BIS Innovation Hub

Project Genesis 2.0

Smart Contract-based Carbon Credits attached to Green Bonds

October 2022

HONG KONG MONETARY AUTHORITY
香港金融管理局

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Foreword

With the record-breaking summer this year, and the number of lives lost and families displaced in climate disasters in recent years, climate risks can no longer be ignored. More effort and partnerships from all sides are clearly needed to achieve the ambitious goal of limiting temperature rise to 1.5°C above pre-industrial levels, as set out in the Paris Agreement.

Finance has historically been a vehicle that facilitates changes, however, to achieve the magnitude and depth of the green transition required, the current green finance market needs to be transformed.

As the clock of nature ticks, the Genesis projects, consisting of Genesis 1.0 and Genesis 2.0, aim to demonstrate the green art of the possible, by making the green finance market more efficient and effective, through the use of innovative technology and public-private partnerships.

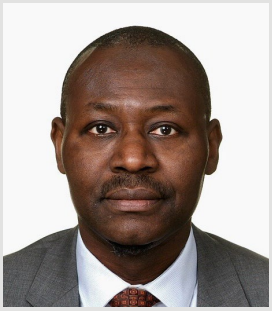
Project Genesis 1.0, BIS Innovation Hub's first green finance project, demonstrated the possibilities arising from a tokenised retail government green bond. The two prototypes, using both a public blockchain and a permissioned blockchain, achieved in conjunction with six private parties, make investing in a retail government green bond more efficient, cheaper, more transparent, and allows investors to track the environmental impact linked to the investment in real time as well as to sell the bonds in a transparent secondary market.

In this Genesis extension project, the BIS Innovation Hub has collaborated with the Hong Kong Monetary Authority and the UN Climate Change Global Innovation Hub. Project Genesis 2.0 explored the use of blockchain, smart contracts, and internet-of-things (IoT), and achieved two prototypes that aim to tackle the greenwashing concern of the green bond market, and transform the carbon market from an ex post reward to an ex ante enabler for green projects.

To ensure that finance is being efficiently channelled towards effective climate solutions, Project Genesis 2.0 combines the green bond market and the carbon market by proposing a new green bond structure appended with mitigation outcome interests (MOIs), which are future contracts with a commitment to deliver, at maturity, verified carbon credits compliant with the Paris Agreement. The technology solutions digitally track, in real time, mitigation outcome data linked to the green bond's lifecycle, providing investors transparency on the climate impact of the investment. The prototypes also achieved digital delivery and transfer of MOIs enabled by smart contracts.

Project Genesis 2.0 demonstrated the benefits of integrating the green bond and carbon markets, as well as the possibility brought about by technology to enhance the transparency and environmental integrity of the green bond market. We hope that the possibility and learnings demonstrated in Project Genesis 2.0 will catalyse innovations in the green finance market, leading to developments that shift mainstream finance towards meaningful and impactful climate solutions.

Bénédicte N Nolens
Head of the BIS Innovation Hub Hong Kong Centre



Massamba Thioye
Project Executive of UNFCCC Global Innovation Hub

Executive summary

The BIS Innovation Hub Hong Kong Centre and the Hong Kong Monetary Authority collaborated with private consortia in 2021 under Project Genesis 1.0 to address the inefficiency in issuance, the uncertainty of green impact committed to at issuance and the lack of liquid and transparent secondary markets of government green bonds for retail investors.

As an extension to Project Genesis 1.0's successful proof-of-concept on the tokenisation of retail green bonds using both a public blockchain and a permissioned blockchain, Project Genesis 2.0 sought to address issues of greenwashing and additionality of green bonds, thereby enhancing the transparency, objectivity, and environmental integrity of the green bond market. In this project, a new structure of green bond is explored to ensure that green bonds serve the 1.5°C climate goal. In this new structure, a green bond is appended with MOIs, which are de facto verified carbon credits recognised by either international, national, or other recognised verification mechanisms in line with the Paris Agreement. In addition, the integration of the green bond market and carbon market transforms the carbon market from an ex post reward to an ex ante enabler for green projects.

Under Project Genesis 2.0, the BIS Innovation Hub Hong Kong Centre, the Hong Kong Monetary Authority, the UN Climate Change Global Innovation Hub, in conjunction with two private consortia: one composed of Goldman Sachs, Allinfra, and Digital Asset; and the other composed of InterOpera, Krungthai Bank, Samwoo and Sungshin Cement, achieved two prototypes with the use of blockchain, smart contracts, and internet-of-things (IoT) to digitally track, deliver and transfer MOIs appended to the green bond.

The prototypes demonstrated the ability to allow investors real-time transparency on the environmental impact of the use of proceeds from the green bond, efficient trading and settlement of MOIs, as well as potential solutions to concerns of double counting in carbon credits.[1]

The first prototype developed in conjunction with the Goldman Sachs, Allinfra and Digital Asset consortium showcases a simulated solution for an end-to-end digital flow for institutional green finance. The straight-through process via a blockchain-based platform is able to digitally track, deliver and transfer MOIs in addition to tokenising the issuance of the green bond itself. It is able to achieve smart contract-based delivery of bonds and MOIs, and provides source data transparency enabled by IoT technology.

The second prototype developed in conjunction with the InterOpera, Krungthai Bank, Samwoo and Sungshin Cement consortium is built on an interoperable host chain designed as part of a wider ecosystem. With a combination of blockchain, smart contract and API technologies, it digitally tracks, delivers and transfers MOIs throughout the full green bond lifecycle.

This report includes three sections: Section A outlines the vision of Project Genesis 2.0, which discusses the green washing and additionality issues in the green bond market, proposes a new green bond structure appended with MOIs, and provides an overview of the benefits demonstrated in the project; Section B takes a deep dive into the two prototypes' respective technology solutions, key learnings and future considerations. A sample term sheet template for issuers on the proposed green bond and MOI structure contributed by King & Wood Mallesons is attached as Annex.[2]

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1. While eliminating the concerns of double counting in carbon credits is out of scope for Project Genesis 2.0, the two prototypes developed under Project Genesis 2.0 could be further explored as theoretical solutions to address the double counting problem in carbon credits as well as in the context of internationally transferred mitigation outcomes in relation to the Paris Agreement Article 6.2.
2. The present report shows the technical infrastructure of prototypes created by the two consortia. The prototypes described herein are being co-developed with the BIS Innovation Hub for the sole purpose of investigating technological feasibility and should not be understood to imply or express any regulatory policy stance or endorsement by the BIS. Given that the prototypes are purely conceptual with no actual bond or MOI issuance involved, this material should also not be construed as a recommendation or an offer to sell or the solicitation of an offer to buy any security and nothing contained herein shall constitute legal advice or form the basis of any contract or commitment. The present report should not be copied in whole or in part without the express written consent of the BIS Innovation Hub.

A.1 Vision of Project Genesis 2.0

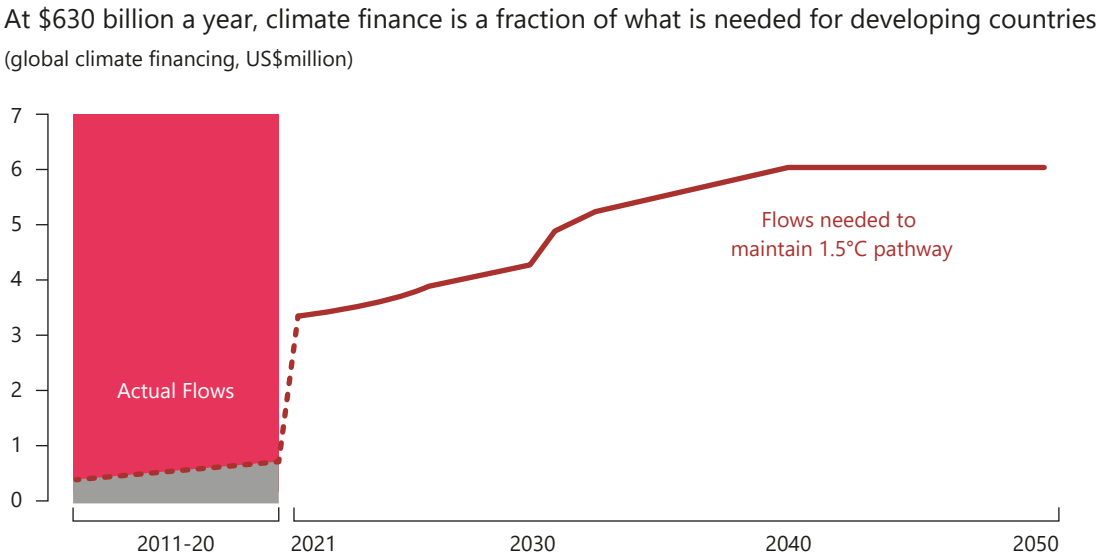
> Project Genesis 1.0 demonstrated how technology and innovation could improve the efficiency and effectiveness of channelling retail savings into sustainable projects through a tokenised government green bond. Genesis 2.0 goes further, it explores how innovations in a new sustainable financial instrument and technologies can shift mainstream finance towards direct contributions to climate goals, by addressing the issues of additionality and greenwashing of the current green bond market.

A.1.1 Green bond as a sustinable investment instrument

Transitioning rapidly to a low carbon economy is necessary in order to achieve the climate goal agreed in the Paris Agreement. The latest report from the Intergovernmental Panel on Climate Change, the Sixth Assessment Report, concluded that global emissions would need to almost halve by 2030 in order to limit temperature rise by 1.5°C,[3] which is estimated to require an additional average annual clean energy and infrastructure investment of around US$ 3 trillion by the end of the decade.[4] The International Monetary Fund is also calling to harness private climate financing in emerging markets and developing economies (see Figure 1). The financial market has a vital role to play in channelling capital towards the required capital investment.

3. See The Intergovernmental Panel on Climate Change, Sixth Assessment Report, April 2022, www.ipcc.ch/assessment-report/ar6/
4. Estimated by the International Energy Agency. See International Energy Agency, World Energy Outlook, 2021, www.iea.org/reports/world-energy-outlook-2021

Figure 1: Climate financing gap in developing countries



Source: "Public sector must play major role in catalyzing private climate finance" (K Georgieva and T Adrian), International Monetary Fund, August 2022, www.imf.org/en/Blogs/Articles/2022/08/18/public-sector-must-play-major-role-in-catalyzing-private-climate-finance

Green bonds have risen to be the mainstream sustainable finance instrument in the market. Since the first green bond was issued in 2007 by the European Investment Bank, the green bond market has ballooned into a market with cumulative issuance of US$ 1.6 trillion. Green bonds issuance in 2021 grew by 75% from the previous year, surpassing US$ 500 billion.[5]

Green bond standards

Green bonds are fixed-income debt securities similar to conventional bonds, but the funding raised from the bond's issuance is, in principle, directed towards environmental sustainability.

The introduction of the Green Bond Principles (GBP) in 2014 has helped to promote the green bond market by providing best practice guidance on the approach for issuance of a green bond. The GBP set out four core components for determining whether a bond is green:

1. Use of Proceeds: proceeds are exclusively for eligible green projects, which should be appropriately described in the legal documentation of the security.

5. See Climate Bond Initiative, Sustainable Debt Global State of the Market, 2021, www.climatebonds.net/files/reports/cbi_global_sotm_2021_02h_0.pdf

2. Process for Project Evaluation and Selection: the issuer should clearly communicate to investors the environmental sustainability objectives of the eligible green projects, the process by which the issuer determines how the projects fit within the eligible green projects categories, and complementary information on processes by which the issuer identifies and manages perceived social and environmental risks associated with relevant project(s).

3. Management of Proceeds: the net proceeds of the green bond, or an amount equal to these net proceeds, should be credited to a sub-account, moved to a sub-portfolio or otherwise tracked by the issuer in an appropriate manner, and attested to by the issuer in a formal internal process linked to the issuer's lending and investment operations for eligible green projects.

4. Reporting: issuers should make, and keep readily available up-to-date information on the use of proceeds to be renewed annually until full allocation, and on a timely basis in case of material development.

The GBP also set two recommendations for heightened transparency:

i. Green Bond Frameworks: issuers should explain the alignment of their green bond with the four core components of the GBP in a Green Bond Framework or legal documentation in a readily accessible format to investors.

ii. External Reviews: issuers are recommended to appoint (an) external review provider(s) to assess pre-issuance the alignment of their green bond with the four core components of the GBP. Post issuance, it is recommended that an issuer's management of proceeds be supplemented by the use of an external auditor, or other third party, to verify the internal tracking and the allocation of funds from the Green Bond proceeds to eligible Green Projects.[6]

While the GBP is the most notable green bond standard in the market, there is no single established global standard. Furthermore, there are also different definitions of eligible green projects.

In a bid to unify the domestic green bond market and align with international standards, Mainland China has recently launched a set of green bond principles with reference to the GBP in August 2022. The European Commission is also establishing an EU green bond standard as part of the European Green Deal - EU's growth strategy to transition the EU economy to a sustainable economic model, including to become the first climate neutral continent by 2050.

On the eligibility of green projects, the International Platform of Sustainable Finance Taxonomy Working Group, co-chaired by the People's Bank of China and the EU Commission, is developing a Common Ground Taxonomy (CGT) for eligibility criteria for activities across sectors. The CGT draws on the EU Taxonomy and the Green Bond Endorsed Projects Catalogue in China, and is envisaged to be used by other countries as reference to develop their own standards to foster better international comparability of taxonomies. The Green and Sustainable Finance Cross-Agency Steering Group[7] in Hong Kong SAR will also work towards incorporating the CGT in Hong Kong's local green classification framework.

6. See International Capital Market Association, Green Bond Principles, www.icmagroup.org/sustainable-finance/the-principles-guidelines-and-handbooks/green-bond-principles-gbp/
7. See Hong Kong Monetary Authority, Cross-Agency Steering Group Press Release, June 2022, www.hkma.gov.hk/eng/news-and-media/press-releases/2022/06/20220621-5/

Green bonds are considered sustainable financial instruments as funds raised by green bonds are earmarked for green projects and advocates believe that the "greenium" on green bonds incentivise corporates to invest in green activities. Greenium is a phenomenon whereby demand outstrips the supply of green bonds, due in part to increased demand for sustainable investments amongst investors and the inclusion of the green bond index, thereby driving the green bond's yield lower than a comparable conventional bond without funds being earmarked to green projects, thus providing a premium on the green bond.

> However, questions have been raised on green bonds, together with the rest of the environmental, social and governance (ESG) investing industry, on whether they deliver the environmental impacts necessary for the scale and speed required to achieve the 1.5°C climate goal.

"Greenwashing" has become the concern of many investors, and some warn that the green label is being exploited to over-promise the contributions towards environment outcomes. A green bond is required to ring-fence the use of proceeds for green projects, however, there is no requirement on the greenness of other activities of the issuer, such that the issuer may engage in carbon-intensive activities elsewhere. Thus, investment firms run the reputational risk of being scrutinised for overstating the green attributes in their investments when investing in green bonds issued by carbon-intensive issuers. Furthermore, while the various green bond standards mean that there is a lack of definition of "what is actually green", it is also difficult to assess the environmental impact of the green bond as current green bond standards only recommend but do not require issuers to report on the impact of the bond. Emma Howard Boyd, Chair of the Environment Agency warned that "if we fail to identify and address greenwashing, we allow ourselves false confidence that we are already addressing the causes and treating the symptoms of the climate crisis. Greenwashing makes it more likely that we won't realise this deception until it is too late".[8]

In addition, questions are also being raised on whether new financing is being brought in to close the "climate gap", as some green bonds are being used to refinance existing green projects or projects that would have been funded regardless. A recent study (Caramichael and Rapp (2022))[9] found that whether a green bond drives additional environmental impact from new green projects, as opposed to refinancing existing projects, had no significant pricing differential in the primary market.

In fact, we are falling behind in tackling the climate crisis; global energy-related carbon dioxide (CO2) emissions rose to a record high in 2021, following only a temporary drop in CO2 emissions due to economic shock caused by COVID-19.[10]

8. See Speech: E H Boyd, Chair of the Environment Agency, Environment Agency, "Finance, resilience, net zero and nature", July 2022, www.gov.uk/government/speeches/finance-resilience-net-zero-and-nature
9. See J Caramichael and A Rapp, "International Finance Discussion Papers 1346, The Green Corporate Bond Issuance Premium, Washington": Board of Governors of the Federal Reserve System, www.federalreserve.gov/econres/ifdp/files/ifdp1346.pdf
10. See International Energy Agency, Global Energy Review: CO2 Emissions in 2021, 2021, iea.blob.core.windows.net/assets/c3086240-732b-4f6a-89d7-db01be018f5e/GlobalEnergyReviewCO2Emissionsin2021.pdf

A.1.2 Addressing additionality of green bonds

> It is therefore important to ask the question of whether green bonds are allocating capital towards climate solutions that were previously not funded, in other words, are they scaling up green activities that would otherwise not occur.

There are two elements to the question:

- Is the issuer of the green bond able to access additional or cheaper funding (for example, in the form of greenium) than its prevailing financial conditions would allow for without the green attribute of the bond?

- Is the economic benefit, in the form of additional or cheaper funding, filling a financial viability gap of the financed green activities[11] which would otherwise be economically not viable under prevailing financial conditions?

If green bonds do not address these two questions, one may query the direct role green bonds play in contributing towards climate goals, or whether they are just another form of "greenwashing", which works only to incentivise bonds to be labelled as green without any material climate impact.

11. Project Genesis 2.0 assumes that the green solutions will deliver additional environmental impact against their baselines. There is some discussion around determining the environmental additionality of a green project, however this is not the primary focus of this project.

A.1.3 Carbon markets as a market mechanism to decarbonise

Carbon markets are an important market mechanism for decarbonisation; they put a price on greenhouse gas (GHG) emissions in units of metric tonne of carbon dioxide equivalent (tCO2e) and have been expanding rapidly in recent years as governments and private companies commit to net-zero GHG emissions targets.

Significant cuts in GHG emission is required globally across sectors in order to limit warming to 1.5°C, the Intergovernmental Panel on Climate Change estimated in its latest Sixth Assessment Report that global GHG emissions would need to fall by 43% by 2030 in order to limit warming to 1.5°C.[12]

Carbon markets reduce carbon emission by putting a price on carbon emission which changes market participants' behaviours with regard to their GHG emissions:

- Emitters are being forced to internalise their GHG emissions and incentivised to reduce their emissions.

- Businesses are incentivised to invest into cost-effective emission reductions and carbon removals.

Carbon markets comprise of the compliance market operated under a regulatory authority and a self-regulated voluntary market.

Compliance market

Under a compliance market, which is also referred to as an emission trading system (ETS), a regulatory authority imposes a compulsory cap on the total volume of GHG emissions for entities in certain industries[13] in a "cap-and-trade" system, or determines a baseline emission level for covered entities under a "baseline-and-credit" system. There are currently 32 ETS in force, covering approximately 17% of global GHG emissions.[14]

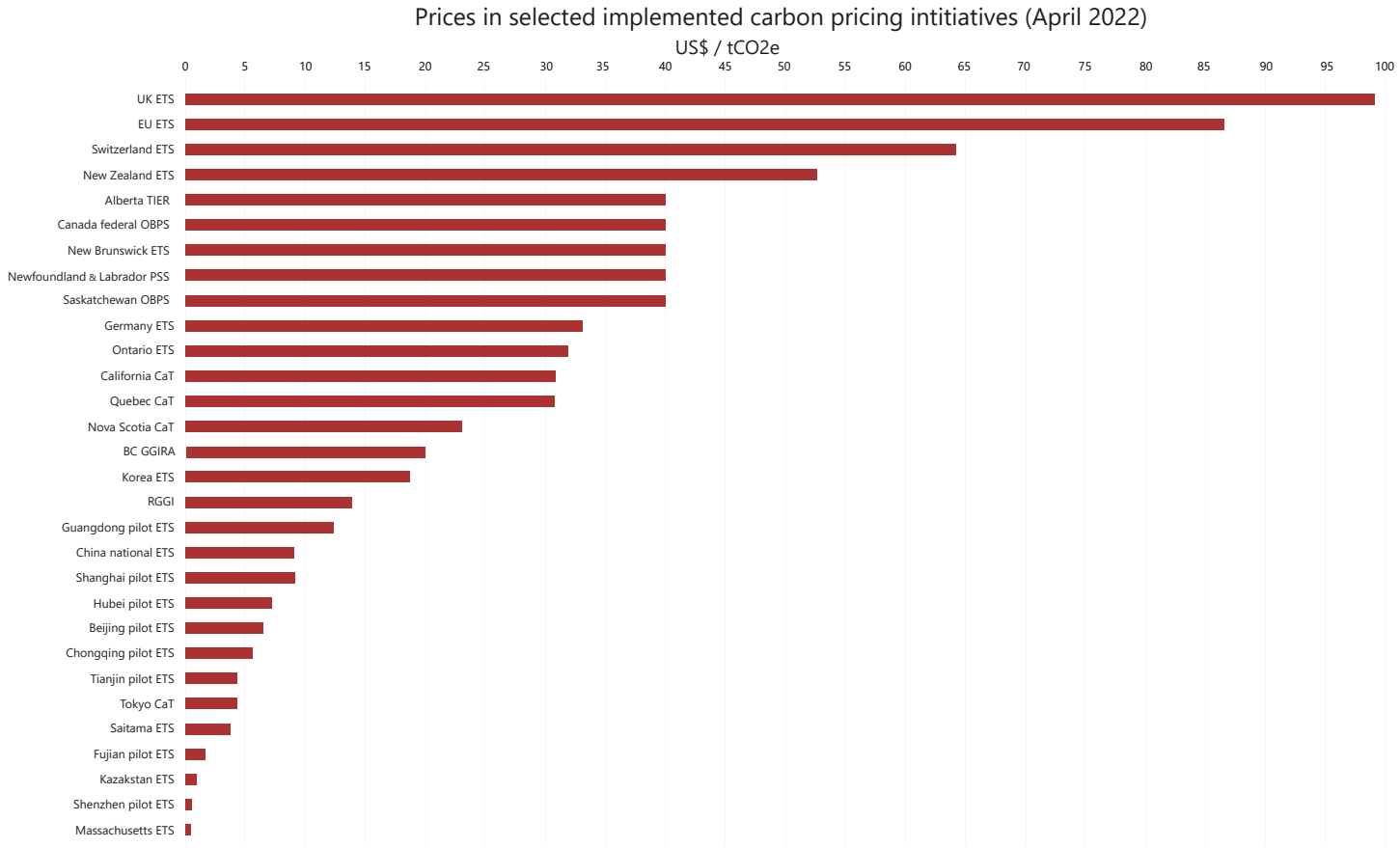
In the case of "cap-and-trade", emission allowances are auctioned or distributed by the authority to entities covered by the cap, and entities can sell surplus allowances to entities that need to buy additional allowance.

For the "baseline-and-credit" system, covered entities can trade emission credits to cover surplus emissions relative to the baseline.

Some ETS allow covered entities to meet their obligations with carbon credits from the voluntary market with quantitative limits (typically around 5-10%) and / or qualitative requirements (such as only accepting certain project types).[15]

12. See The Intergovernmental Panel on Climate Change, Sixth Assessment Report, April 2022, www.ipcc.ch/assessment-report/ar6/
13. For example, the EU ETS covers sectors including electricity and heat generation, oil refineries, teel works, production of iron, aluminium, metals, cement, lime glass, ceramics, pulp, paper, cardboard, acids, bulk organic chemical, nitric, adipic, glyoxylic acids and glyoxal; and commercial aviation.
14. See The World Bank, Carbon Pricing Dashboard, carbonpricingdashboard.worldbank.org
15. For example, China national ETS, California Cap-and-Trade Program, South Korea ETS allow the use of carbon credits from voluntary markets. See The World Bank, Carbon Pricing Dashboard, carbonpricingdashboard.worldbank.org

Figure 2 Carbon prices as of 1 April 2022 (US$ /tCO2e)



Source: The World Bank, Carbon Pricing Dashboard, carbonpricingdashboard.worldbank.org

Voluntary market

Unlike the compliance market, there is no emission cap or emission baseline for entities to adhere to in the voluntary market. Instead, entities voluntarily purchase carbon credits to meet their decarbonisation commitments. The voluntary market has seen significant growth in recent years, carbon credits issued by independent mechanisms grew by 88% in 2021, and the total value exceeded more than US$1 billion for the first time in November 2021.[16] The Taskforce on Scaling Voluntary Carbon Markets estimated in 2021 that the global demand for voluntary carbon credits could grow 15 times in volume by 2030.[17]

16. See The World Bank, State and Trends of Carbon Pricing, 2022, https://openknowledge.worldbank.org/handle/10986/37455
17. See Task Force on Scaling Voluntary Markets, Phase II Report, July 2021, www.iif.com/Portals/1/Files/TSVCM_Phase_2_Report

Carbon credits are generated by projects that either avoid (avoidance / reduction credits) or remove (removal credits) GHG emissions and are issued by independent crediting standards such as the Gold Standard and Verra, domestic crediting mechanisms such as the Australia Emission Reduction Fund, and international crediting mechanisms such as the CDM (see Figure 3 for the volume of issuance by different credit mechanisms).

However, there is currently a lack of standardisation in the methodologies of approving projects across the different standards, leading to concerns over the quality and environmental integrity of carbon credits. These concerns include double counting the emission reduction or removal by different mechanisms, the methods of demonstrating additionality of carbon credits which are often subjective and prone to manipulation, reversals in carbon reductions or removal whereby the GHG is re-entered into the atmosphere particularly for credits with biological storage such as forestry projects, and the credibility of baselines used to estimate the GHG emissions avoided. Recent efforts from multilateral initiatives are addressing the quality and integrity concerns of carbon credits in order to scale the voluntary carbon market, for instance, the Integrity council for the Voluntary Carbon Market is developing the Core Carbon Principles (CCP) to set threshold integrity standards to ensure the quality of carbon credits.

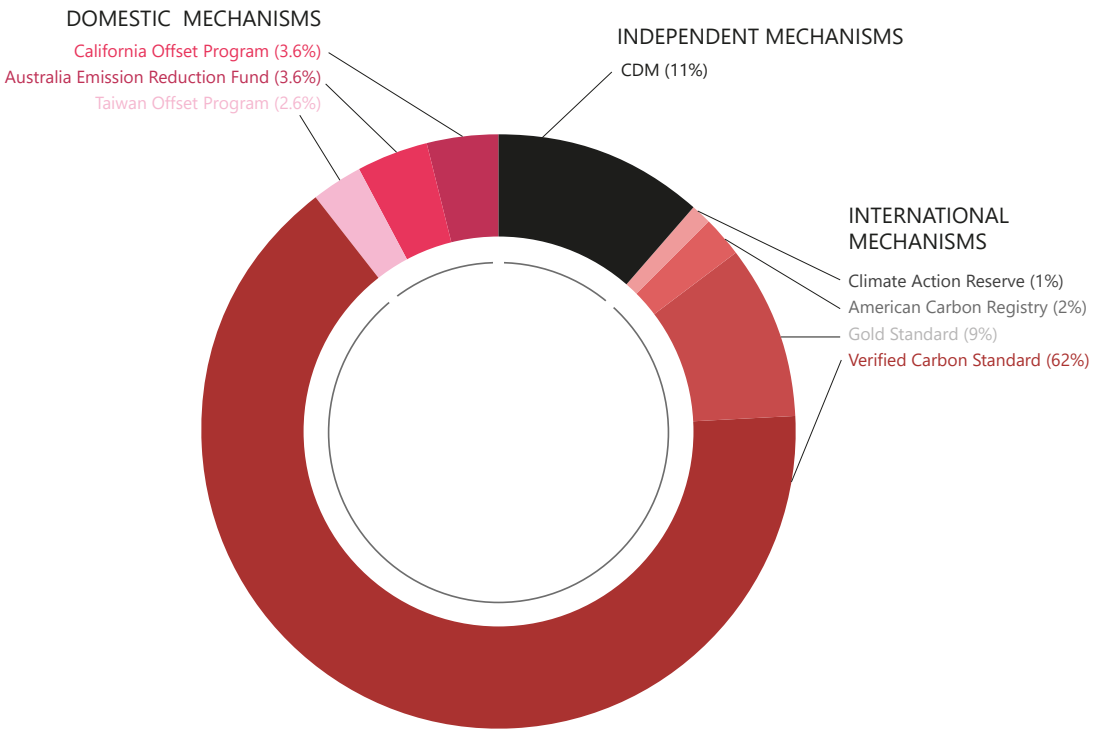
Demand for carbon credits in the voluntary market mainly stem from the following groups:

- Regulated entities purchasing carbon credits eligible for their respective compliance market ETS to meet their obligations under national or international or sectoral compliance markets;

- Entities purchasing carbon credits as part of their efforts to meet their voluntary mitigation commitments in addition to internal abatement of GHG emissions from their operations and value chain, and

- Financial investors who invest in carbon credits as an alternative asset class in anticipation of future price increases and to diversify their portfolios or hedge against inflation.

Figure 3 Global volume of issuance by crediting mechanism in 2021



Source: The World Bank, State and Trends of Carbon Pricing, 2022, https://openknowledge.worldbank.org/handle/10986/37455

In an attempt to address the issues of greenwashing and additionality of the green bond market, Project Genesis 2.0 proposes a new structure of green bond that serves the 1.5°C climate goal, specifically, green bonds appended with MOIs which are de facto verified carbon credits recognised by either international, national or other recognised verification mechanisms in line with the Paris Agreement.

To allow investors real-time transparency on the environmental impact of the use of proceeds from the green bond to avoid greenwashing, and enable a scalable and efficient market, two prototypes have been built as part of Project Genesis 2.0 with the use of blockchain, smart contracts, and IoT technology to digitally track, deliver and transfer MOIs appended to the green bond.

The following sections will outline the solutions explored in Project Genesis 2.0.

