Transition power, a JGB SLB, prints in USD[1]

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Japan has made a clear commitment to weaning itself off fossil fuels. The sovereign has announced that it will issue a Climate Transition Bond (CTB) under its GX framework on 14 February.

While it is encouraging to see Japan remove controversial ammonia-coal-cofiring from the capex use-of-proceeds (UoP) of this bond, it could achieve an even greater impact if it were to complement the issuance with a sustainability-linked bond (SLB).

Japan has an excellent opportunity to take a global lead in sustainable finance by issuing an SLB focused on its ambitious 2030 carbon emissions reduction target. The SLB structure would deliver considerable benefits:

- Lower cost-of-capital to drive a successful decarbonisation
- Flexibility in the selection of carbon-reduction measures, enabling Japan to incrementally respond to technological improvements
- An issuance in US dollars or Euros would attract international investors to the GX framework

For investors, the transaction would not only reduce their carbon footprint - the financial terms should also be attractive. The SLB gives investors an option to hedge against the issuer missing its emissions target and the ability to manage both coupon and impact risk in the US dollar benchmark curve.

Figure 1. Sample term sheet for a Japan sovereign (JGB) SLB with a step-up/step-down structure and an investor option value of 5.7bps. Indicative/hypothetical pricing. Not a recommendation. Source: AFII.

Observation and step date	Feb 2031
SPT 1	-46% CO_2 reduction at 2030 from 2013 baseline, equivalent to ~710Mt pa.
SPT 2	-56% CO_2 reduction at 2030 from 2013 baseline, equivalent to ~579Mt pa.
Coupon adjustment	+37.5bp on not achieving SPT1 -37.5bp on achieving SPT2
Pricing	JGB USD curve -5.8bp
of which:	-6.6bps option value of SPT1
	+0.8bps option value of SPT2
	Indicatively TSY10+13.2bp

[1] A traditional Japanese haiku is a poem with seventeen syllables, written in a 5/7/5 syllable count.

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Global investors and Japan's Climate Transition Bond

Japan is among the most coal-dependent countries in developed markets and a key issuer of sovereign bonds, and as such should be a focal point for climate/transition focused global fixed income investors. It has recently been announced that the Ministry of Finance (MOF) will be issuing "10-year Japan Climate Transition Bonds" on 14 February, following a prolonged discussion around the format of such bonds and their positioning within the so-called GX framework.[2] Recent updates to the bond framework have stepped back from capital expenditure on controversial ammonia-coal-cofiring in the UoP, even if R&D costs for it can still be covered. The GX framework has very recently been verified by DNV and JCR,[3] and the bond UoP - tighter than the general GX framework – has generated an expectation that it will be designated 'green' by the Climate Bonds Initiative (report here).

Still, the bond's UoP in terms of ammonia-coal-cofiring R&D is not uncontroversial, as there are question marks about Japan's export-orientated focus on the technology.[4] The basic concept in ammonia-coal-cofiring is to replace approximately 1/3 of the coal input in a coal plant with ammonia, which should lead to a commensurate reduction in carbon emissions, with some important caveats and technical challenges, especially around lock-in effects.[5]

The first issuance of CTBs will be yen-denominated and likely targeted at domestic investors, but it seems that the MOF has taken feedback from global investors, as the original GX format has been significantly adjusted. [6]

A decarbonisation-linked complement to the use-of-proceeds bond

Based on this, to further engage global investors, we believe a complementary SLB issuance to the CTBs in a carbon emission reduction-linked format would be a powerful statement in terms of the sovereign's commitment to decarbonisation.

With national decarbonisation targets in place, and with a mechanism to measure data and progress towards the target, the groundwork for a SLB is already in place. The advantages to both investors and the issuer are clear:

For investors, the SLB structure allows a risk-hedge in terms of climate exposure, as it will increase returns if the issuer is not able to reduce climate risks in terms of carbon emissions. The

[2] A number of articles have been published on the topic, e.g., "Japan's green transition bonds find 'more open-minded' investors", NikkeiAsia, 6 Nov 2023; "First Sovereign Transition Bond Drawing Little Foreign Interest", Bloomberg, 26 Oct 2023.

