

The background of the cover features a blurred image of financial market data, including various line charts, bar charts, and numerical values in shades of blue and white. A large, solid teal diagonal shape cuts across the lower right portion of the cover, serving as a backdrop for the title and subtitle.

TRANSFORMING GREEN BOND MARKETS

Using Financial Innovation and Technology to
Expand Green Bond Issuance in Latin America
and the Caribbean



Authors: Juan Antonio Ketterer, Gabriela Andrade, Maria Netto, and Maria Isabel Haro
Contributors: Isabelle Braly, Alexander Vasa, and Enrique Nieto

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INTRODUCTION

Climate change and global warming represent an increasing threat to economies around the world. In Latin America and the Caribbean (LAC), increasingly frequent and intense climate events—hurricanes, heavy rains, floods, and droughts—and extreme weather are imposing higher risks to the region’s development. Consequently, there is an urgent need for climate-friendly investment in the region. The amount of investment needed could reach US\$23 trillion by 2030 (IFC, 2016).¹ However, the public sector will only be able to fund about one quarter of this amount. Thus, alternative financing mechanisms must be found.

The last decade saw the emergence of innovative mechanisms to direct private financial resources to climate-change mitigation and adaptation activities. These advances were supported by the widespread adoption of technological innovation in both industry and finance and the public commitment to mobilize incremental private funds. In this context, green bonds emerged as one of the most promising tools.

The idea behind green bonds was that a growing class of investors would be willing to pay a premium to invest in climate-friendly activities. Using a fixed income instrument, a bond, and labelling it “green” would somehow assure its investors that the proceeds of its placement would be used to fund only green projects. In 2007 a green bond market was created, and since then it has been rapidly expanding.

Fixed income markets are a natural fit for low-carbon infrastructure assets, which are commonly characterized by high up-front capital costs and long-term income flows. The promotion of a deep, global, green bond market can greatly facilitate access to relatively less expensive sources of funding for issuers to finance green projects.² At the same time, it can expand opportunities for climate-aware investors actively seeking to increase the share of green ventures in their portfolios.

Despite its remarkable growth, however, the size of the green bond market represents less than 1 percent of the overall bond market. Moreover, global development of the green bond market has been uneven, concentrated in a few issuing regions or countries, and green bonds are still being used to raise financing in only a few sectors. Europe, the United States and, most recently, China are the dominant players in the market, which focuses largely on renewable energy projects. Despite vast green investment potential in these and other sectors, emerging and developing regions, including LAC, are lagging behind.³

The most important premise of green bonds—that investors would be willing to pay a “green premium”—has not yet materialized. While no consistent premium in green bonds can yet be identified using existing data and green bond pricing spreads are still a matter of debate, advantages of green bonds vs. standard bonds have been found to be rather insignificant, in the range of 0 to 3 basis points (bps).⁴

¹ The International Finance Corporation (IFC) (2016) analyzed national climate commitments made in Paris by 21 emerging market economies where major investment in infrastructure and climate-smart solutions are expected. Specific sectors considered in the analysis include renewable energy generation, transmission and distribution, buildings, industrial energy efficiency, transport, and waste management.

² The cost of project finance debt is higher than the yield for investment-grade project bonds in most markets.

³ Serebrinsky (2014) estimates infrastructure investment needs in LAC are on the order of US\$250 billion, with some additional US\$30 billion required to meet climate mitigation and adaptation needs. The resulting financing gap to cover these investment needs is roughly US\$130 billion, which represents 2.6 percent of the region’s GDP.

⁴ Figures from analyses of green bonds performance in primary and secondary markets. See Zerbib (2018) and CBI (2018b).

To further weaken the appeal of green bonds, there is the presumption of higher transaction costs. Because of the need to reassure investors that the bond proceeds will finance green investments, structuring, monitoring, and reporting are generally expected to be more cumbersome and costly for green bonds than for standard issuances. The costs associated with labelling a bond green depend on many factors related to the characteristics of both the issuer and the underlying asset and, consequently, to the types of certification and verification processes used. Providing sounder guarantees to verify the green label, such as by adding external reviews by an authorized second or third party, adds to the cost, par-

ticularly for small or first-time issuers.⁵ The impact of monitoring costs also can vary widely depending on the assets being financed, with more heterogeneous pipelines involving a much more complex, and therefore costly, framework.