A.2 A proposed new financial instrument that can directly contribute to the climate goals set under the Paris Agreement

> A new structure of green bond proposed by Massamba Thioye of the UN Climate Change Global Innovation Hub is explored as part of Genesis 2.0 whereby a green bond is acquired with appended MOIs.[18]

A.2.1 Mitigation outcome interest

Mitigation outcome interest (MOI) is an instrument of carbon unit indebtedness of a green bond issuer to the holders of the MOI. Future repayment of MOIs is made using mitigation outcome units (MOUs).

MOUs are units of GHG emissions reduction, in other words, carbon credits recognised under international or national verification mechanisms compliant with the Paris Agreement.

In essence, MOI is a commitment to deliver units of GHG emission reduction attached to the bond.

A.2.2 A new structure for a green bond

The green bond structure proposed as part of Project Genesis 2.0 is appended with MOIs, which will be repaid in MOUs, de facto carbon credits recognised under international or national verification mechanisms compliant with the Paris Agreement. The MOIs can be sold and traded immediately, separate from the bond issuance.

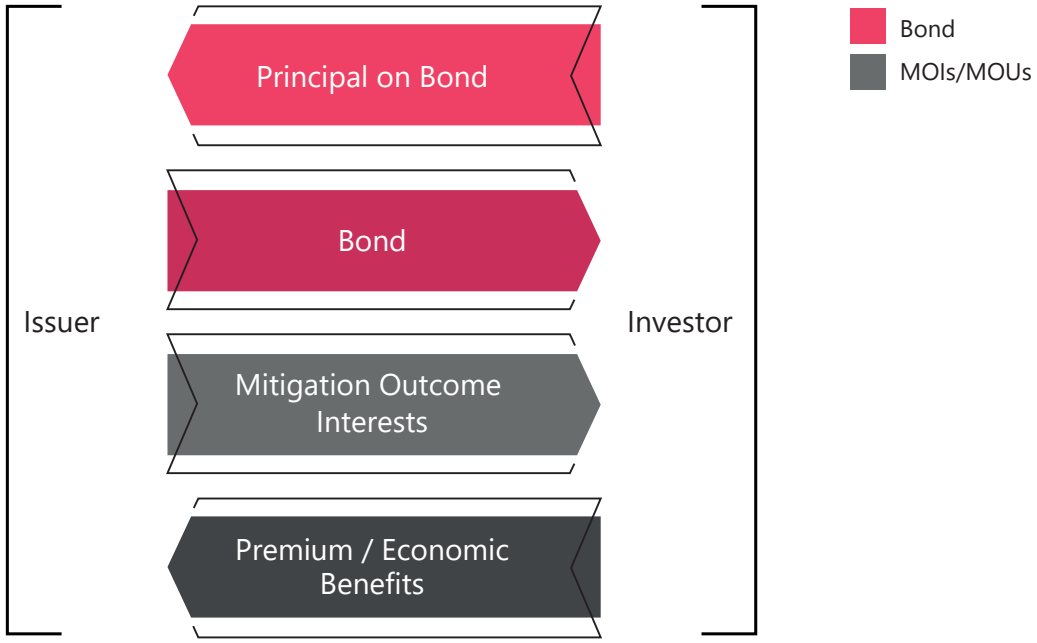
MOUs used to repay for the MOI obligations will need to be mainly generated by the asset or activities financed by the proceeds of the bond, and not simply bought from the carbon market.

In exchange for an MOI, the bond investor pays a premium or provides to the issuer another type of economic benefit compared with its baseline source of financing.

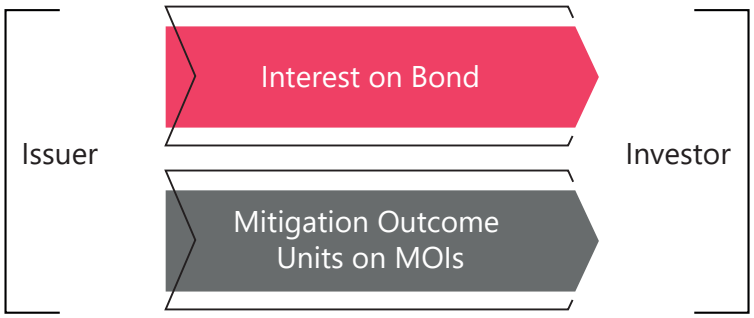
The proposed green bond structure endeavours to take into account the greenness of the issuer's entire investment plan, such that MOUs generated by the assets or activities financed by the proceeds of the bond will first be used to offset any climate performance gaps from other activities of the issuer financed after the issuance of the bond. Only the remaining MOUs can be used to repay for the MOIs to the bond investor.

18. See M Thioye, "Aligning finance for the net-zero economy: new ideas from leading thinkers, making green bonds serve the climate goals", EIT Climate-KIC, April 2021, www.unepfi.org/wordpress/wp-content/uploads/2021/03/5-Green-Bonds

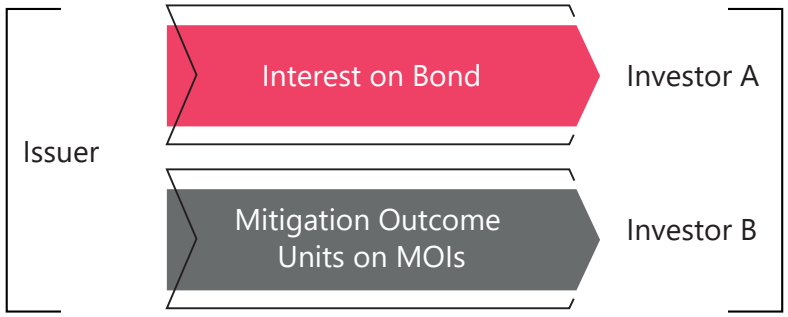
Figure 4 - Diagrammatic illustration of the proposed structure of green bond
At issuance



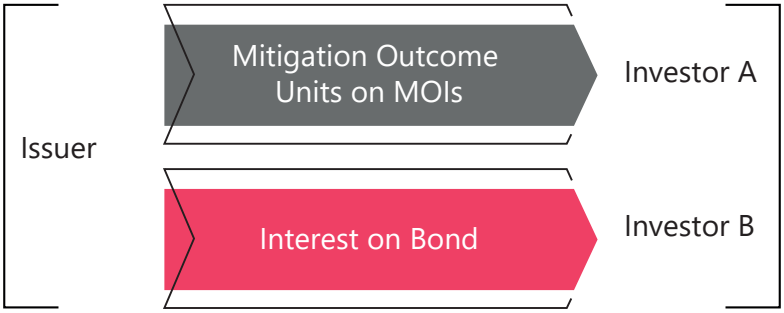
During the bond lifecycle
Scenario 1 – Investor keeps both Bond and MOIs



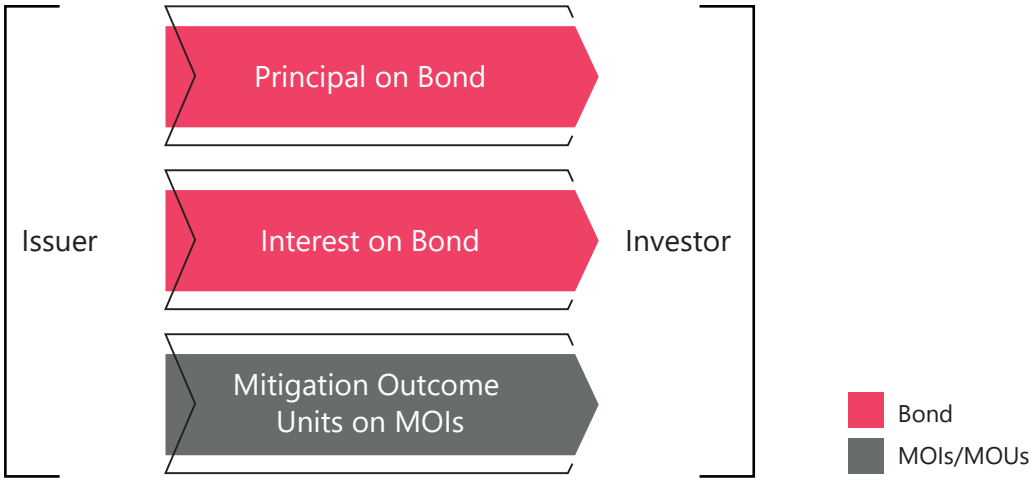
Scenario 2 – Investor A sells MOIs in the secondary market to Investor B and keeps only the Bond



Scenario 3 – Investor A sells Bond in the secondary market to Investor B and keeps only the MOIs



At maturity



A.2.3 Blockchain, smart contracts, and IoT solution to enhance the benefits of the proposed green bond structure

Traceability of the funded environmental impact

To enhance real-time transparency of the environmental outcome of the asset or activities funded by the bond's proceeds, Project Genesis 2.0 explores blockchain, smart contracts, and IoT solutions that digitally track and record real-time mitigation outcome data associated with a digital MOI linked to a bond lifecycle in an immutable form, which in turn are used to settle delivery obligations under the MOI. Unlike the current lengthy and manual process of measurements, reporting and verification (MRV) processes for carbon credits, the two prototypes developed in this project demonstrate the ability for investors to monitor, and trace back the environmental impact of the funded asset or activity on a granular level, in a timely and cost-efficient manner. This increases the visibility for investors on the likelihood of full MOU delivery thereby allowing them to better manage the risk of any potential shortfall of MOUs.

Efficient redemption of MOUs

Through the use of blockchain technology, Project Genesis 2.0 also showcases smart contract-based delivery of MOUs at maturity, which enables automated transfer and conceptual trading of MOUs. The automation reduces the need for reconciliation of data between different parties. This includes the issuer, registrar, custodian, carbon credit validator, the investor, etc, and ensures that the redemption conditions of MOIs have been met before the transfer of the MOUs, thereby reducing the settlement cycle and achieving atomic settlements for MOUs.

Eliminating the double-counting problem

To ensure carbon credit integrity, a single carbon credit must not be issued more than once for the same GHG emission abatement, and cannot be claimed more than once by any entity. Similarly, to ensure that the carbon market is contributing to the global climate goal, double counting of carbon credits on an international level must also be avoided. This requirement is set out in the Paris Agreement Article 6.2 mechanism, which establishes a mechanism for countries to transfer internationally transferred mitigation outcomes (ITMOs) from voluntary carbon projects. A country selling mitigation outcomes must make a "corresponding adjustment" of its own Nationally Determined Contributions (NDC) reporting emissions balance to reflect the sale of mitigation outcomes; the concerned ITMOs will therefore count towards the NDCs of the buying country and not the buying country.

The blockchain and digital asset technologies which digitally represent and track MOIs appended to the bond and MOUs explored in Genesis 2.0 allow investors as well as other stakeholders in the carbon credit ecosystem such as national GHG accounting, carbon credit registries and carbon exchanges to trace the origin of the GHG data associated with the carbon credit and access the same "golden-source of truth". This functionality demonstrated by the two prototypes showcases potential theoretical solutions for addressing the double counting problem with carbon credits and transfer of ITMOs in the context of Paris Agreement Article 6.2. Interoperability across different registries would be key in realising the potential benefit of eliminating double counting; see more discussions to be covered in section B.1.6 and B.2.5 on "Key observations and future considerations" of the two prototypes.

Article 6 of the Paris Agreement

Article 6 of the Paris Agreement finalised during COP 26 provides a framework for international cooperation in the international carbon market.

Article 6.2
Article 6.2 establishes a mechanism for countries to voluntarily cooperate in achieving their NDC targets with ITMOs. ITMOs are emission reductions and are in units of tCO2e or other non-GHG metrics. The corresponding adjustment to avoid double counting is applied to all ITMO transfers. Countries may enter into an agreement whereby one party reduces carbon emissions and transfers those reductions to the other party which counts the carbon emissions towards its NDC targets.

Article 6.4
Article 6.4 creates a new carbon crediting mechanism, governed by the UNFCCC, which will generate carbon credits recognised under the Paris Agreement to be traded by both public and private sectors. The new mechanism is expected to replace the Clean Development Mechanism of the Kyoto Protocol.

While Article 6 is yet to be operationalised, 87% of parties to the Paris Agreement have signalled interest in participating in the mechanism established under Article 6.[19]

19. See The World Bank, State and Trends of Carbon Pricing, 2022, openknowledge.worldbank.org/handle/10986/37455

A.2.4 Benefits demonstrated in Project Genesis 2.0 of combining the green bond and carbon markets

Access to potentially lower cost of capital for green projects or activities

Conceptually, the advantage of pledging carbon credit units as part of the green bond coupon enables bond issuers to access cheaper funding for green investments compared with their prevailing financial conditions. The economic benefits in exchange of future delivery of carbon credit units attached to the bond transforms the current carbon market from an ex post reward for corporates into an ex ante enabler to facilitate access to lower-cost finance from the capital market. This addresses the concern of "additionality" of green bonds mentioned earlier in this report, given that the premium paid for the attached MOIs fills the financial viability gap of the funded green activities, which would otherwise not be economically viable without the green bond.

From a market development angle, green bonds will no longer reward only issuers who are already able to mobilise mainstream finance to fund projects that would have anyhow occurred, but also green projects that would additionally contribute to the climate goal. Similarly, this could allow issuers in countries with low capability to access low-cost financing for green projects. To date, such countries have implemented only a limited number of clean development mechanism projects under the Kyoto Protocol, which leads to an imbalance in the regional distribution of clean projects.[20] IPCC's Sixth Assessment Report reaffirmed that the largest adaptation gaps exist among lower-income population groups and will continue to grow, calling for accelerated implementation to close the adaptation gaps.

Reduced risk of greenwashing

As mentioned earlier, there is currently a lack of standardisation of the definition of green bonds in the market, which leads to the potential risk of greenwashing. There has been increasing attention to claims by green bond investors when investing in green bonds issued by carbon-intensive corporates. The MOIs appended to the green bond in the proposed green bond structure provide an objective definition of green, allowing investors to clearly demonstrate the environmental integrity of the green bond they invest in, thereby protecting them against the reputational risk of being accused of greenwashing.

In addition, one essential element in ensuring the integrity of the green bond market is to ensure that the use of proceeds of green bonds are financing green projects as set out in the green bond framework at issuance. However, it requires time and costs for investors to track and audit the use of proceeds. The real-time mitigation outcome data throughout the bond lifecycle demonstrated in Project Genesis 2.0 allows investors to have a cost- and time-efficient transparency that funds raised are generating genuine green impact.

Exposure to carbon market

Putting a price on carbon is an effective way to drive changes in emission behaviour, and the carbon market provides an instrument for entities in hard-to-abate sectors to fulfil their emission targets. As highlighted in the priorities for private finance for COP26, one of the goals is to encourage a transparent, credible market structure that is required for scaling a liquid, transparent and reliable voluntary market, alongside parallel initiative ensuring that these markets have the highest level of environmental integrity.[21]

The proposed green bond structure would deepen participation of financial investors in the market, which will provide much-needed liquidity to the market, and facilitates price discovery of carbon credits.

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20. See M Thioye, "Aligning finance for the net-zero economy: new ideas from leading thinkers, making green bonds serve the climate goals", EIT Climate-KIC, April 2021, www.unepfi.org/wordpress/wp-content/uploads/2021/03/5-Green-Bonds.pdf
21. See M Carney, "Building a private finance system for net zero, priorities for private finance for COP26", November 2020, ukcop26.org/wp-content/uploads/2020/11/COP26-Private-Finance-Hub-Strategy_Nov-2020v4.1.pdf

Figure 5

Summary table of benefits demonstrated in Project Genesis 2.0:

	Benefits
Green Bond Issuers	• Access to cheaper funding provided by the premium on MOIs • Transforming the carbon market from an ex post to ex ante enables filling the financial viability gaps of green projects, especially in countries that have limited access to traditional finance
Investors	• MOUs provide an objective definition of green, protecting investors from potential reputational risk of greenwashing • Gain exposure to the carbon market as an alternative investment class • Offset own GHG emissions to meet emission targets with MOUs • Delivery of MOUs offer the transparency of the environmental impact of the green bond
Sustainable Finance Ecosystem	• MOIs pledged as part of the green bond ensure additionality of green bonds, channelling much needed finance towards climate solutions that would otherwise not be implemented • Delivery of MOUs reduces the risk of greenwashing of green bonds, thereby shifting mainstream finance towards effective climate solutions that contribute to climate goals • Provide liquidity and price discovery for the carbon market by deepening participation of financial investors in carbon credits

The next section demonstrates the two prototypes with the use of blockchain, smart contracts, and IoT technology developed under Project Genesis 2.0.

Section B: Prototypes

This section demonstrates the two prototypes developed under Project Genesis 2.0 in conjunction with two consortia. Section B.1 illustrates the prototype developed with Goldman Sachs, Allinfra and Digital Asset. Section B.2 illustrates the prototype developed with InterOpera, Krungthai Bank, Samwoo and Sungshin Cement.

Goldman Sachs

ALL INFRA

Digital Asset

B.1 Goldman Sachs, Allinfra and Digital Asset consortium

Goldman Sachs (Asia) LLC (hereafter referred to as Goldman Sachs), along with Digital Asset and Allinfra have collaborated to provide a prototype solution for Project Genesis 2.0, providing a simulated solution for the digitised tracking, delivery and transfer of MOIs (later settled through the delivery of MOUs, in addition to tokenising the issuance of the green bond itself to develop an end-to-end digital flow for institutional green debt finance. To achieve this solution, blockchain and smart contract technology have been leveraged in addition to IoT technology.

The consortium of Goldman Sachs, Digital Asset and Allinfra (hereafter referred to as the "consortium" or "we") is a multi-disciplinary team. Each party brings unique and market-leading technical and environmental financial product capabilities that support transparency, objectivity and integrity of the green bond and carbon markets, such as to-source data transparency, and smart contract-based delivery of bonds, MOIs and MOUs.

The Goldman Sachs Group, Inc. is a leading global investment banking, securities and investment management firm and brought its capital market expertise to Genesis 2.0. Digital Asset is a software and services provider that helps enterprises build economic value through interconnected networks and worked with Goldman Sachs in this project. Allinfra Climate is a blockchain-based environmental platform by Allinfra that helps institutions achieve their sustainability goals - it provided climate relevant data from asset devices and product expertise to the project.

B.1.1 Consortium executive summary

B.1.1.1 Consortium objectives

The core objectives of the consortium were to showcase a straight-through process (STP) for the issuance and transfer of MOIs and its redemption delivery of MOUs via a blockchain-based platform. These objectives included providing a scalable prototype for bringing new asset types to market quickly and effectively, that is responsive on a real-time basis to any given state of the digital asset (ie, retired, pending, active etc). The process involves streamlined workflows to support a reduction in errors and operational burdens. Increased ability to source liquidity and greater market access are key benefits, in addition to visibility into the provenance of an asset and its underlying data. By providing synchronised interstate processes and real-time issuance of assets, issuers can monetise their ESG assets, including future emission reductions, thus supporting improved cash flows and filling financing gaps.

B.1.1.2 Highlights of the prototype

Scenario use case:

APAC Future Energies Corporation[22] is looking to raise funds to finance its development stage initiative of an onshore wind farm in Vietnam. APAC Future Energies Corporation is looking to raise US$80 million in debt financing for this initiative across bond and MOI products, supporting its current stage development with the promise of future delivery of MOU assets.

APAC Future Energies Corporation forecasts that each year for the next 10 years from bond issuance, the onshore wind farm will result in a reduction of 140,000t of CO2e per annum, and therefore proposes to issue 120,000 MOIs per annum to support this future delivery.

APAC Future Energies Corporation will leverage the consortium's solution to issue a zero-coupon tokenised green bond and accompanying MOIs to be delivered in MOUs. The total green bond issuance will be US$80 million, with a total MOI issuance of 1.2 million (at a $5 notional per MOI) will be issued in 10 tranches, each relating to a delivery vintage.

22. Fictitious company used for the purposes of simulation.

For the purposes of this project, we selected a scenario based on a hypothetical onshore wind farm[23] in Vietnam as the subject asset to be financed (the "Asset"). The consortium selected this scenario for the following reasons:

- The opportunity for Genesis 2.0 is to build on the familiarity that BIS created via Genesis 1.0 in relation to creating tokenised interests in renewable energy assets (the asset type utilised under Genesis 1.0) with digital monitoring and reporting built in. Genesis 2.0 takes the model underpinning Genesis 1.0 further, expanding the digital monitoring into a digital measurement, reporting and verification tool that allows for the creation, allocation and transfer of a stand-alone carbon product, in addition to directly connecting the environmental outcome of the Asset to the overarching financial product.

- Given MOIs are a new concept, the consortium wanted to focus on an asset class that has strong and proven device-metered data collection capabilities in the traditional carbon market. Renewables, like wind power, are some of the least esoteric asset types financed by green bonds, as well as some of the more familiar asset types underpinning carbon credit contracting, monitoring, reporting, verification, and the allocation of carbon credit claims. The benefits brought about by using the consortium's solution under Genesis 2.0 versus traditional practices would be more comprehensible for a wider audience as compared to other carbon-market-related assets. Such benefits include energy efficiency, waste management, transport, carbon sequestration or land use. While these asset classes are important climate-aligned asset types, green bond issuers and investors may be less historically familiar with the asset type.

- Renewable assets have devices that can deliver data in the context of traditional carbon credit creation and, in the case of Genesis 2.0, that underpin the core of the MOI and subsequent MOU delivery. In addition to power production data, renewable projects can feature a range of data and reporting requirements, such as input of grid emission factors (the CO2 intensity of the relevant electricity grid given the blend of electricity feeding into it), creation of credentialled user-defined formulas to calculate emission reductions, and potential for carbon credits to be accompanied with other reports, such as biodiversity reports for the area adjacent to the site, maintenance reports, and other ESG surveys, all of which can be added by credentialled parties and digitally associated with the central MOU product.

- Vietnam was selected as an applicable market given there have been Vietnamese wind projects approved by key registries[24] for carbon credit creation during the proposed period specified under the simulated bond terms; hence, real world operational assets can be found in the market for reference and comparison. Vietnam is also a relatively nascent market in relation to renewables,[25] thus an appropriate selection in alignment with the Genesis 2.0 objectives of supporting developing markets.

23. It is recognised that renewables do not necessarily need to meet additionality tests in certain markets, and that this may be phased out over time. However, as a base scenario, renewables have a strong data collection standpoint and thus a viable use case for this prototype. Additionally, the tranches in the prototype have been back-dated to 2021 when additionality tests were stronger.
24. For reference: registry.goldstandard.org/projects?q=&page=1&countries=VN&project_types=12 [Accessed 21 Sept 2022]
25. In 2021, 77.27% of Vietnam's total energy came from fossil fuels (coal, oil and gas), versus 22.73% derived from low carbon energy sources (including hydropower, solar, wing, geothermal, wave and tidal and bioenergy). Source: Our World in Data: ourworldindata.org/energy/country/vietnam [Accessed 21 Sept 2022]

Given the above factors we felt that a Vietnamese onshore wind asset would be an ideal hypothetical asset to use to demonstrate the technology and financial structure simulated for Project Genesis 2.0, while also investigating potential product and implementation challenges. The simulation has addressed the following core areas:

- Simulated end-to-end tokenised bond, MOIs and MOUs, via the Goldman Sachs tokenisation Digital Asset Platform (DAP)[26] ESG prototype, covering all lifecycle stages on a blockchain-based platform including: book-building, allocation, primary issuance, settlement, custody, asset servicing and secondary trade booking;

- Via the usage of smart contract technology, the project can digitally define and represent each type of asset as well as associated terms, rights and obligations, and ensure these are performed / enforced across the asset lifecycle. It also ensures overall reduction of product issuance and settlement time, due to the elimination of manual reconciliation and input steps required during the book-building period. It significantly reduces time and cost required for each issuance for the issuer, through the scheduled delivery of digitally monitored MOUs. Atomic delivery versus payment settlement is utilised, leveraging on-ledger payment options;

- Connectivity to Allinfra's climate data platform to provide direct device metrics, for computing of estimated real-time MOU production and final MOU production in a timely manner with the fewest possible intermediaries. It provides a solution for MOI holders (ie, holders of future emission reductions) to have ongoing insight into the performance of the financed assets, versus visibility only at the end of each manual verification process. The verification process typically takes 4-8 months from preparation for site visits, data collection, reporting and issuance and usually results in a static one-time report for a single backward-looking production period for the purpose of any given carbon credit issuance.[27] Therefore, in comparison to the traditional green bond market, the potential of this new instrument allows for greater standardisation of Asset related data;

- Creation of a robust structure and solution for the issuance of tokenised green bonds with tokenised MOIs attached, allowing for the future value of emission reductions from financed assets to be brought forward and contributing to the development and / or construction stage financing. It will essentially be acting as an ex ante enabler in what is currently an ex post market, this could, in the near term, be attractive to impact investors, given the fundamental tie back to the environmental data and thus transparency;

- Theoretical connectivity to off-platform carbon marketplaces to facilitate secondary trading of MOUs.[28] In addition to potential connectivity to carbon marketplaces, integration with other market infrastructures and data providers is possible via ledger API. In the same vein, theoretically the prototype platform could be connected to NDC registries to support cross-border reporting (B.1.6). This can be conducted within a network or across networks, as all assets built within the same smart contract language can enforce a common data model, enabling issuers, syndicate banks, asset servicers and investors to interact across platforms without complex reconciliation processes or custom APIs, while at the same time providing a golden source of truth at all times;

- Importantly, the solution has accounted for scenarios whereby the issuer fails to meet their MOI commitments (shortfall workflow) and illustrates the remediation factors necessary to ensure the investor is made whole on their investment. The MOI and MOU propositions provide a product that fits in neatly with the industry trends towards digital carbon accounting, ratings and reporting, and they also, along with the prototype platform, provide the scope for a future-proofed product as it pertains to reporting requirements and standards, via the provision of a "golden source of truth".

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26. The tokenization and digitised lifecycle workflows and design of DAP and other intellectual property described in this document are proprietary to Goldman Sachs Group.
27. See The World Bank www.worldbank.org/en/news/feature/2022/07/27/what-you-need-to-know-about-the-measurement-reporting-and-verification-mrv-of-carbon-credits
28. For the purposes of Project Genesis 2.0 no connectivity to carbon marketplaces/exchanges was created, however via the use of smart contract technology it is technically possible to connect two distinct chains together for the purposes of trading etc.

B.1.2 MOI and bond overview

In the simulated solution, MOIs are a tokenised asset, modelled with smart contracts that create issuer obligations to deliver MOUs to MOI holders in accordance with pre-defined delivery schedules (eg, to meet the settlement obligations under a given MOI, the issuer must deliver one MOU by or before an agreed date, specific to that MOI vintage). MOIs are initially stapled to the bond but are detachable and tradable separately post primary issuance. For the purposes of the simulation, 1 MOI equates to 1 MOU.

MOUs are intended to be a legally transferrable claim to one metric tonne (Mt) of CO2e abated (ie, avoided, reduced or removed), in smart contract form (data-fed). Data from the Asset(s) will be recorded daily and will form the basis for the minting of each MOU to be delivered against each MOI. The frequency of MOU minting will be set by the issuer upon MOI and bond issuance, (eg once per year or once per quarter). Equally, the frequency for testing of shortfall or excess MOUs against MOI obligations can be flexible and include a notification and cure period (all laid out by the issuer in the pre-issuance stage in the term sheet).

The pricing of the MOIs is expected to be tied to the value of the MOUs expected to be delivered in the future, which would be calculated by reference to, amongst other things, the then-current market pricing, the project type, and the credit risk of the relevant issuer, noting that the credit risk component in pricing of the MOI falls away once the MOU is crystallised and delivered. While MOIs should be tradable across vintages, there are expected to be price differentials between different vintages. There should however be fungibility between MOIs from a particular vintage, (eg, MOI23, MOI24, MOI25, MOI26 and MOI27 contracts that are entitled to MOU23, MOU24, MOU25, MOU26 and MOU27 deliveries in those corresponding years).

B.1.2.1 MOI and bond structuring terms

The following four tables illustrate the term and product details across the project being financed (Table 1), MOI (Table 2) and bond (Table 3), in addition to the overall bond and MOI primary issuance structure (Table 4).

Table 1 - Asset details

Name	VietnamTestWind
Location	Vietnam
Asset Type	Onshore Wind
Nameplate capacity	50MW
Revenue grade meters (production)	3
Consumption meters	1
Operating Period	Minimum of 20 years
Offtaker	Vietnam Utility
Ownership of environmental attributes	Retained by project (contracted under MOIs)
Construction Start Date (NTP)	1 July 2019
Current Phase	Late Stage Development
Estimated commissioning / production start date	1 Jan 2021
Total Capex	US$ 100m
Debt/Equity	80/20
Bond Size	US$ 80m

Table 2 - MOI details

MOI Issuer	APAC Future Energies Corporation[29]
MOI Issuance Date	1 Jan 2021
Description	MOI Issuer is obligated to deliver MOUs to the then-current MOI Holder based on the MOU Delivery Schedule
Delivery Ratio	1 MOI : 1 MOU
Term	10 years
Contract MOI Volume[30]	1,200,000
Contract MOU Volume	1,200,000
MOU Delivery Schedule	120,000 MOUs to be delivered on each 12 month anniversary of the MOI Issuance Date over the course of the Term of the contract (each an MOU Delivery Date)
Purchase Consideration	US$5 multiplied by the Contract MOU Volume[31]
MOI Price	100% of the Purchase Consideration divided by the Contract MOI Volume, paid upon issuance of each MOI
MOU Price	0% (all pre-funded)
Shortfall MOUs	The number of MOUs scheduled to be delivered on a given MOU Delivery Date minus the number of MOUs actually delivered on a given MOU Delivery Date, with the MOI Issuer being obliged to make up any Shortfall MOUs with Replacement MOUs
Replacement MOUs[32]	MOUs or other equivalent emission reductions as determined by the ESG auditor. *Note: the delivery of Replacement MOUs would need to remedy any system Shortfall MOU notification in the system*

29. Fictitious company used for the purposes of simulation.
30. It is assumed that there will be a production of 50MW wind in Vietnam, with reference to performance of other wind assets in Vietnam in terms of utilisation, power production and grid emission factors, which can yield up to 140,000t of CO2e per annum (vs an average of 120,000 per annum under contract).
31. Purchase price is assumed at a flat price across the 10 vintages given that risk is taken into account at the date of pricing. Price determination of US$5 is based on known prices of carbon futures across various markets.
32. Off-chain terms

Table 3 - Bond details

Issuer	APAC Future Energies Corporation[33]
Issuance Size	US$ 80m
Currency	US$
Denominations	50k
Tenor/Maturity	15yrs
Issuer Rating	AA
Listing	Unlisted
Coupon	Non-coupon bearing
Redemption Price	100%
Issue Closing Date	1 Jan 2020

For the simulation, the structuring of the stapled products is in the form of 10 independent order books, each of which could be over-subscribed or under-subscribed. 10% of the bond issued was associated with each vintage of MOI (assuming a 10-year MOU delivery schedule[34]), hence the below illustrates the issuances per MOI vintage:

Table 4 - Simulation tranche breakdown

Book1	$8m bond + 120k MOI21 (delivering 120k MOUs in Dec 2021)
Book2	$8m bond + 120k MOI22 (delivering 120k MOUs in Dec 2022)
Book3	$8m bond + 120k MOI23 (delivering 120k MOUs in Dec 2023)
Book4	$8m bond + 120k MOI24 (delivering 120k MOUs in Dec 2024)
Book5	$8m bond + 120k MOI25 (delivering 120k MOUs in Dec 2025)
Book6	$8m bond + 120k MOI26 (delivering 120k MOUs in Dec 2026)
Book7	$8m bond + 120k MOI27 (delivering 120k MOUs in Dec 2027)
Book8	$8m bond + 120k MOI28 (delivering 120k MOUs in Dec 2028)
Book9	$8m bond + 120k MOI29 (delivering 120k MOUs in Dec 2029)
Book10	$8m bond + 120k MOI30 (delivering 120k MOUs in Dec 2030)
Total	Bond issuance $80m, MOUs delivered 1,200,000

33. Fictitious company used for the purposes of simulation.
34. The MOU time period for all MOUs regardless of location work on a calendar year based on UTC time zones.