[3] In Japanese only: the framework: "Climate transition bond framework", METI, Nov 2023, and second party opinions "Japanese Government Climate Transition Bond Framework", DNV, 7 Nov 2023; "Japan Climate Transition Bond Framework", Japan Credit Rating Agency (JCR), 7 Nov 2023. "Japan considers green transition bond issuance for next fiscal year", Reuters, 11 Jan 2023. The framework is available here (Japanese language version): "クライメート・トランジション・ボンド・フレームワーク 令和".

[4] See "JERA is putting Japan's decarbonisation goals at risk", NikkeiAsia, 26 Jan 2024.

[5] See "Sovereign SLB: an option for Japan's transition", AFII, 15 Jun 2023, for a further discussion.

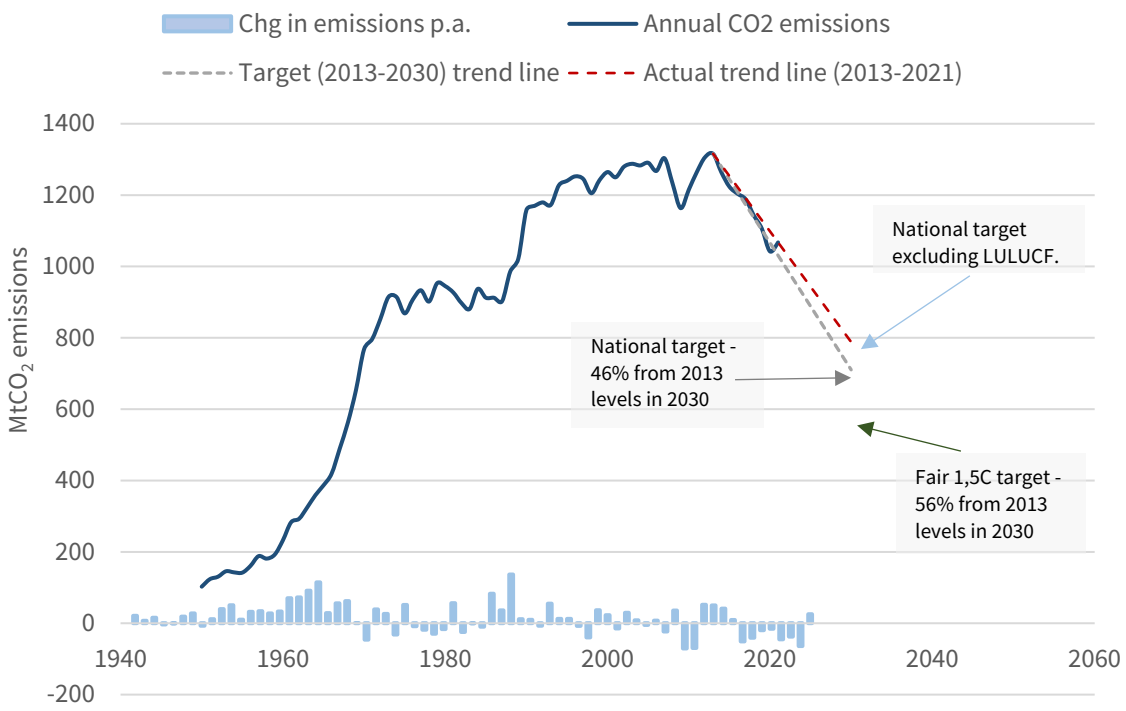
[6] As reported in "Japanese transition bonds could help refine concept of transition finance, says Axa IM", Environmental Finance, 13 Nov 2023; "First Sovereign Transition Bond Drawing Little Foreign Interest", Bloomberg, 27 Oct 2023; "Investors Wary of Greenwashing in Japan's $140 Billion Bond Plan", Bloomberg, 18 Nov 2022; "Japan may face backlash over plans to issue transition bonds", Asahi Shimbun, 1 Feb 2023.

general corporate purpose (GCP) [7] format of the SLB shifts the focus from potentially controversial technologies that may be show-stoppers in the UoP format to the macro-outcome. Over time, we would also expect SLB issuance to become as standardised as green bond issuance, potentially becoming even easier to use, as a headline target will be monitored rather than capex on a diverse set of projects.

