond universe and their matched Brown Bonds (Figure 6). The comparison takes inspiration from the work carried out in Table 2 of "*(In)-Credibly Green: Which Bonds Trade at a Green Bond Premium*"[5]. This gives a view to the distribution of bond characteristics for the Analysed Universe. The characteristics or metrics that have been chosen to compare are those which have not been controlled (or matched) for (such as Coupon Rate, and Issue Price).

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It is worth noting that the matching used in J. Kapraun et.al.[5] was conducted to find peers when measuring premiums in the primary market, and in absolute yield, whereas the focus of this analysis is on the secondary market, and in the Z-Spread. As a result of these differences, the criteria used in our matching are not the same, and we do not produce a comparison for the same bond features.

The three characteristics or criteria most relevant for our comparison are the Coupon Rate, Issue Price, and the Yield to Maturity (as of the Date of Issuance). As can be seen in Figure 6 below, the mean and standard deviation of these three characteristics is very close to one another, demonstrating the closeness of the distributions for these features between the Green Bonds and their matched twins. A bond's coupon and price are the primary mechanisms by which any Greenium is evident, so it is essential to not control for these when carrying out matching. The similarity however shows that the bonds are of similar desirability and behaviour with regards to cash flow. This is more apparent when looking at the similarity of the absolute Yield to Maturity (as of Date of Issuance). These show that the overall returns from the Green and Brown Bonds are of similar composition to one another at issuance and therefore are of similar financial desirability. Any changes in the pricing and therefore the yield post-issuance will consequently relate to a Greenium, if present.

Figure 6: Bond Criteria Comparison

Metric	Bond Label	Percentile					Mean	Standard Deviation	Number of Bonds
		5th	25th	50th	75th	95th			
Coupon Rate (%)	Green Bond	0.00	0.15	0.70	2.06	4.63	1.36	1.53	79
	Brown Bond	0.00	0.33	0.85	2.05	3.82	1.37	1.28	73
Issue Price (%)	Green Bond	99.17	99.81	100.00	100.00	100.62	99.80	1.36	79
	Brown Bond	98.74	99.80	100.00	100.00	100.00	99.79	1.44	69
Yield to Maturity (as of Date of Issuance) (%)	Green Bond	0.02	0.29	0.97	2.07	4.63	1.43	1.50	79
	Brown Bond	0.19	0.48	0.98	2.05	3.88	1.45	1.23	69

4.2.3. Calculation of Spreads

To measure a premium in the pricing, we have chosen to examine differences in the Zero-Volatility Spread (Z-Spread) between a given Green Bond and its matched Brown Bond twin. A Z-Spread is the difference between the value of the real cash flows of a bond and the risk-free spot rate curve, so it is a measure of the premium over the risk-free rate due to its liquidity and creditworthiness.

We have chosen the difference in Z-Spreads to measure Greenium for several reasons. Z-Spreads are a standard measure for comparing bonds, especially once the initial issuance has passed and the bond is being traded on secondary markets. Z-Spreads also provide a consistent benchmark that incorporates the credit risks of the issuer (reducing potential sources of differences for comparisons between bonds from the same issuer), and by taking into account the entire real yield curve, they

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ensure any premium results from credit-risk, liquidity, or willingness-to-pay, as opposed to different expectations surrounding interest rates during the remaining term of a bond.

For all bonds in our Analysed Universe, we have used the Z-Spread dating back to either the issuance of the bond or 1 January 2021 (whichever is more recent) until 31 May 2024, with daily evaluation points.

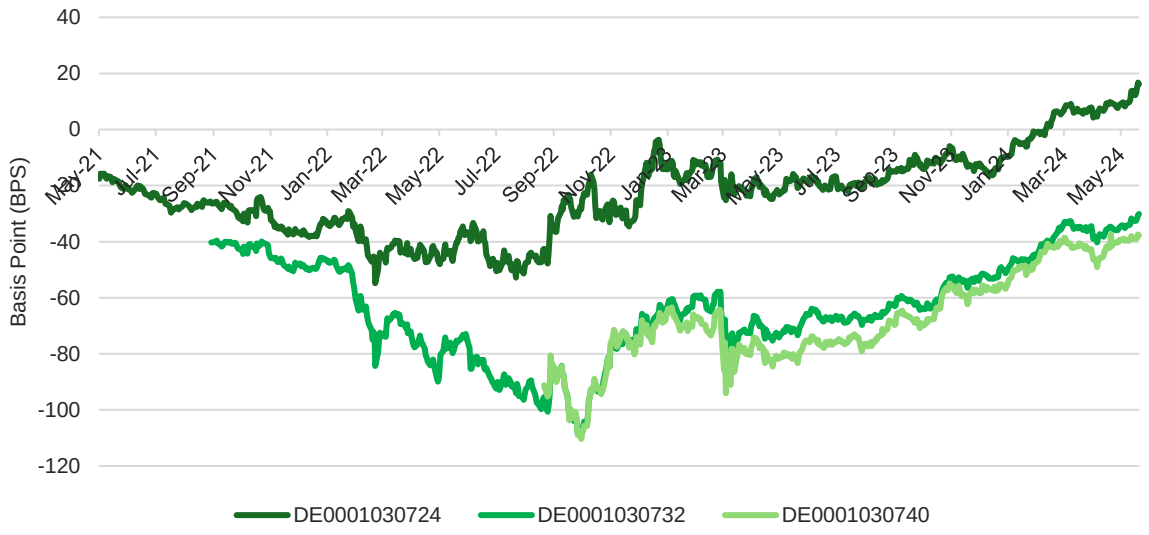
4.3. Analysis Approach

The historical Z-Spreads for all the selected Green Bonds from an individual issuer were calculated and compared against each other to examine whether there were any common trends or significant differences. Historical Z-Spreads were also plotted for all the selected Brown Bonds from an individual issuer. After plotting the Green and Brown Bond spreads for all the individual issuers, all the Green and Brown Bonds (that is, the matched pairs) for each individual issuer were plotted together, again to examine the bond pair behaviours and whether they were similar or not. Finally, the 'delta', being the Brown Bond Z-Spread less the Green Bond Z-Spread, of the bond pairs were plotted, as well as the overall delta for the individual issuers to identify if, on average, Greenium exists.

To demonstrate the analysis approach described above, three German government bond pairs, issued by Germany (Federal Republic Of) have been selected as an example.

The chart below shows the three selected Green Bonds issued by Germany and their pricing history from 1 May 2021 to 31 May 2024 (Figure 7). The chart illustrates that the Green Bonds are tracking fairly similarly, with the same relative pricing movements.

Figure 7: Germany (Federal Republic Of) Green Bond Z-Spreads



The chart below shows the three Brown Bonds issued by Germany, which were matched to the selected Green Bonds, and their pricing history from 1 May 2021 to 31 May 2024 (Figure 8). The chart illustrates that the Brown Bonds are also tracking similarly, with the same relative pricing movements.

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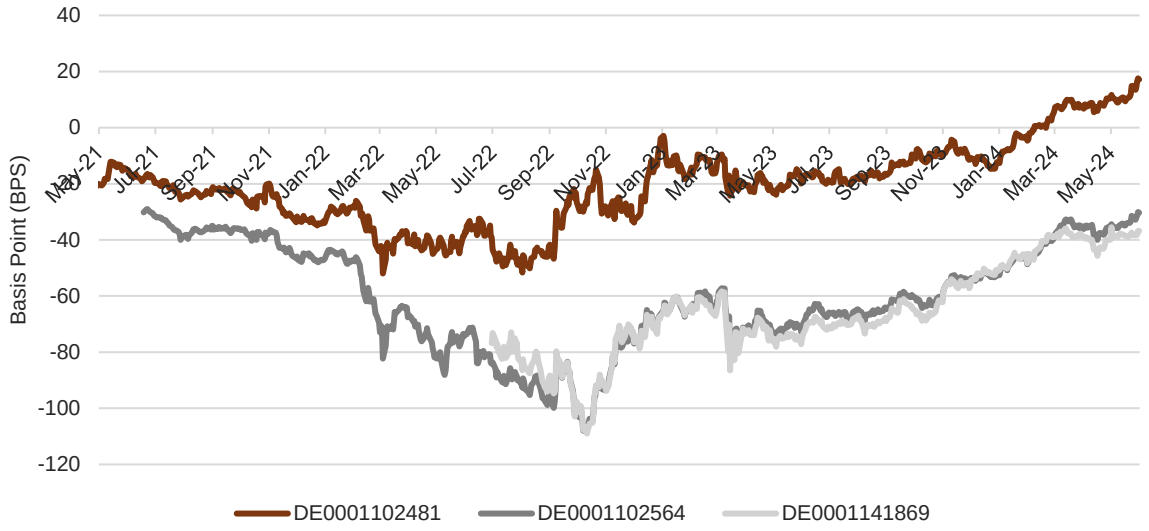
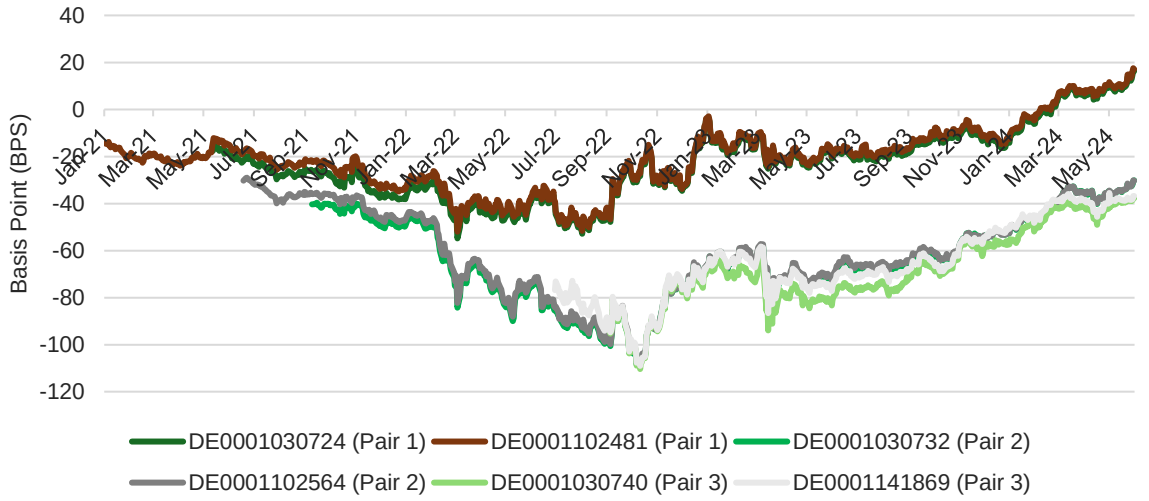
Figure 8: Germany (Federal Republic Of) Brown Bond Z-Spreads