B.1.2.2 Rationale for MOI + bond structure

A bond with detachable MOIs serves a number of purposes, including both supporting environmental goals of issuers and investors, and achieving optimal cost of funds for the issuer / party raising financing:

- A structure that ties the forward sale of environmental products to a bond that is financing the Asset(s) that will generate such products allows the issuer to realise all of the environmental product generation benefits upfront (rather than over the life of the project/bond). This structure serves to reduce the amount of equity and / or debt required to fund each project, reducing dilution or debt service costs, and encouraging the development of such environmentally positive projects.

- Allowing the component products to be detached results in the participation of parties that are best able to price a product, which is preferable from a market efficiency perspective compared to a compound product, composed of, for instance, a fixed income instruments and embedded environmental products.

- Furthermore, given the MOIs under this solution are set out in vintages corresponding to MOUs that must be delivered in predetermined schedule, the detachable MOIs can then be sold into markets where voluntary and / or regulatory-driven buying activity is strongest for those years. One example is where the implementation measures under the NDCs set by any of the 197 countries under the Paris Agreements begin to create new demand.[35]

B.1.3 Functional scope overview

The consortium's solution is comprised of the following components:

- DAP ESG prototype;

- Distributed Ledger – A Layer 2 Digital Asset Canton ledger;

- Allinfra Climate Platform; and

- Goldman Sachs Blockchain Platform ESG prototype.

With the solution highlighting the core features:

- Fully blockchain-agnostic prototype platform (private and permissioned);

- Digitisation of multi-party workflow;

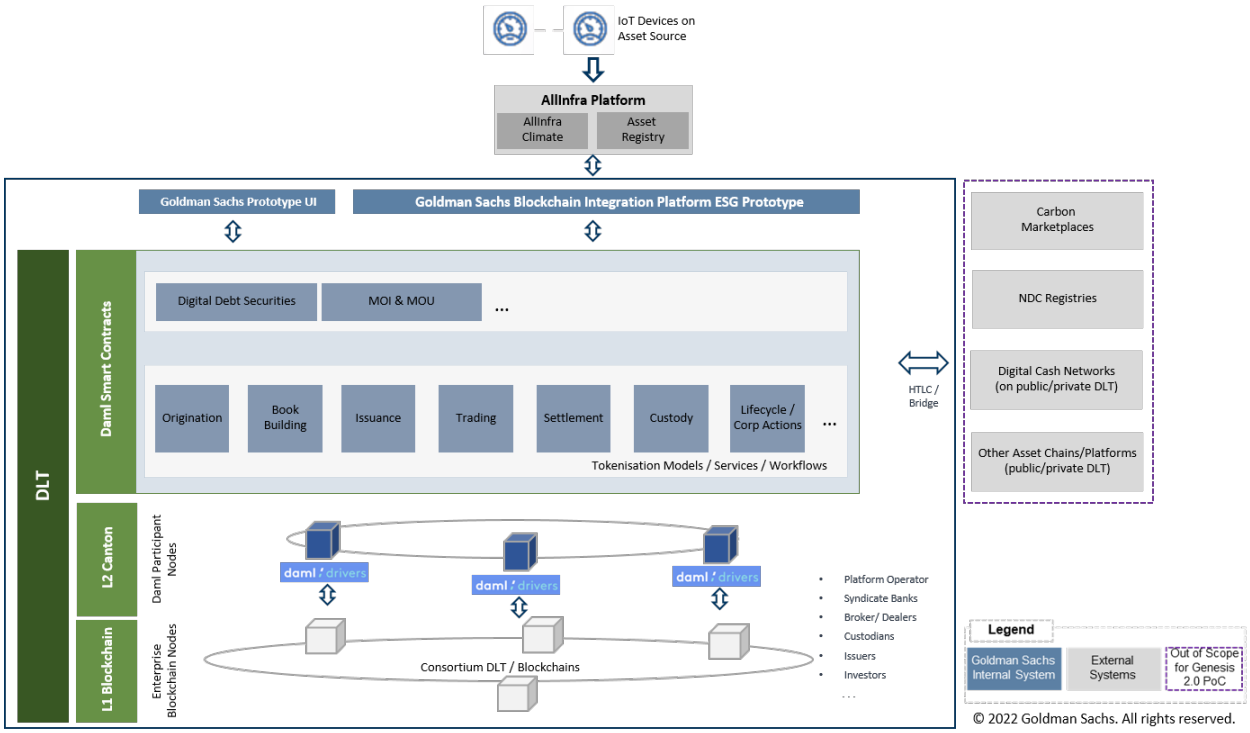
- End-to-end tokenisation and smart contract-based lifecycle management of bond and MOI across primary issuance, book building, OTC secondary trading, registry and custody, settlement, asset servicing, etc;

- End-to-end tokenisation and lifecycle management of MOU tokenisation, data capture, distribution, redemption, shortfall and excess management; and

- Complete traceability and audit of the ESG physical asset data recorded directly from the financed project; using on-field IoT sensors and integrated into Allinfra's Climate platform.

35. Regions and dates for various national and sub-national carbon pricing mechanisms are summarised on tools such as the World Bank's Carbon Pricing Dashboard, carbonpricingdashboard.worldbank.org/

Figure 1 – DAP ESG prototype technical architecture



B.1.4 Workflow design

B.1.4.1 Onboarding

The DAP ESG prototype supports role-based onboarding of market participants to perform various functional roles:

Table 5 - Platform roles

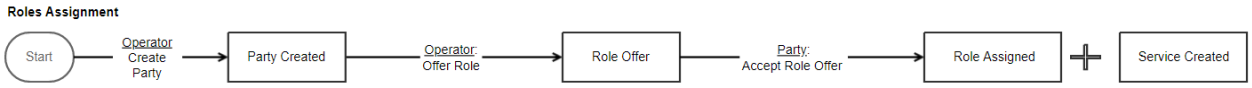
Platform Roles[36]	Description of role and associated services
Platform Operator	Responsible for the maintenance of the platform including administrative functioning. Operator assigns roles on the platform.
Issuer	Responsible for triggering bond and MOI origination, and issuance processes.
Registrar	Approval of bond, MOI and MOU origination, tokenisation, issuance, custody and settlement functionality.[37]
Paying Agent[38]	Identifies the coupon rate / redemption event for a particular payment date. Receives net coupon payment / redemption proceeds from issuer and pays to the registrar who cascade it downstream to Tier 1 to N digital asset holding accounts. Paying agent triggers the shortfall workflow in case of MOU shortfall.
Settlement Agent[39]	Settlement / payment instructions generation, settlement execution.
Cash Token Provider	Digital cash origination and issuance.[40]
Syndicate Bank(s)	Primary issuance management, investor management functionalities (eg invite investor(s), submit orders).
Custodian(s)	Account opening functionalities and custody.
Investor	Order submission functionalities.
ESG Data Provider	Connectivity to external data sources (ie Allinfra Climate).
Secondary Trader	Bulletin board to facilitate OTC off-platform secondary market - create/ delete Indications of Interest, trade booking and confirmation.
ESG Auditor	Act as independent third-party to approve the MOU tokenisation, in addition to providing validation of shortfall fulfilment should the scenario arise whereby the issuer is obligated to cover MOU shortfall by buying in the open carbon market.

36. Certain roles conducted across the simulated solution may require the entity performing them to be licensed, therefore it is assumed that whichever entity undertakes such roles has the necessary licenses.
37. Local market regulatory and legal review would be required to determine whether the associated market Distributed Ledger Technology (DLT)/blockchain can be used as a Registry service/to play the role of Registrar. This ought to be conducted on a market-by-market basis given there are evolving regulations as it pertains to acceptance of blockchain technology for registration means.
38. This role could be assumed by automated bot running on the prototype platform.
39. This role could be assumed by automated bot running on the platform.
40. For the purposes of the Project Genesis 2.0 simulation it is proposed that digital cash would be used for bond and MOI settlement, with an appropriate Cash Token Provider assuming this role.

Role assignment is the first step required in the setup process to conduct an issuance. This function is conducted by the platform operator, ie, granting different entities a platform role which enables specific functionality depending on the role assigned. The role assignment workflow is as follows:

- Platform operator offers a role to a specific party / entity,
- Party accepts / declines the role offer,
- If the party accepts the role offer, it assumes that role and has access to the corresponding functionality as defined in the relevant service contract (if any).

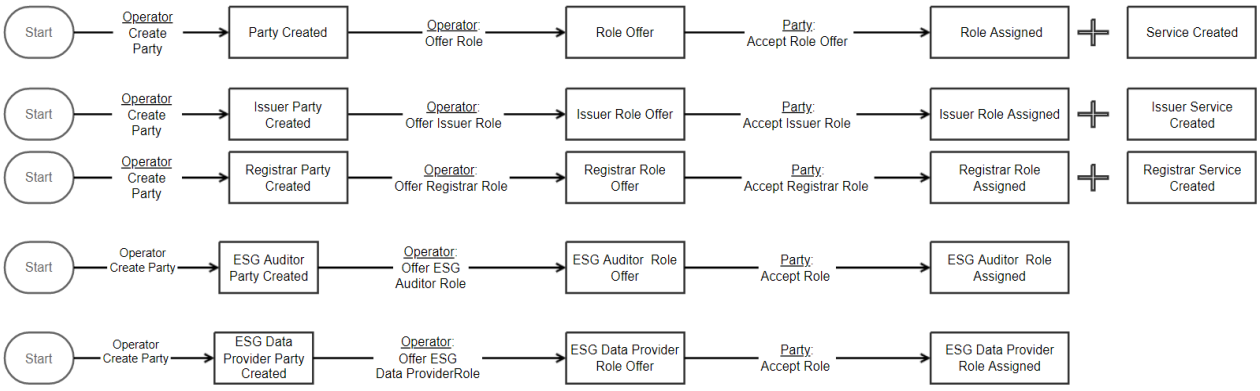
Figure 2 - Role assignment



The role assignment will be carried out by the platform operator on a deal-by-deal basis. Assuming the role and having access to the service essentially means that one would be able to access the functionality defined within the scope of that role definition (detailed in Table 5).

Assuming a particular platform role and service does not mean that the assuming party would be allowed to act or participate in each platform issuance. Validation would be performed at the tranche level to only allow specific parties to participate in each issuance. A single party can assume multiple roles within the prototype platform.

Figure 3 - Role assignment and service creation



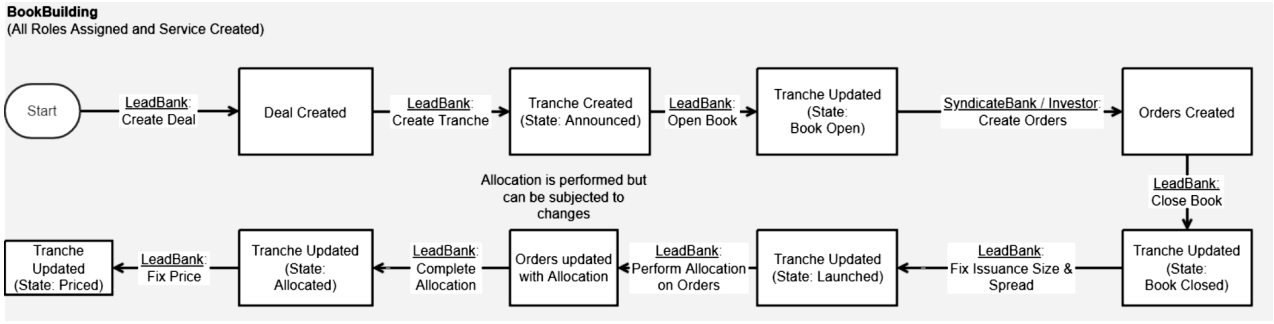
B.1.4.2 Bond and MOI subscription and allocation workflow

This workflow can be divided into three phases in sequence:

Book building ie bond and MOI allocation and pricing

Bond and MOI structure is not in existence at this point. Figure 4 reflects the workflow of the book-building activity that is occurring on the platform. Book-building events/data can be input via the platform's user interface ("UI") or feed independently into the platform via integrations with external service providers or traditional book-building platform. For investors submitting the primary orders (IOIs), it is expected that they will be able to choose: 1) bond + MOI(s) with multiple options for the shade of green[41] depending on the number of MOIs stapled to the bond or, 2) vanilla-bond (excludes MOIs). Given the bond and MOI structure (as defined in B.2.2.1) investors subscribe per tranche; this is captured in the book-building process.

Figure 4 – Book-building[42]



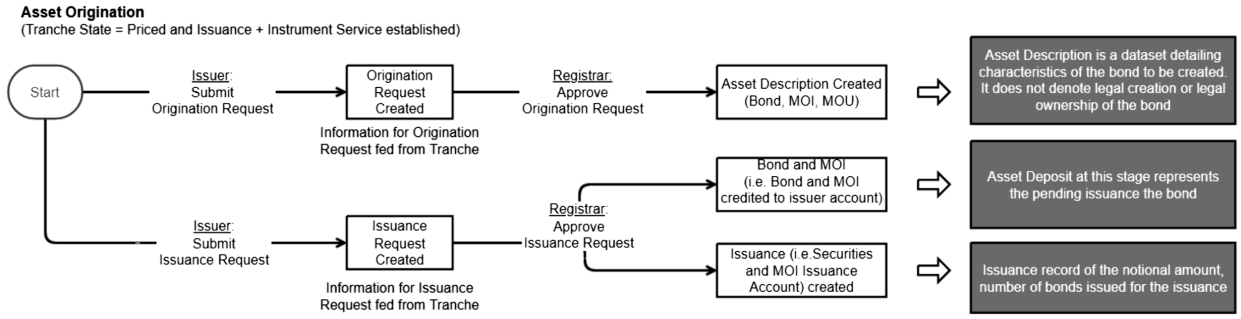
Origination, ie where the bond, MOI and MOU smart contracts are originated but no tokens are generated

Tokens are generated in the issuance - origination step wherein the bond and MOI tokens are minted and credited to the issuer. The (bond, MOI and MOU) origination workflow ("Origination") can be initiated after the corresponding deal tranche status has transited to "Priced", which is an indication that all tranche information is finalised.

To perform Origination, the issuer accepts the role assignment and submits the request to create the bond, MOI(s) and MOU(s), which are channeled to the registrar for approval. At this point, the smart contracts indicating the specified terms and conditions of the bond, MOIs and MOUs are created. Similarly, the registrar approves the issuance request at which point the tokens, are minted and credited to issuer (representing the legal ownership), and the issuance (ie, the issuance record of the notional and number of bonds, MOIs and MOUs issued) is created.

41. Shade of green is measured in terms of the number of MOIs per dollar funded for buyers of the primary issuance. Therefore, the darker the shade of green the more a buyer has covered its future offset needs (per dollar spent), from a trader perspective the greater the price-based option available. Beyond having a contract for increased/reduced emissions reduction, the shade of green elected by a primary buyer doesn't impact the product more broadly, ie, there is no penalty or disadvantageous terms for buyers of vanilla bonds.
42. Book-building illustrated in this diagram is per tranche.

Figure 5 - Asset origination



Primary trades booking and settlement

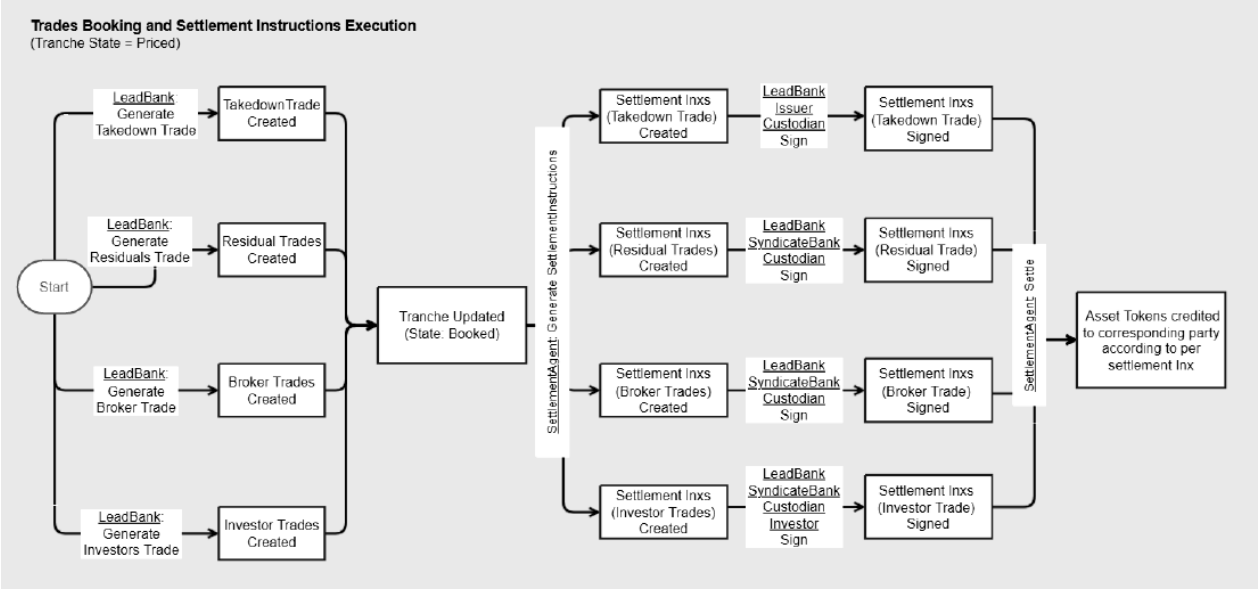
The DAP ESG prototype is flexible and can support multiple primary issuance models (eg underwriting, direct investor allocation) and generation of the corresponding trades:

- Takedown Trade (ie, the underwriting trade between the issuer and lead bank to take down the full issuance);
- Investor Trades;
- Residual Trades (ie, the sharing of the residual unallocated bonds and MOIs between the syndicate banks in the event of an undersubscription)[43]; and
- Broker Trades (ie, the trade between the lead bank and other syndicate banks to let them distribute and settle directly with their own investors).

After trades and settlement instructions are generated, the corresponding parties sign the smart contracts via the platform's UI. Settlement agents (manual or automatic bot) can execute the settlement instructions after all signatures are captured.

43. There could be the scenario where the issuer retains MOIs in an undersubscription scenario, the issuer could then trade these MOIs on the secondary market themselves if desired.

Figure 6 - Trade booking and settlement instruction execution



B.1.4.3 MOI issuance, redemption and retirement and MOU drawdown workflow

The DAP ESG prototype has been integrated with Allinfra Climate, which collects, stores and makes available data direct from the Asset(s) financed by the green bonds' proceeds. The Asset data collected and made available by Allinfra Climate is periodically fed into the DAP ESG prototype, forming the basis for MOU creation.

The MOI Asset Description in the DAP ESG prototype is updated periodically with interim asset data from Allinfra Climate to provide an ongoing estimated MOU production outcome over the course of an MOI vintage. At the time of scheduled MOU delivery for a specific MOI vintage, the prototype platform refers to the MOU Asset Description to read the final MOUs generated, which responds with the final CO2e calculation for the queried period based on gathered electricity production data and the relevant grid emission factor accounted for (in the case of the subject asset in this PoC and for any given project, as determined under the relevant carbon standard and methodology being used). The data received by DAP ESG prototype is initially in the form of grams. The prototype platform then converts this into tonnes to be able to compute the ongoing MOU contribution from the financed project per tranche. The DAP ESG prototype monitors and triggers the MOU distribution workflow following pre-defined policy/logic.[44]

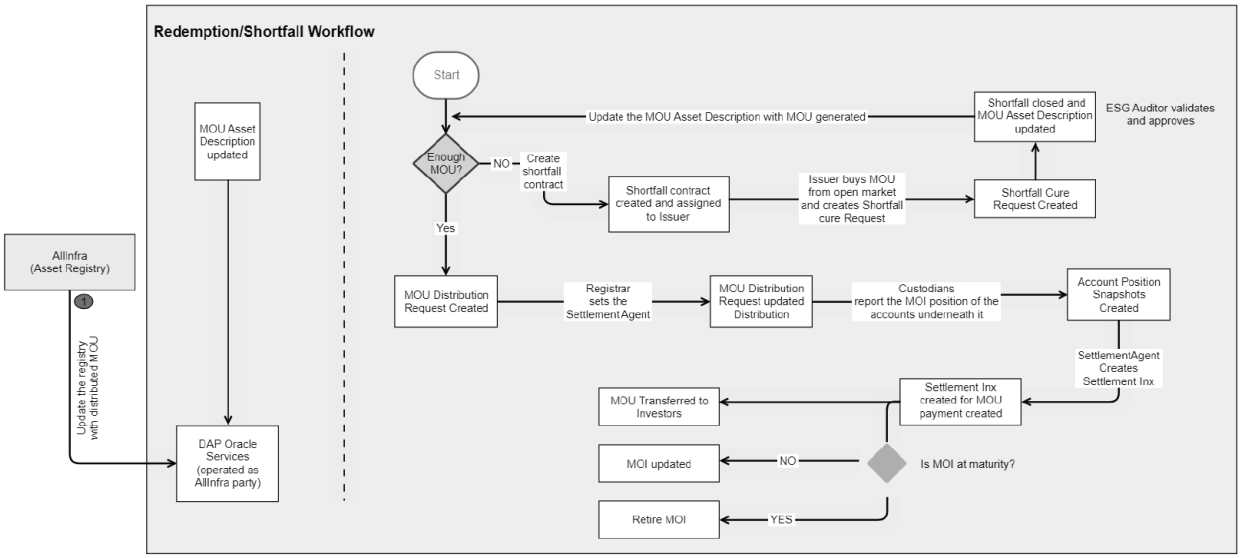
B.1.4.4 MOU shortfall workflow

At the time of MOU distribution, should a shortfall occur, the issuer is required to source the deficit MOUs from other ESG assets owned by the issuer and/or the open market (eg, external carbon marketplaces). The terms governing the occurrence of a shortfall would be defined in the Emission Reductions Purchase Agreement (ERPA) or initial term sheet. In addition, it is the consortium's expectation that sustainable development goals will be negotiated and agreed in the context of MOI subscription which may, under certain circumstances, give rise to certain terms that impact the settlement of the final payment upon MOU delivery.

44. Such policy is defined up-front by the issuer as part of the term sheet.

In the scenario that the issuer is short in terms of the necessary MOUs to satisfy delivery obligations for a specific vintage, a shortfall notification is generated with a cure period stated.[45] MOUs to be delivered against MOIs must be sourced (i) from the issuer's asset(s) that was financed by that particular green bond, (ii) failing that, from MOUs from other assets owned by the issuer,[46] and (iii) only thereafter from the open carbon market ("Replacement MOUs"). Replacement MOUs may or may not be natively digital (for example, it may be the case the issuer can replace shortfall with emission reductions from a then-operating "mitigation outcome" framework under Article 6 of the Paris Agreement or from the likes of Gold Standard, Verra, GCC or other voluntary carbon standards) and hence the delivery fulfilment state of the MOI will require third-party auditor validation to ensure satisfaction of initial MOI terms. The consortium envisages that the ERPA terms will be detailed with respect to which instruments would qualify as Replacement MOUs, and apart from needing to be equivalent in volume, Replacement MOUs would also need to meet vintage and quality (eg asset type, location, etc) parameters set out in the agreed terms. Subsequent MOU distribution is similar to the regular coupon distribution.

Figure 7 - MOU shortfall



The MOU final redemption workflow and MOI retirement are similar to Figure 7, with the difference being, upon final redemption of the MOU the prototype platform would retire the MOI.

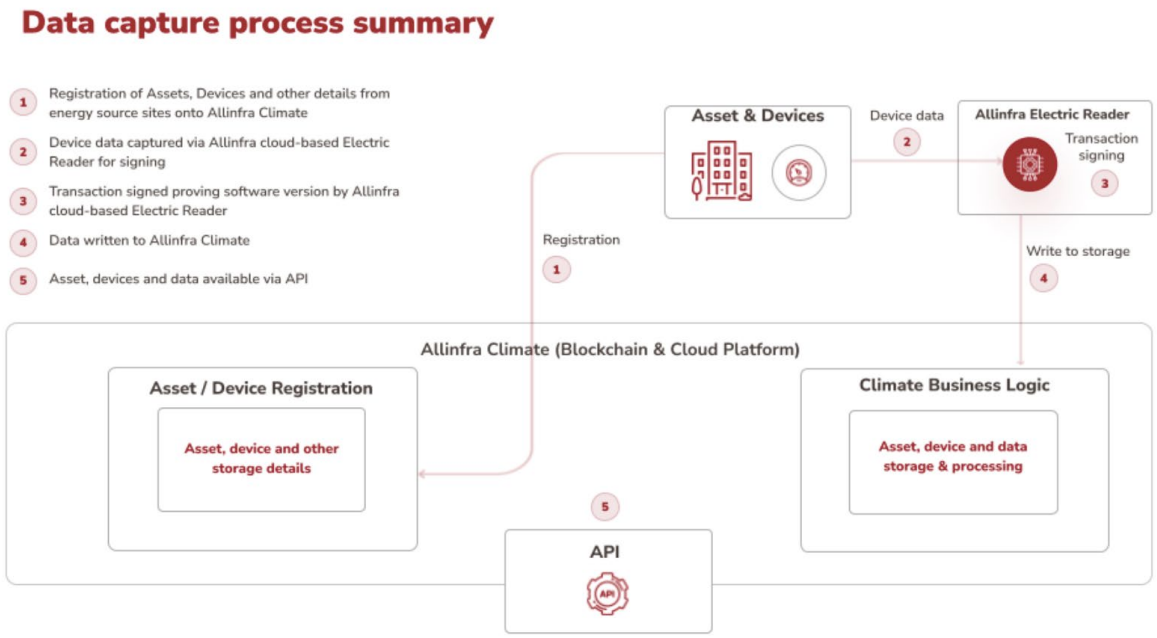
B.1.4.5 MOU tracking and visibility

The DAP ESG prototype allows for investors and issuers alike to see, to the nearest hour, the current amount of MOUs that have been delivered for the open tranche. This visibility is available given the API connectivity between the DAP ESG prototype and Allinfra Climate. Investors and issuers can see this view via their portfolio page, allowing them to make further investment or trading decisions based on the latest asset production information.

45. The issuer has a "cure period" in which to rectify the shortfall position; it is proposed that this is set to 14 days so that the investor receives the MOUs in the expected delivery month.
46. In a scenario where an issuer is an owner and operator of other carbon-relevant assets, a framework could be established whereby the issuer is required to set Paris-Aligned targets for their broader asset portfolio (if possible, monitored digitally and if not, by a reputable third party), and only when their broader portfolio continues to be aligned with these targets, can replacement MOUs come from their own portfolio.

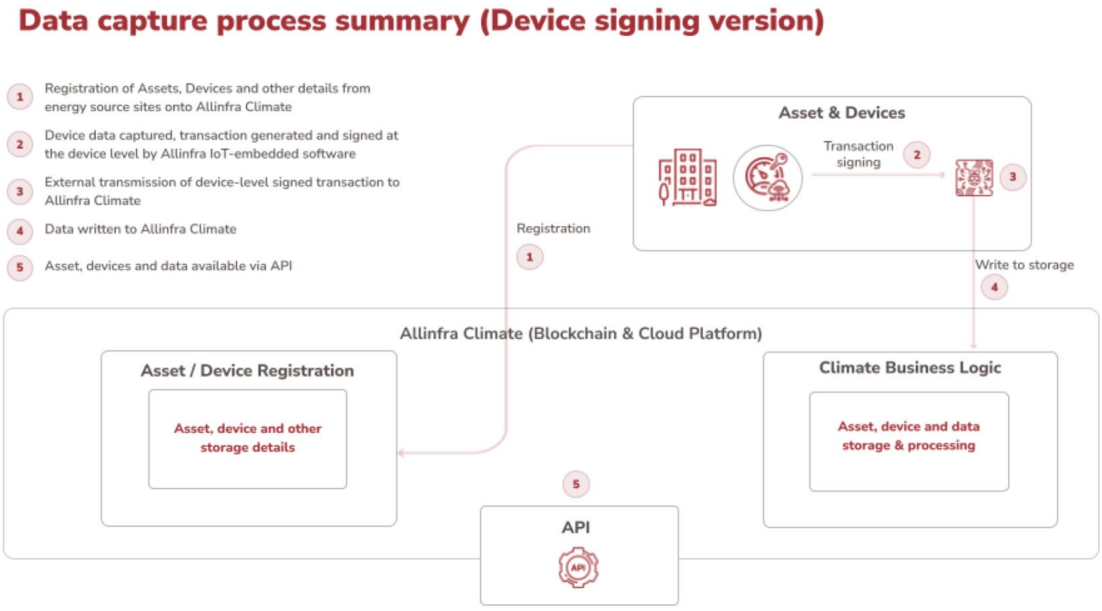
B.1.4.6 Allinfra Asset, device registration and connectivity

Figure 8 - Data capture process summary



Asset and device registration will occur on Allinfra Climate, which is a blockchain and cloud platform. Allinfra Climate's design ensures that only a device's dedicated service can write data into its designated data store. This design, powered by Allinfra's proprietary Electric Reader, provides assurance that data collected has not been altered from the point of capture to the point of storage.