For the issuer, embedding strategy into a bond contract signals substantial commitment to their climate targets, and an expectation that investors will diligently track progress. As investors are compensated if the issuer goes off target, recurring issuances will be smoother as there will be less of a debate around previous commitments and the fulfilment of those. Moreover, as we show in the option pricing analysis, the SLB structure should come with some pricing advantage if the issuer successfully achieves the targets.

It is important to note the complementary nature of the UoP CTB and the SLB GCP bonds. UoP focused investors can contribute crucial capital to specific projects that are necessary to achieve the decarbonisation strategy. GCP investors ensure holistically that strategy targets are met, through following up on the headline carbon reduction numbers. This is a benefit not only to bond investors directly, but to stakeholders across the 'capital structure'.

Figure 2. Historical CO_2 emissions and forward projections, 1940-2030. Sources: JapanGov: Carbon neutrality, How Japan could reach carbon neutrality by 2050 \| McKinsey, AFII.



[7] A UoP bond commits borrowed capital to a number of pre-defined areas of capital expenditure (e.g. a wind power farm). It is convenient for the investor in the sense that they have clarity about how the money is being invested. A GCP bond is capital that the borrower is free to use for whatever purposes it wants. When combined with sustainability-linked features, this type of bond has the advantage of holistically targeting the strategy of the issuer (e.g. total CO_2 emissions), not only one part of the borrower's balance sheet.

An option pricing approach to Japan's decarbonisation targets

How should such a structure be priced? This section illustrates an indicative way to price an SLB based on national decarbonisation targets. Data and numbers are as of Nov 2023, and should be revised to reflect new data points as they arrive.[8]

Underlying this pricing exercise is the mathematical argument that an issuer committing to an ambitious target with financial payouts tied to it, like an SLB, is associated with some financial value. AFII's option pricing model for SLBs applies a traditional option pricing framework but with sustainability KPIs as the strike level.[9] Core to this valuation will be the probability inference on how likely it is the issuer will reach the target, as the (discounted) value of the step-up cash-flows are fixed.[10]

To calibrate the probabilities in our model, we start by illustrating the historical data and trends of Japan's CO_2 emissions in Figure 2. 2013 was the peak year of emissions at 1.31Gt, and we have seen an average 31.0Mt reduction on a year-on-year basis since then (2021 emissions were 1.07Gt). Japan has set a target of reducing emissions by 46% until 2030, using the (peak) 2013 number as the baseline, at 710Mt. The equivalent year-on-year reduction rate would be a 35.6Mt reduction, meaning that between 2013 and 2021, a 78Mt reduction deficit has built up. Translating this into forward-looking compensations, the reduction rate from 2021 onwards would need to be -39.7Mt per annum.

Cognisant that 2022 and potentially 2023 data should be available relatively soon, this would still indicate that the -46% (2030) reduction is ambitious. Even nearly the current actual vs plan deficit would require the closure of one large additional coal plant every year.[11]

A main caveat is that the 2030 target is inclusive of Land Use, Land-use Change and Forestry (LULUCF), whereas the baseline year was not. Excluding LULUCF, the 2030 target is 813MtCO_2 p.a. versus 788Mt when it is included.[12] Indeed, the current trend of carbon reduction is almost indistinguishable from the trendline of intended targets but excluding LULUCF. We believe a new SLB structure should be very transparent on whether the baseline will be restated in case of inclusion of LULUCF or not.

Given these numbers, an SLB with a -46% target as described should be able to price within a fair degree of optionality, as the probability that the target is (or is not) reached is likely to be in the region of >50%, under the observation that the issuer is currently off-target from the intended trajectory, unless LULUCS is included.

As a second target, to provide a possible step-down instead, we set a target at -56% (to 579Mt p.a.). This is a less ambitious target than suggested by a 1.5C pathway (-60%) or a 1.5C fair-share pathway (-70%), but given recent trends, and overshoot versus trend so far, it is still a hard-to-reach target.

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[8] A recent update on progress "Japan Inc.'s plans to cut emissions fall short of 2030 national target", NikkeiAsia, 20 Jan 2024, has not been included in this analysis.
[9] "An Option Pricing Approach to Sustainability-linked Bonds", AFII, 11 Aug 2022.
[10] See "Notes on Risk-Neutral Pricing of SLBs and Step-down Structures", AFII, 25 Oct 2022.
[11] A modern 1.6GW hard coal plant emits between 6-8Mt CO2e per annum.
[12] See Climate Action Tracker: Japan, 17 May 2023, accessed 7 Nov 2023, also reproduced in Figure 5 at the end. The document provides a review of country policies beyond the scope of this paper. In this context, it should be noted that Japan has the highest number of companies setting Science-Based Target Initiative targets in 2022, see SBTI Monitoring Report 2022, August 2023.