The chart below shows the three matched Green/Brown pairs issued by Germany and their pricing history from 1 May 2021 to 31 May 2024 (Figure 9). In the case of the Germany matched pairs, Figure 9 illustrates that the matched pairs are all tracking the same which is expected as the German government bonds are issued as “twins”.

Figure 9: Germany (Federal Republic Of) Green/Brown Bond Matched Pair Z-Spreads



The chart below shows the delta (or average) Greenium of each of the three matched pairs, as well as the average Greenium overall for Germany (Figure 10). Looking at Germany as an individual issuer, and the three matched pairs, on average, there appears to be a slight Greenium, with the most being around 4 bps, and the least being 0.5 bps.

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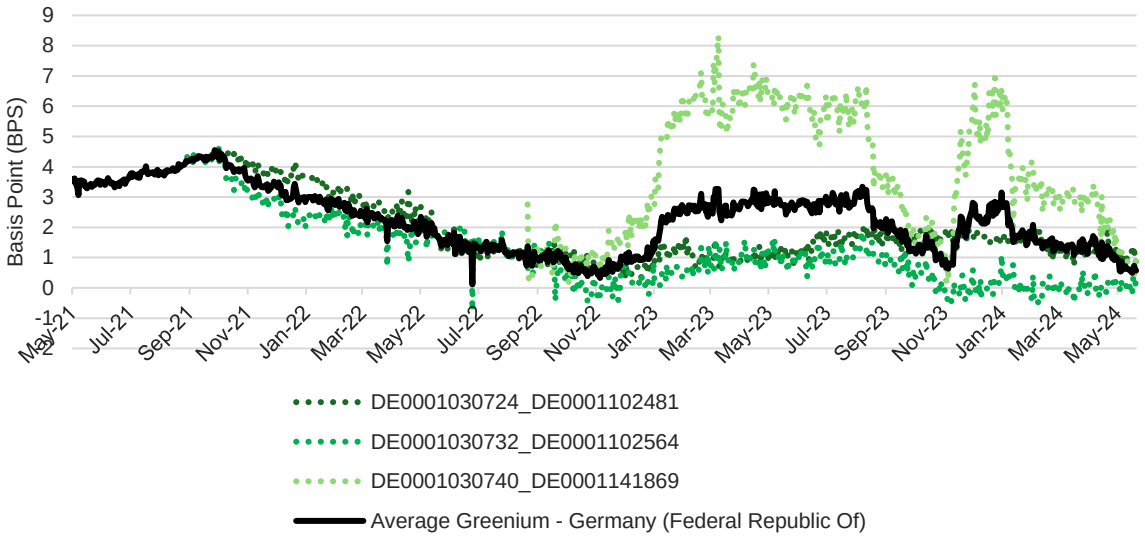
Figure10: Germany (Federal Republic Of) Z-Spread Delta



4.3.1. Bond Disclosure (Pre- and Post-Issuance Reporting)[10]

Lastly, pre- and post-issuance documentation, including SPO, Allocation Reporting, Impact Reporting and Third-Party Assurance, was looked at for each of the Green Bonds within the Analysed Universe.

As can be seen in the table below (Figure 11), in the case of the German government bonds, whilst they have been certified by a third-party and allocation reporting is available, no impact reporting can be expected because in the case of all three of the selected Green Bonds, the issuer has not committed to report until the end of the project. Whilst there is some Greenium in the case of the Germany government bonds, it does not appear to be due to disclosure as there is no current impact reporting.

[10] All reporting data as of 31 May 2024.

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Figure 11: Germany (Federal Republic Of)

ISIN	DE0001030724	DE0001030740	DE0001030732
Impact Bond Type	Green-certified by third party	Green-certified by third party	Green-certified by third party
Issue Date	18/05/2021	02/09/2022	10/09/2021
Second Party Opinion	24/09/2020 (of Issuer Framework)	24/09/2020 (of Issuer Framework)	24/09/2020 (of Issuer Framework)
Latest Allocation Reported	31/03/2023	31/03/2023	31/03/2023
Latest Impact Reported	Not Committed to Report Until End of Project	Not Committed to Report Until End of Project	Not Committed to Report Until End of Project
Latest Third-Party Assurance	23/03/2023	23/03/2023	23/03/2023
Impact Metrics	None reported	None reported	None reported

4.4. Results & Analysis

4.4.1. Analysed Universe for Euro-Issued Bonds

The chart below shows the change in the average Greenium for EUR-issued bond pairs (the 'Analysed EUR Universe') over time, with the solid black line representing the mean Green Bond premium, whilst the dotted lines represent the upper and lower quartiles (Figure 12).[11]

On average, a slight Greenium appears to be present within the Analysed EUR Universe. It is significantly higher earlier in the timeseries, with the average Greenium staying above 5 bps from 2021 until March 2022 (noting that there are fewer bond-pairs during this time-period). The mean Greenium is at its lowest of 0.2 bps in October 2022. From 2023 onwards, the average tracks closely with the upper quartile of the distribution, going beyond from September 2023 onwards. This demonstrates that only a few bonds are able to achieve a significant Greenium, beyond what is seen as 'typical' for the Analysed EUR Universe as a whole. Across the entire timeseries, there are only 5 days where the median Greenium was greater than the average Greenium, meaning that most bonds within the sample achieve a small (or even negative) Greenium, and the average is therefore being increased by only a few bonds which have significant Greenium.

[11] The mean, upper and lower quartiles are represented in the same way in all of the Average Greenium (Absolute) charts seen in sections 4.4.2. and 4.4.3.

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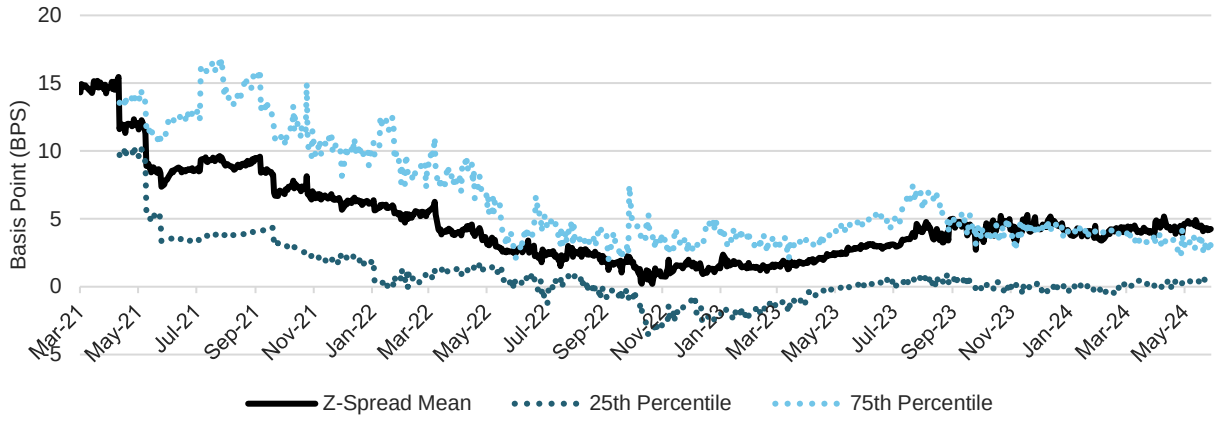
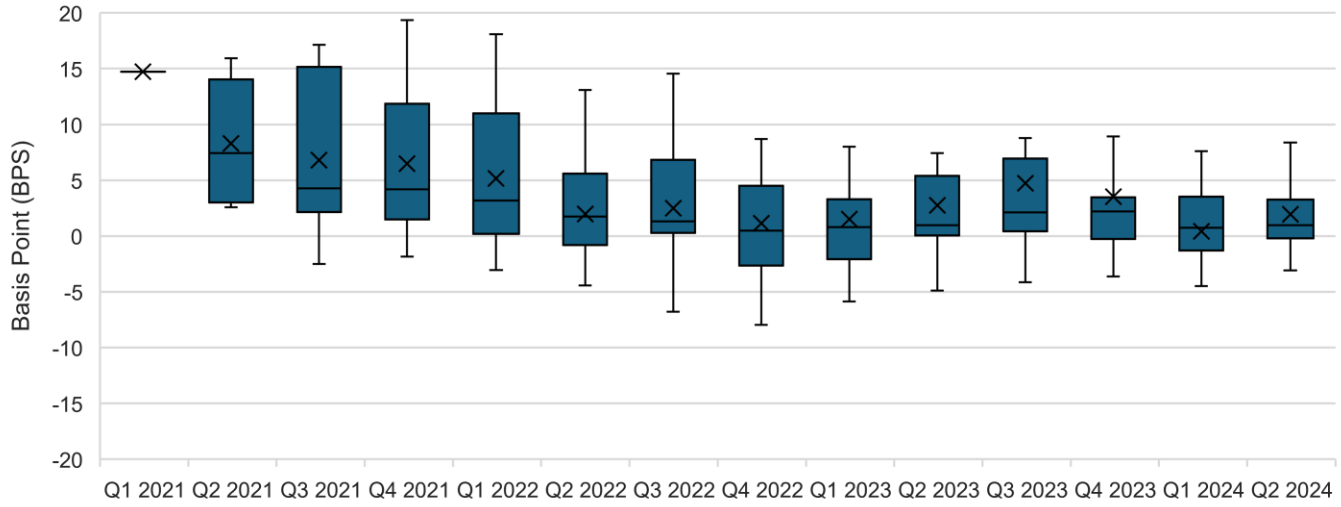
Figure 12: Average Greenium (Absolute) for the Analysed EUR Universe