Figure 9 - Data capture process summary (device signing version)



Power generation and consumption data is gathered from three revenue grade meters and one consumption metering device on an hourly basis. As a base case, the data is gathered via Allinfra's cloud-based micro service which through its design and integration with a suite of Allinfra smart contracts, provides a high degree of certainty that data collected and stored has not been altered between the point of capture and storage. Allinfra in parallel has implemented an example of its embedded device technology, which can be integrated at the device level, on either the metering device or IoT device attached to meter. This implementation demonstrates the variety of ways that Allinfra is able to reliably capture data from assets with a view to ensuring that data can be easily provenanced and tied to a financial instrument or reporting tool.

B.1.4.7 Coupon payment

For the purposes of this simulated issuance the bond has been structured as a non-coupon bearing instrument. This is because the attractiveness of a coupon-bearing instrument may vary depending on the tax implications in different markets. Should there be a coupon distribution associated with the green bond, it would be paid in either fiat or / digital currency in each case initiated by the Paying Agent leveraging the smart contract design of the prototype platform. The Settlement Agent uses the information to create cash settlement transactions between the custody provider and beneficiary. Upon settlement, the investor receives the proceeds of the coupon in their account.

B.1.4.8 Secondary market transactions

The DAP ESG prototype has built-in capabilities for OTC transactions in the form of a bulletin board style interface. Buyer / seller (broker / dealer's secondary trader or investor) could post an indication of interest (IoI) to buy or sell bonds or MOIs or a combination. A buyer / seller interested in the trade could contact (off platform) that buyer / seller to agree on the trade and proceed to trade, confirm and settle in a similar way to in the primary issuance (Figure 11). MOUs are only created on the satisfaction of the MOI KPIs and can only become tradable after they are counted against the MOI obligation.

Figure 10 - OTC Transactions

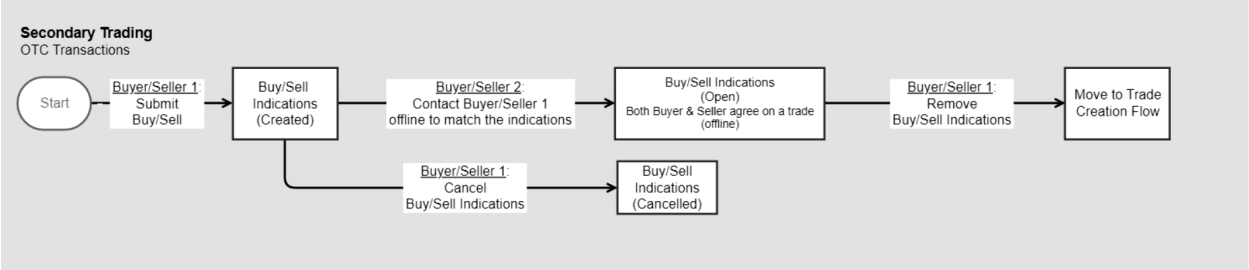
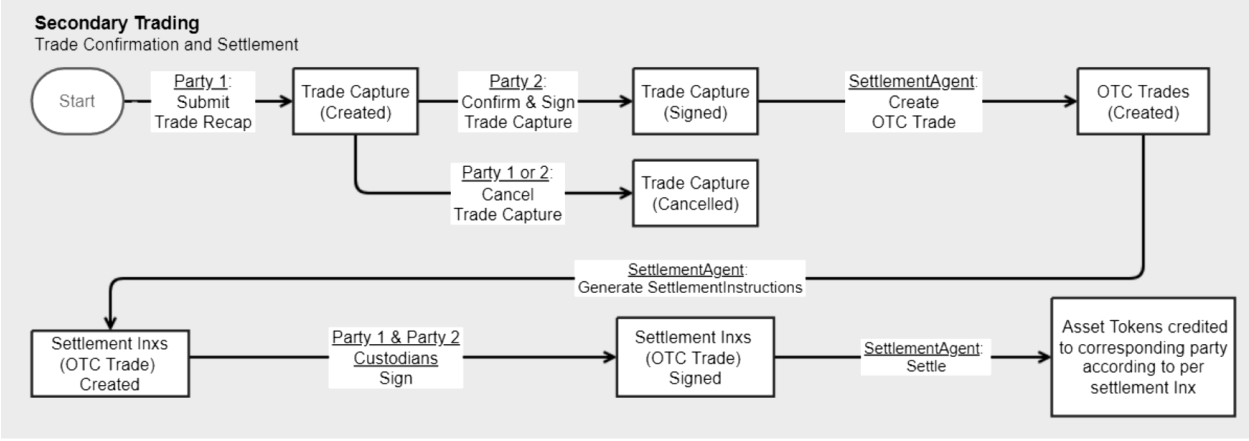


Figure 11 - Trade confirmation and settlement



B.1.4.9 Prototype user interface

The DAP ESG prototype provides a Web UI for market participants to execute the aforementioned lifecycle workflows, interact with the underlying smart contracts and Canton ledger, and view the assets portfolio and transactions.

Multiple deployment structures and integration methods are available (as detailed in B.1.5.5) for a market participant to choose based on its preference, technology investment and capability.

Figure 12 - Tranche creation

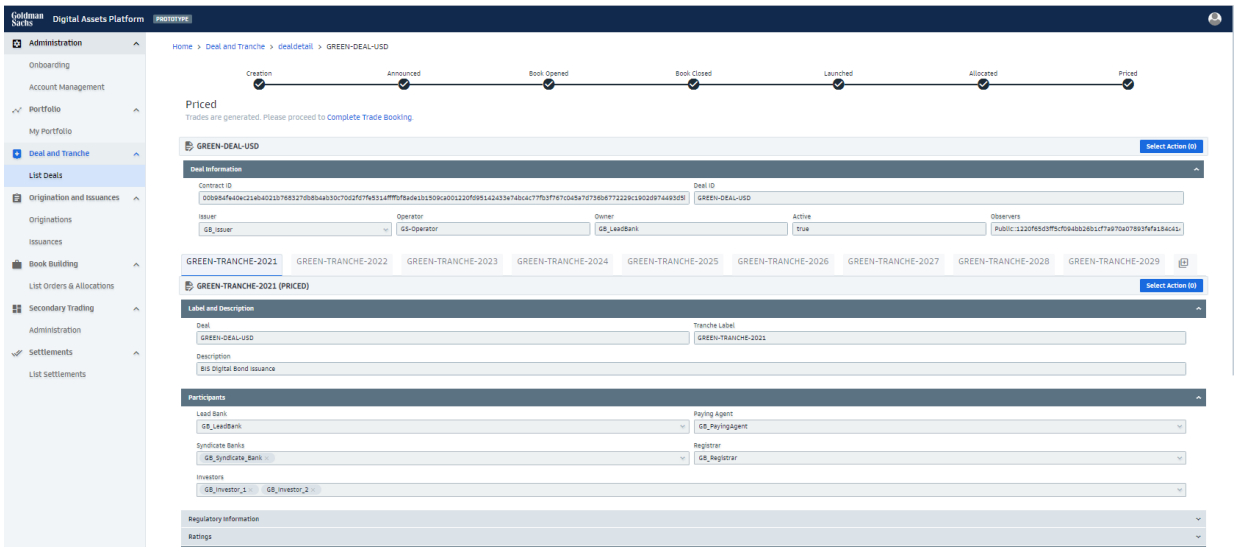


Figure 13 - Create order

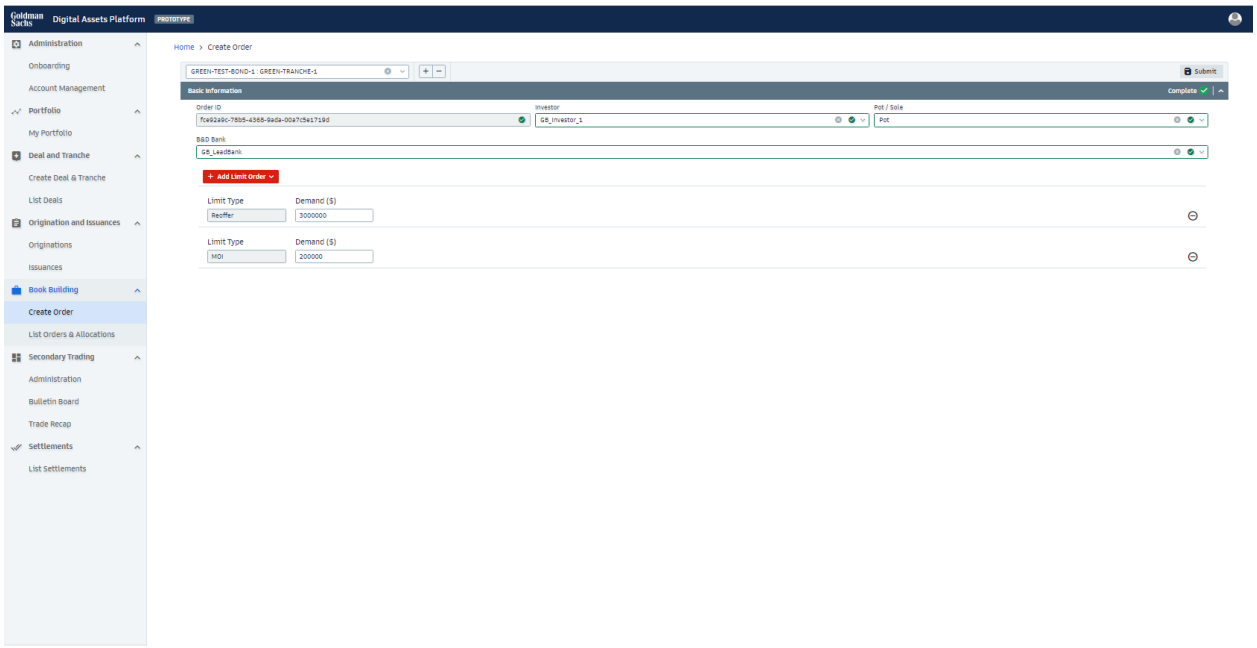


Figure 14 - Fix benchmark

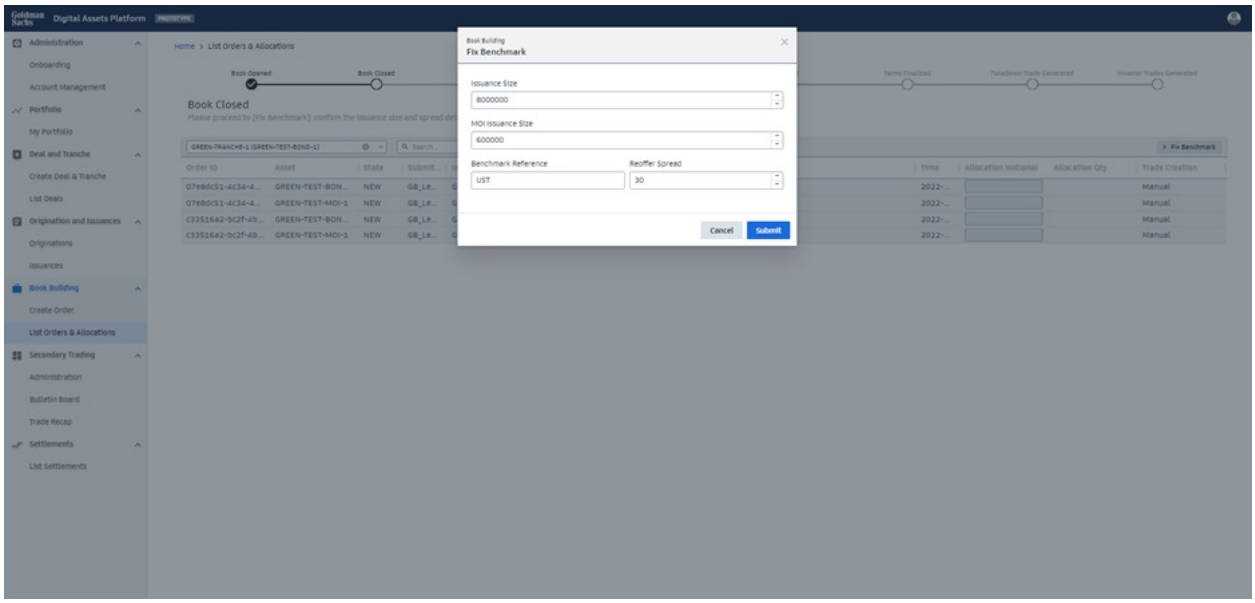


Figure 15 - Order allocations

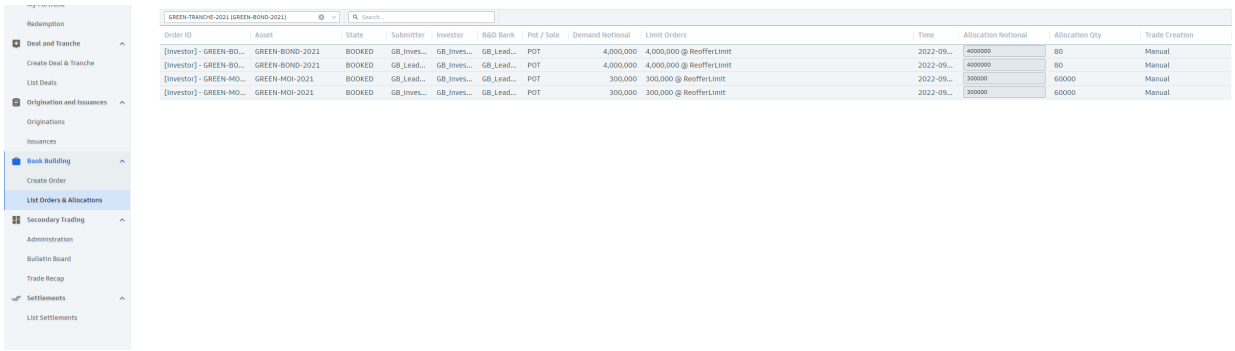


Figure 16 - Origination request

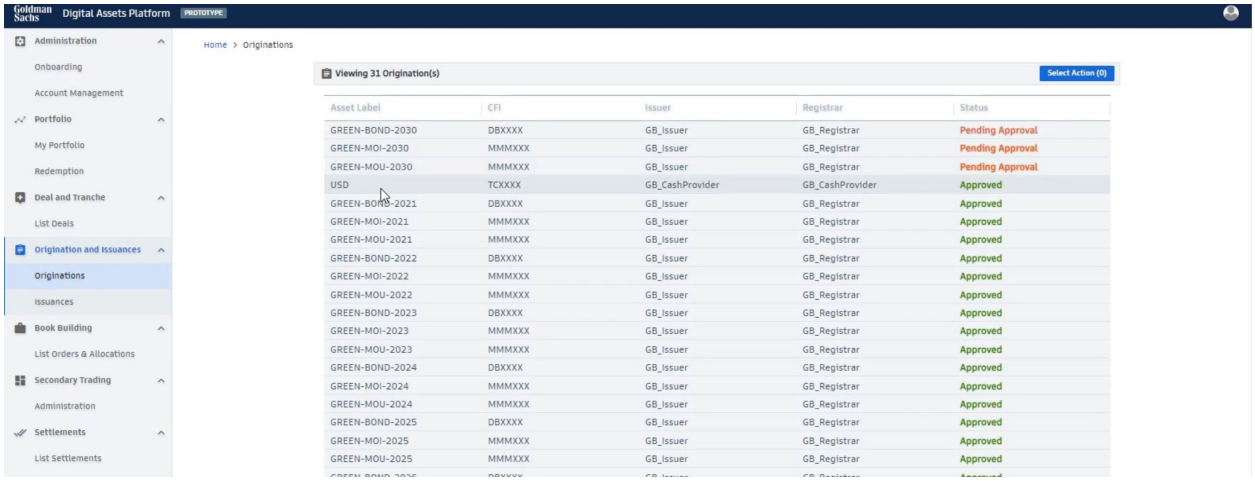


Figure 17 - Initial investor portfolio

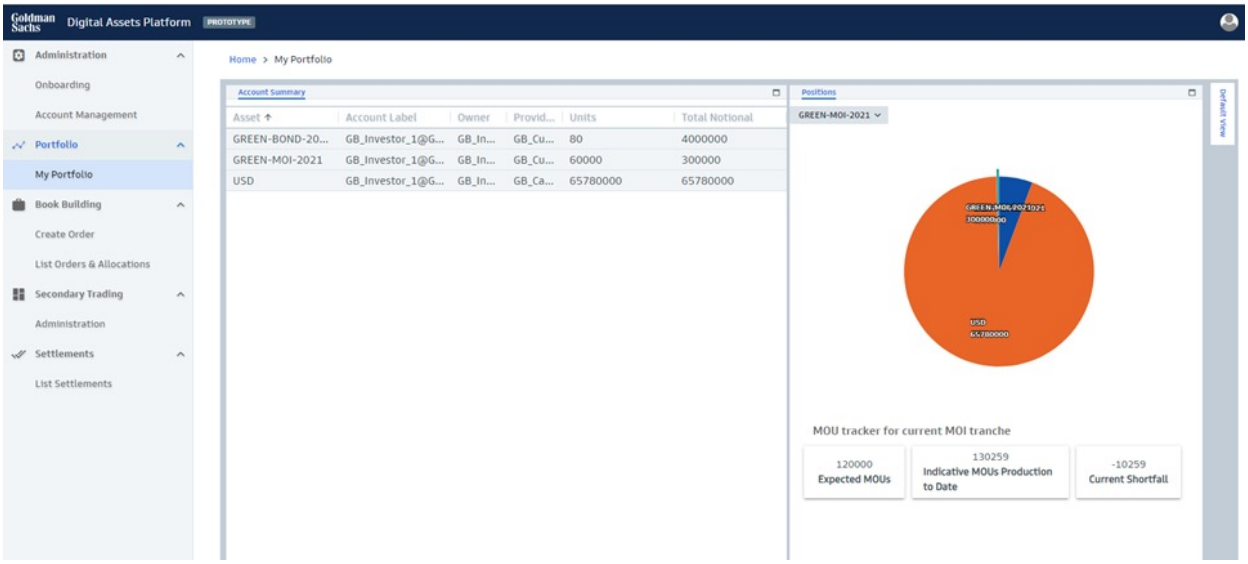


Figure 18 - Settlement instructions

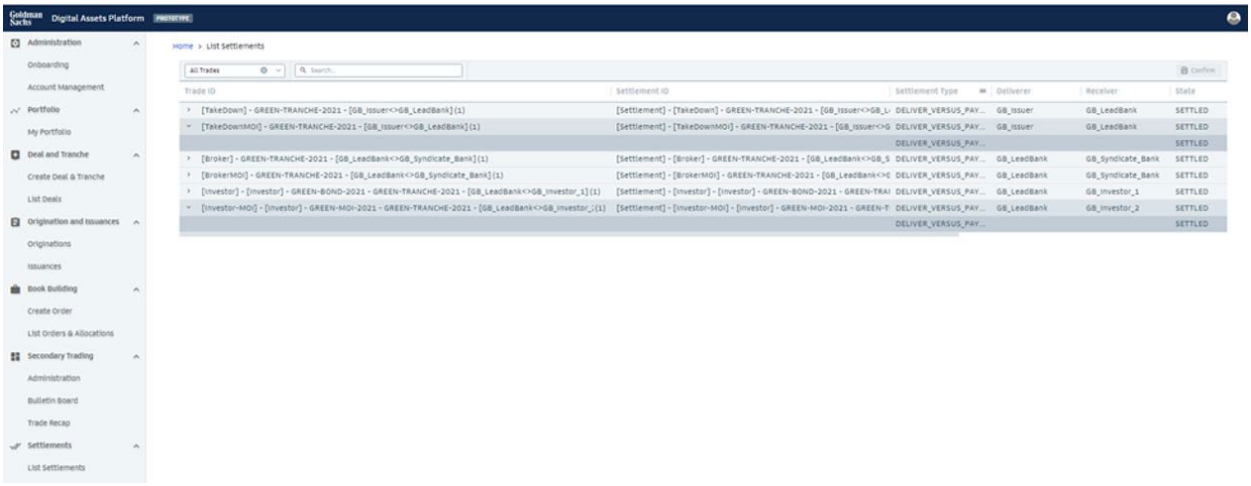


Figure 19 - Portfolio view with shortfall

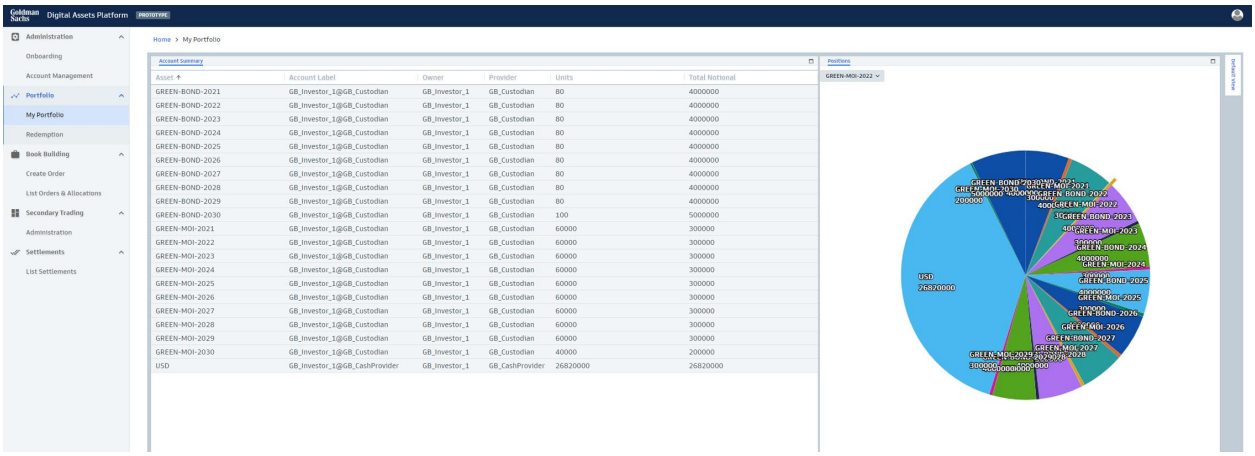


Figure 20 - Shortfall redemption

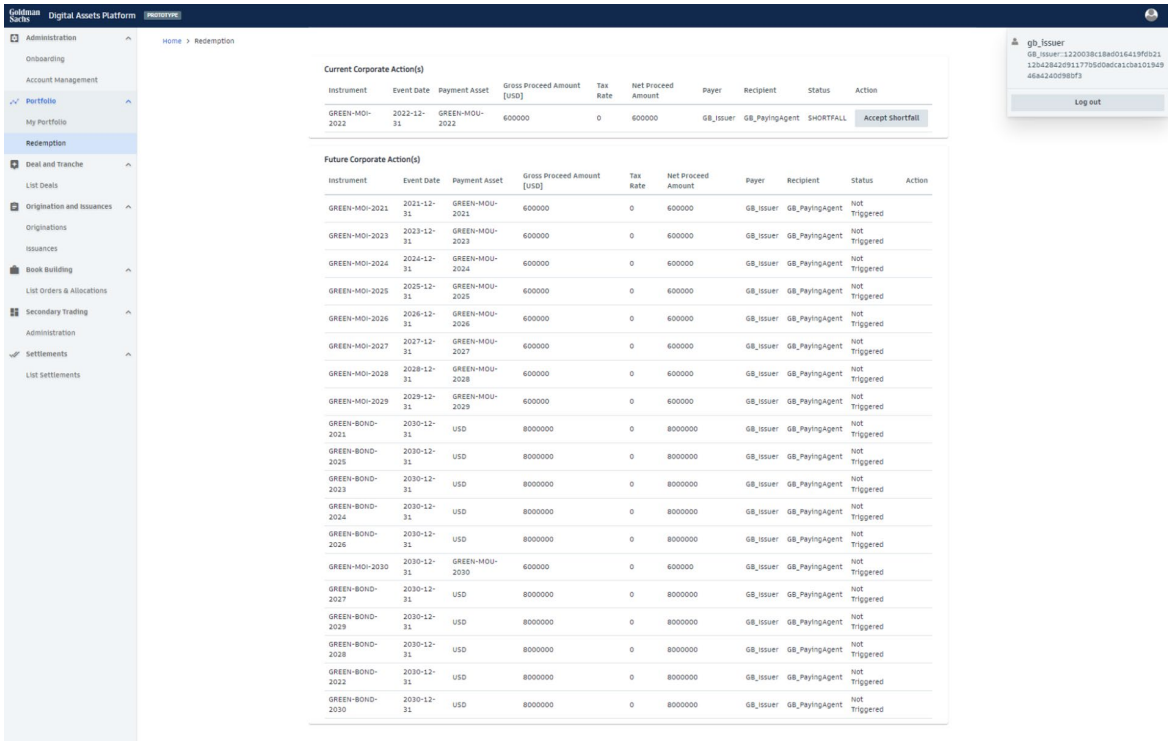
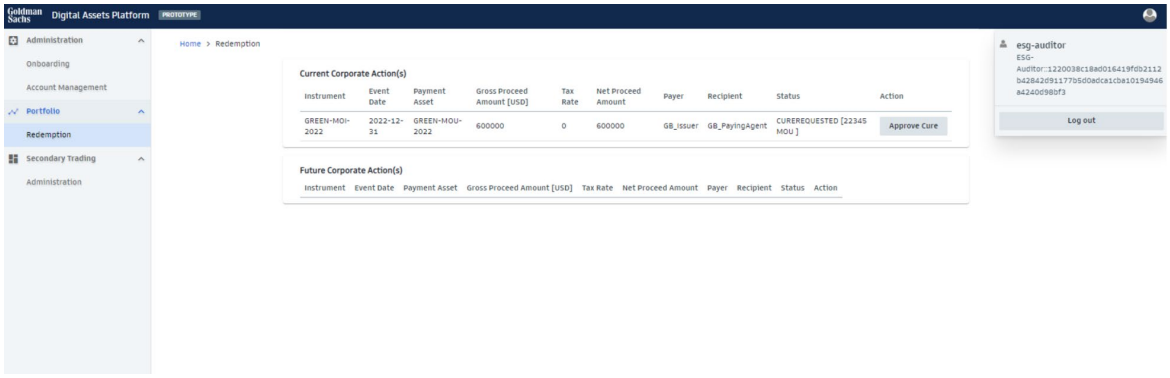


Figure 21 - ESG Auditor shortfall cure approval



B.1.5 Technical architecture

B.1.5.1 Goldman Sachs DAP ESG prototype

The core tokenisation logic and workflow leverages the DAP ESG prototype, which is built upon Daml smart contract technology, to provide an end-to-end digitisation platform with the following design features:

- Streamline the ESG finance value chain leveraging and integrating blockchain DLT and IoT;
- End-to-end digitisation with enhanced functionalities across pre-issuance, primary issuance, OTC secondary trading, multi-tier digital asset registry and custody, settlement, asset servicing, etc;
- Tokenised and digitally native assets - multi asset classes and products;
- Blockchain agnostic (permissioned / private); and
- Enterprise grade digital infrastructure – multi-cloud and multi-participant workflows across issuers, syndicate banks, brokers/dealers, registrar, custodians, settlement agent, investors, etc.

B.1.5.2 Distributed ledger

Project Genesis 2.0 leverages Digital Asset's privacy-enabled blockchain Canton, and the Hyperledger Besu network.[47] It provides secure synchronisation between multiple nodes on a wide range of technologies and controls the management and progression of all workflows in the solution. In conjunction with Daml smart contracts, Canton stores every state transition in the ecosystem being modelled, delivering three key benefits:

- A real time state machine - to eliminate reconciliation between parties to shared workflows, guaranteeing at all times that all parties see the latest, accurate and consistent product data that they are entitled to;
- Immutable record of all transactions - every state transition in the workflow is captured and committed to the Ledger. All parties gain access to a complete immutable records explaining each of the actions taken in the system and how the ecosystem arrived at the current state; and
- True smart contract interoperability - across Canton networks while maintaining the privacy properties of each independent ledger. This means that any two or more applications written in Daml and running on Canton ledger can be combined, both at the language level and, more importantly, at the runtime level.[48]

B.1.5.3 Allinfra Climate

Allinfra Climate collects carbon-relevant operational data from asset devices, recording data directly and permanently and making that data available via API for a variety of reporting and verification use cases. Carbon-relevant operational data, as typically required for measurement and verification of emission reductions, is recorded in a way that ensures a consistent and permanent link between the data that underpins environmental financial products and the data source. Additional data from other on-site or off-site devices can be ingested to provide context to the primary operational data (eg pyrometer data for solar or anemometer data for wind, both of which support metered power output).

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47. Hyperledger Besu is an open source project, however the network leveraged for this prototype is a private Goldman Sachs owned network.
48. Although interoperability across Canton networks is possible this concept was not leveraged for the purposes of the Genesis 2.0 simulation.