This paper provides an overview of the green bond market. It analyzes some of the issues inhibiting its development and suggests ways to expand it. Specifically, it explores two key dimensions: (I) the risk profile of the green bond instrument and (II) the transaction costs associated with issuance of and reporting on green bonds.

⁵ Second opinion or third-party assurance costs are estimated at between US\$10,000 and US\$100,000. See OECD (2016). According to Ehlers and Packer (2107), the upper bound cost of a green assessment by a major rating agency should not be higher than the cost of a normal credit rating (up to 3 to 5 bps of the issue value).

1. GREEN BOND MARKET OVERVIEW

Definition of Green Bonds

A green bond is a fixed-income debt instrument with long-term maturity. It is just like a regular bond, except that the issuer commits to use the proceeds solely for the financing or refinancing of investment projects, assets, or business activities considered “green” (i.e., they deliver environmental benefits).⁶ It is also similar to a regular bond in terms of regulation, legal framework, documentation, and financial disclosure requirements, issuance, and the placement process. The main difference is that a “green” label adds additional disclosure and procedure obligations intended to provide assurance to investors on the use of proceeds to achieve ends that are favorable to the environment.⁷

Evolution of the Green Bond Market

The European Investment Bank issued the first green bond in 2007 under the name Climate Awareness Bond. It was a structured bond with proceeds dedicated to renewable energy and energy-efficiency projects. Until 2012, the issuers were mostly multilateral development banks (MDBs) and other sovereign supranational agencies (SSAs). Between 2013 and 2015, supported by the launch of the Green Bond Principles (GBP), the

market saw further diversification of issuer profiles to include corporations, banks, and governments. Since then, annual green bond issuance has grown rapidly.

Global green bond supply exceeded US\$155 billion in 2017 (a 78 percent increase from 2016) (CBI, 2018a) and is projected to have totaled US\$167.3 billion by end 2018.⁸ Further issuer diversification and more clarity around standards and definitions are expected to continue to expand the market, with issuances projected to reach US\$200 billion in 2019 (Figure 1.1).

On the demand side, interest in green bonds has been growing among the investor community. Pension funds, insurance companies, sovereign wealth funds, and other institutional investors are increasingly looking for sustainable, responsible investments.⁹

According to the Climate Bond Initiative (CBI), investors with at least US\$45 trillion of assets under management have publicly committed to climate and responsible investments. The UN-supported Principles for Responsible Investment (PRI)¹⁰ now has over 1,700 signatories from more than 50 countries; the aggregated volume of assets under management

⁶ Beyond the labeled green bond market, there are unlabeled bonds that support green projects but are not specifically labeled as green. The market for unlabeled or “climate-aligned” bonds can be significantly larger.

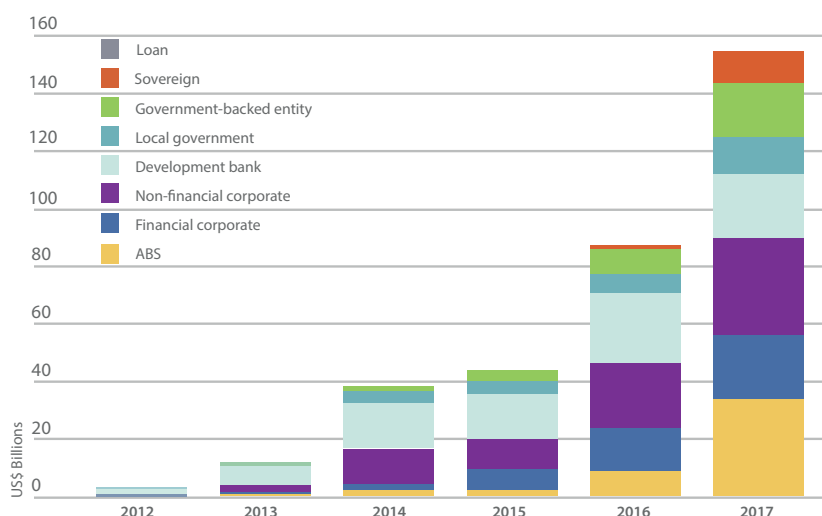
⁷ Green bond standards are continuously evolving in line with the development of the market. Although it started with bonds being issued without certification, that market practice has become less accepted by investors over time. Today, the norm is to have the green label certified under at least one of the standards available. In an attempt to standardize the market and provide clarity on the approach for green bond issuance, in January 2014, the International Capital Markets Association (ICMA) published a set of voluntary guidelines, called the Green Bond Principles (GBP). The GBP, updated annually, comprise four core components: (i) use of proceeds; (ii) process for project evaluation and selection; (iii) management of proceeds; and (iv) reporting. It also adds recommendations on external reviews to be carried out in connection with the issuance. The GBP are currently the most widely used standards. Other standards focus on assets (e.g., CBI for climate-related activities) or jurisdictions (e.g., national standards, such as the Chinese). The International Organization for Standardization (ISO) and rating agencies are currently reviewing green bond good practices, standards and other performance requirements.