The chart below shows the average distribution of Greenium for the EUR bond pairs in the Analysed Universe from Q1 of 2021 through to Q2 2024 (Figure 13). The cross represents the mean Greenium observed, the box represents the upper (75th) and lower quartiles (25th) of the distribution, the median is shown by the line, and the whiskers extend to the largest and smallest datapoint within 1.5 times of the interquartile range from the upper and lower quartiles respectively[12]. Overall, Greenium is more predominant between ~5-10 bps in 2021, before moving closer to 0-5 bps from Q2 of 2022 onwards. However, the whiskers of the plot show that there is significant variation even after discounting outliers with high (or negative) Greenium. The number of bonds in the Analysed EUR Universe increases over the analysed time-period, so the earlier distributions are more susceptible to the contribution of a single bond pair. The mean is typically above the median, indicating the data is skewed towards Greenium being present in most quarters. The only exception is Q1 of 2024 where the mean Greenium hovers just below the median.

Figure 13: Quarterly Greenium Distribution for the Analysed EUR Universe



[12] The mean, median, upper, and lower quartiles are represented in the same way in all of the Quarterly Greenium Distribution charts seen in sections 4.4.2. and 4.4.3.

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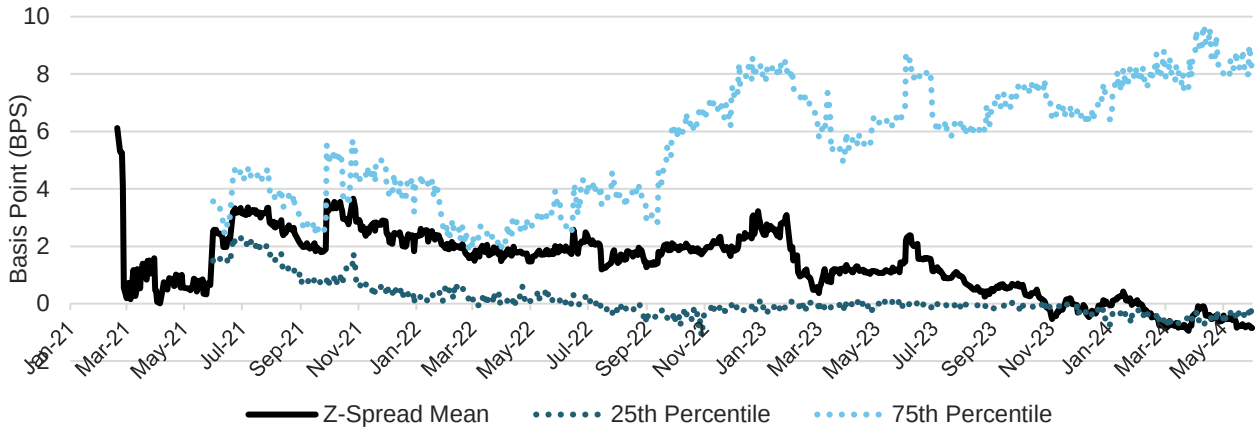
4.4.2. Analysed Universe for Japanese Yen-Issued Bonds

The chart below shows the change in the average Greenium for JPY-issued bond pairs (the 'Analysed JPY Universe') over time (Figure 14). Similarly to the Analysed EUR Universe, there is a slight Greenium observed in the Analysed JPY Universe for most of the examined time-period. As with the EUR-issued bonds, the mean Greenium is greater in earlier periods, mostly staying between 1 and 4 bps until February 2023. From February 2023 onwards, the mean aligns more closely with the lower quartile, on occasion dipping below it in 2024. This appears to demonstrate that most bonds do in fact achieve a Greenium, with a few bonds trading at significant discounts. Beyond 2023, the Greenium is non-existent, with the average occasionally falling into negative Greenium. A closer examination, however, shows that the data is significantly more symmetric than it appears (with the median hovering around the mean, always remaining within 2 bps of each other), indicating that most of the bonds in the Analysed JPY Universe do not achieve any Greenium. Given the median, mean, and lower quartile are so closely aligned, those few bonds with a significant Greenium, do so without a limit (i.e. the fat upper tail near the 75th percentile is more likely to include very high values compared to the rest of the distribution).

Figure 14: Average Greenium (Absolute) for the Analysed JPY Universe



The chart below shows the average distribution of Greenium for the JPY bond pairs in the Analysed universe from Q1 of 2021 through to Q2 2024 (Figure 15). Overall, Greenium is more predominant between ~0-5 bps in 2021 and 2022, before moving closer to 0-2 bps from Q1 2023 onwards. From 2023 onwards, the whiskers of the plot show that there is also significant variation even after discounting outliers with high (or negative) Greenium. It is worth noting that the count of bond pairs increased over the analysed time-period, so the earlier distributions are more susceptible to the contribution of a single bond pair. Unlike the EUR-issued bond pairs, the data distribution is relatively symmetric with the mean always being within 2 bps of the median, suggesting no significant tails where a few bonds have either a very high or very low (negative) Greenium.

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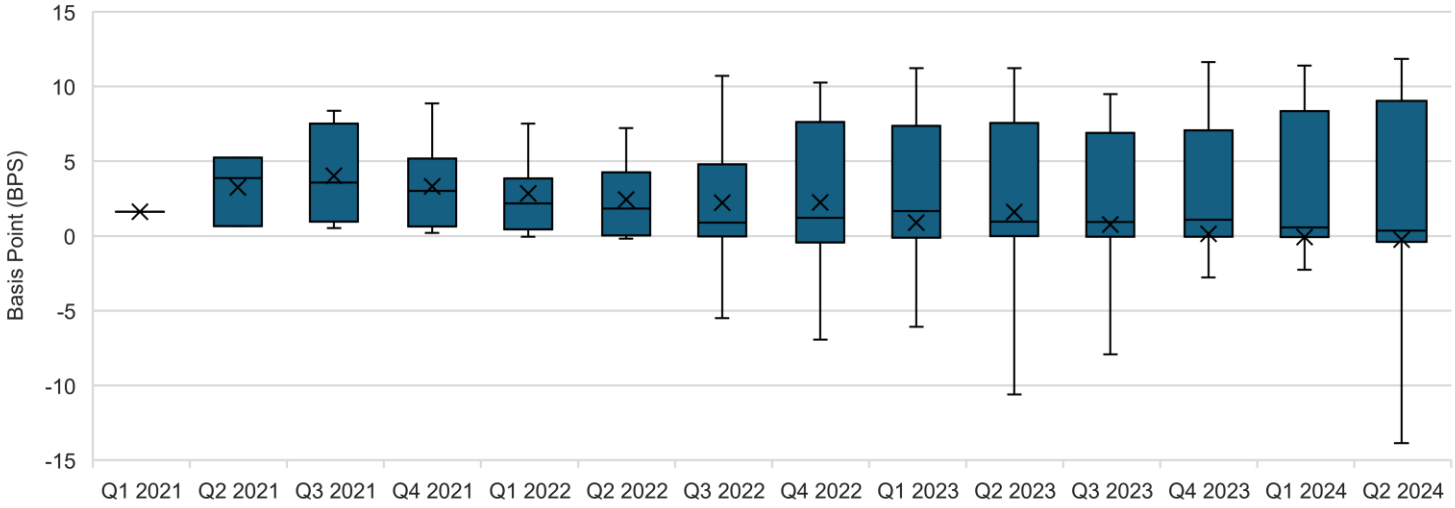
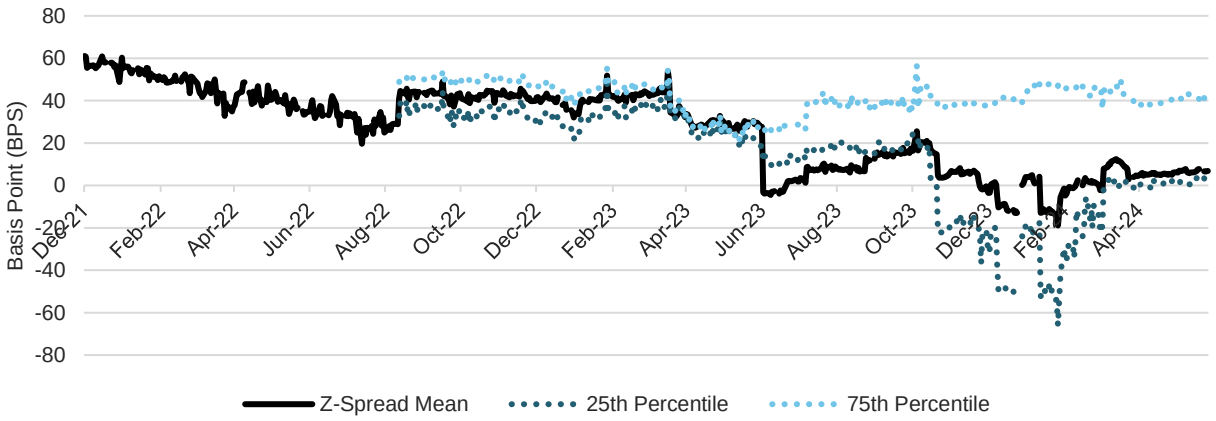
Figure 15: Quarterly Greenium Distribution for the Analysed JPY Universe