As part of Genesis 2.0, Allinfra Climate showcased the following functional capabilities:

- Ability to capture device meter data via the existing cloud-based electric reader or device-embedded reader[49] and signer as the optimum level of data provenance and authenticity;

- Enhanced blockchain transaction indexer to better process a high volume of assets, devices and meter data readings; and

- User-defined formulae and methodologies to enable customised carbon emission or equivalent calculations at asset or device level.

Off-device data, such as relevant reports from credentialed parties (like biodiversity reports, labour reports or letters of assurance and authorisation from host-country governments) may also be tied to operational data and to the relevant product. Overall, the system allows for a party to access timely, reliable, granular asset data that can be easily tied to a financial product – adding to the transparency, efficiency and objectivity of the climate markets.

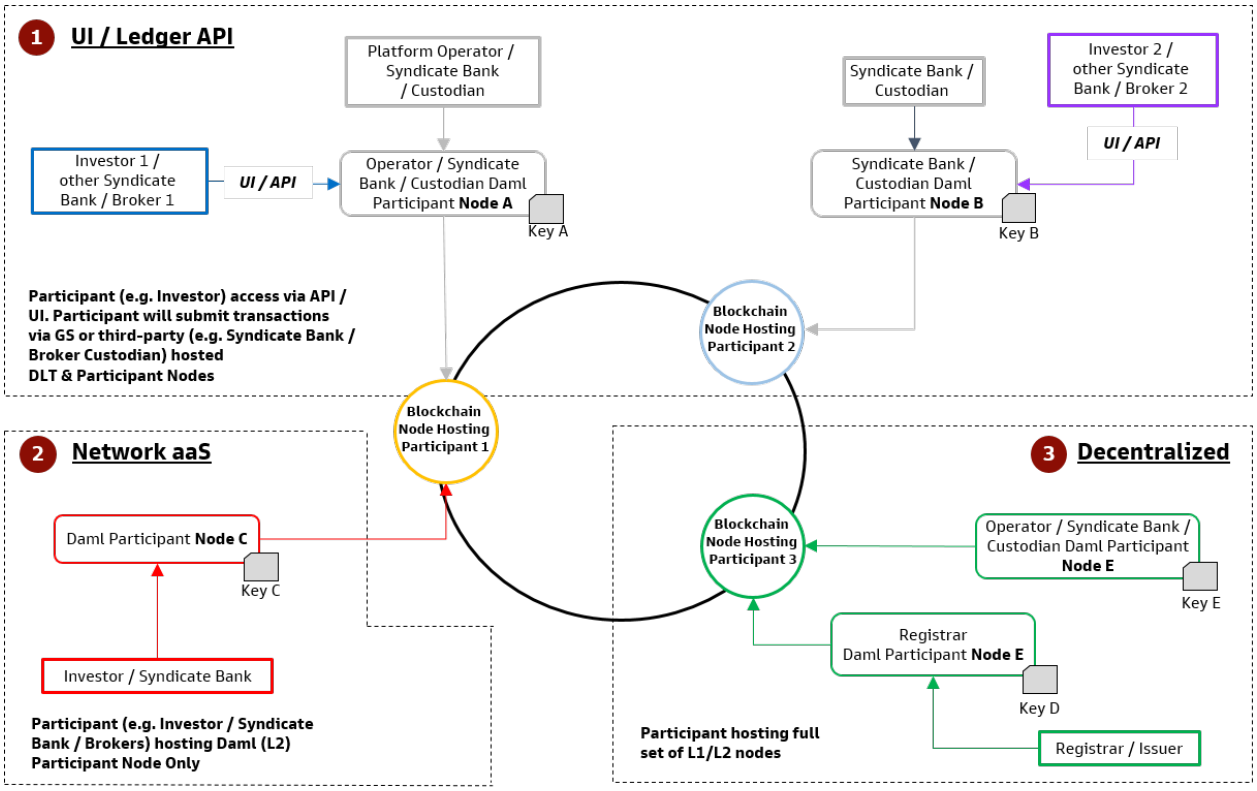
B.1.5.4 Goldman Sachs blockchain integration platform ESG Prototype

The Goldman Sachs blockchain platform ESG prototype provides flexible and robust integration and mapping services between on-chain processes, and ledger transactions and off-chain traditional systems. For this simulation, a core API integration was made with Allinfra Climate to ensure that there could be timely ingestion of asset data, used to accurately compute the number of MOUs generated.

B.1.5.5 Participant deployment architecture

For the purposes of the simulation, the deployment options were limited; however, theoretically participants (eg syndicate bank(s), a broker / dealer, ESG auditor, custodian or investor) have the option of three distinct ways of interacting with the platform and underlying network, with varying levels of technical integration, and different trust levels. These range from UI / API connectivity only, Daml participant node hosting only and all the way to full usage of distributed ledger technology ("DLT") and Daml node hosting.

Figure 22 - Deployment Architecture



49. Reader is a term used to denote the collection (in this case software) of data.

UI / ledger API as a service[50]

- Participant, Investor 1, initiates actions via a syndicate bank hosted participant node (the "Syndicate Bank Participant Node") and UI / API.

- The Syndicate Bank Participant Node populates and signs smart contracts on behalf of Investor 1 and sends the signed contracts to the underlying ledger for validation.

- Other participant nodes involved in Investor 1's transaction (eg counterparty, custodian), validate that "Investor 1" belongs to the Syndicate Bank Participant Node and verify that the contained Daml contract is valid and signed.

- Similarly, Investor 2 is also accessing the DLT using a third party participant node.

Network as a service – hosted participant node[51]

- Participants can choose to host their own Daml participant node, allowing them to submit contracts signed using their own private key.[52]

Decentralised domain[53]

- Participants, can choose to host their own Daml participant node and DLT node, for the purpose of executing smart contracts using their identity, to send and sign the transactions to the underlying ledger.

- This model provides full cryptographic security and verifiability, as well as uninterrupted network access.

50. Only deployment option leveraged for this simulated solution.
51. Out of scope for this simulated solution given time constraints and set up efforts of unique nodes.
52. Private key refers to the cryptographic key generated by participants that are used to sign all transactions emanating from the node.
53. Out of scope for this simulated solution given time constraints and setup efforts of unique nodes; however, it is worth noting that Goldman Sachs already has its own Daml participant node, therefore this was leveraged for the purpose of the simulation.

B.1.6 Key observations and future considerations

Throughout Project Genesis 2.0, the consortium has been able to work through some key challenges pertaining to product structuring and marketability, legal and regulatory considerations, asset performance tracking and, intrinsically relevant to this project, the fundamental use of emerging technologies.

B.1.6.1 Product structuring and marketability

For the simulation it was assumed that the bond and MOI are appended to each other for primary issuance, however there is the ability to decouple the products on the secondary market. This therefore increases the distribution alternatives for issuers and appeals to a diversified investor base. The incentive to append the products to the bond for primary issuance relates to supporting the uplift of green finance projects, supporting development-stage project funding and incentivising issuers to launch green initiatives. While the economics terms of this type of product versus a traditional green bond and carbon credit are unlikely to differ greatly at this point in time, there is an increased transparency which could be viewed as attractive by investors. A core challenge of pricing this as an overarching product will be the novelty of the product; this will result in a required collaboration between different desks at sell-side institutions in addition to ample buy-side education to understand pricing structure given that green bonds and carbon credits typically sit with unique desks.

When considering the funding and delivery of the product, the MOI structure allows for significant structure flexibility with respect to payment and subsequent MOU delivery, while ensuring that the issuer is delivering an environmental financial product from the project(s) linked to the financed bond.

The consortium decided to structure the product so that the buyer pays fully upfront for future delivery of the MOUs. This is to further support the UN sustainable finance goals, and in particular to ensure support of development-stage project funding. However, the structure and payment terms of the product could be easily amended to facilitate partial upfront payment and payment of the balance on delivery. This would result in a different risk profile and pricing structure, and potentially appeal to an alternative issuer and investor audience. The structuring of the MOI component of the product, for the purposes of the simulation, takes MOU vintages into account, with a 10-year contract period of MOIs. The consortium appreciates that there would be market sensitivity in terms of a long-dated forward payment which in turn would be reflected in forward pricing. In general, the consortium expects that longer dated MOI terms requiring full upfront payment would be limited to projects / entities with higher grade credit ratings, with the majority of other projects potentially utilising one or both of either shorter MOI terms and / or partial payment terms upon MOU delivery.

Pricing of the MOI component of the product will be highly dependent on three factors: i. the size of partial upfront payment at the time of MOI issuance, ii. the credit worthiness of the issuer, and iii. the required collateralisation of the MOIs:

i. The greater the proportion of total payment required for the environmental product at MOI issuance, the lower the likely total price achievable for the environmental product sold.

ii. The effect of this payment split on overall value for the environmental product sold will partially depend on the creditworthiness of the issuing entity. Issuers with a higher credit rating will be able to demand a greater portion of total value to be delivered at MOI issuance with a lower impact on total value received.

iii. For lower-rated issuers, the pricing impact could be mitigated through a collateralisation requirement for the MOI - requiring a certain proportion of funds or assets to be pledged by the issuer in favour of MOI holders up and until the MOU is delivered.

While for the purposes of this simulation the consortium pursued a 1:1 ratio of MOI:MOU, it would be technically possible to equate 1 MOI to Xn MOUs, with n being determined by the issuer of the given bond. The consortium felt that, for this initial simulation, it was important to retain a standardised ratio. If the ratio of MOI:MOU was 1:Xn the product structure would differ and take the form of a product akin to a bond (MOI) with coupon payments (MOUs), thus a drawdown structure.

Additionally, for the simulation, it was assumed that there would be an even distribution of MOU delivery per vintage for each tranche, based on the kWH forecast for the specified wind asset. These forecasts and thus MOU delivery schedule could, however, follow a bell curve or other distribution method based on external factors and forecasts.

Under the scope of Genesis 2.0 and in our design of the prototype solution, we considered factors relating to voluntary carbon market instruments and registries, national and sub-national instruments and registries, and mechanisms and instruments being discussed and negotiated under Article 6 of the Paris Agreement. We believe that the prototype represents a solution that could bring material value to any and all of these areas of the carbon market. For example, a third party such as a voluntary standard or government body or the UNFCCC could play a role in verifying that the precise construct for device-based data collection, credentialled party data inputs, computation using uploaded formulas and finally production and legal transfer of claims is consistent with a relevant methodology used by that standard. Furthermore, having a product where not only can the underlying data is captured and retained immutably, but where associated reports can also be inextricably linked to products, allows products to exhibit features such as achievement of sustainability and development goals. Lastly, whether related to voluntary markets or ITMOs under the Paris Agreement, ensuring that the chain of transfer of a product is traceable back to a particular source at a given time can help to avoid double counting of claims, as well as help to ensure corresponding adjustments to national carbon accounts are made between countries that have transacted ITMOs cross-border.

B.1.6.2 Disclosures

While the proposed solution does not require commitment from the issuer to have an entirely green portfolio in order to be an eligible green bond issuer, the consortium have considered how to incentivise issuers to commit to additional climate goals, ideally along a Paris-aligned de-carbonisation path ("Paris-alignment"), for future development of Genesis 2.0. A commitment by the issuer to Paris-alignment could apply to the issuer's entire operating, and to-be-commissioned, asset portfolio. However, as a consortium we believe the approach to contractual obligations, ongoing monitoring, triggers for breach and remedies (the "Disclosures") would need to be flexible and dependent on overall size and diversification of the issuer's asset portfolio.

For Project Genesis 2.0, the consortium has chosen not to impose a portfolio-wide approach in respect of the full suite of Disclosures for a number of reasons including: (i) belief that the market is not yet ready (and it may be too cost- and resource-intensive) to implement the technical and legal due diligence needed to set up the necessary baseline and monitoring regime required to implement a mandatory portfolio-wide requirement on bond issuance at this stage; and (ii) assuming the legal documentation were put in place, together with a baseline and monitoring plan, and assuming a mid-large and diversified issuer, it would likely be cost-prohibitive to track and enforce against the issuer's full portfolio when compared to the value of the bond itself as a stand-alone instrument.

Given the current state of industry development and current stage of climate pledges, the market is experiencing a transition phase and one where we would expect to see an increasing number of large and diversified asset owners setting de-carbonisation targets. The consortium believes that those issuers

who are currently producing fossil fuels or operating large and diversified heavy industry asset portfolios, should be part of the target market for Genesis 2.0-style transition financing and should be encouraged to raise funds for Paris-aligned projects (provided the funds raised are leveraged for the intended purpose), thus supporting their overall portfolio's transition.

Taking the above into consideration, the consortium has considered how disclosures could be implemented in due course, at the appropriate market time and depending on the size and complexity of the issuer's asset portfolio. To start with, there could be a regime of material and enforceable commercial obligations imposed on the issuer, including events of default if the issuer is unable to remedy a breach of these obligations. The issuer could cite explicit commitments it agreed to within the lifetime of the bond ie, the issuer could commit to not building and commissioning new plants of xyz specifications (notably those that would contribute towards a carbon-intensity above a set baseline), and could commit to retrofitting or retiring certain other assets over an agreed period of time. This would provide investors with the confidence that the issuer is incentivised to meet their commitment to avoid an event of default.

The consortium believes that this type of undertaking, with fairly macro asset exclusions and transition obligations, is more realistic, with validation from Second Party Opinion providers and third party auditors required to approve the framework and ongoing activities, than an issuer committing to a detailed transition and monitoring regime across their entire asset portfolio. In terms of remedy, the consortium believes an obligation could be put on the issuer to purchase offsets from the market, equivalent in quality to the MOUs issued under the bond, to cover any increased GHG emissions that arise from an event of default. This would have the same effect as first using the bond MOUs to cure the event of default and then going into the market to replace the shortfall MOUs, and could likely be more acceptable to bond investors.

As a final point, in the event the issuer's assets fall under a national or regional GHG reduction and monitoring regime, where the costs of implementing are not solely borne as a cost of the bond, then it may become feasible to tie the bond greenwashing terms to a complete Paris-aligned portfolio transition; however, the consortium believes that this stage requires market and policy change to be implemented.

B.1.6.3 Legal and regulatory considerations

A variety of legal and regulatory issues arise with the prototype solution. This section provides a sampling only of some of the points for consideration. Points for consideration will vary depending on the jurisdiction and evolution of the product and regulatory framework, as well as subsequent developments in relation to the Paris Agreement.

Firstly, one should consider the characterisation of the novel nature of the MOIs and assess on a jurisdictional basis, whether any legal or regulatory requirements such as licensing requirements, selling and distribution restrictions arise in relation to the product. An MOI can potentially be viewed as a forward transaction over a commodity (MOU) with no cash settlement alternative nor fluctuating return by reference to changes in an underlier. The MOI simply entitles the holders to a predetermined amount of MOUs at a specified point in the future. While no specific market was selected to consider the financial instrument, the Hong Kong SAR was considered by the consortium given the parties involved in the broader project working group. From a Hong Kong perspective, the product as described would likely result in the MOIs being out of scope from the Hong Kong OTC derivatives licensing regime, as and when that regime comes fully into force, and therefore the better view is currently that it would be viewed, in Hong Kong, as an unregulated product.

Following the characterisation of the financial product itself, we can turn to the actual trading of the products. As the MOIs represent the contractual obligations of the issuer to deliver MOUs, they may be viewed similarly to the debt obligations owed under bonds but settled in MOUs rather than money. As such, the structuring of the MOIs within the solution raises the same issues from a tradability perspective as the debt obligations owed under the bonds. The MOI obligations could either be undertaken by issuers directly to holders and then transferred by novation or assignment, or a conventional structure could be used where the issuer holds the obligations to a trustee intermediary instead, where the trustee holds the right to receive MOUs on trust for the holders of the MOIs and enforces the right collectively. It is worth highlighting that the offer of the bulletin board UI for secondary trading may give rise to licensing and other regulatory requirements depending on the jurisdiction of offer or use.

The consortium also considered whether the MOUs transferred upon the settlement of MOIs can be recognised under Article 6 of the Paris Agreement. Article 6 contemplates whether nations will be able to trade mitigation outcomes, meaning the benefit of emissions abatement that occurs in one country, Country A, may be transferred to another party in another country, Country B, and then Country B is able to claim the benefit of that abatement for the purpose of meeting its Paris targets. At the time of this paper, the regime is not yet in force and so it follows that the transfer of MOUs would not be recognised under the Paris Agreement. For the product to provide for the transfer of Paris Agreement recognised abatement, the Paris Agreement trading rules and framework should be finalised and implemented, and in addition, countries (including Hong Kong) would need to consider if they want to create MOUs for their market or rely on international MOUs, as well as opting in to allow for the export of their abatement.

B.1.6.4 Asset performance tracking

One of the key asks of Project Genesis 2.0 was to provide timely tracking of mitigation outcome data. The simulation provides predictability from ongoing data feeds, unlike traditional manual measurements. It also provides MRV processes through use by the consortium of a timely data feed from the asset(s) that will deliver future MOUs against the MOI obligations. This provides the MOI holders with greater confidence and forecast capabilities as to the likely volume and timing of delivery. Historically, whether a delivery was likely to be on time, below or above expected volume was a fairly opaque process until near the end of typically lengthy manual verification processes. This ongoing visibility becomes particularly important where evidence of shortfall risk begins to arise, providing MOI holders with the ability to hedge any potential shortfall from that specific project upfront. Likewise, in cases where excess MOUs are likely to be produced, and where the MOI holder may have rights or options over excess MOUs, plans can be made in advance. Additionally, MOI performance is particularly important in informing accurate pricing and investor decisions in the secondary market.

B.1.6.5 Technology usage

While the solution does not provide connection to carbon exchanges, connectivity capabilities such as this could be considered for the solution at a later date. This connectivity could support the shortfall cure workflow, whereby the issuer is obligated to make the investors whole in the event of MOU shortfall. Additionally, connectivity to carbon exchanges would streamline the secondary trading element of the design to support trading of MOUs, or MOIs.

Allinfra Climate allows for easy sharing of granular asset-level data, making it seamless for third party administrators, carbon registries and other stakeholders to access critical data related to MOI/MOU production. This functionality is essential in the context of national and international targets and carbon accounting across borders where the ability to transparently trace the origin of any carbon or environmental product is needed to ensure NDCs, and other targets can be reliably reported against with reduced double counting risk.

B.1.7 Conclusion

Overall, the consortium has sought to answer the key asks of Project Genesis 2.0 by leveraging blockchain technology, smart contracts and IoT devices. The concept of this novel product has the prospect of supporting the financing of development-stage green initiatives, while also providing investors with a choice on product composition. Through the use of a blockchain-based platform, such as the solution developed by the consortium over the course of Project Genesis 2.0, investors and issuers alike are able to have transparent and timely visibility of their overall portfolio holdings, thus allowing them to directly align such investments to their ESG mandates/ goals. The consortium sees this level of data granularity as a critical step forward in enhancing market adoption of green financing products, in addition to supporting cross-border and international monitoring schemes. As the consortium has detailed in this paper, the design and structuring of the solution is still in early market stages and, to come to fruition, would likely require policy and licensing regime changes, including: consensus on the fundamental classification of the financial instrument; the role that a voluntary standards or governmental body could play in verifying the construct of digital MRV; in addition to the uplift cross-border reporting and transfer programmes so that MOUs could be considered under Article 6 of the Paris Agreement. Overall, to support market adoption, issuer and investor education will be critical to allow potential participants to appropriately price, structure and market the instrument, thus making it a broadly recognised tradable in global markets.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KRUNGTHAI BANK
SAMWOO
SUNGSHIN 성신양회주식회사

B.2 InterOpera consortium

The InterOpera Consortium is made up of InterOpera, Krungthai Bank, Sungshin Cement and Samwoo, bringing together partners with expertise across digital asset tokenisation, climate finance and carbon markets. InterOpera was part of the Liberty Consortium (via its subsidiary, Shareable Assets)[54] and had delivered the technology prototype for Project Genesis 1.0.

InterOpera is a Singapore-based technological infrastructure provider for capital market digitalisation with a focus on inter-chain bridging and interoperability. InterOpera leveraged its expertise in digital capital markets infrastructure to design a technology prototype solution for Genesis 2.0 in consultation with its partners.

Krungthai Bank is a leading bank in Thailand with a strong focus on environmental and social issues. Within the blockchain space, Krungthai bank has displayed market leadership with the sale and distribution of DLT-based Thai Government Savings Bonds to retail investors in 2020 and facilitating digital bond issuances through its Pao Tang platform. To the Consortium, Krungthai Bank brings perspectives as a potential market participant for the new green bond structure with MOI explored in Genesis 2.0.

Sungshin Cement is a leading Korean cement company with established networks in Asia. Sungshin Cement is committed to environmental sustainability and is an active participant in the carbon markets, which brings invaluable insights to the Consortium from the perspective of a potential investor of the new green bonds.

Samwoo is a future-oriented company specialising in automobile parts, new materials and steel, and is based in Korea. Samwoo continuously strives for sustainable improvements, bringing the perspective of a potential green bond issuer to the Consortium.

B.2.1 Consortium executive summary

The InterOpera consortium's prototype explores the technological feasibility to track, deliver and transfer tokenised MOIs and MOUs in the context of MOIs being issued with green bonds. The proposed solution is designed to digitally issue and track digital tokens of MOU / MOI, and connect carbon markets with capital markets via its interoperable blockchain infrastructure.

The consortium was set up to combine the experience and technical know-how of the technology infrastructure provider for digitised MOIs and MOUs (InterOpera), capital markets participants (Shareable Assets and Krungthai Bank), and carbon market issuers-cum-investors (Sungshin Cement and Samwoo).

The prototype is designed to integrate carbon markets with capital markets. Bond tokens and MOI tokens are digitally issued together but as separate instruments and with different terms (refer to B.2.4.2). To productionise the green bond structure, bond tokens can be issued based on local digital asset regulatory frameworks. Investors of MOIs have the right to receive MOUs (certified carbon credits) from the bond issuer.

The Prototype runs on InterOpera's proprietary blockchain infrastructure, Regulated Defi Operating System (RDOS). RDOS' interoperable and modular design, embedded investor production and regulatory controls, will allow for easy integration with capital markets. This is important for the solution to be commercially viable (refer to B.2.5.1).

54. Shareable Assets Pte Ltd is a wholly-owned subsidiary of InterOpera. It is regulated by the Monetary Authority of Singapore (MAS) as a Capital Markets Services Licence (CMSL) holder.

Key technical features introduced in InterOpera's proof-of-concept include:

- To track, deliver and transfer digitalised MOIs / MOUs using smart contracts to represent the green attributes generated from green activities.

  - **Tracking of MO:** Uncertified Mitigation Outcomes (MOs) data generated by green projects financed with the bond proceeds are tracked in real-time through an API call and displayed on the MO tracking dashboard to promote transparency for all stakeholders.

  - **Issuance and transfer of MOU tokens:** The prototype assumes a UNFCCC process that supervises MOUs via a blockchain or non-blockchain based MOU registry. Issuance of certified MOU tokens are based on a blockchain-based consensus mechanism where the MOUs are transferred to the operator's custodian account. A matching amount of MOU tokens will then be minted to the Issuer's wallet.

  - **Issuance and management of MOIs:** MOI tokens are issued and paired with bond tokens to allow investors to monitor the green impact of their investments. Settlement of MOI obligations is subject to fulfilling issuer's climate performance shortfalls. Issuers can also address MOU shortfalls by external purchases up to a designated cap.

Additional conceptual design features which are not covered in this proof-of-concept that InterOpera plans to develop independently:

- **Interoperability bridging** will allow a single MOU / MOI blockchain-based digital registry (a host chain, elaborated further in section B.2.4.3) to monitor all native MOU issuances. This will ensure uniformity in standards and facilitate transfers that are secure and scalable. It mitigates double counting issues due to (i) multiple claims of green attributes by different parties in the green value chain, or (ii) double issuances from the usual Lock-and-Mint mechanism with transfers between different blockchains.

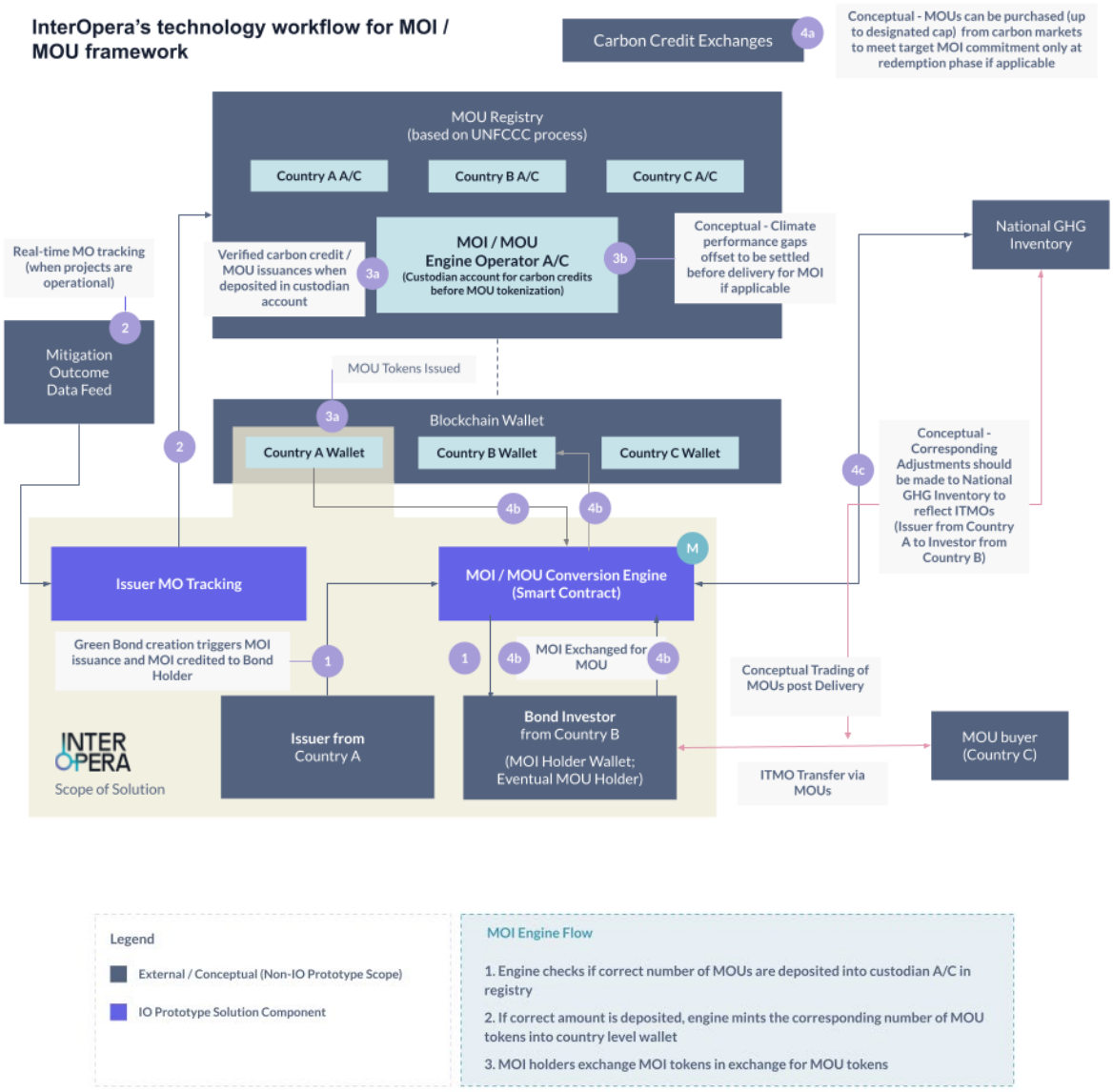
- **Smart contract-based Capital Market Protocols (CMPs) for ITMOs** checks if the MOUs are approved by the host country's government before initiating international transfers.

- **Smart contract-based CMPs for MOI** checks if the projects tied to the green bond specific MOI have been validated by an accredited carbon credit validation body, or under the UNFCCC process for issuance of MOUs under the Article 6.4 mechanism.

Overall, InterOpera's solution combines an interoperable host chain with CMPs to (i) digitally issue, track and potentially standardise global carbon credits and (ii) maximise the benefits of digital capital market infrastructure that has been applied to existing financial products to the new MOI financial instrument. Such solution allows a blockchain-based global depository system to certify carbon credits as certified MOUs for global and regional issuers, and for financial institutions to utilise this solution and deal in a globally accepted MOI.

B.2.2 Functional scope

Figure 1: InterOpera's technology workflow for the proposed green bond structure explored in Genesis 2.0



The scope of InterOpera's prototype is demarcated in the indicated area in Figure 1 above. The prototype was designed with MOIs / MOUs (carbon credits instruments) forming a part of a wider ecosystem including the MOU registry, carbon market exchanges and, potentially, national registries. This framework illustrates other essential components (not in the current prototype scope) necessary in the context of the Article 6.4 mechanism and the conceptual technology solution for the ideal state of the UNFCCC process for MOU registry, ie DLT-based as shown in Figure 15, and how it interacts with other ecosystem participants is discussed in section B.2.4. InterOpera's solution uses a combination of blockchain technology, smart contracts, and APIs to digitalise and manage MOs / MOIs / MOUs for operational efficiency, and to potentially mitigate the loopholes of double counting (of carbon credit claims) and greenwashing.

Key benefits offered by InterOpera's prototype for Project Genesis 2.0 include:

- **Prototype provides efficiency gains through digitalisation of the issuance process.** Through the use of this prototype, the issuer is able to fully digitise the subscription, allocation and settlement process to tokenise the green bond and MOI assets, allowing it to be delivered directly to the investors' digital wallet. All these enable the issuer to interface directly with investors, removing redundant stages, shortening the settlement cycle and ultimately lowering the costs, risks, and capital requirements of the market.

- **Transparency of green impact from financed projects achieved through MO tracking, mitigating green washing.** The prototype allows for real-time MO raw uncertified data of the green activities financed by the green bond to be monitored on demand. This improves the transparency of the projects' green impact, the progress of its green attributes commitment (ie MOI obligations) and allows all stakeholders to make definitive decisions based on their investment objectives. It also serves to mitigate green washing by enabling investors to track the achievement of MO by the Issuer and facilitate the delivery of eventual certified green attributes directly to investors.