⁸ See CBI (2019). Other estimations, including by Commerzbank Global, HSBC, Moody’s Investors Service, and the United Nations Environment Programme, are in the range of US\$170 to US\$200 billion. Growth in 2018 slowed down from previous years, possibly due to bond label diversification (sustainable, social, and SDG bonds).

⁹ Also, regulatory pressures on investors to disclose how they are addressing environmental risks in their portfolios are emerging. Article 173 in France is an example.

¹⁰ The PRI were launched in 2006 to guide investors in integrating environmental, social, and governance (ESG) factors into investment decisions and ownership practices.

Figure 1.1. Global Green Bond Market Growth



Source: CBI (2018a)

represented by this group amounts to US\$73.5 trillion.¹¹

Amid this momentum, the global green bond market potential is estimated to be in the range of US\$4.7 trillion to US\$5.6 trillion of outstanding bonds by 2035, with annual issuances on the order of US\$620 billion to US\$720 billion (roughly a 4 percent share of the current debt securities market).¹² However, despite investor enthusiasm and favorable policy developments that have led to the exponential growth experienced since 2015, the green bond market still represents only a small fraction (less than 1 percent) of the global bond market. Furthermore, the market is highly concentrated. In 2018, the top five issuers (China, France, Germany, the Netherlands, and the United States) accounted for 55 percent of the global market, and these countries are bound to continue to show high growth rates in green bond issuances. They also have the greatest share of repe-

at issuers which, although fewer in number than single issuers, are driving overall green bond volumes. According to CBI data, 63 percent of issuance volume in 2018 corresponded to repeat issuers.

In emerging economies except for China, issuances have grown at a much slower pace than in their developed counterparts. This is mostly due to their relatively shallow and underdeveloped local capital markets, limited investor demand for local green offerings, and lack of awareness (IFC and CBI for Sustainable Banking Network, 2018). In addition, 52 percent of green bond proceeds in emerging markets are financing renewable energy¹³, leaving other sectors far behind. Although some other sectors, such as land use and buildings, are already gaining in importance, much work is still needed to support diversification and stimulate these markets.

¹¹ Green Bonds – Ecosystem, Issuance Process and Regional Perspectives, GIZ and SEB, Brazil Edition (November, 2017) and Mexico Edition (January, 2018). Other similar initiatives include: the Paris Green Bond Statement, signed in 2015 in the context of the Paris Climate Agreement by investors with USD 10 trillion of assets under management, the Statement of Investor Expectations for the Green Bond Market, subscribed by 26 large global investors, and the Green Infrastructure Investment Coalition.

¹² See OECD (2017). This analysis focused on four markets (China, Japan, the United States, and the European Union) in three sectors (energy efficiency, low-emission vehicles, and renewables), which account for 80 to 90 percent of the low-carbon assets included in the two-degree scenario.¹⁵ Globally, this share is about 45%.