4.4.3. Analysed Universe for United States Dollar-Issued Bonds

The chart below shows the change in the average Greenium for USD-issued bond pairs (the 'Analysed USD Universe') over time (Figure 16). There is significant variability due to the relatively small sample size throughout the timeseries, with both the width of the interquartile range expanding significantly in June of 2023, and then again in October 2023. We also see the skewness change significantly and the average Greenium peaks above the 75th percentile on occasion between April and June 2023, and then dips sharply below the 25th percentile following the issuance of a particular bond that trades at a significant green discount. The volatility seen in the absolute average Greenium chart shows the distribution repeatedly and rapidly changes between being positively and negatively skewed.

Figure 16: Average Greenium (Absolute) for the Analysed USD Universe



The chart below shows the average distribution of Greenium for the USD-issued bond pairs in the Analysed Universe from Q1 of 2021 through to Q2 2024 (Figure 17). As seen in Figure 17, identification of any Greenium is difficult due to the smaller sample and higher variation within the Analysed USD Universe. The highest quarter for Greenium is Q4 of 2021, where the Greenium hovers just under 60 bps for the single bond available, whilst at its lowest, the average quarterly Greenium is at -2 bps in

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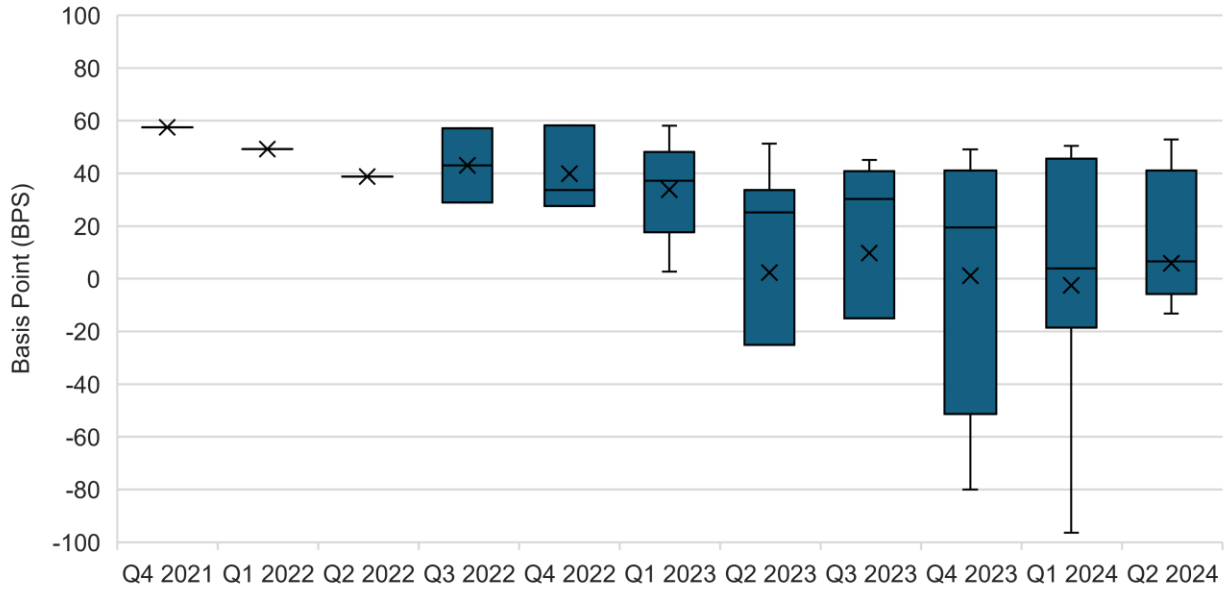
Q1 of 2024. The interquartile range spans 30 bps at its smallest in Q3 of 2022 and remains very high. As such, it is difficult to define any trends in the distribution with meaningful distinction.

Figure 17: Quarterly Greenium Distribution for the Analysed USD Universe



4.4.4. Analysed Universe Reporting

Sustainable Bonds are typically accompanied by a number of documents that are published by the issuer, both pre- and post- issuance of the bond. Issuers may go beyond the initial prospectus and ground their sustainability claims with SPO's (pre-issuance), as well as with Allocation and Impact Reports, and Third-Party Verification of these claims (post issuance).

SPO's are independent reviews of an issuer's proposals for a Sustainable Bond. They are validations provided by external organisations that evaluate the environmental and social credentials of a Sustainable Bond and are made at the point of issuance. Issuers seek SPO's to act as a validation of their sustainability claims and to increase investor confidence in the projects.

At post-issuance, there are two documents that can be produced by the issuer directly - Allocation Reports and Impact Reports. Allocation Reports disclose information on the use of the proceeds raised by the bond for the financing of the actual projects under the bond's remit. Details such as breakdowns of the allocation and share unallocated are also typically reported. Impact Reports disclose the extra-financial effects that the projects have had so far. This may include specific sustainability outcomes such as 'Renewable Energy Generated' and may be disaggregated by project or sustainability objective. These issuer documents enable investors to track the credibility of their investments both financially and in terms of real-world impacts.

Third-Party Assurances are documents produced by external organisations who provide a verification or assurance on the Allocation and Impact Reports made after issuance. They typically audit the allocation of proceeds given in the allocation report, and verify the methods, assumptions, and data used to determine the real-world impacts. Again, this process aids in ensuring that the issuer's claims are accurate and reliable.

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The table below shows the availability of a particular document (expressed as a percentage) for the Analysed Universe (Figure 18). Bonds issued in EUR or JPY are significantly more likely to have SPO's, as well as allocation and impact reporting. Allocation reporting is slightly more common than impact reporting, whilst the least common documentation is the Third-Party Assurance. Only Green Bonds issued in EUR have more than half of the Analysed Universe that produced any form of assurance for their allocation and/or impact reports. The USD Analysed Universe has significantly lower reporting of all types, however, this might be due to the existence of private placements within the sample, which may have a reduced need to report due to the more restricted nature of the investors involved.

Figure 18: Proportion of the Analysed Universe with Reporting and External Review

Currency	Total Number of Analysed Green Bonds	Second Party Opinion	Allocation Reporting	Impact Reporting	Third Party Assurance
EUR	32	81%	81%	66%	59%
JPY	36	97%	83%	78%	28%
USD	11	18%	27%	27%	27%

The below chart demonstrates the average Greenium (or if negative, the discount), depending on whether a particular report was available (Figure 19).

Figure 19: Pre- and Post-Issuance Reporting

Analysed Green Bonds (Currency)	Average Greenium (Total)	Second Party Opinion Available		Allocation Reporting Available		Impact Reporting Available		Third-Party Assurance	
		Yes	No	Yes	No	Yes	No	Yes	No
EUR	*3.40*	3.80	1.69	5.12	-4.06	4.89	0.56	6.15	-0.61
Number of EUR (issued) Bonds	*32*	*26*	*6*	26	6	*21*	*11*	*19*	*13*
JPY	0.36	0.63	-8.93	0.11	1.64	0.04	1.5	-7.31	3.32
Number of JPY Bonds	*36*	*34*	*2*	*29*	*7*	*28*	*8*	*10*	*26*
USD	*-2.44*	7.08	-4.56	15.89	-9.32	15.89	-9.32	15.89	-9.32
Number of USD Bonds	*11*	*2*	*9*	3	8	*3*	*8*	*3*	*8*

Of the Analysed Universe, Figure 19 above shows that on average there may be a small average Greenium overall of 3.4 bps for Green Bonds issued in EUR, and 0.4 bps for Green Bonds issued in JPY. However, the per-bond variation is significant, and therefore no statistically significant claim of Greenium can be made for either of the currencies. The USD-issued bonds within the Analysed Universe seem to demonstrate a green discount on average, with a Greenium of -2.4 bps. However,

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this result is also not statistically significant, with the USD sample having both high variability in the data and a reduced sample size compared to EUR and JPY's Analysed Universes.