- **Automated repayment of MOIs with MOUs through smart contracts.** The prototype includes a smart contract-based conversion engine that can automatically monitor, execute, and enforce the MOI redemption / repayment phase to achieve transparent, autonomous exchange of MOIs with MOUs and the subsequent delivery of MOUs to the investor upon MOI maturity. The repayment settlement occurs immediately with the atomic swap of digital assets of MOIs with MOUs, ultimately reducing overall operational burden[55] and processing time.

- **Conceptual elimination of double counting and double issuance issues in ITMO transfers.** InterOpera has modelled ITMO transfers as cross-chain MOU transfers which can conceptually be accomplished via our innovative bridging technology (elaborated further in section B.2.4.3), eliminating potential double counting and issuance problems.

Users of InterOpera's prototype

InterOpera's prototype is intended to serve a range of market participants for the issuance and management of the new green bonds with MOIs (and consequently MOUs) including issuers, arrangers, investors, adminstrator or operators and observers.

- **Issuers / Investors:** The prototype design is country agnostic and applicable to serve institutional users including sovereign, financial institutions and corporate entities which are likely issuers and investors for the green bond and carbon credit instruments (MOIs and MOUs) which can be eventually used for compliance purposes under NDCs. Both issuers and investors have respective portal interfaces to manage the MOIs / MOUs process.

- **Arrangers:** Financial institutions acting as arrangers are used to the issuance of wholesale bonds (and consequently the new green bond with MOIs) and will interact with the prototype particularly during the creation and issuance phase.

55. In a traditional non-automated setup, the repayment of MOIs with MOUs would be carried out manually with the involvement of paying agents and registries that will need to trace and send payments across to the MOI holders.

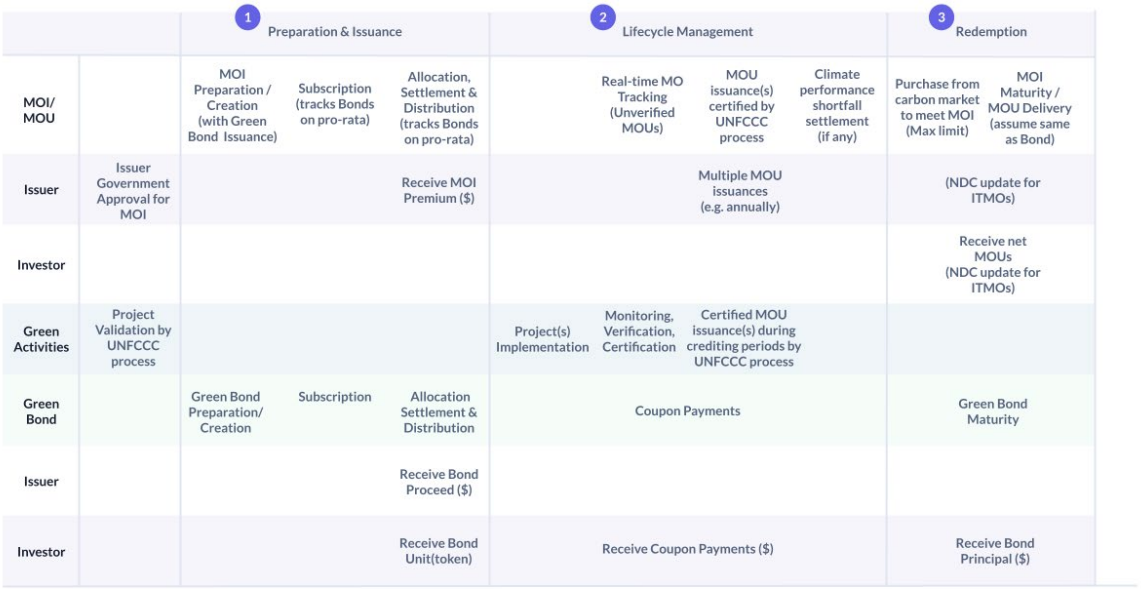
- **Administrator and Operators:** Financial institutions to host and operate a new platform to issue and manage financial instruments, green bonds and MOs.

- **Observers:** Potential users are anticipated to include supervisory bodies, regulators or any relevant entities who require read-only access.

B.2.3 Workflow design

B.2.3.1 Process flow for MO green bond (under Project Genesis 2.0)

Figure 2: Green bond and MOI / MOU process operationalised under Project Genesis 2.0



Green bond and MOI preparation and issuance

- The green bond is issued simultaneously with appended MOI units (to deliver certified carbon credits ie MOUs). Post issuance, the green bond and MOIs can be transferred through smart contracts independently.

- To facilitate MOI issuance, prior approvals are required, namely (i) validation of green projects to be financed and (ii) issuer country's government approval to issue the MOIs / deliver MOUs. This ensures that green projects comply with requirements set up by the MOU certification body from the onset, before any commitment to MOI holders and green activity implementation. The issuer country's government approval addresses potential subscription to the bond and MOIs by overseas investors that would consequently impact the issuer country's GHG emission reduction / avoidance units and its NDC accounting with the MOUs transferred internationally at maturity. This is applicable to our assumed scenario where an issuer from Country A issues a green bond with MOI to investor from Country B requiring ITMOs at maturity.

- The amount of MOI units (in tCO2e) issued to the investor(s) is allocated on a pro-rata basis against the bond investment amount during the subscription and allocation phase. In exchange for MOI units received, the investor would pay to the issuer an MOI premium (upfront payment under our scenario assumption) and help reduce the overall funding of the new green bond through the pledged carbon credits (MOIs).

Lifecycle management (duration before maturity)

MO tracking (with green projects data feed)
Post issuance, the issuer proceeds to finance the green activities for its implementation. Upon achieving operations, the relevant stakeholders such as issuers, MOI holders and accredited validation bodies can track unverified mitigation outcome data of the validated green activities through integrating a green data feed via APIs. This brings about greater transparency on the issuer's progress in meeting its MOI obligations and mitigates greenwashing. In the future, such data to track real-time (uncertified) mitigation outcomes digitally can facilitate/ complement the monitoring process.

MOUs (UNFCCC process for certified carbon credits) issuance(s)
MOUs can be issued multiple times before MOI maturity to accumulate or settle any shortfalls within the climate performance goals in the issuer's investment plan. In our scenario, we have assumed periodic MOU issuance requests (eg annual) to accumulate MOUs to meet MOI obligations.

Redemption of green bond + MOIs at maturity

We have assumed a bullet repayment of MOIs with delivery of MOUs with maturity date tracking green bond maturity (see smart contracts functionality in section B.2.4.2(6)). Technologically, other scheduled amortised repayments of MOI structures can be supported.

Conceptually, if there are insufficient MOUs for the MOI obligations, the issuer can purchase MOUs from carbon markets, up to a specified limit (eg 20%) of the total MOI committed to meet MOI obligations. Such purchases would only be made available shortly before maturity to prevent purchases to cover climate performance shortfalls, as these should be generated from the financed green activities to reduce greenwashing.

B.2.3.2 Hypothetical scenario terms and assumptions

Common Terms	
Issuer	PowerGenco Limited
Issuer Country	Developing Country A
Investor(s)	- InvestGreenCo Limited - InvestGreenFinancial Limited
Investor Country	Developed Country B
Bond Terms	
Specified Currency	US$
Deal Size (Aggregate nominal amount)	US$ 150,000,000
Minimum Subscription	US$ 250,000
Specified Denomination	US$ 1,000
Issue Price	100% of aggregate nominal amount
Issue Date	20 July 2020[56]
Maturity Date	20 July 2030 (10-year tenor)
Interest Rate	2.95% fixed rate payable semi-annually
Coupon Payment Dates	20 July and 20 January of each year, commencing 20 July 2020, to and including the maturity date
MOI Terms	
Total MOI Committed	450,000 tCO2e
% MOI Committed	80% of expected total portfolio generation
MOIs appended per bond denomination	3 MOI tCO2e/US$ 1,000 denomination
Total MOI Premium	US$ 29,300,000 (equivalent to US$ 65/MOI)[57]
Capital Intensity[58]	270 (US$ /tCO2e)
Maturity Date	20 July 2030 (same as bond maturity)
Redemption Basis	1 MOU represents 1 tCO2e reduction / avoidance per MOI
Maximum purchased MOUs for MOI Repayment	20% of committed amount (90,000 tCO2e)
Repayment Type	Single bullet payment at maturity date
Project Asset Type	Renewable energy: solar *Note: issuer is assumed to be a power generation and utility company based in a developing country in Southeast Asia*

56. To simulate utilisation of the proposed green bond framework for financing green projects, we have chosen to backdate the issuance in our scenario such that the financed projects will turn operational during our prototype implementation.
57. MOI premium is determined to be US$ 65 per MOI with reference to EEX EUA spot price as of 1 Oct 2022. Total MOI premium can be derived as a product of the MOI committed and the MOI premium.
58. Calculated based on total bond amount/MOI generation potential in tCO2e.

Investment Plan Details

- Investment plan includes both existing activities (including carbon emission emitting) and planned green activities
- Investment activities are expected to emit 2,000,000 tCO2e emissions over 10 years
- Green activities expected to generate 550,000 tCO2e emissions reductions / avoidance over 10 years with 450,000 tCO2e (ie ~80%) pledged for MOI delivery
- Net emissions over 10 years expected to be [2,000,000 – 450,000] = 1,550,000 tCO2e

Other Working Assumptions	
Construction Period	Dec 2020 – July 2022
Expected Operational Date	25 July 2022
Other scenario assumptions	- Full repayment of MOIs with MOUs at maturity (no climate performance gaps, or purchases required) - Periodic certified MOUs issuances cumulated by issuer before maturity (ie, annual issuance when projects are operational) - Government approvals for green bond + MOI issuance and ITMO transfer obtained - Validation approval obtained for projects under the UNFCCC process - Hybrid model where the registry is not DLT-based and custody of underlying MOUs (into operator entity account) is required before MOU tokens minted on DLT-based platform; ideal state is MOU registry to be DLT-based

Project asset type: For simplicity, our hypothetical scenario assumes the project asset type supporting the green activities to be solar power in a developing country in Southeast Asia, where the Issuer is domiciled.

This is largely driven due to (i) solar energy being one of the fastest-growing renewable energy sources (the other being wind), (ii) the Southeast region generally enjoys sunny weather conditions and has high levels of annual global horizontal irradiation (GHI), and (iii) the greater potential for growth of solar and other renewable energy given the region's higher reliance on fossil sources.

MOI units committed: In assessing the number of MOI units to be committed for the green bond investors, the issuer would consider the (i) total MOU generation potential of the issuer's investment plan during the lifetime of the green bond; (ii) upfront payment required by the issuer to implement green activities versus liquidity position; and (iii) the issuer's industry inclusion in national compliance programmes.

Whether the issuer is operating in an industry covered in the national compliance programmes or in a highly scrutinised industry emitting significant carbon emissions is a potential key consideration in determining the number of MOI units that can be committed. An issuer in a covered industry would likely have to retain a portion of the generated green attributes for its own use and could commit less MOI units to a green bond issue, while an issuer in a non-covered industry or green industry (pure renewables) would have more flexibility in committing either a significant or the entire amount of MOs expected to be generated during the lifetime of the green bond.

MOI premium: For our prototype, we have assumed that the MOI premium is a lump sum upfront payment to reflect the context of an issuer (in a developing country) issuing the green bonds to finance the implementation of new green projects which are capital intensive in nature, and to separate the payments for the green bond and MOIs to reflect their independent natures. Other forms of economic benefit and structuring of the payment of MOIs that are commercially acceptable should be considered.

In principle, the MOUs that can be used to settle MOI obligations should have a higher quality than normal carbon credits as the new structure has enabled green activities that otherwise are not possible through filling the viability gap of green activities and through creating the potential for a developed country to claim the facilitation of climate finance for a developing country (where the MOI holder is a developed nation buying an MOI from a developing nation). This could take place in the context of the commitment from developed nations to mobilise US$100 billion annually in support of developing countries.[59]

B.2.4.3 Green bond and MOI technology prototype workflow

1. Green bond + MOI creation and issuance

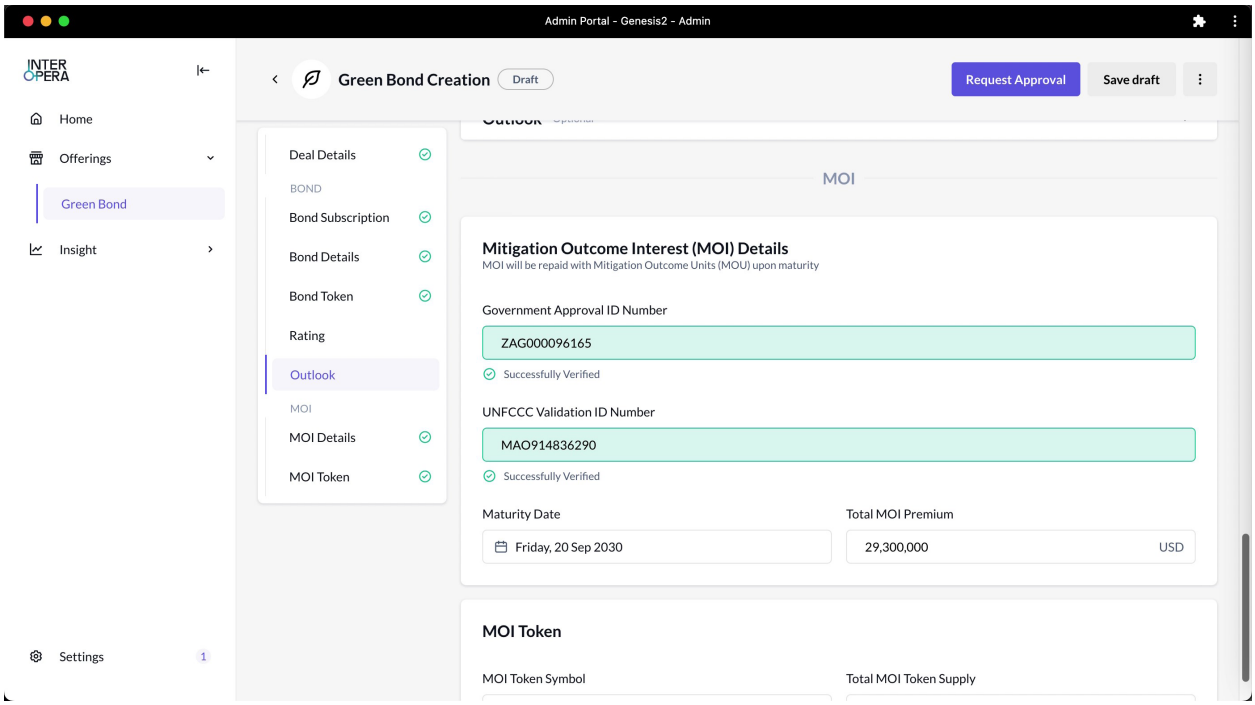
(i) Pre-issuance and creation

The prototype is first used at the pre-issuance phase where the green bond and MOI terms have been structured and settled by an appointed lead arranger(s) and the issuer, and ready for subscription by potential institutional investors. The term-sheet details are captured on the web application, including standard bond details such as maturity date, coupon rate and subscription period. Specific to the MOI instrument issued alongside the green bond, details such as the MOI units committed, MOI premium, the issuer's government approval ID and the UNFCCC process validation ID (both approvals to be system verified) are required in the prototype creation page.

The Government Approval ID is essential to the issuance of MOIs as redemption of the instruments is made via the delivery of MOUs for which corresponding adjustments need to be made to the national GHG inventory, affecting the country's GHG reporting under its NDCs due to international transfers of MOUs. Validation of planned green projects under the UNFCCC process in the Issuer's investment plan must be done prior to issuance, to ensure that MOUs issued from these activities can meet the MOI obligations. The prototype ensures that this condition is fulfilled by the issuer through the input and verification of a Validation Approval ID before digitally native MOIs are issued.

59. See United Nations, Framework Convention on Climate Change (2015). Adoption of the Paris Agreement, December, 21st Conference of the Parties, Paris.

Figure 3: InterOpera's prototype Green Bond and MOI creation page



The prototype is intended to be a one-stop platform for all relevant market participants, such as the issuer and arranger(s), to interact and manage the end-to-end digitally native green bond and MOI placement and lifecycle process with prospective investors through a web application. Arrangers would solicit investors from their client base. Investors, once onboarded, would be tracked according to the subscription link unique to each arranger for efficient management of origination activities.

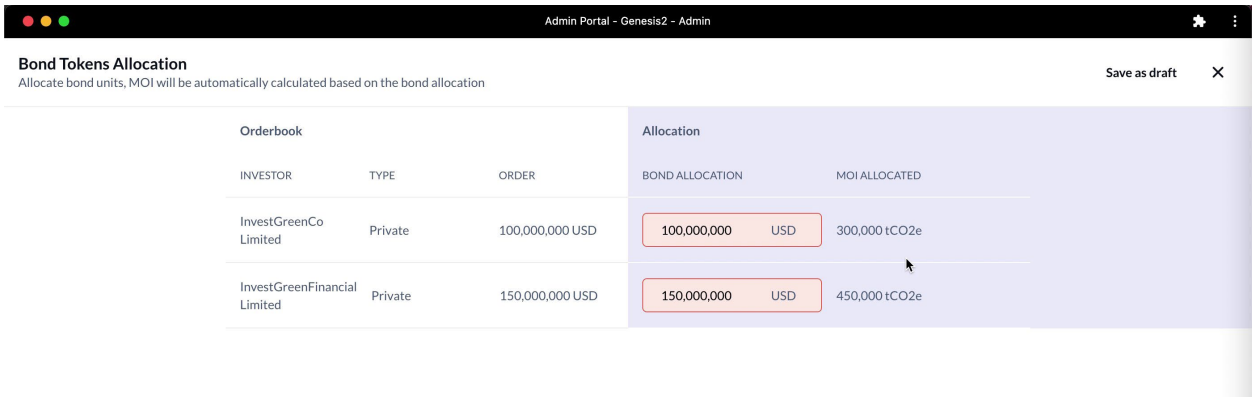
(ii) Subscription, allocation and settlement

Issuers interact with prospective institutional investors via InterOpera's prototype at the subscription phase after client onboarding and customary KYC / AML processes.

Subscription for the green bond and MOI will be opened for the specified period. Pre-selected institutional investors who have been on-boarded onto the system can subscribe to the green bond and MOIs, allowing arranger(s) to flexibly and direct deal with their targeted clients and manage the subscription and issuance process digitally within a single platform.

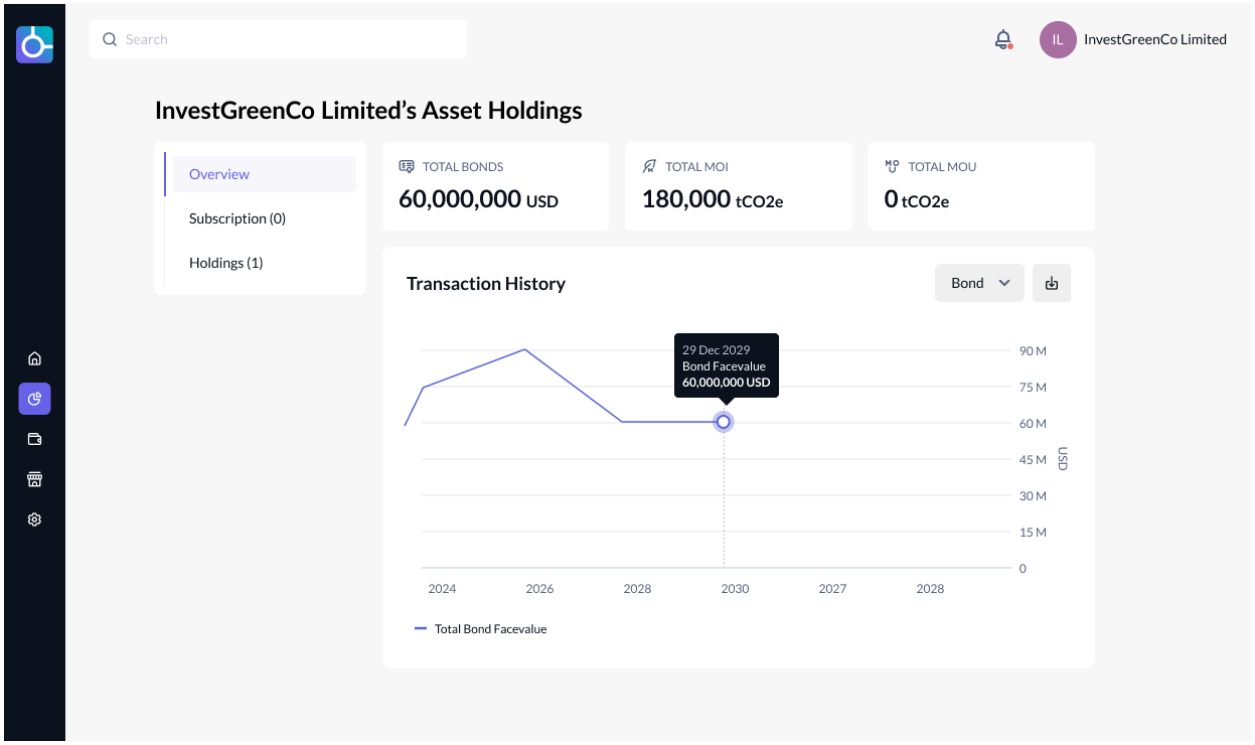
Investors can place orders for the green bond and MOIs on the platform with payment being done securely and efficiently on-chain. Payments will be sent to a smart contract which will take custody of the funds that will be used for settlement with the issuer. Usage of smart contracts in the order payment process eliminates the need for custodian banks, reducing issuance costs for issuers, arrangers, and investors alike.

Figure 4: InterOpera's prototype arranger's allocation page for green bond and MOI



At the close of the subscription period, the arranger will be directed to key in allocation details for the bond issue (MOI units are allocated pro-rata to the share of bond allocated), which is then subject to internal approval within the arranger bank. The request for approval will be sent via email to the approving officer who will need to make the necessary approval on the green bond issuance platform. Upon approval of the allocation, the bond and MOI asset tokens will be minted and distributed by a smart contract, and any oversubscribed funds will be returned to the investor's wallet. This completes the settlement process with an on-chain delivery versus payment (DvP) against the funds that were sent by the investors. If investors are allocated less than their subscribed amount, the remaining funds will be refunded to their on-chain wallets automatically after settlement of the bond issue. On-chain settlement allows for atomic DvP, shortening the time required for the full issuance process while eliminating delivery risk.

Figure 5: InterOpera's prototype investor's wallet page displaying green bond and MOI asset tokens transferred upon issuance



Upon settlement of the green bond and MOI issuance, the investor would be able to see the bond and MOI tokens in their asset holdings, along with the details of the issue. Notably, once the green bond and MOI asset tokens are issued / minted, they can be transferred independently to one another and have separate commercial terms governing each instrument.

2. Tracking of MO (uncertified) before MOI maturity

In our assumed scenario, the green projects funded from the green bond issue are solar power projects for which MO can be tracked based on the net electricity fed into the grid. Through InterOpera's prototype, green data from financed green activities is fed through from an external green data provider through an API connection and tracked once the projects turn operational.

Figure 6: InterOpera's prototype showing issuer's MO tracking page

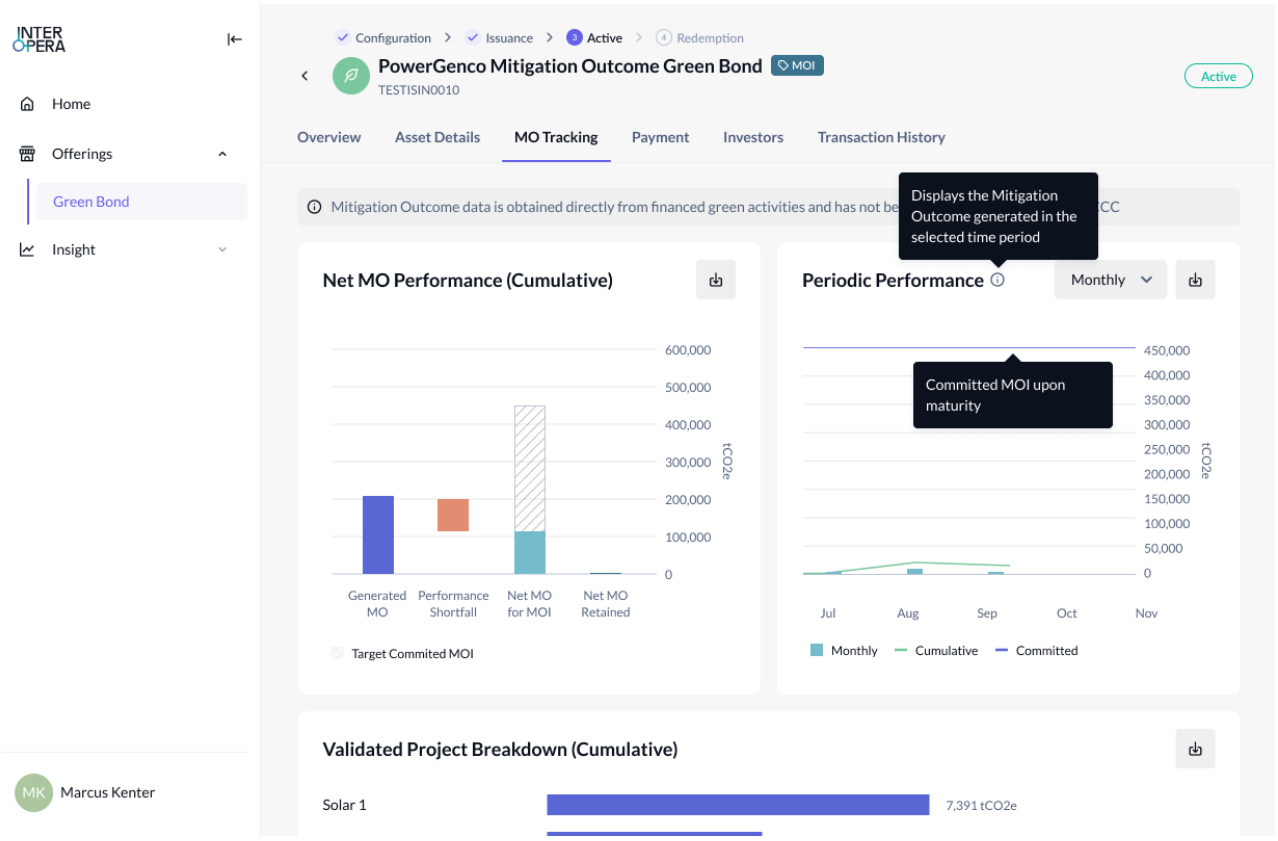
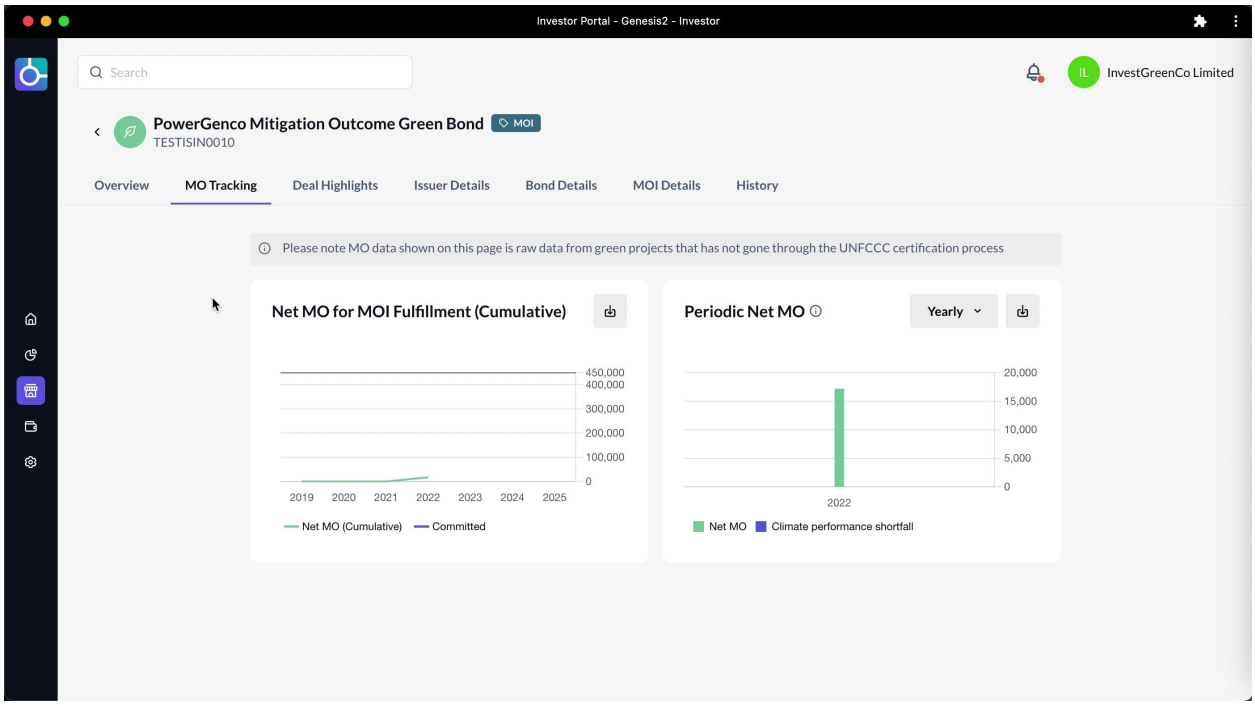


Figure 7: InterOpera's prototype showing investor's MO tracking page



MO green data (uncertified green attribute) are readily available to provide timely updates (near real-time) for both the issuer and investors, facilitating the monitoring of the issuer's climate performance and the likelihood of MOI obligations being fulfilled. This provides greater visibility and transparency on the progress of delivering its targeted green attributes, ensuring issuer discipline to execute its investment plan proposed under the green bond financing and mitigating greenwashing. Specific to the issuer, additional details are incorporated to track specific green projects and net MO retained by the issuer post MOI obligations. Hence better management of its overall climate performance and position.