To deduce a fair pricing level for this amount of ambition, we apply the option pricing model for SLBs, where the main inputs and non-structural inputs are volatility and drift (trend). These parameters essentially determine the likelihood of the issuer reaching the SPTs, and thus that the investors benefit from a coupon-step. We calibrate volatility to 6.9% per annum based on historical volatility from the 1970s linear and onwards and assume a drift factor (current trend) based on the extrapolation of the 2013-2021 emissions trend. Using the notation of our pricing model[13] this gives that $\sigma = 6.9\%$ and $\delta = -3.31\%$.

We furthermore assume a 10-year SLB structure with an observation date of 2030 in line with a -46% reduction target, and 37.5bp step-up if the -46% target is not met, and a 37.5 step-down if the more ambitious carbon reduction level is reached (see Figure 5 at the end). This would mean a 7-plus 3-year structure, which aligns well with other typical issuance and liquidity points.[14]

In option language, both these options assume a forward value of 788Mt, with the first option having a strike of 710Mt ⇔ a 66% implied probability that the forward will be exceeded, and that the coupon will step-up. Analogously, the step-down option has a strike of 579Mt and an 8% implied probability of it being hit.

The discounted value of either coupon stream (step-up or -down) with 100% probability for payout is +/-83.5c in net-present value, or equivalent to +/-10.0bp running.

This structure is symmetrical in terms of payout of step-up and step-downs, but because the step-down is further out-of-the-money than the step-up, the total optionality is worth 6.6bp-0.8bp=5.8bp running. In practice, this means that an SLB offering the optionality should price 5.8bp inside the curve of a vanilla bond.[15]

Where should the Japan sovereign issue in USD?

The above analysis has made some assumptions in terms of pricing a JGB labelled issuance in US dollars or Euros, as we believe these would be the likely issuance currencies. From our understanding, the SLB format is less suitable for yen issuances, as that would rely on a domestic investor base where many investors have constraints on variable-coupon instruments, needing to

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[13] Using a closed form of the Black-Scholes formula for binary options pricing and assuming a geometric Brownian motion as driving the carbon emissions, the price of the coupon stream SLB_0^2 can be expressed as:

$$SLB_0^2 = \phi(d_2) \times \sum_{t=\tau}^{n} \frac{CSU_t}{B(O,t)}$$

where:

- ϕ the cumulative distribution function
- $d_2 = d_1 - \sigma\sqrt{t_\tau}$, $d_1 = \frac{ln\left(\frac{CE_\tau}{D \times CE_0}\right) + \left(\delta + \frac{\sigma^2}{2}\right) \times t_\tau}{\sigma\sqrt{t_\tau}}$, CE0 being the option's strike price

and where δ is the drift parameter (assumed carbon emissions reduction trend), and σ is the historical volatility of carbon emissions.

[14] For example, the 7step3 structure aligns well with liquidity points on the CDS curve (3, 5, 7, 10y), see "Greenback SLBs: an impact standardization proposal", AFII, 10 May 2023.