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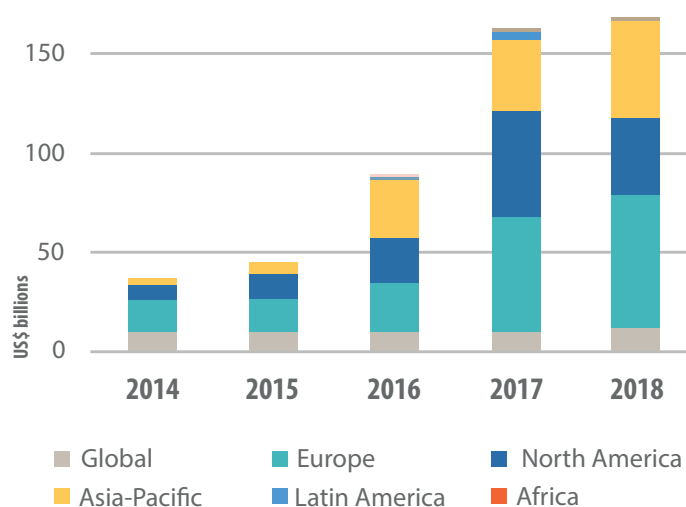
In LAC, overall market value of green bonds reached US\$8.1 billion in 2017, more than twice the US\$3.7 billion reached in 2016 (US\$1 billion in 2015).¹⁴ However, a single green bond issuance of US\$2 billion to finance the new Mexico City Airport drove the exponential increase in 2017. This was the LAC region's largest such issuance to date, but also an outlier that poses statistical interference for green bond data series in the region. In 2018, issuance totaled US\$540 million. Bearing in mind that the US\$3.96 billion raised in the previous year includes the Mexico City Airport bond, 2018 still marks a decline with respect to the normalized trend. This is potentially due to uncertainties in the region's major economies, which may have slowed down capital flows (Garrido, Feliba, and Castells, 2019). On average, green bond issuances correspond to only 1.6 percent of total LAC bond issuance in international markets, although this share continues to display an upward trend (ECLAC, 2017). Ultimately, the region's volume remains small compared to that of Europe, North America, and especially Asia (Figure 1.2), representing less than 1 percent of total global issuances.

Financial Performance of Green Bonds

As the market evolves, issuers have seen strong demand for their green bond issuances, usually realizing increased access to new investors and higher oversubscription. However, views with regards to a concrete pricing advantage are still mixed. Several studies on the financial performance of green bonds relative to conventional bonds are available, but without definitive results.

The CBI's comparative analysis (CBI, 2018b) on the performance of U.S. dollar- and euro-denominated green bonds in the primary markets vis-à-vis non-green bonds suggests that green bonds perform only slightly better than their non-green counterparts. While the former achieve larger average oversubscription, cost differences with their plain-vanilla equivalents are not found to be significant. The resulting spread compressions are quite small, at -0.4 bp and -2.4 bp for bonds denominated in euros and U.S. dollars, respectively, suggesting that attaching a green label to an issue does not have a significant impact on

Figure 1.2. Issuance of Green Bonds by Region



Source: CBI (2019).

¹⁴ The average value of the green bonds issued in LAC between 2014 and 2017 is some US\$310 million. Due to its exceptional size, this average excludes the 2017 Mexico City Airport bond. See Netto et al. (2018).

its price or yield at issuance. HSBC (2016) also analyzes green vs. conventional bond yields at issuance and finds no significant differences. At the other end of the spectrum, a comparison of credit spreads at issuance by the Bank of International Settlements (Ehlers and Packer, 2017) finds a mean difference of -18 bps in spreads of green bonds vs. conventional bonds in their sample. Research on yield differentials on secondary markets also show contrasting results, going from no premium identified, to premiums on the order of -1 or -2 bps, and up to -17 bps (-25 bps observed in some specific types of green bonds) (Bloomberg, 2017; Preclaw and Bakshi, 2015; Zerbib, 2018).

The evolving landscape of the market includes ongoing efforts to better reflect green factors in credit-risk analysis and bond pricing, with increasing involvement of fixed-income investors and credit rating agencies. The evidence appears to reinforce the perception that green bonds still offer little financial incentive to issuers.¹⁵ That is, the reduction in yield due to investors' appreciation of the green label is not perceived to be sufficient to offset the presumed incremental issuance costs that the label implies.