For EUR-issued Green Bonds, all documents are associated with an increase in the Greenium. The largest difference is associated with the presence of allocation reporting, where a +9 bps difference exists between bonds with allocation reports and bonds without. Whilst this is a big increase in the Greenium and may be indicative of the importance of regular reporting to the pricing of a bond post-issuance, it does not reach statistical significance to draw such a conclusion.

JPY-issued Green Bonds show the opposite, with most reporting leading to a reduction in the Greenium found in bonds with Impact Reporting, Allocation Reports, or Third-Party Assurance. The exception is SPOs, which is associated with a +9 bps difference where available. This is in comparison to EUR-issued Green Bonds being associated with only a +2 bps increase in Greenium where SPOs are available. Again, whilst there are differences between the reporting and non-reporting bonds, there is not a reasonable level of statistical significance to draw conclusions that SPOs, or any other reporting, leads to Greenium.

USD-issued Green Bonds do provisionally show increases with regards to reporting, however no meaningful conclusions can be drawn from this.

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5. Impact Assessment

5.1. Data Sources

The bonds in the Analysed Universe were compiled from the ICE Sustainable Bond database using the ICE Sustainable Bond Classification Service to identify the classification of each Sustainable Bond. The ICE Sustainable Bond database is compiled using publicly available security documentation such as bond prospectuses, term sheets and exchange listing records. It also draws on the Luxembourg Stock Exchange DataHub which contains use of proceeds information collated from pre- and post-issuance documentation such as Allocation and Impact Reports. ICE additionally calculates normalised values for bond records and apportions impacts and allocations at the individual bond level.

The data collected for each individual bond included in the Analysed Universe for the impact assessment included the following:

- Impact Metric(s) against which the bond is reporting.
- ICMA Effective Categories against which the bond is reporting.
- UN SDGs against which the bond is reporting.
- Date of latest Allocation Report (pre-issuance).
- Date of latest Impact Report (post-issuance).

5.2. Methodology

To complete the Impact Assessment Analysis, a number of data processing, variable standardisations and aggregation calculations took place in order to generate portfolio-level impact metrics.

5.2.1. Standardization of Impact Metric

The process of categorising Sustainable Bonds into specific groupings of impact metrics allows for the standardisation of the reporting units within a given Impact Metric grouping. To allow for more direct comparisons within each impact metric, an approach which effectively calculates an impact per US $ invested is used (the impact contribution which is further explained below in 5.2.3). To enable a consistent approach to be applied to the impact analysis of each individual Sustainable Bond, the variables for each bond need to be standardized. Standardization is applied to the categorization of impact metrics, the impact metrics themselves and the level of reporting of the metrics, as the approach to reporting the impact metrics can vary between bonds, even for bonds within the same category. Metrics can be reported at a global, category, geographic or project level. For issuers with a programme of bonds, the metric can be reported across all their bonds at an aggregated ‘pooled’ level. For this reason, the method for reporting has been standardized to the bond-level across all Sustainable Bonds within the Analysed Universe.

5.2.2. Standardization of Units

The units of reported impact metrics by the issuer vary across Sustainable Bonds. Even bonds within the same category or impact metric type can have differing units of measurement. To be able to calculate a single impact metric the units of measurement within each impact metric category are standardized to a single, appropriate unit of measurement so that direct comparisons can be made for each of the impact metrics wherever possible.

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Reported cumulative impact metrics are annualized and included in the standardization process where possible. For example, if a reported impact metric is stated as having a daily impact, i.e. 2,500 cubic meters of water treated per day, then these units are annualized assuming 365 days in a year. We take a conservative approach in annualising so where it may be unclear to annualize, these cumulative impact metrics are disregarded.

5.2.3. Reporting Status

The reporting status of Sustainable Bonds is tracked by comparing the date of their latest impact reporting, to the frequency promised in pre-issuance documentation (typically the prospectus). Reporting status is important to help track the quality of bond governance on a per-bond basis, determining if a bond is overdue to report. Bonds are marked as 'Reported' if they have reported within the frequency as promised in an issuer's pre-issuance documentation or if no frequency is stated, within the last 18 months. Bonds are marked as 'Overdue to Report' if they have not reported within the frequency as promised in an issuer's pre-issuance documentation, or if no frequency/timeframe is stated, within the last 18 months. Bonds are marked as 'Not Expected to Report' where the issuer of the bond is committed to report but only within a certain timeframe, for example, the issuer has committed to a report at the end of the project (as seen in the example of Germany (Federal Republic Of) issued bonds described in section 4.3.1).

5.2.4. Reporting Standard

The reporting standard of Sustainable Bonds is determined from an issuer's pre-issuance documentation and whether they have declared alignment to a reporting standard(s) or not. Alignment is based on the specific methodology used for reporting by the issuer and is limited to European Union Green Bond Standard (EU GBS), ICMA, Multi-National Development Bank (MDB), and Nordic Public Sector Issuers (NPSI)[13]. Failure to align to a reporting standard does not mean that the wider guidelines or principles of a reporting standard are not being observed, and issuers may instead choose to obey their own framework for reporting impacts, especially in jurisdictions without a dominant standard or regulatory preference. Many reporting standards stipulate that post-issuance reporting is best practice and required under that standard. If an issuer of Sustainable Bonds has stated a reporting frequency and is overdue to report, this may be seen as a breach of the reporting governance of the claimed guideline. Bonds are identified if they are 'Overdue to Report' and have stated alignment with a reporting standard or no reporting standard at all.

The reporting standards against which the bonds within the Analysed Universe were aligned to are:

- ICMA
- ICMA & MDB
- MDB
- No Reporting Standard

5.2.5. ICMA Effective Categories

A Sustainable Bond's proposed allocation to project categories originates from the issuer's pre-issuance documentation, as well as subsequent documentation issued at actual allocation. Issuers that follow industry recognised frameworks, such as ICMA, may express these project categories in a

[13] See Appendix 8.2 for more details on these reporting standards.

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standardised manner, whereas other issuers may adopt a more 'free text' or less consistent approach. To easily compare across projects that are being funded by these bonds, project definitions as stated by the issuer, are mapped, per bond, to an ICMA Effective Category to calculate the project allocation within a portfolio. As a bond may be funding more than one project, or the issuer has categorised the project(s) into more than one definition, to avoid double-counting, allocation is pro-rated towards the Effective Categories to prevent overstating contribution towards these sustainability objectives.

5.2.6. UN SDGs

The UN SDGs are a set of 17 global goals that were set by the UN in 2015 to be achieved by 2030. The goals address various social, economic, and environmental challenges facing the world, such as poverty, inequality, climate change, environmental degradation, peace, and justice. The reported alignment of project funding with SDGs in the dataset originates from the security documentation where available. This includes the framework document, second-party opinion, or the issuer's own reports. Where this information is unavailable, auto-mapping is carried out based on the investment project(s) classification as per the ICMA Standards (i.e. the mapped categorisation). There may be more than one SDG to which a project aligns, and a bond may be funding more than one project, so to avoid 'double-counting', allocation is pro-rated towards the SDGs to prevent overstating alignment to these sustainability objectives.

5.2.7. Impact Contribution

Once the process of the standardization of impact metrics has taken place (as described in 5.2.1), the impact contribution can be calculated. The impact contribution approach provides the ability to compare the annualised impact of bonds within impact metrics and their higher-level categories (green or social), as well as allowing for ongoing assessments regarding the relative impact of a portfolio. To provide impact contributions, a latest year methodology was used which calculates the impact contributions for the latest year a bond is held based on the latest available reported data. Using the latest available reported impact metrics, these are then divided by the issued amount of the bond. Contributed impacts of the same metric are then summed across the portfolio to demonstrate overall portfolio impacts.

5.3. Results & Analysis

5.3.1. Overview

For the purposes of the Impact Analysis Assessment, the Analysed Universe was used to form the constituents of an equally weighted portfolio, with a value of 1 billion (USD) (the 'Analysed Universe' portfolio).[14] Equally weighted portfolios, with a value of 1 billion (USD) were also created for each of the currencies (the 'Analysed EUR Universe', 'Analysed JPY Universe' and 'Analysed USD Universe' portfolios. The aggregated portfolio metrics seen within this report have been generated from the ICE Sustainable Bond Analytics Dashboard.

[14] For purposes of the Impact Assessment Analysis, the Analysed Universe only includes Green Bonds, as Brown Bonds are not expected to have any impacts to report on.

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The Analysed Universe portfolio is more heavily weighted (59%) towards bonds that are funding an environmental objective and consequently the impact metrics captured in this report are representative of this (Figure 20). This heavier weighting is, however, illustrative of the proportion of bonds issued in the market in general. Figure 21 below shows the market issuance trends for Sustainable Bond's as of 30 June 2024 and demonstrates that Green and Sustainability Bond issuance continues to be strong, with 2024 Green bond issuance already at 60% of the full year's issuance in 2023 and 66% for Sustainability Bonds. Issuance amount values for 2024 are only for a 6-month period, whereas 2022 and 2023 represent full years of issuance.