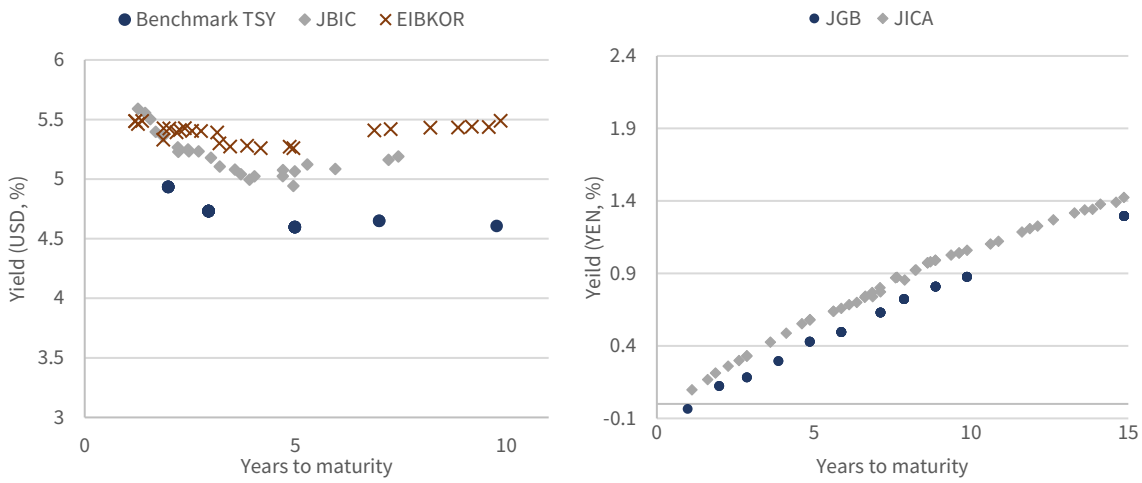
[15] For a recent example of how the option value can accrue to investors, see "Enel SLBs: market update", AFII, 8 Nov 2023, and "Enel SLBs: update on 2023 observation date", AFII, 20 Oct 2023.

classify them as structured products. AFII's earlier work[16] discusses a few Japanese SLBs where coupon steps are paid in alternatives, such as carbon offsets, rather than through coupon changes.

To estimate where an US dollar issuance might occur, we benchmark it by comparing the sovereign to two large, guaranteed SSA issuers, JBIC and JICA. JBIC has already a number of labelled bond issuances in USD, but less of a yen curve, whereas JICA is a prolific yen issuer, also in labelled bonds. These curves are illustrated in Figure 3.

Focusing on the ten-year point, we can see that JICA trades at around 18bps at a premium to the sovereign. However, the JBIC curve does not extend further out than seven years (2031) in terms of the US dollar curve, where it trades at a G spread of 54bps (over Treasuries). Hence, we extrapolate the US dollar curve of another SSA issuer (EIBKOR, rated AA), where the EIBKOR 5.125 09/33 trades closely matched to the current 10-year Treasury, indicatively at CT10+88bps.

Figure 3. Benchmarking a USD-denominated JGB to other SSA issuers in USD, and SSA issuer in yen. We assume JBIC and JICA funding flat to each other. Source: Bloomberg, AFII.



Thus, we estimate a fair issuance level for a 10-year USD-denominated JGB through the following (Table 1) relative value calculation:

Table 1. Illustrative calculation to price a JGB SLB in USD. Source: Bloomberg, AFII. Indications as of early February, 2024.

Bond	Adjustment	Pricing implication
EIBKOR USD 10y		CT10+68
	- [EIBKOR USD 7y – JBIC USD7y]	-30
	- Curve adjustment	-1
	- [JBIC YEN 10y – JGB YEN 10y]	-18
JGB USD		= CT10 + 19
	- SLB option premium	-5.8
JGB SLB in USD		**= CT10 + 13.2 [+5.8 option]**

These calculations are estimates and do not include a new issue premium, nor any (non-pecuniary) greenium. We estimate a plain USD-denominated 10-year JGB to trade at CT+19 and thus, including a 5.8bp option premium, to have a fair value at CT10+13.2.

[16] "SLBs: alternative steps", AFII, 23 May 2023.

It is worth to consider that many investors will own US Treasuries for liquidity purposes and would not normally switch between those books and an SSA issuance such as a US dollar JGB. However, we think there are reasons especially for climate-aligning investors to consider using a small proportion of such liquidity pools if Japan were to issue a robust climate change mitigation bond.

First, given the political landscape in the US, the risk of timely coupon payment failure is higher than for the JGB, as is reflected in United States CDS underperforming JGB CDS in recent years, as seen in Figure 4, currently trading a differential of +20bps (US vs Japan, 19 Jan 2024).[17]

Second, there is a significant risk of a change in the US political landscape, such that current climate policies are stopped and/or reversed,[18] in which case we anticipate a debate around de-emphasising US Treasuries' weight in portfolios due to their financing of adverse climate impact.

Lastly, as shown in Figure 4 right, although Japanese SSA paper has been trading wider to US Treasuries in 2023, levels are still elevated versus 2021-2022H1. In late 2021, JBIC traded as tight as only 17bps over the US Treasury benchmark.