The MO tracking dashboard can be configured to show MO progress at different time intervals (eg monthly and yearly) with an export function available for users to generate and download data for their ease of use in emissions reporting under national compliance programmes which require periodic reporting of emissions data.

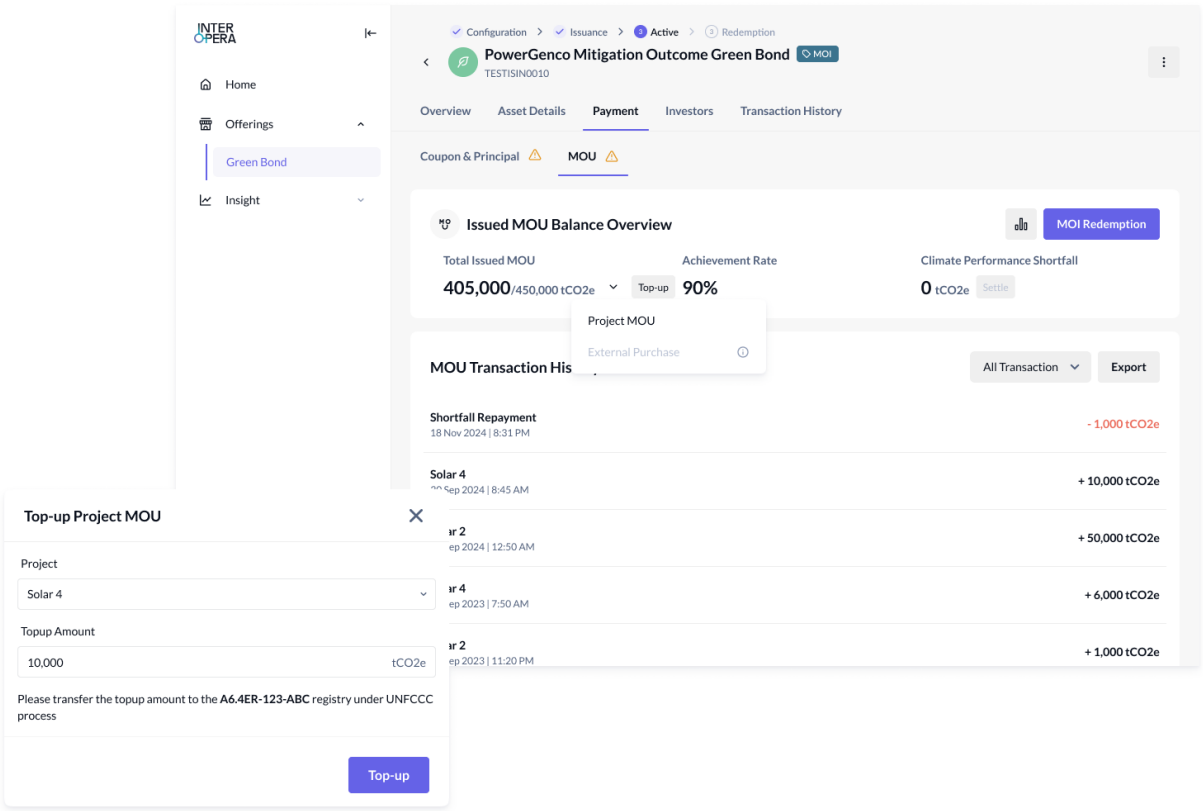
Our hypothetical scenario assumes a single bullet repayment of the MOIs at maturity for which the prototype will show the lifetime cumulative MOs achieved from the financed projects. In an alternative scenario with periodic scheduled MOI repayments, the MO tracking dashboard would accommodate the multiple repayments by tracking the cumulative MOs achieved towards each repayment date.

The MO tracking dashboard can be made available to the UNFCCC process with a similar view as to the issuer, potentially facilitating direct monitoring and verification in the future for MOU issuance under the Article 6.4 mechanism.

For the illustrated scenario in this prototype, climate performance shortfall is not reflected, nevertheless, conceptually the climate performance shortfall data would be captured through an API feed which may be implemented in the future if a full view of emissions data from all operating assets becomes available.

3. MOU issuances

Figure 8: InterOpera's prototype displaying issuer's accumulated MOU issuances certified by the UNFCCC process



A green project developer (issuer) can request for the issuance of MOUs under the UNFCCC process upon verification and certification of MO data by a Designated Operating Entity (DOE). As this process can be done multiple times over the crediting period of the project(s), we assume an annual MOUs issuance request to the registry once the green projects are operational.

Upon issuance of the underlying MOUs, the issuer should request on the prototype system to top up the MOU tokens in its wallet. Next, the issuer will transfer the underlying MOUs attributable to projects financed by the green bond to a custodian account (run by the prototype system's operator) in the registry. The operator will then verify off-chain that the correct type and number of MOUs have been deposited into the custodian account before triggering the tokenisation of the MOUs.

For the purpose of the prototype, we are assuming that the (non DLT-based) registry is housed in a centralised database that requires MOUs to be held in a custodial account before being tokenised. With an API connection to the registry, it is possible to automate the process of verification and tokenisation of MOUs. The ideal state is for the registry to be blockchain-based, facilitating direct digitally native MOUs that can be better managed and transferred, which we have explored in our conceptual design in section B.2.4.

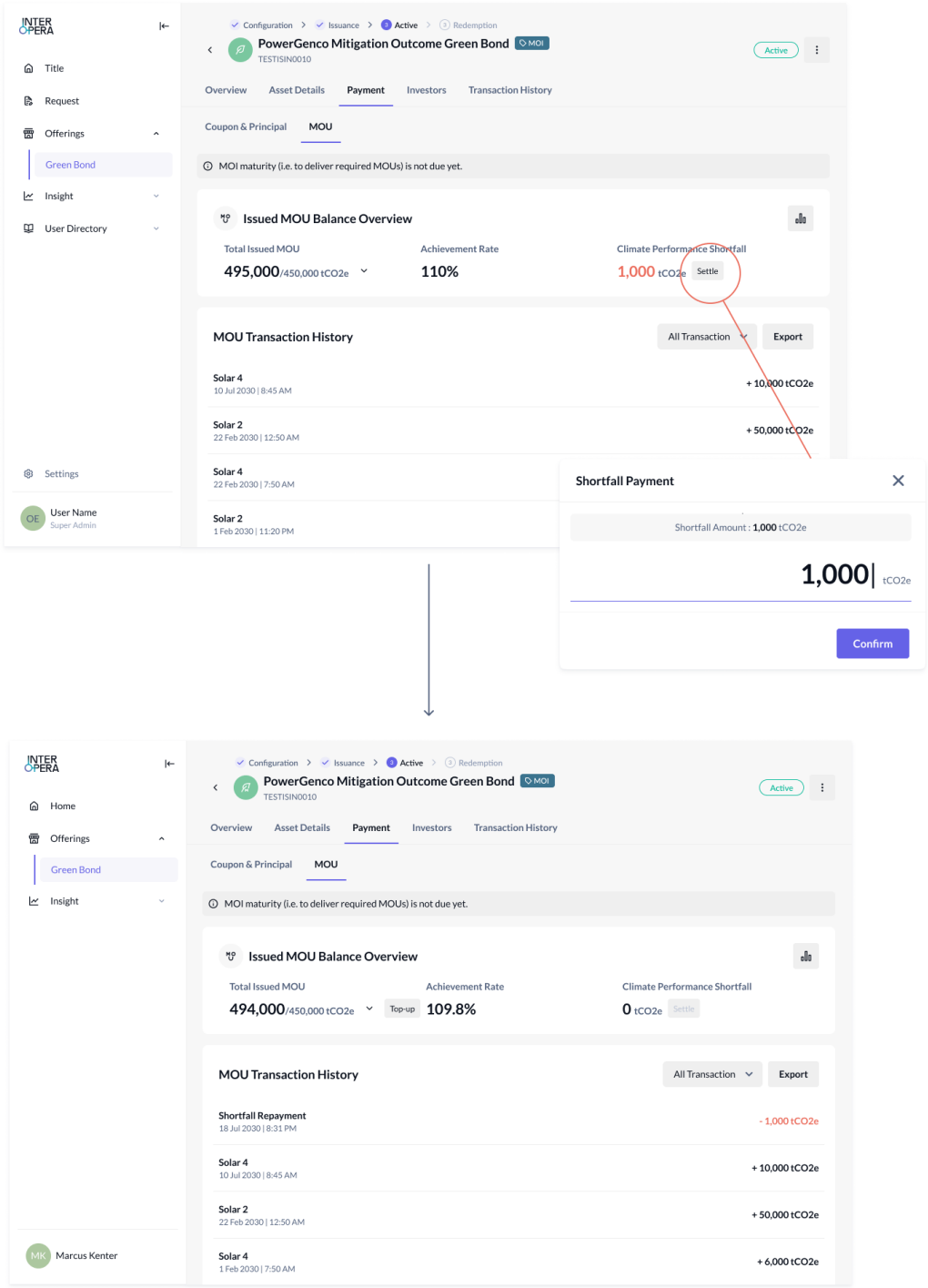
We have made a further assumption that all MOUs attributable to the issuer's investment plan will be deposited into the custodian account and tokenised on the prototype to capture a full picture of the issuer's climate performance against that which they have represented to investors when raising the green bond.

Our scenario assumes the full repayment of MOIs without any climate performance shortfalls. Notwithstanding this, the issuer's climate performance shortfall (in relation to its carbon emissions) under its investment plan for its non-green activities can be tracked digitally with the data being fed to the prototype via a conceptual API.

On a periodic basis, the issuer can settle the climate performance shortfall on the prototype with the MOU tokens attributable to the projects financed by the green bond in its wallet. We have assumed all shortfall repayments must be done on the prototype to ensure that all shortfalls are captured by the prototype, preventing greenwashing and ensuring discipline that shortfalls are settled predominantly with MOUs generated from green activities rather than purchased MOUs.

Settlement of climate performance shortfall (Conceptual)

Figure 9: Illustrating a hypothetical deduction of issuer's MOUs to settle issuer's climate performance shortfall in its proposed investment plan



4. Trading of MOIs / MOUs (conceptual)

While InterOpera's Project Genesis 2.0 prototype has not implemented a trading functionality into Project Genesis 2.0, similar secondary market activity functionality has been explored in our prototype for Project Genesis 1.0, where buy and ask orders for bond tokens were passed to the Stellar DEX which uses limit order books to implement its decentralised exchange functionality.

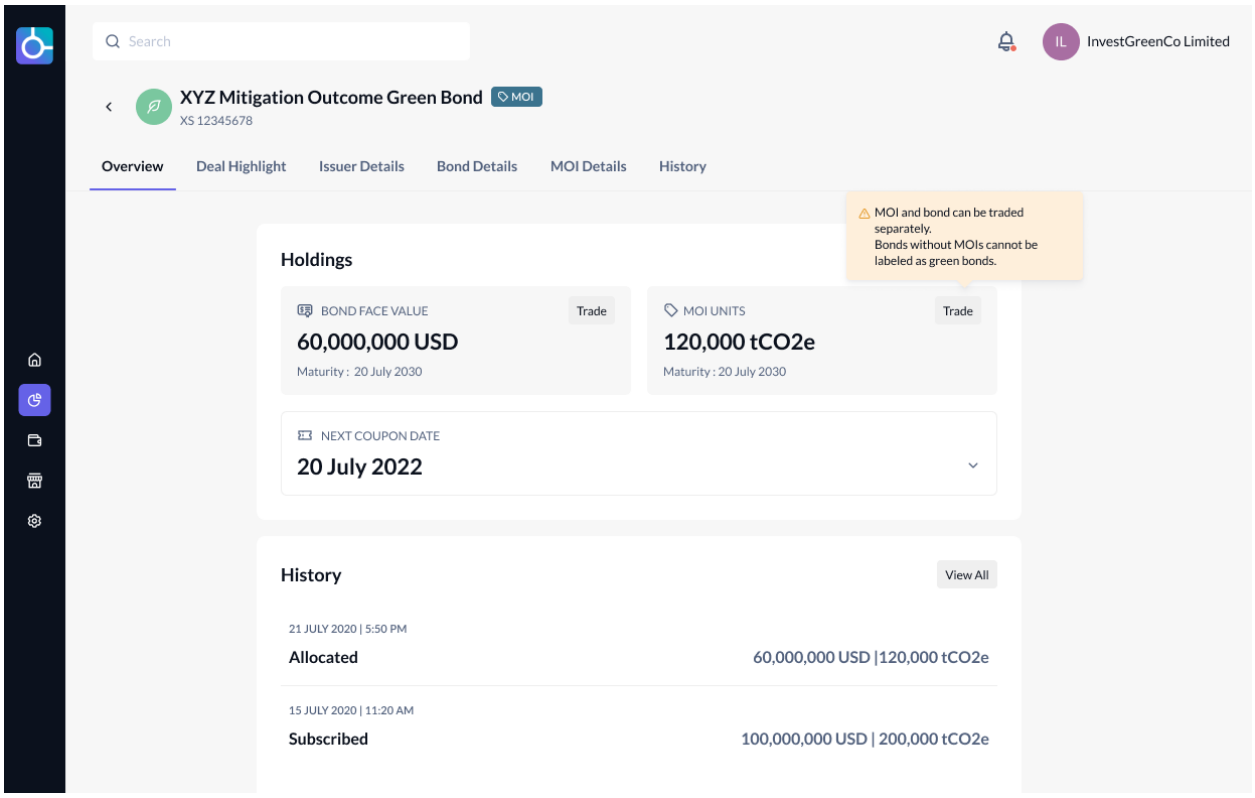
For Project Genesis 2.0, conceptually, the secondary trading could take place on an independent marketplace for MOIs / MOUs within InterOpera's prototype, or on external existing secondary carbon market exchanges that can be connected to the prototype. The platform would envisage a trading engine to support order routing and a technical service interface.

The independent marketplace could adopt either an order book, peer-to-peer, or Automated Market Maker (AMM) system. While there are advantages and disadvantages to each of these three options, in our opinion, a peer-to-peer system would be appropriate at this juncture due to its flexible nature. It can cater for trading of heterogeneous MOU tokens until a conversion factor system is in place to homogenise MOU tokens.

To ensure pricing efficiency of MOIs / MOUs, the ability to perform price discovery should be a key feature of the marketplace. We envision this feature to be implemented on the Web2.0 layer, extracting and presenting data from transactions executed on different carbon markets (both on-chain and off-chain) for investors to make informed decisions on pricing.

The prototype has also been conceptually designed to facilitate standalone transfer and trading of MOIs and the bond, reflecting the independent nature of both digital assets once they are issued. Once MOIs are separately traded, the bond may not be labelled green due the absence of the accompanying green attribute.

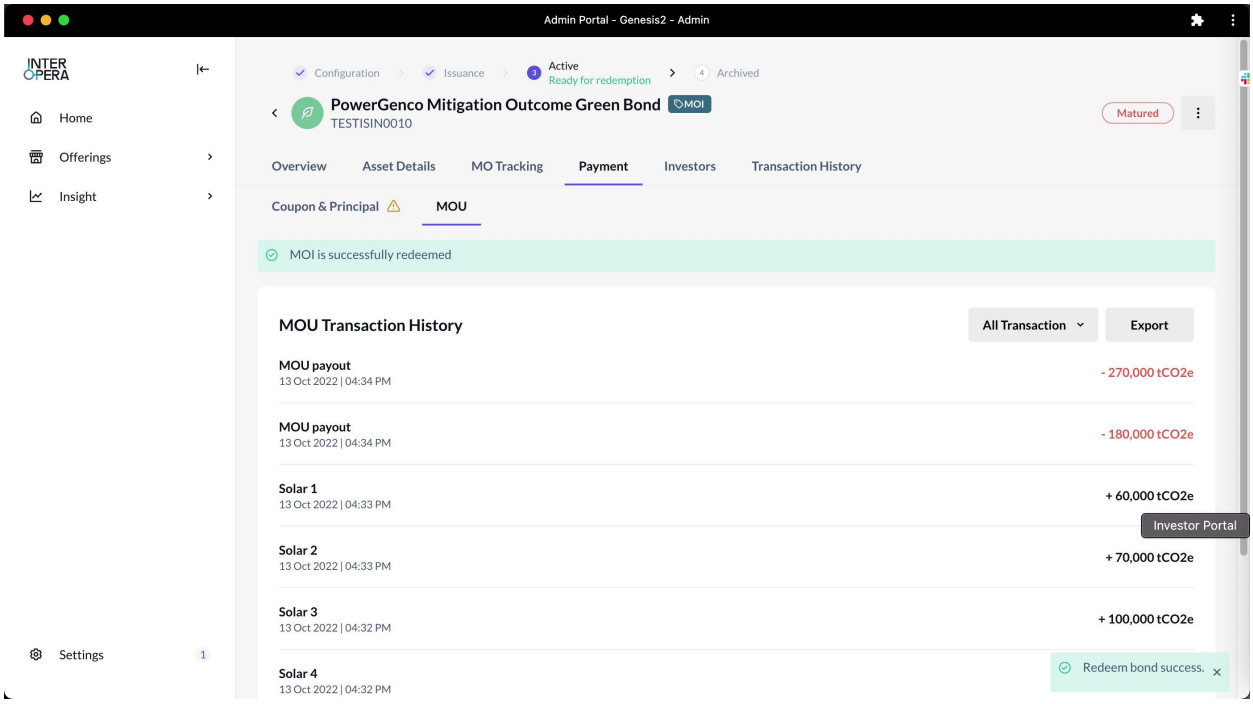
Figure 10: Illustrating a hypothetical sale of issuer's MOIs independent to bond before its maturity



5. Delivery of MOU and redemption of Bond and MOI

(i) MOI redemption with MOU at maturity

Figure 11: InterOpera's prototype MOI redemption with issuer's certified MOUs

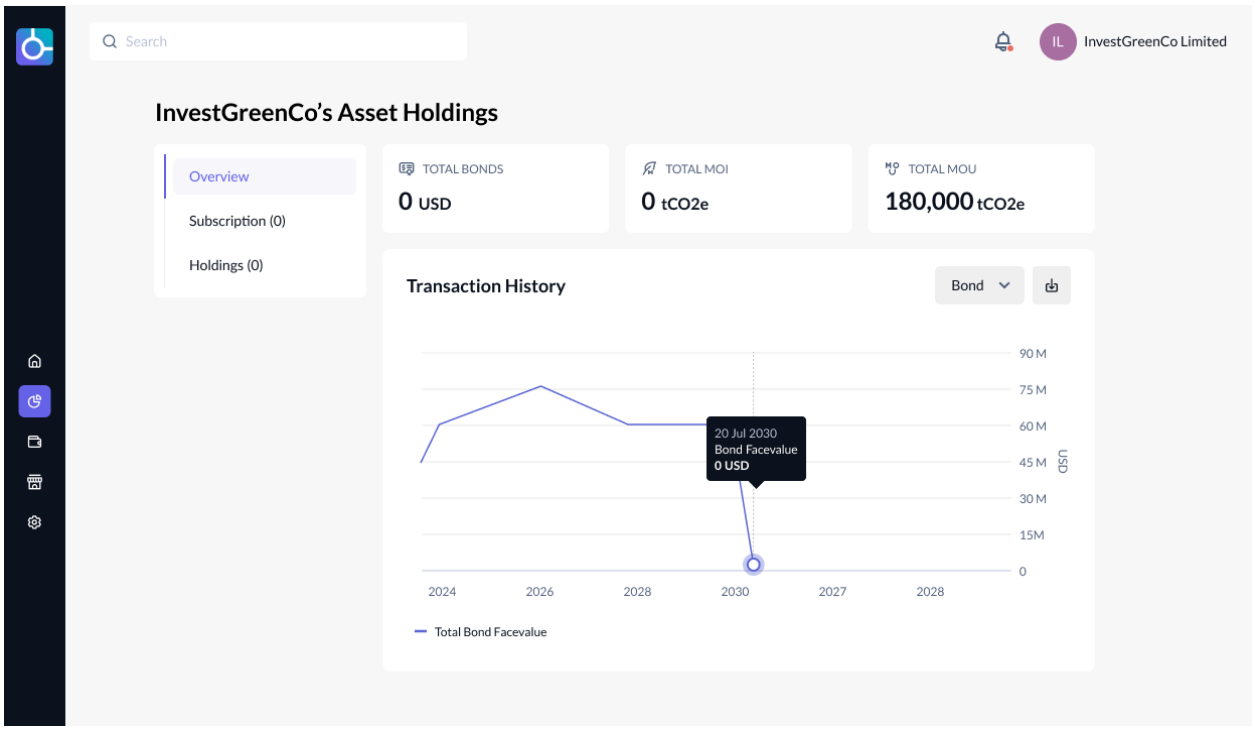


At the MOI redemption phase, the prototype has integrated a notification functionality to alert the issuer of the upcoming MOI maturity. Indeed, two weeks prior to MOI maturity, an email notification is automatically sent to the issuer prompting it to check and ensure that it has sufficient MOUs to meet its obligations. Delivery of MOUs to fulfil MOI obligations is subject to the issuer's settlement of climate performance shortfalls in its investment plan which is conceptually reflected in the prototype. This process for settlement of climate performance shortfall is described above under section 3. MOU issuances.

When the issuer has sufficient MOUs in its wallet, it can seek internal approval for MOI redemption on the prototype. This will prompt the responsible officer in the issuer to check and approve the redemption.

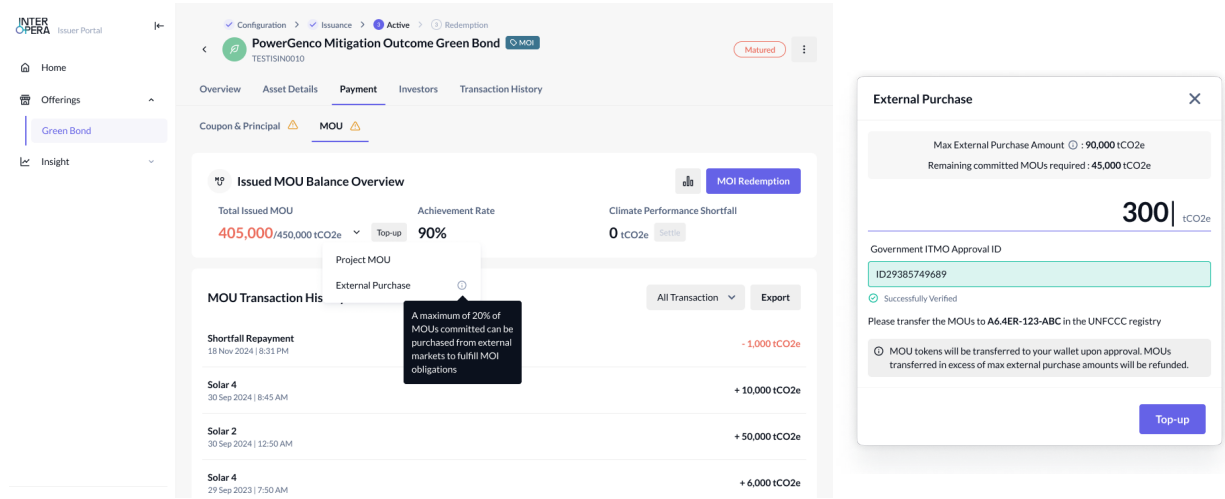
Upon approval of the redemption on the prototype, the MOU tokens will be sent to a smart contract and investors will be prompted to exchange their MOI tokens for MOU tokens. Once an investor acknowledges this exchange via an interface, he / she essentially gives permission to transfer his / her MOI tokens out of his / her wallet in exchange for MOU tokens to be transferred in. Using smart contract technology, the prototype conceptually (barring legal concerns or requirements from investors) removes the need for a custodian in the redemption process, reducing associated costs and achieving instant settlement and transfer of MOUs on satisfaction of the required commitments. A further benefit of the technology is that this process can be fully automated such that the MOUs do not need to be delivered to each investor by the issuer (or their appointed agent), reducing the administrative burden.

Figure 12: InterOpera's prototype Investor asset holding page of MOU tokens received at maturity



External purchased certified MOU top up to fulfil MOI obligations at maturity (Conceptual)

Figure 13: Hypothetical purchase of MOUs (within limits) from carbon market to meet target MOIs



While our scenario assumes that the issuer can fulfil its MOI obligations with MOUs generated under its investment plan, if the issuer has a deficit in the amount of MOUs generated under the investment plan to settle its MOI obligations, it is conceptually allowed to purchase MOUs externally to fulfil the obligations, subject to an assumed designated cap of 20% of the total MOI committed amount. This cap is set to prevent greenwashing, ensuring the delivery of the green commitments is predominantly from financed green activities, rather than through purchasing MOUs that are generated by others.

As an additional safeguard against greenwashing and to protect the integrity of the proposed green bond structure where MOI must be repaid with generated MOUs from financed green activities, the prototype restricts the time when an issuer can purchase external MOUs to a month before the maturity of the MOIs for the sole purpose of meeting any gaps in its MOI obligations. This prevents the issuer from offsetting climate performance shortfalls using external MOUs rather than those generated under its investment plans.

The process of such top ups will be similar to the regular MOU top ups given that the prototype does not have access to any MOU exchange. As such, the 20% cap is applied in the prototype by preventing the issuer from requesting a top up amount of more than 20% of its total obligations. Should there be a transfer exceeding the cap, the excess MOUs are refunded back to the issuer's account in the MOU registry and only the maximum allowed amount will be tokenised.

(ii) Bond principal redemption at maturity

Similar to the MOI redemption process, the issuer will receive a notification a month before maturity of the bond. The principal amount will be transferred to the operator account before minting the transferred amount in the issuer's wallet. A request for approval is sought internally for the issuer before bond redemption is executed.

The bond repayment is executed through a smart contract holding the fiat tokens and conducting the exchange of bond tokens held by investors. With smart contracts, the traditional role played by paying agents and registrars can conceptually be fully automated as bondholder records are tracked in real-time. This removes the need for a record date (usually 15 days prior to maturity) to determine the recipient of the bond principal repayment, conceptually allowing for trading of the bonds right before maturity.

B.2.4 Technical architecture

InterOpera's technical architecture design for Project Genesis 2.0 is centred around its proprietary RDOS which can flexibly accommodate the needs of all key stakeholders while meeting the requirements of capital markets regulations in the inception and management of a new financial instrument like MOIs.

In the ideal state, there will be a DLT-based MOU global registry under the UNFCCC process that hosts and oversees MOUs while allowing MOU / ITMO transfers without compromising on double counting issues and security. The infrastructure design is intended to link up all relevant market participants and stakeholders that are able to direct and access the underlying MOUs that are hosted in the MOU registry under the UNFCCC process. The illustrated ideal state assumes a linkage between the MOU and MOI registries which is elaborated on in Figure 15.

B.2.4.1 Overview of InterOpera's RDOS

RDOS is an interoperable blockchain infrastructure for all capital markets, to connect blockchain networks of governments, regulators, financial institutions, and investors, across jurisdictions and/or between the public or private blockchain networks that are adopted by licensed / regulated institutions.

RDOS acts as the ultimate registry / depository framework, enabling blockchain-based efficiency gains with DLT and smart contracts. It is designed to operate within the confines of prevailing regulatory regimes and securitisation protocols. This way, the registry, exchange operator and regulator can reserve privileged rights or access, and delegate any of those rights or authority to a licensed entity / institution at its discretion.

As the ultimate middle-layer blockchain solution facilitating issuance of, and dealing in, capital markets products (and new instruments such as MOIs / MOUs) with investor-protection and regulatory safeguards incorporated, RDOS adds swiftness and convenience to the participants of the existing system without compromising on customary investor and market protections.

Through Genesis 2.0, InterOpera introduces RDOS, which can be interoperable with carbon markets so that carbon markets and its instruments can be a part of regulated capital markets.

B.2.4.2 InterOpera's blockchain infrastructure - RDOS components

(1) InterOpera iWASM

The InterOpera RDOS is built on a private chain using the Cosmos SDK and iWasm. The iWasm module powers our CMP (elaborated below) which enables (i) the MOU registry to act as the single source of truth (on the host chain), (ii) investor protection and (iii) privileged access exclusively for regulators / authorities. iWasm was designed utilising CosmWasm. iWasm allows the creation of privileged smart contracts which are reserved solely for authorised regulatory entities under the UNFCCC process to conduct privileged actions, enabled through root access to the InterOpera RDOS at the blockchain level.

(2) Proof of Regulatory Authority (PORA)

PORA is a consensus mechanism/model created together with iWasm. It is not a radical new consensus model, but to satisfy capital markets and regulatory requirements and future-proof market participants for MOI/MOU for the advent of Web3.0. PORA is a consensus mechanism combining elements of Proof of Authority with certain aspects of Proof of Stake.

(3) CMP for MOI/MOU

The green bond structure tested in Project Genesis 2.0 can potentially marry the carbon and capital markets through the MOI. The MOI is conceptually similar to the idea of a forward or futures contract, with the key difference being that the investor is required to pay the issuer in full at the issuance of the instrument, eliminating the typical margin associated with forward or futures contracts.

With the integration between the carbon and capital markets through the creation of new instruments such as MOIs and MOUs, traditional safeguards found in the capital markets should be brought over and applied to both MOIs and MOUs.

To this end, CMP conceptually allows the application of traditional capital markets' customary safeguards to ensure markets can continue to function efficiently, and digitally native asset transactions can be regulatory compliant. CMP provides the following key advantages:

a. Investor protection through CMP - legitimacy in ownership
   Investor protection is afforded through assurance of legitimacy in ownership of MOU and MOI tokens. This is provided by tying back each token to the underlying asset held in the Host Chain through interchain accounts supported by the Inter-Blockchain Communication (IBC) protocol.

b. Market protection through CMP
   Market Protection is provided by CMP by applying traditional capital markets regulations, fostering investor trust in the market, which is key to ensuring that markets continue operating smoothly. Regulations are applied through standard filters in relayers (within IBC module), namely (i) KYC / AML verification, (ii) product suitability, (iii) investor suitability, and (iv) taxation checks which will be applied to all transactions taking place on the platform. The filters ensure that only transactions that fulfil regulatory requirements can be finalised on the blockchain, reducing the need for manual checks and the risks associated with manual data verification.