Additional Transaction Costs Associated with the Green Label

While issuing bonds with a green label does not seem to offer significant pricing benefits to issuers, it does imply several additional processes and costs, both upfront and throughout the life of the bond. These costs arise from the need to reassure investors on the use of the proceeds and the environmental impact of the underlying projects. Investors do not necessarily have

the capacity to assess the green element of a bond and must weigh the potential reputational risk that the integrity of the bond might be challenged if the investment is purported to be green but is actually not. Much work has been devoted to determining what counts as green and to preventing so-called greenwashing.¹⁶ Certification and reporting are key in this respect, as they help mitigate this risk and provide sufficient confidence to investors willing to invest in these markets. Typically, this entails the following steps (following the GBP):

- **Transparent process for project evaluation and selection:** Issuers should clearly and transparently communicate to investors: (I) the environmental objectives of the projects, (II) how the projects fit into one of the categories established by the GBP and (III) the eligibility criteria or any process that applies to the projects with environmental effects.
- **Management of proceeds:** Issuers need to hire independent auditors to verify the authenticity of the fund allocation process or to complement the scope of their annual audits with this type of verification.
- **Reporting:** To provide clear and up-to-date reporting, issuers must maintain a full list of all projects that have received proceeds from the green bond, with each project's description and intended results. Performance metrics and their application methodology in the reporting process are necessary for investors to gauge the impact of their investments.¹⁷
- The GBP also recommends that issuers use external parties to confirm alignment with the principles.¹⁸ There are three main audit

¹⁵ Such has been so far the global market understanding of this issue. See I4CE (2016) and OECD (2017).

¹⁶ According to the OECD, the term "greenwashing" is used when an issuer does not use proceeds for their intended purposes or when it is unable to prove that resources were used to fund projects with positive environmental impacts.

¹⁷ The fourth core component of the GBP emphasizes reporting by issuers. Originally focused around a requirement to account for the allocation of proceeds either on a project-by-project or an aggregated portfolio basis, it has since been updated to emphasize the importance of disclosing the key underlying methodology and/or assumptions used in the determination of quantitative indicators that help inform investors.

methods: (I) second-party opinions on the methodology used by the issuer to select the projects for investment, (II) unrelated third-party certification and verification of the green bond, and (III) use of an auditor to verify the internal tracking method and allocation of funds.¹⁹

Estimates for upfront and ongoing transaction costs—including labelling and associated administrative, certification, reporting, verification and monitoring requirements—vary widely, depending on the market, the type of bond (corporate versus project) and other specifics of the transaction. A green certification under the GBP, the standard followed by most issuers in the market, ranges between US\$15,000 and US\$20,000 for a single issu-

ance. The OECD estimates that second-opinion verification of procedures and reports by an authorized third party can cost anywhere from US\$10,000 to US\$100,000 (OECD, 2016), although it is unclear how much of it is entirely attributable to the green nature of the bond. Even if major rating agencies (e.g., Moody's, Standard & Poor's) continue to move toward integrating the issue of ESG in their rating processes, it is argued that any cost associated with the development of a green assessment should remain of no concern to those already using normal credit ratings (estimated at as much as 3 to 5 bps of the issue value) (Ehlers and Packer, 2017). Nonetheless, as the bulk of the costs seem to be more or less the same regardless of the size, these costs can have a much greater impact on smaller issuances.

¹⁸ In Europe, the region currently dominating global green bond markets and with highest reporting standards, more than 98 percent of issuance benefits from external reviews.

¹⁹ Audits are provided by specialized verifiers (e.g., Vigeo, Sustainalytics) and/or large consulting firms (e.g., Deloitte, KPMG, PwC).

2. A ROADMAP TO IMPROVE THE GREEN BOND MARKETS

The analysis above can be summarized as follows. Green bond issuance has grown substantially in global terms, but it is still a small fraction of the overall bond market, and it is concentrated in few jurisdictions and sectors. Issuing a green bond involves extra costs due to the additional reporting requirements, which in some cases may be significant or perceived as such. Nevertheless, issuers have not yet been able to realize a sufficiently meaningful price advantage. At the same time, investors have no incentive to accept lower yields as, in general, the credit risk of a green bond is the same as any other bond from the same issuer. This clearly becomes a deterrent to issuance and partly explains the restrained state of this market.