Figure 4. Left: Japan and US CDS (in USD and EUR respectively). Right: JBIC $1.25 01/2031 spread to UST benchmark, Source: Bloomberg, AFII.

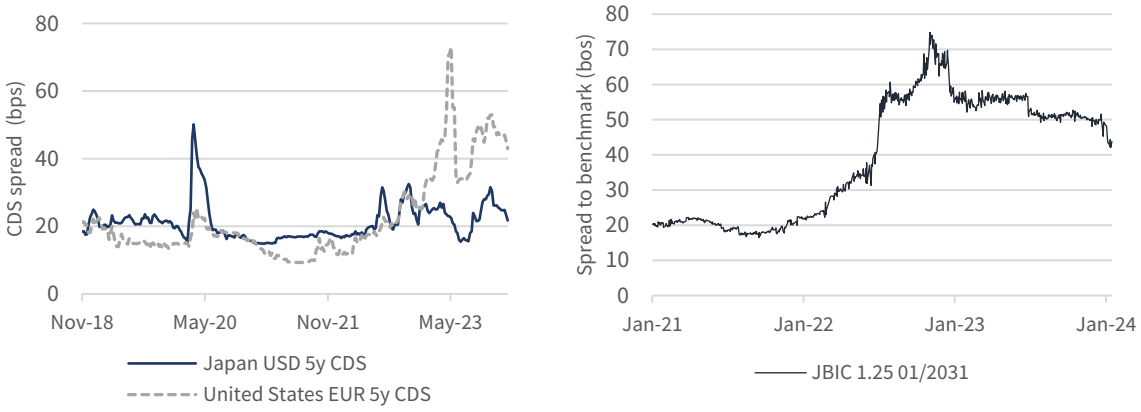
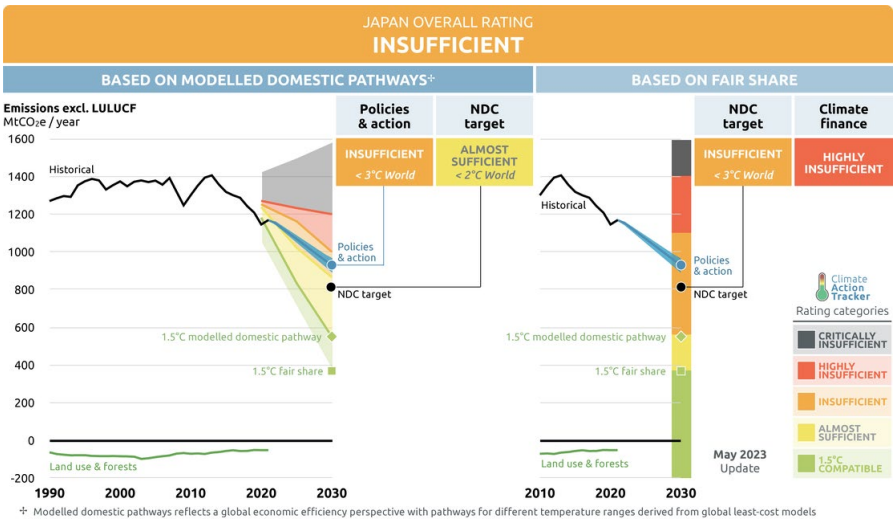


Figure 5. Climate Action Tracker overview of the Japanese national climate alignment, including National Defined Contribution (NDC) targets, and estimated fair-share 1.5C level. Accessed 17 Nov 2023.



[17] Japan sovereign CDS are traded in US dollars, and US CDS in Euro. For a further discussion on the quanto risk, see "Quanto CDS Spreads", Lando, D. and Nielsen, A. B., SSRN, 20 April 2018.

[18] "Donald Trump would gut Joe Biden's landmark IRA climate law if elected", Financial Times, 23 Nov 2023.

Conclusion

An SLB with targets aiming to meet Japan's 2023 decarbonisation plans would be strongly complementary to the shortly forthcoming UoP CTBs.

By issuing in US dollars, such a structure could further cater to global investors and increase credibility and transparency around the GX framework.

The issuer would be able to access lower cost-of-capital compared to vanilla bonds, if successful in the decarbonisation drive, while investors would be hedged if current targets are missed.

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