Figure 20: Proportion of Green Bond's Classification Breakdown

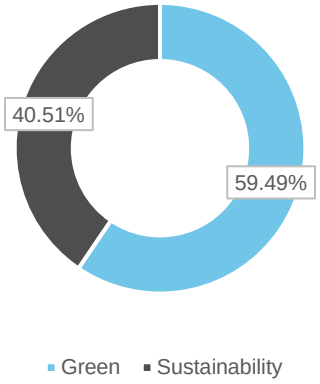
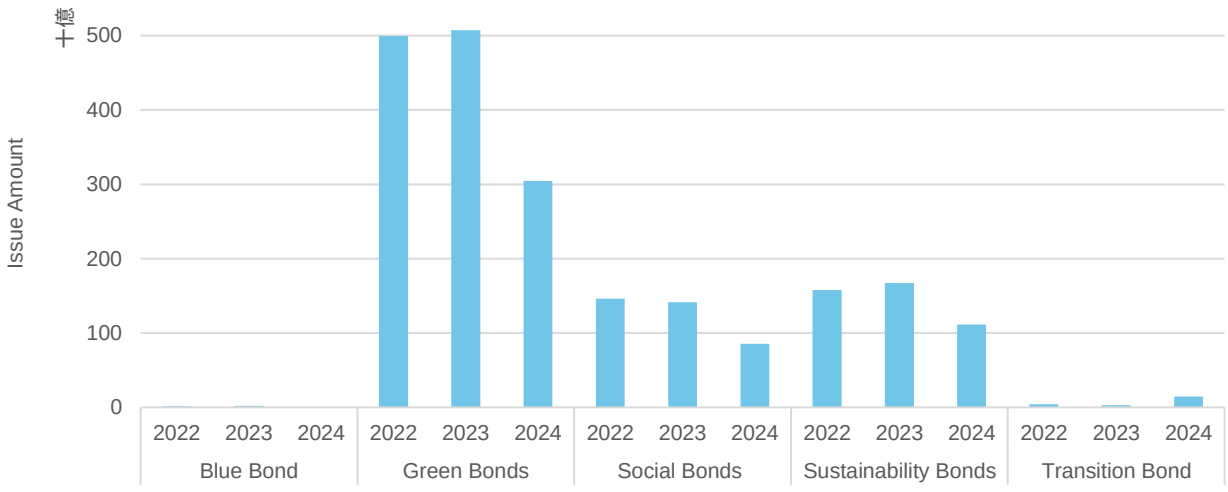


Figure 21: Trends in Market Issuance of Sustainable Bonds by Type



The below chart shows the proportion of Green Bond's current reporting status within the Analysed Universe portfolio and whether they have reported, are overdue to report, or not expected to report. Of this portfolio, 53% have reported, 33% are overdue to report and 14% are not expected to report (Figure 22). Interestingly, more of the Analysed JPY Universe Portfolio has completed Impact Reporting (64%) compared to the Analysed EUR Universe (50%) and Analysed USD Universe (27%)

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(Figure 23). A bond's 'Reporting Status' is based on the issuer of the bond's latest Impact Report (post-issuance).

Figure 22: Proportion of Green Bonds by Impact Reporting Status

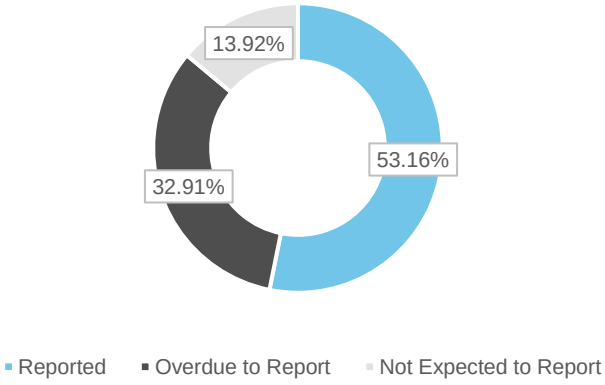
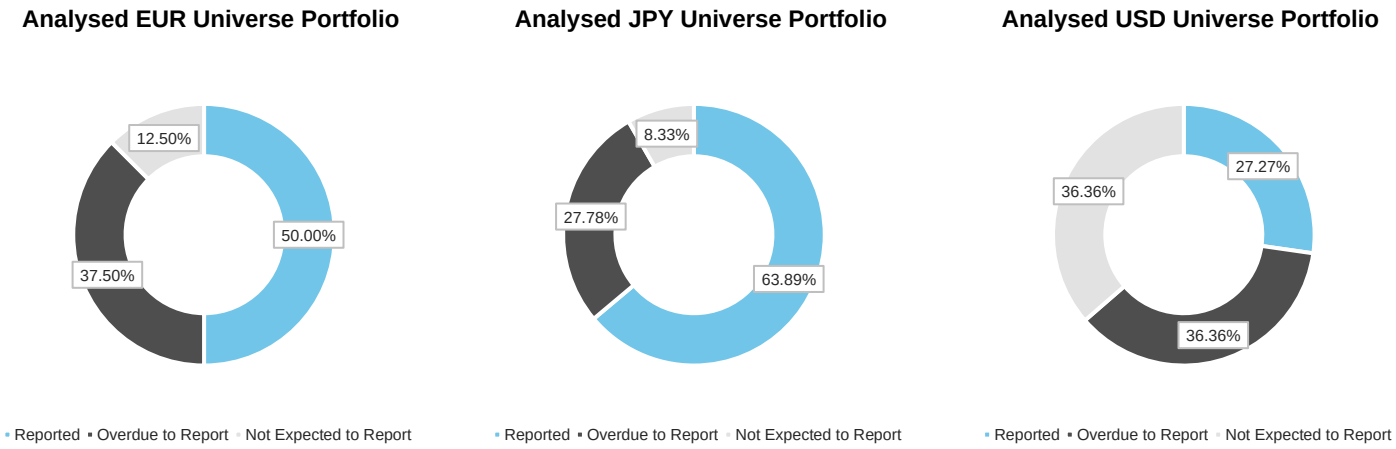


Figure 23: Proportion of Green Bonds by Impact Reporting Status and Currency



The below chart shows the proportion of bonds within the Analysed Universe that have reported on the alignment of bond proceeds into different green or social categories, as defined by the ICMA Green/Social Bonds standards (Figure 24). The largest allocation of bonds' proceeds at pre-issuance have been to the following Effective Categories; 25% of bonds' proceeds have been allocated to Green Buildings (Green) Projects and 15% to Renewable Energy (Green) Projects. The largest contributor towards the allocation of proceeds towards Green Buildings Projects, is the Analysed JPY Universe portfolio where its allocation is 48%. 'Reported Effective Categories' are based on the pre-issuance documentation of the bond.

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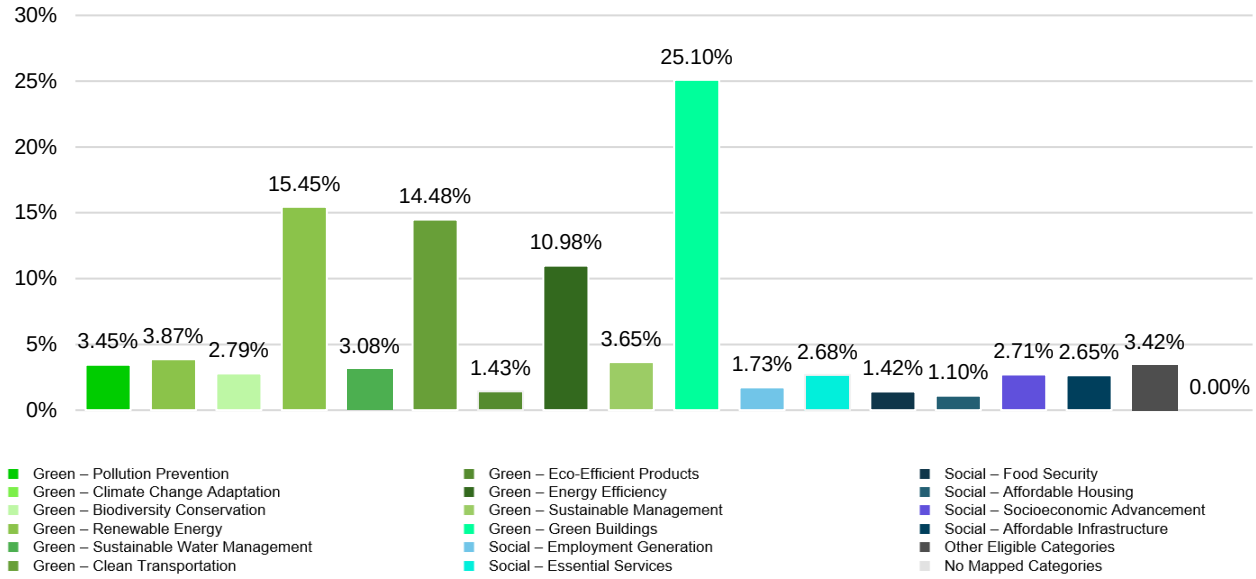
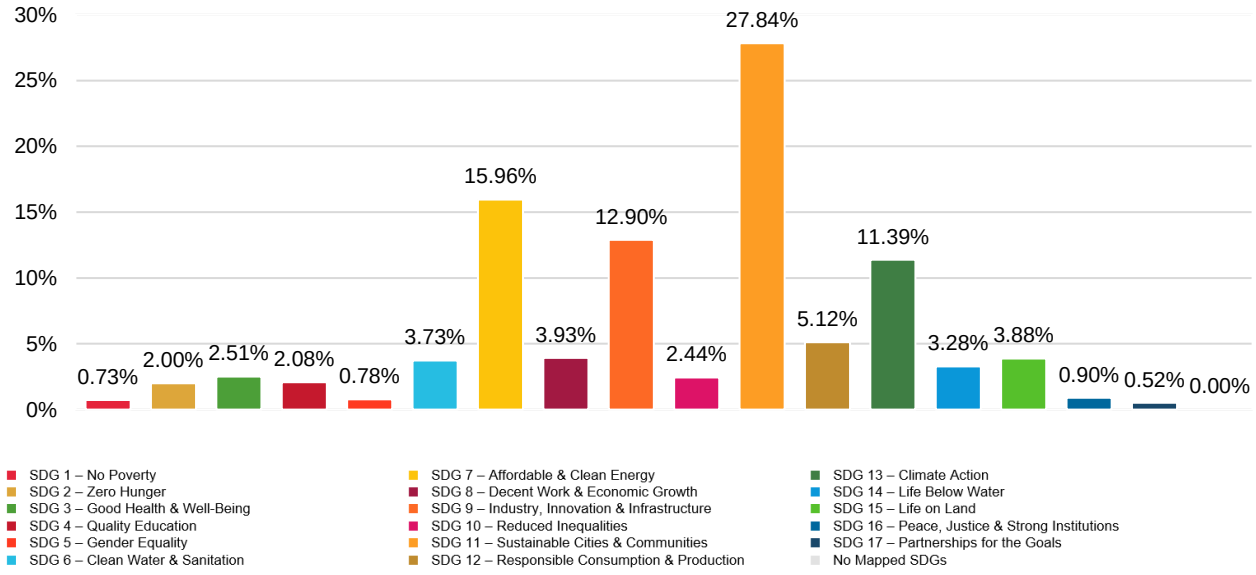
Figure 24: Proportion of Green Bonds with Reported Effective Categories (Pre-Issuance)