Beyond the four standard filters outlined above, the market protection service allows for customisable filters to be applied based on the use case and other regulations that may apply (eg sanctions). Two custom filters specific to either MOI or MOU transactions are introduced below:

Custom filters for Project Genesis 2.0:

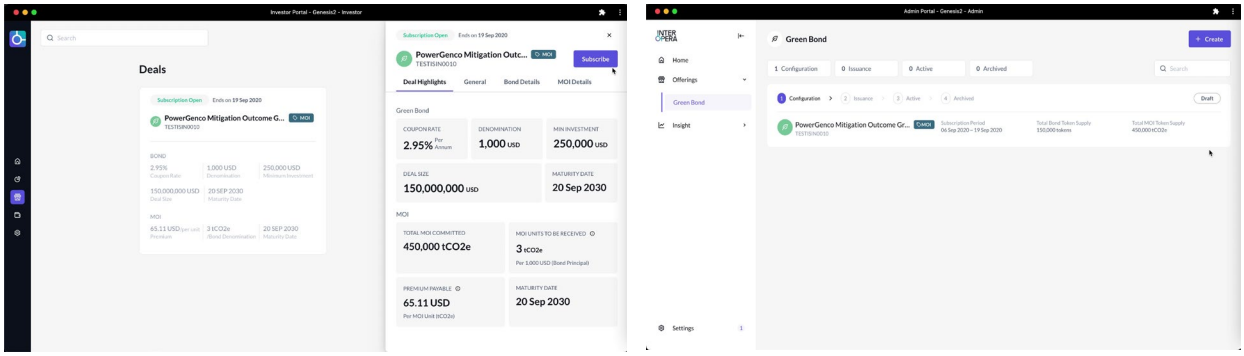
- **MOI-specific filter: a UNFCCC process project validation filter** is specifically designed for MOIs. This filter checks if the projects tied to the green bond specific MOI have been validated by the UNFCCC process for issuance of MOUs under the Article 6.4 mechanism. This provides assurance to secondary market participants that the MOIs they purchase are likely to be repaid using certified MOUs under the UNFCCC process. These in turn can be used to meet their compliance obligations.

- **MOU-specific filter: an ITMO transfer approval filter** is applied on international transfers of MOU tokens, including in the event of repayment at MOI maturity. This theoretical filter checks if the MOUs are approved for international transfers by the host country's government, finalising cross-border MOU transfers only if approval has been obtained. This filter mechanism is critical as cross-border MOU transfers require the host government's approval due to the corresponding adjustments that need to be made to the country's GHG emissions inventory.

(4) Front-end interface

InterOpera's prototype for Project Genesis 2.0 uses a white-labelled web-based interface for various market participants of MOIs / MOUs to interact and manage. The prototype offers two different web application interfaces for issuers and investors (as seen in figure 14). The operator portal is used by issuers, and arrangers to conduct management of green bonds and MOIs and other administrative tasks. The investor portal is designed for usage by investors to perform investment functionalities directly through the platform.

Figure 14: Web application interfaces for operator [left] and investor portal [right]



(5) Technology solutions to access RDOS
InterOpera's RDOS Web2.0 and Web3.0 solutions have been designed to be inclusive to serve a range of market participants with varying technology capabilities to ensure fair access to the benefits of the technology.

- **Web2.0:** The Web2.0 layer allows stakeholders to connect to RDOS via APIs, enabling blockchain transactions to be finalised without private data being sent over the network. Node validators query the centralised database maintained by the UNFCCC process to check if transactions fulfil regulatory requirements without data being transmitted over the network.

- **Web3.0:** This is the blockchain component and the underlying foundation of RDOS. Web2.0 interacts with Web3.0 and creates blockchain transactions by invoking smart contracts. Smart contracts are written as modularly as possible for flexibility and application to different types of digital capital market instruments. Once transactions are created, node validators will validate these transactions to create a block and the transactions will be added to the blockchain ledger.

(6) Smart contracts functionality
The smart contracts that govern the lifecycle of the MOIs and MOUs have been designed and written to mirror those of the majority of existing capital markets instruments, with functions implementing existing Ethereum Improvement Proposals (EIP) standards.

In its simplest form, a single type of asset token following the EIP-20 Token Standard would implement the EIP-20 Mint, EIP-20 Transfer, and EIP-20 Burn functions within its smart contract. These functions are usually sufficient as a starting point for standard capital markets instruments, however, may not cater for certain processes that involve the atomic settlement of more than a single token type eg the atomic transfer of green bonds and MOIs upon issuance. As such, we have implemented the MOI and MOU smart contract following the EIP-1155 Multi Token Standard, which in addition to the EIP-20 functionalities, allows handling of multiple token types within the smart contract through the EIP-1155 BatchTransferFrom function.

Lifecycle Phase	EIP-20 and EIP-1155 functionalities used
MOI preparation	EIP-1155 Instantiate, EIP-1155 Mint
Subscription	EIP-20 Mint, EIP-20 Transfer
Allocation, distribution and settlement	EIP-1155 BatchTransferFrom (for the settlement of green bonds, MOIs, and fiat token refunds for unsuccessful subscriptions)
Depositing MOUs	EIP-20 Mint
MOU redemption upon MOI maturity	EIP-20 Transfer, EIP-20 Burn

B.2.4.3 Multi-chain bridging for MOU and ITMO transfers

Conceptual MOU and ITMO transfer supported by Inter-blockchain communication (IBC) protocol

With the operationalisation of the Paris Article 6.2 and 6.4 mechanisms, there is a need for a system that can ensure the integrity of both mechanisms to avoid double counting / double issuance of MOUs and that corresponding adjustments are captured for ITMO transfers. There should be a suitable technology solution that addresses a realistic and likely scenario of a multi-chain DLT ecosystem (each country using heterogeneous blockchains for their MOU registry).

InterOpera's CMP provides interoperability between heterogeneous permissioned chains through IBC technology. The technology designates the native chain as a Host Chain and other chains as Controller Chains which have access to the Host Chain through Interchain Accounts.[60]

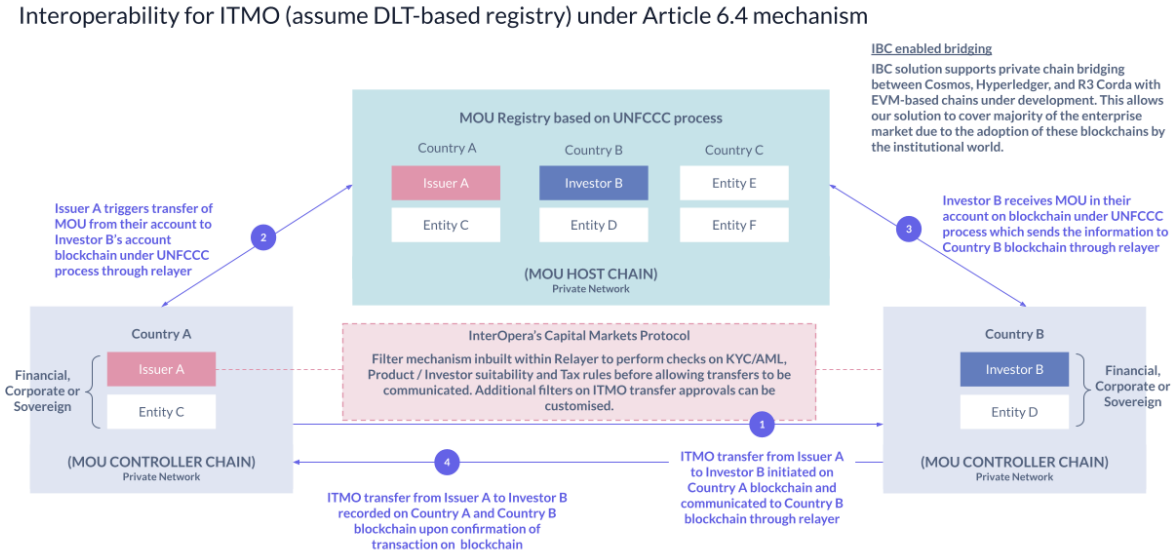
Investors on the Controller Chain can purchase non-native tokens through the IBC connection which relays the transaction information to the Interchain Account on the Host Chain where the tokens are held. Any transactions involving these tokens would therefore occur only on the Host Chain, with the Controller Chains merely mirroring the relevant information without minting "wrapper" tokens. This removes the need for a Lock-and-Mint mechanism (locking tokens on the original chain and minting "wrapper" tokens on the other chain) which potentially leads to double issuance and counting issues when investors purchase non-native tokens. We believe this technology can be useful in the scenario where a national blockchain network is created under the Article 6.4 mechanism and when an investor purchases MOUs that are originally issued under the UNFCCC process. The CMP can support IBC-enabled permissioned chains based on Hyperledger, R3 Corda and Cosmos which would potentially cover the majority of the enterprise blockchain market.

The MOU smart contract follows the EIP-1155 Multi Token Standard, which in addition to the EIP-20 functionalities, allows handling of multiple token types within the smart contract through the EIP-1155 Batch Transfer From function.

Figure 15 shows our envisioned ideal state of the integration between the MOU registry under the UNFCCC process and individual countries' heterogeneous blockchain infrastructure.

60. Definitions:
a) Host Chain: The chain where the interchain account is registered. The host chain listens for IBC packets from a controller chain which contain instructions that the Interchain account will execute.
b) Controller Chain: The chain registering and controlling an account on a host chain. The controller chain sends IBC packets to the host chain to control the account.
c) Interchain Account: An account on a host chain. An interchain account has all the capabilities of a normal account. However, rather than signing transactions with a private key, a controller chain will send IBC packets to the host chain which signals what transactions the interchain account must execute.
d) Interchain Account Owner: An account on the controller chain. Every interchain account on a host chain has a respective owner account on the controller chain.

Figure 15 - ITMOs transfer based on interoperability between permissioned chains



Illustrative example of ITMOs include:

1. **Issuer A of country A** initiates transfers of MOUs to **investor B (MOI holder) of country B.**

2. Relayer communicates transfer information from **Controller Chain (country A)** to / from **MOU Registry** which is acting as **Host Chain** for the underlying asset token if it fulfils criteria specified for in-built filters, ensuring **market protection.**

3. Transfer of underlying MOU takes place on **MOU registry** as **Host Chain.**

4. Relayer communicates information of successful transfer on MOU Registry to Controller Chains which finalises transfer in parallel based on information received from relayers, ensuring that the total holdings across issuer / investor sub-wallets are always equal to the holdings in the client commingled master accounts on the **Host Chain (MOU Registry)**, thereby ensuring **investor protection and mitigating double counting of carbon credits with ITMOs.**

An investor from a different country to the issuer can receive MOU tokens at the maturity of the MOI in exchange for the MOI tokens through a smart contract that tracks the wallet addresses of both the issuer and investors to automate repayment transactions. The exchange of the tokens is enabled with the IBC protocol which allows for seamless transactions to be made across (assumed) heterogeneous chains without utilising wrapper tokens.

B.2.4.4 Green data feed integration

Green data is obtained near real-time in the form of carbon emissions avoided as a function of power generated through green power plants. As this data needs to be displayed to the users for transparency, a microservice can be implemented to pull data from different sources, either from a green data provider or directly from IoT sensors. Data collected can be stored on a centralised database or on the blockchain. For this prototype, green data was simulated hourly from solar plants and captured via API calls from an external source.

B.2.5 Key observations

Smart contracts functional benefits are well illustrated through this prototype to automate as many lifecycle events as possible and digitally issue, track, deliver and settle MOIs and MOUs. Nevertheless, there were situations that limited full automation and required issuer's action and discretion. One example is when the issuer faces default risk and has insufficient MOUs to repay MOI obligations. Smart contracts should not automatically trigger immediate action to purchase external MOUs.

MOU registry under UNFCCC process could be DLT-based to issue and manage digitally native MOUs. With the operationalisation of the Article 6.4 mechanism underway, we have considered how our technology can efficiently deliver the necessary functions under the framework. Keeping in mind that any system operated for the Article 6.4 mechanism should include market and investor protections and allow for corresponding adjustments to be made to national GHG inventories seamlessly, a DLT-based system for the MOU registry would be most suitable. Utilising a DLT system would enable automated handling of corresponding adjustments while eliminating double counting / double issuance issues that are critical to the integrity of the framework. InterOpera's multi-chain bridging solution is designed to eliminate double counting and double issuance in cross-chain transactions which enables it to handle corresponding adjustments seamlessly with a DLT-based registry.

Possible DLT-based GHG inventory to be considered. The ability to accurately capture corresponding adjustments from ITMO transfers is of prime concern given the possibility of double counting. Through Project Genesis 2.0, we have observed that it would be challenging to apply corresponding adjustments accurately in the current environment given that each country maintains separate databases housing their GHG inventory data, requiring them to manually update the inventory each time a transfer is effected. We envision that accurately capturing corresponding adjustments from ITMO transfers would require each country to maintain its GHG inventory on a DLT-based system which will then be bridged through our RDOS, automatically applying corresponding adjustments for any ITMO transfer.

Standardised methodology on corresponding adjustments needs to be agreed. Many countries currently have NDCs with a single year target which means that these countries can meet their NDC targets by simply ensuring that emissions levels are brought down to the promised levels in the target year. This poses a challenge to environmental integrity which can only be addressed through an internationally agreed standard on how corresponding adjustments should be applied over the NDC period (ie multi-year average or otherwise).

Potential to facilitate digitising measurement, reporting, and verification processes. The InterOpera prototype includes the functionality to track real-time uncertified MOs and this presents an opportunity to integrate and allow UNFCCC to digitise and directly manage its monitoring and verification process to certify MOUs on the platform - this is fitting for an ideal state for the MOU registry to be DLT-based hosting digitally native MOUs.

B.2.6 Future considerations

The following are considerations for different market participants, that when sufficiently addressed help to encourage further market adoption and commercialisation of MOI and MOU instruments in the context of the proposed green bond structure.

Technology considerations

Standardised MOI / MOU tokens while addressing different capital intensity. While our scenario terms have assumed a homogeneous carbon credit, in reality there are different levels of capital intensity (amount of capital per ton of CO2 abated during the lifetime of the financed green activities) of MOI owing to the underlying green activities implemented. This limits the liquidity of the MOI / MOU by their level of capital intensity and adoption. Capital intensity standards should be established before technology can be implemented efficiently. Conceptually, a possible solution is a conversion factor to align different capital intensity levels of MOI to one consistent metric before MOI tokens are minted (similar to how different GHG emissions are converted into CO2 equivalents).

Regulatory considerations

Regulatory safeguards of capital markets products to be applied to MOI. MOI is a newly formed financial instrument with the underlying being MOU (ie certified carbon credits), and as with all capital markets instruments, similar customary regulatory safeguards on existing capital market products could be applied to MOI to encourage adoption.

Carbon market considerations

Potential blockchain-based carbon market interconnectivity. Connectivity to carbon markets (DLT and non-DLT based) is key to encouraging more market activity and could potentially achieve higher liquidity and adoption of both MOI and MOU instruments. Having blockchain-based carbon markets that can seamlessly connect, transfer, and manage digitally native assets of MOI / MOU is ideal.

Large scale issuance

Optimal structure of MOI premium / payment. One potential consideration in supporting large-scale issuances is to consider the perspectives of both issuers and investors in structuring the MOI premium payment in exchange for issuer to receive MOI units. While our scenario has assumed an upfront lump sum payment to reflect the issuer's requirements due to the capital-intensive nature of project implementation and a cleaner structure to separate out both the bond and MOIs, other payment structures may need to be considered.

C. Project participants

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Musheer Ahmed, Project co-lead
Teresa Lin, Project co-lead

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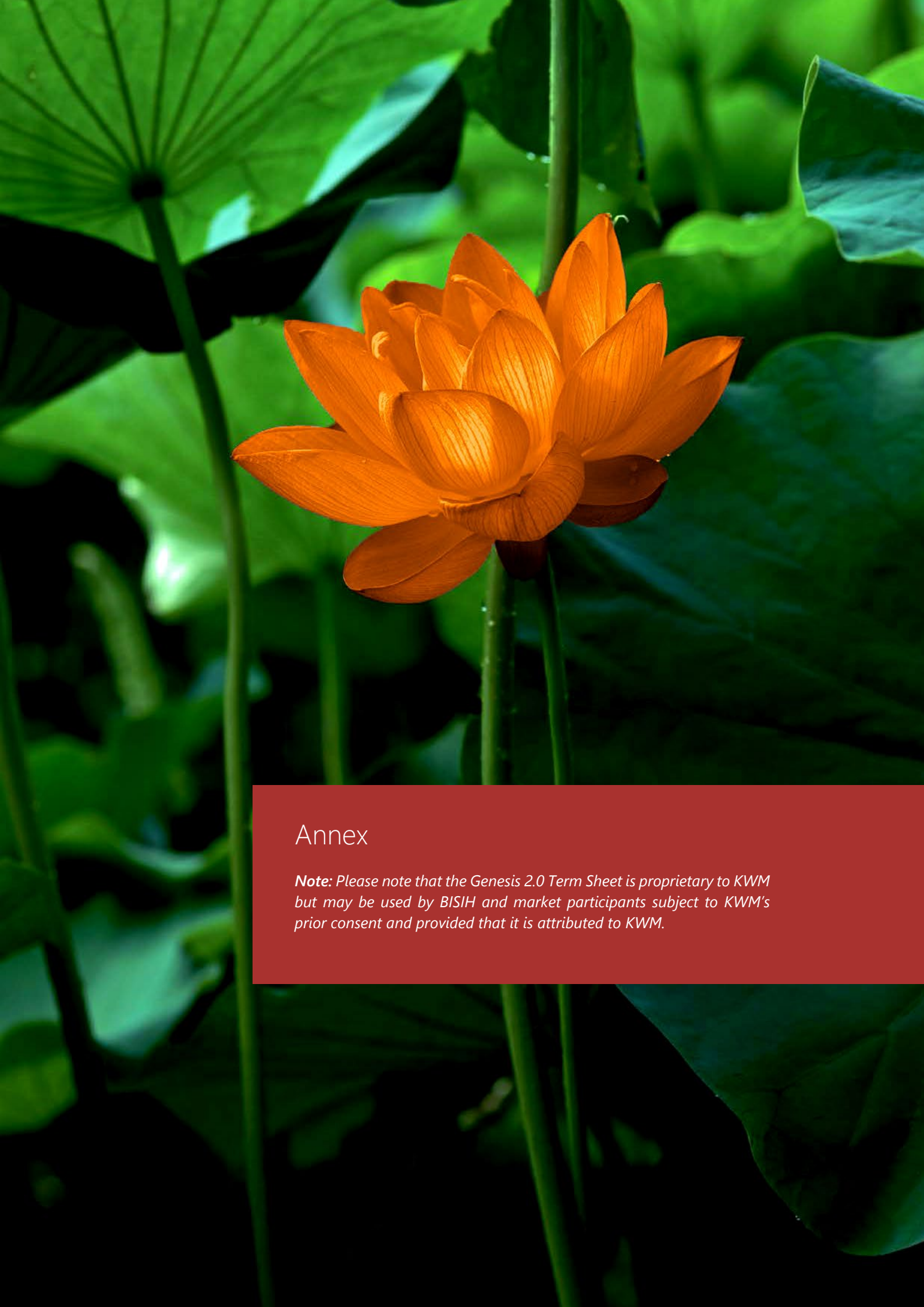
Rebecca Wong – Managing Director – Debt Capital Markets
Felix Yip – Executive Director – Global Head of Digital Assets Engineering
Rosie Hampson – Executive Director - Digital Assets
Brijesh Gupta – Executive Director – Digital Assets Engineering
Pratul Varshney – Executive Director – Digital Assets Engineering
Andrew Chan – Executive Director – Debt Capital Markets
Allinfra
Dave Sandor – Co-founder and CEO
Bill Kentrup – Co-founder and Head of Origination
Kelvin Yuen – Head of North Asia and CFO
Michel Dinh – CTO
Nicolae (Nick) Oprisan – Head of Engineering
Francisco Angulo – Full Stack Blockchain Engineer
Ryan Chan – Full Stack Engineer
Andreea Petrovan – Project Management / Quality Assurance
Digital Asset
Karen Qian – Associate Director, Business Development
Dorrit Du – Technical Sales Engineer

InterOpera consortium
InterOpera
Will Lee - Founder and Executive Chairman
Michael Chin - CEO
Pete Park - Head of Engineering
Lianne Lee - Tech Lead / Product Manager
Calvin Neo - Head of Business Development
Krungthai Bank
Varong Vongsinudom - Head of Capital Market Innovations
Sungshin Cement
Kim Tae-Hyun - Chairman
Samwoo
Shin Sung-Jae - Vice Chairman

King & Wood Mallesons
Urzula McCormack – Partner
Jo Dodd – Partner
Dale Rayner – Partner



Annex

Note: *Please note that the Genesis 2.0 Term Sheet is proprietary to KWM but may be used by BISIH and market participants subject to KWM's prior consent and provided that it is attributed to KWM.*

KING&WOOD MALLESONS
金杜律师事务所

DRAFT

CONFIDENTIAL AND PRIVILEGED [INSERT DATE]

[*INSERT BOND ISSUER'S NAME*] [$/€/*OTHER CURRENCY*][*AGGREGATE PRINCIPAL AMOUNT*] BONDS DUE [*YEAR*] [ISSUED TOGETHER WITH][1] MITIGATION OUTCOME INTERESTS

TERM SHEET[2]	
Issuer	[*Insert full name of issuer*] ("**Issuer**")
[Joint] Lead Manager[s]	[*Insert name/s*]
Type of Instrument	[Fixed/Floating Rate Bonds / [*other*]] ("**Bonds**") with Mitigation Outcome Interests ("**MOIs**") to be attached (at issuance) to one or more tranches of the Bonds.[3]
Type of Issuance	[Syndicated / Private Placement / Non-syndicated]
Aggregate Principal Amount of Bonds	[USD/EUR/HKD/*other currency*][*amount*]
Denomination / Face Value / Issue Price of each Bond	[USD/EUR/HKD/*other currency*][*amount*]
Pricing Date	[*]
Issue Date	[*]
Maturity Date of the Bond	[*][4]
Issuer Ratings	[*] by [S&P/Moody's/Fitch/*other*]
Bond Ratings	[*] by [S&P/Moody's/Fitch/*other*/Not rated]
ESG Ratings	[*insert*]
Documentation	[*Describe documentation under which Bonds and MOIs are issued e.g. Issuer's MTN Programme + special provisions for MOIs*]

[1] [Terminology TBD – could use "with MOIs attached" or something similar instead.]

[2] [The Bond, MOI and MOU prototypes described in this Terms Sheet are purely conceptual and do not relate to an actual issuance of any product. Nothing in this Term Sheet or any related material should be construed as a recommendation or an offer to issue or sell any product or a solicitation to buy any product and nothing contained herein constitutes legal advice or forms the basis of any contract or commitment.]

[3] [MOIs can be "detached" post-issuance and traded separately – can also be "re-attached".]

[4] [Bond/MOIs will not necessarily have the same maturity – there will be flexibility re tranches of MOIs and maturity dates (i.e. can be different maturity dates across tranches). Would be a little like an amortising bond (but tranched). Investors would have the ability to choose the MOI/MOU "vintage"]

Number of MOIs	MOIs will be [issued together with / attached] to [all / some tranches of Bonds in the series of Bonds] and [*insert number*] MOIs will be attached to each Bond [in the relevant tranche], i.e. [*insert number*] MOIs per [USD/EUR/*other currency*][*amount*] of principal amount
Issuer's investment plan[5]	[*summary of Issuer's investment plan to be included, noting the financial viability gap which is identified therein*]
BOND TERMS	
[Interest Rate[6]	[*]% per annum]
[Benchmark Reference Rate[7]	[EURIBOR/SONIA/SOFR/HIBOR/*other*]]
[Margin[8]	+[*] bps]
[Interest Rate / Margin step-up]	[*if applicable, include a description of the circumstances in which the Interest Rate or Margin would increase, e.g. if issuer does not satisfy green objectives / goals*]
Yield	[*]%
Re-offer Price	[*]%
All-in Price	[*]%
Interest Payment Dates	[*] [*month*], [*] [*month*], [*] [*month*] and [*] [*month*][9] in each year from and including [*] [*month*] [*year*] up to and including the Maturity Date
Day Count Fraction	[Actual/365 or Actual/Actual-ISDA]/[Actual/365 (Fixed)]/[Actual/360]/[30/360 or 360/360 or Bond Basis]/[30E/360 or Eurobond Basis]/[Actual/Actual-ICMA]/[RBA Bond Basis or Australian Bond Basis]
Business Day Convention	[Following/Modified Following/Preceding] [adjusted/unadjusted]
ISIN	[*]
Common Code	[*]
Currency	[USD/EUR/*other*]
Minimum Denomination(s) / Multiples	[*]
Relevant Financial Centre for Business Days	[London/Sydney/Hong Kong/*other*]
Status	Senior, unsecured and [unsubordinated/subordinated] obligations of the Issuer
Redemption Amount	[Outstanding Principal Amount / *other*]

[5] [Issuer's investment plan must include the green projects or activities to be financed with the proceeds of the Bonds together with the Issuer's other projects and activities which are not being financed with the proceeds of the Bonds.]

[6] Include for fixed rate bonds only.

[7] Include for floating rate bonds only.

[8] Include for fixed rate bonds only.

[9] Amend depending on whether interest payment dates are quarterly, semi-annual or annual.

Redemption Events	[*Describe any circumstances in which bonds may be redeemed early, e.g. tax and regulatory reasons, change of control of issuer, holder put option, issuer call option*]
Events of Default	[*Describe events of default applicable to bond, i.e. non-payment of interest or principal, breach of other obligations, cross-default / acceleration, insolvency/bankruptcy*]
Paying Agent/Registrar	[*]
Governing Law	[*]
Withholding Tax & Gross-Up	[*Describe withholding tax / gross up provisions*]
Selling Restrictions	[As set out in Bond documentation referred to above / *set out any additional selling restrictions*]
Clearing and Settlement	[*Describe platform*[10] / *other*]
[Listing	[*insert*]]
Use of Proceeds	[*describe Issuer's intended use of proceeds – description of green project/s to be funded by proceeds of bond issuance which are to generate MOUs*][11]
MOI TERMS	
What is a Mitigation Outcome Interest ("MOI")?	An MOI is an instrument of ***carbon unit indebtedness*** which is attached to the Bond if the holder has elected to buy a Bond with MOIs attached to it. The holder of the Bond pays a premium on the issue price of the Bond which constitutes the purchase price for the MOIs which are attached to it. Under the terms of the MOI, the Issuer is obliged to repay the carbon unit indebtedness evidenced by the MOI by delivery of ***Mitigation Outcome Units*** ("**MOUs**") on the MOI Maturity Date (defined below).
What is a Mitigation Outcome Unit ("MOU")?	[An MOU is a [***carbon credit***].][12] The Issuer may generate MOUs through its activities which have been financed by the proceeds of the Bond. To the extent that there is a shortfall (i.e. the Issuer does not have sufficient MOUs to repay the MOIs), the Issuer may choose to purchase MOUs from the carbon markets in order to repay MOIs, however, at least [*]% of the MOIs must be repaid with MOUs which have been generated by projects funded with the proceeds of the Bonds and MOIs.[13]
Issue Price	[USD/EUR/HKD/*other*] [*amount*] per MOI (to be remitted to issuer as a premium on the Bonds)
Form	[*issued under a smart contract which is to be recorded on blockchain*]

[10] For eg: Euroclear/ Clearstream Luxembourg/other

[11] [The carbon mitigation projects must generate MOUs and should generate enough MOUs to repay the MOIs]

[12] Likely to require tailoring depending on the jurisdiction of issuer / issuance.

[13] Note that MOUs cannot be bought from the carbon market and be combined with a regular bond issued by the Issuer in order to make it into a green bond, however, they can be acquired and used to ***supplement the MOIs being issued for*** an already green bond - up to a maximum amount of [x]%. They can't be used to make a vanilla bond green.

MOI Delivery Schedule	Tranche 1: [*insert date*] Tranche 2: [*insert date*] Tranche 3: [*insert date*] Tranche 4: [*insert date*] Tranche 5: [*insert date*] Tranche 6: [*insert date*] Tranche 7: [*insert date*] Tranche 8: [*insert date*] Tranche 9: [*insert date*] Tranche 10: [*insert date*]
[Capital Intensity of MOI]	[*insert amount of capital per ton of carbon dioxide which is to be abated during the life of the activity being financed using the proceeds of the Bonds*][14]
Redemption	MOIs to be redeemed within one month of the Issuer having [met the carbon abatement goals under the terms of the MOI / met all of its climate performance goals as described in its [investment plan]].
Delivery Method	1 Mitigation Outcome Unit ("**MOU**") per MOI MOUs get transferred on [*describe platform*] in exchange for MOIs on the Maturity Date of the MOIs . [obligation extinguished]
Consequences of failure to deliver	[not applicable]/[*describe penalties for / consequences of default*]
MOI Identifier	[*insert*]
Platform [not a trading venue]	[*describe platform*]
Register of MOIs	[*describe blockchain / registry arrangements*][15]
Transfer	Permitted [OTC / via *describe mechanism*]. [*Include any transfer restrictions applicable depending on jurisdiction*].
Conditions Precedent / Subsequent	Government approvals for issuance of MOIs, including re transfer of MOIs from one country to another Evidence of UNFCC validation of projects

[14] TBD. Needs to be comparable and fungible. The amount of private finance mobilised per MOU or MOI - the higher the leverage, the higher the quality of the MOU and MOI because the final user can claim that it has facilitated the mobilization of this amount of money for a green activity.

[15] [TBC: UN is potentially putting together registry – still being discussed]

Bank for International Settlements (BIS)