Addressing the Risk Profile of the Instrument

The difference between a green bond and a plain vanilla bond, issued by the same company, is the issuer's pledge that the proceeds will be used solely to finance green investments. However, this pledge does not affect the risk-return profile of the bond. Credit rating agencies are beginning to explore the business of assessing greenness beyond creditworthiness, by developing more systematic tools to help integrate the issue of ESG criteria as part of their risk assessment.²⁰ Until credit risk analysis evolves to the point where it factors in sustainability issues, the risk characteristics of a green bond will be considered almost identical to those of a plain vanilla bond. Hence, the yields are generally about the same.

To be able to issue a green bond with a yield advantage over a plain vanilla bond, the risk profile needs to be somehow altered. There are two main avenues to accomplish this: (I) by enhancing the risk of the green bond with additional meaningful collateral, and (II) by reducing the green bond risk with a partial credit guarantee issued by a third party with a credit rating that is higher than that of the bond issuer.

Covered Bonds

To provide investors with surety in addition to the claim on the issuer, the concept of covered bonds can be entertained. A covered bond is a bond collateralized against a pool of assets that covers claims in the event of default, providing the investors with recourse against both the issuer and the collateral asset pool (additional cover or dual recourse). Unlike asset-backed securities (ABS),²¹ in a covered bond, both the debt and the underlying asset pool remain on the issuer's balance sheet (i.e., the risk is not transferred from the issuer to the investor). This dual recourse structure affords covered bonds a lower risk profile and superior credit ratings (based on the quality of the specific collateral in the registered cover pool). Lower risk entails smaller risk premiums, lowering in turn the funding costs of issuers relative to similar unsecured bonds. In addition to the risk reduction element, covered bonds can also be useful for bundling smaller underlying assets, helping develop pipelines of small-scale projects normally found in sectors such as sustainable agriculture, small

²⁰ Since the launch of the ESG in Credit Ratings Initiative in 2016, the PRI has been working with investors and credit rating agencies to promote the consideration of ESG factors in credit risk analysis. See PRI (2019). Beginning in 2019, Fitch Ratings launched a new integrated scoring system that shows how ESG factors impact individual credit rating decisions, across all asset classes.

²¹ ABS have been used for green bonds since 2014, specifically in the United States by Fannie Mae's regular issuance of Green Mortgage-Backed Securities bonds.

and medium-sized enterprises, energy efficiency, and housing. They are particularly relevant in emerging economies (see Box 2.1 for more information on covered bonds).

Covered bonds are usually subject to specific regulation, or laws, to protect bondholders. Regulation must cover aspects such as authorized issuing institutions, eligibility of assets that will conform the cover pools, regulatory authorities, and minimum reporting and disclosure standards. This is done by defining conditions that the issuer must comply with to ensure that the quality of the collateral (pool of assets) is maintained and that it consistently backs the covered bond (see Annex 1 for more information on international covered bond frameworks). This entails, for instance, an obligation by the issuer to replace any nonperforming loans or prepaid debt in the pool.

However, the most important function of the legal framework is protecting investors against potential credit events. Regulation must pro-

vide assurance to investors that no court will be able to challenge the enforceability of the contract during a credit event and that the segregation of the collateral pool of assets will not be questioned.

Ultimately, the reduction in the risk premia of covered bonds is a direct function of the perceived quality of the collateral pool and of the confidence in contract enforceability. Furthermore, the transaction costs involved in the structuring of a covered bond are inversely proportional to those two factors.

In some jurisdictions, regulators are reluctant to grant permission, or have introduced restrictions, to bank-issued covered bonds. This is because the pledging of assets works against depositors' security in the event of resolution.²² This understandable reluctance explains why covered bonds have so far only been authorized to back investments deemed of social interest, such as mortgages.

²² Canada limits issuance to 4 percent of bank assets. Australia and New Zealand each have an 8 percent limit. Other countries, such as Germany, Italy, and the Netherlands, impose thresholds on total issuance in relation to the bank's equity.