The below chart shows the proportion of bonds within the Analysed Universe that have reported on the alignment of bond proceeds that map to the UN SDGs (Figure 25). The largest reported allocation of bond's proceeds at pre-issuance have been to the following SDGs; 28% of bonds pre-issuance has been allocated to Sustainable Cities and Communities (SDG 11), 16% to Affordable and Clean Energy (SDG 7). As seen with the Effective Category allocation above, the largest contributor towards the alignment of bonds proceeds to the UN SDGs, is again the Analysed JPY Universe portfolio with 41% of the bonds reporting alignment to Sustainable Cities and Communities. 'Reported UN SDGs' are based on the pre-issuance documentation of the bond.

Figure 25: Proportion of Green Bonds with Reported UN SDGs (Pre-Issuance)



Within the Analysed Universe portfolio, 38 out of 79 bonds reported a total 385,000 tonnes of carbon dioxide equivalent (tCO2e) of Greenhouse Gas (GHG) Emissions Reduced, Avoided, or Abated. The

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GHG emissions reduced, avoided, or abated also seemed to be the most commonly reported impact metric, with the highest number of bonds in both the EUR and JPY Analysed Universe portfolios also reporting on this metric, 17 and 18 reporting bonds respectively. 17 out of 79 bonds reported a total 62,350 megawatts per hour (MWh) of renewable energy generated. It is worth noting that whilst a Green Bond may be classified as Green or Sustainability, it does not mean that the issuer will only report on solely "green" metrics. An example of this can be seen in Figure 26 below, where 12 out of 29 bonds have reported a total of 237,500 people benefitted from bonds within the Analysed Universe portfolio. This observation would seem consistent with earlier research by ICE which highlighted that the growth in Social Bond issuance in recent years has been led by APAC, with Japan and South Korea at the forefront[15]. Hence, the fact that a higher proportion of Green Bonds in the JPY portfolio are reporting on a broader range of metrics, including social metrics, may not come as a surprise. All reported impact metrics within the Analysed Universe can be seen in the table below (Figure 26).[16]

Figure 26: Impact Metrics within the Analysed Universe[17]

Metric	Unit	Portfolio-Weighted Impact	Number of Sustainable Bonds Reporting this Metric
GHG Emissions Reduced, Avoided or Abated	tCO2e	385,310.90	38
Renewable Energy Generated	MWh	62,350.82	17
Energy Savings	MWh	6,500.07	16
People Benefitted	People	237,511.82	12
Jobs Created	Number	1,033.57	12
Renewable Power Capacity Installed or Connected to Grid	MW	31.76	11
Passenger/Freight Distance Travelled by Clean Transit or ZEVs	km	12,000,021.77	7
Habitat Restored, Conserved, or Created	Square-km	2,521.71	6
Transportation Infrastructure Built	km	3.64	5
Building Certifications Achieved	Number	-	5
Students Benefitted	Students	4,331.63	3
Farmers Benefitted	Farmers	162.73	3
Water Use Reduced or Avoided	Tonnes	199,457.56	2
Loans Granted	Number	173.21	2

[15] ICE Sustainable Finance, "*The rise of 'S' Bonds in Asia Pacific (APAC)*", (April 2024), available at: **https://www.ice.com/insights/sustainable-finance/the-rise-of-s-bonds-in-asia-pacific.**
[16] All impact metrics have been portfolio weighted and have an impact per 100 million.
[17] See Appendix 8.3 for all reported Impact Metrics within the Analysed Universe broken down by currency.

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6. Relationship between Greenium and Impact Assessment

Alongside the analysis of a potential relationship between Greenium and bond disclosure, an additional examination of the influence achieved impacts reporting has on Greenium was carried out.

This was done by first segregating the Analysed Universe by currency, then ranking Green Bonds by the average secondary market Greenium achieved. In general, it was found that even amongst Green Bonds from the same issuer, the Greenium achieved by their bonds can vary significantly. This could even be the case when different bonds contribute to the same pool and therefore have the same cost-effectiveness of impact achieved.

For example, in the Euro-issued cohort, the bond with the largest Greenium was ~27 bps over its lifetime. Another bond with the next-highest achieved Greenium from the same issuer had a Greenium of only ~3 bps, despite being an equally sized bond from the same pool with the same achieved impacts.

Despite the variation amongst bonds within pools, there exists some indication of a relationship between Greenium and impact achieved within the Euro-issued Green Bonds that have reported. The table below (Figure 27) shows an example with two bonds from the same issuer, with Greeniums of 23 bps. The two bonds were issued 2 years apart from each other, with coupons reflecting the general interest rates of their times, and otherwise share the same subordination and debt rank. Both bonds show significant impacts in Energy Savings (MWh) and GHG Emissions Reduced, Avoided, or Abated (tCO_2e). The bond with the slightly higher Greenium demonstrates a slightly higher impact.

Figure 27: Greenium and Reported Impacts of example EUR-issued Bonds

Average Greenium	Issue Date	Current Coupon Rate	Energy Savings (MWh)	GHG Emissions Reduced, Avoided or Abated (tCO_2e)	Sustainable Bond Type
23.2	03/16/2021	0.75	258,889	931,653	Green
23.0	05/19/2023	4	207,111	745,323	Green

Any potential relationship shown in the Euro-issued cohort is not reflected within the JPY-issued universe. Whilst the bonds with the largest Greenium tend to be issued by Japanese National Agencies, the impact reporting does not reflect the scale achieved by other bonds in significant transition industries such as automotives and power generation.

In the table below (Figure 28), we see that 2 bonds with the largest Greenium have not reported on impact and/or only show a very modest impact with respect to GHG Emissions Reduced, Avoided or Abated (tCO_2e) savings. This is in stark contrast to the bonds with the highest reported impacts, two of which effectively have no Greenium, and one that trades at a significant discount. This may reflect different expectations across different organisational types and business activities. The bonds with the largest decarbonisation achievements are those from issuers in the power generation and automotive sector, where decarbonisation potential is very significant.

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Figure 28: Greenium and Reported Impacts of example JPY-issued Bonds

Average Greenium	Issue Date	Current Coupon Rate	GHG Emissions Reduced, Avoided or Abated (tCO_2e)	Sustainable Bond Type
10.18	25/05/2023	0.14	Not reported	Green
9.92	16/09/2022	0.415	28	Green
0.24	14/04/2022	0.33	2,784,451	Green
0.09	14/04/2022	0.574	2,320,375	Green
-36.49	06/02/2023	1.015	1,690,680	Sustainability

The USD-issued cohort did not contain a large enough sample size of reporting issuers to imply any trends, with only 3 bonds having impact reporting available to examine. Given the prevalence of the MDB's harmonised framework in the USD-issued Analysed Universe, there may be a lack of expectations for reporting, as the framework does not make recommendations on the communication of impacts for investors, unlike EU GBS or ICMA for example.

Across the Analysed Universe, we observe no indication for a relationship between the actual impacts achieved by Green Bonds and their respective Greenium. This implies that the actualised extra-financial impacts of a bond are not yet material factors in the investment decisions of investors in secondary markets.

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7. Conclusion

The analysis presented in this report suggests that there may be some Sustainable Bonds that trade at a premium within the secondary market, providing evidence of Greenium. This indication of Greenium, however, is not consistent across all Sustainable Bonds (some trade at a discount), and the effect is varied across the Analysed Universe examined in this report.

When Sustainable Bond disclosure documentation is considered, one may assume a relationship with the extent of Greenium. However, the analysis suggests there is mixed evidence regarding the extent of influence documentation and disclosure has on Greenium in secondary markets. There is some evidence that investors give recognition to the sustainability credentials of a bond through its Second Party Opinion at pre-issuance. There is also weak, yet consistent indications that the actual achieved impacts, as shown in post-issuance reporting, do have a positive reaction towards the Greenium a bond achieves.

More broadly, however, there does not seem to be a wider market reaction to the availability of pre- and post-issuance reporting, and the differences between reporting and non-reporting bonds is not sufficiently large to be conclusive. This implies that presently, pre- and post-issuance information is not a major factor in investor decision-making in secondary Sustainable Bond markets.

The lack of (or at least limited) observation of Greenium in this analysis suggests investors may not be penalised for trading in Sustainable Bonds. The observation of only limited correlation between Greenium and Second Party Opinion/achieved impacts also suggests potential for environmentally-friendly cash flows can be acquired at a discount.

This is, however, not to say this will not change in the future. As the global transition towards a Net Zero economy gathers momentum in the years ahead, and target deadlines are approached (2030 emission reduction plans and 2050 Net Zero targets) investor focus on climate ambition achievement has the potential to sharpen, with asset price sensitivity to climate outcomes increasing. Under such conditions it would be reasonable to assume that investors could give greater attention to Sustainable Bond disclosures, with both Second-Party Opinion and Impact Achievement having a more significant influence.

Indeed, if current trends of issuance in Sustainable Bonds continue to grow, liquidity risks for all market participants have the potential to reduce, which may lead to a Greenium becoming more reflective of the transparency and materiality of the bond’s achieved impacts. Under such circumstances, it may make economic sense for issuers to issue Sustainable Bonds, disclose information, and invest the proceeds into impact projects, thereby contributing to the realization of a sustainable economy and society by the capital market.

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8. Appendix

8.1. ICE Pricing and Reference Data Dictionary Definitions

Field Name	Definition
Identifier (ISIN)	A field that contains the instrument identifiers used by the global capital markets industry such as CUSIP and ISIN.
Primary Name (Issuer)	Most common name by which the issuer of an instrument is known. The name is pulled from the offering document or prospectus.
Issue Date	The date on which the instrument was first made available to the market.
Maturity Date	The date on which the issue is due to mature. For bonds with an extendible maturity feature, this date will be adjusted to reflect any maturity extensions exercised.
Debt Rank Type	Specifies the order in which payments are to be made by the issuer to holders of the security in relation to other obligations.
Subordination Type	Indication of the relative placement of the instrument in the payment capital structure or securitized deal cash flow.
Issue Amount	The amount of the security at the time of issuance.
Issue Amount Currency	A three-character ISO currency code for the currency of the issued security at the time of issuance.
Issue Price	The nominal value associated with a financial instrument at the time of issuance.
Call Indicator	Specifies if the security is eligible to be redeemed by the issuer through a call event.
Put Indicator	Specifies if the bond carries provisions that allow for redemption at the request of owners of the security.
Sink Indicator	The security carries a sinking fund as part of its terms and conditions.
Convertible Indicator	Specifies whether an issue is convertible or exchangeable.
Guarantee Type	Used to classify the guarantee provided by the guarantor firm associated with the security identified by the instrument ID.
Coupon Type	Identifies the specific nature of the method by which interest is paid over the life of a fixed-income security.
Current Coupon Rate	The annual rate of interest currently applicable to the instrument.
Sustainable Bond Type	Indicates the type of Sustainable Bond as per ICE's Sustainable Bond Classification Service.
Quote Sources	The number of distinct dealers that have quoted for a particular bond during a particular day.
Price/Evaluation Date	The date of the price/evaluation.
Z Spread	Zero-volatility spread is the measurement of the spread that an investor will receive over the entirety of the Treasury yield curve.

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8.2. Reporting Standards

Reporting Standard	Overview	Source
EU Green Bond Standard (EU GBS)	On 28 February 2023, the Council of the European Union and the European Parliament announced that they had reached a provisional agreement on the creation of European green bonds (EuGB). On 30th November 2023, the regulation was published in the Official Journal of the EU and entered into force. The EuGB Regulation lays the foundation for a common framework of rules regarding the use of the EuGB designation for bonds that pursue environmentally sustainable objectives as defined by the EU Taxonomy Regulation. It also sets up a system for registering and supervising companies that act as external reviewers for green bonds aligned with the EuGB framework.	https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32023R2631
International Capital Markets Association (ICMA)	Green bonds enable capital-raising and investment for new and existing projects with environmental benefits. The Green Bond Principles (GBP) seek to support issuers in financing environmentally sound and sustainable projects that foster a net-zero emissions economy and protect the environment. The GBP, updated as of June 2021, are voluntary process guidelines that recommend transparency and disclosure and promote integrity in the development of the Green Bond market by clarifying the approach for issuance of a Green Bond. The GBP recommend a clear process and disclosure for issuers, which investors, banks, underwriters, arrangers, placement agents and others may use to understand the characteristics of any given Green Bond	https://www.icmagroup.org/sustainable-finance/the-principles-guidelines-and-handbooks/green-bond-principles-gbp/
	Sustainability bonds are bonds where the proceeds will be exclusively applied to finance or re-finance a combination of both green and social projects. The Sustainability Bond Guidelines (SBG), updated as of June 2021, confirm the relevance of the Principles in this context and facilitate the application of their guidance on transparency and disclosure to the sustainability bond market. The common four core components of the Principles and their recommendations on the use of external reviews and impact reporting therefore also apply to sustainability bonds.	https://www.icmagroup.org/sustainable-finance/the-principles-guidelines-and-handbooks/sustainability-bond-guidelines-sbg/
Multilateral Development Banks (MDB)	MDB; supranational financial institutions providing financing and know-how for economic and social development projects. They were founded by sovereign states which contribute capital and provide guarantees allowing MDBs to raise funds in international capital markets at attractive rates. Given that MDBs are non-profit organizations, they are then able to provide loans to less developed countries at attractive conditions.	https://documents1.worldbank.org/curated/en/839481540790602457/pdf/131398-WP-MDBs-Harmonized-Framework-for-Additionality-in-Private-Sector-Operations-PUBLIC.pdf
Nordic Public Sector Issuers (NPSI)	NPSI - A position paper which builds on the approaches laid out in the 'Harmonized Framework for Impact Reporting' released by a group of international financial institutions in November 2015 and impact indicators suggested by ICMA works groups and supplementing with additional guidelines where needed.	https://norrkoping.se/download/18.68a507b01864b837bb416cb/1677050806615/NPSI_Position_paper_2020.pdf

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8.3. Analysed Universe Impact Metrics

8.3.1. Analysed EUR Universe Portfolio Weighted Impact Metrics

Metric	Unit	Portfolio-Weighted Impact	Number of Green Bonds Reporting this Metric
GHG Emissions Reduced, Avoided or Abated	tCO2e	120,490.45	17
Renewable Energy Generated	MWh	138,740.20	12
Energy Savings	MWh	15,422.24	11
Jobs Created	Number	2,550.65	10
Renewable Power Capacity Installed or Connected to Grid	MW	76.67	7
People Benefitted	People	152,934.46	5
Passenger/Freight Distance Travelled by Clean Transit or ZEVs	km	944,469.00	3
Habitat Restored, Conserved, or Created	Square-km	23.67	3
Transportation Infrastructure Built	km	6.94	3
Water Use Reduced or Avoided	Tonnes	492,410.85	2
Loans Granted	Number	427.60	2
Students Benefitted	Students	3,564.13	1
Farmers Benefitted	Farmers	133.81	1

8.3.2. Analysed JPY Universe Portfolio-Weighted Impact Metrics

Metric	Unit	Portfolio-Weighted Impact	Number of Green Bonds Reporting this Metric
GHG Emissions Reduced, Avoided or Abated	tCO2e	738,035.62	18
People Benefitted	People	383,857.38	5
Renewable Energy Generated	MWh	13,500.80	5
Passenger/Freight Distance Travelled by Clean Transit or ZEVs	km	25,493,853.10	4
Building Certifications Achieved	Number	-	4
Energy Savings	MWh	17.28	2
Transportation Infrastructure Built	km	1.82	2
Habitat Restored, Conserved, or Created	Square-km	5,512.39	1
Renewable Power Capacity Installed or Connected to Grid	MW	1.29	1

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8.3.3. Analysed USD Universe Portfolio-Weighted Impact Metrics

Metric	Unit	Portfolio-Weighted Impact	Number of Green Bonds Reporting this Metric
Energy Savings	MWh	1,761.08	3
GHG Emissions Reduced, Avoided or Abated	tCO2e	1,325.85	3
Renewable Power Capacity Installed or Connected to Grid	MW	0.80	3
Students Benefitted	Students	20,762.13	2
People Benefitted	People	4,605.93	2
Farmers Benefitted	Farmers	779.47	2
Jobs Created	Number	2.83	2
Habitat Restored, Conserved, or Created	Square-km	1.06	2
Energy Savings	MWh	1,761.08	3
GHG Emissions Reduced, Avoided or Abated	tCO2e	1,325.85	3
Renewable Power Capacity Installed or Connected to Grid	MW	0.80	3
Students Benefitted	Students	20,762.13	2
People Benefitted	People	4,605.93	2
Building Certifications Achieved	Number	-	1

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More information: ice.com/sustainable-finance-data

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