Box 2.1. Covered Bond Market Facts

Dating back to 18th century Prussia, the first covered bonds were issued in 1769, as a way to allow banks to raise funding for loans for housing and land in the aftermath of war. By 1900, the instrument was included in the German Mortgage Bank Law and was later used widely to finance post-war reconstruction and reunification infrastructure (Damerow, Kidney, and Clanaghan, 2012).

Traditionally, covered bonds have been used much more extensively in European markets. The instrument has been adopted in many other countries, including Australia, Canada, Chile, New Zealand, Singapore, South Korea, and the United States, all of which have already implemented covered bond legislation (except for the United States, where no covered bond legislation has been passed to date, despite several attempts after the crisis).²³ Other jurisdictions—including some LAC countries such as Brazil, Mexico, Panama, and Peru—are exploring the introduction of covered bonds or are already in the process of adopting legislation.

In 2016, the outstanding covered bond market stood at €2.5 trillion, practically unchanged in relation to 2015. Issuances fell by 10 percent from the previous year, reaching some €485 billion. The collateral used for covered bonds still consists mostly of mortgages, which account for €2.1 trillion (nearly 85 percent of the outstanding market). Europe is still the largest market player, with Denmark, France, Germany, and Spain accounting for 53 percent of the outstanding market volume. Non-EU countries accounted for more than 1 percent of total outstanding covered bonds in 2016 (ECBC, 2018a).

In 2015, the German real estate and mortgage bank BerlinHyp issued the first green covered bond (Pfandbrief), raising €500m with a seven-year tenor and coupon of 0.125 percent. The cover pool consisted of green building certified mortgages, with assets located in Germany, France, the Netherlands, Poland, and the United Kingdom. The issue achieved oversubscription of 4x and produced 15 new investors for BerlinHyp (CBI, 2017).

See Annex 1 for additional information on specific covered bond markets.

²³ The market operates under the Federal Deposit Insurance Corporation Covered Bond Policy Statement, from 2008, and the U.S. Treasury's Best Practices for Residential Covered Bonds. These are non-binding international guidelines.

Today, policymakers generally regard green investments as socially desirable. The potential of the green bond market could be unlocked by enacting legislation as part of an enabling financial infrastructure to facilitate funding via covered bonds for lending in areas targeted by green policy. Regulation could be developed or updated to accommodate new asset classes considered green (e.g., green buildings, renewable energy, sustainable transport, water conservation). While there is no common definition of what constitutes a green asset, the use-of-proceeds criteria of a regular green bond could be applied to identify green assets within segments of the existing covered bonds market and to develop standards for further covered issuances.

An appropriate legal framework should be solid enough to guarantee investor claim privileges, provide clear definitions on the characteristics of the assets in the cover pool, and compel issuing banks to maintain high levels of discipline in originating the loans that will be included in the pool. As the market of green covered bonds develops, new investors attracted by the enhanced risk profile of the issuances will generate more demand, which in turn will influence bond pricing and liquidity of the market.

A boost in covered bond market activity has already been linked to a growing interest in green financing of banks and investors alike, driven by evolving policy and the widespread notion of environmental and reputational benefits. According to Standard & Poor's, "the emergence of green covered bonds highlights the growing prominence of green finance in the traditional area of covered bonds and

offers an alternative mechanism for banks to contribute to financing global climate commitments" (Standard & Poor's, 2018: 1). The relatively steady long-term cash flows of a good number of green projects makes them well-suited assets to be used as collateral. Investors, on the other hand, would need minimal adaptation of portfolio guidelines because of the high level of security offered by the instrument.

MDBs can assist countries in supporting identification of green assets in potential cover pools (including the development of standards and definitions) and designing or upgrading regulation that will make green covered bonds viable and attractive to issuers and investors. Specifically, they can assist governments in developing local guidelines and procedures that allow a straightforward identification of projects with environmental impact and mitigate the risk of greenwashing, as well as in assessing current regulation and coordinating the incorporation of frameworks for specific asset classes based on that assessment.

MDBs can also play a role in facilitating the availability of good-quality assets eligible for the cover pool of the bond. They can provide resources or enhancement mechanisms for green lending by national development banks or other potential issuers,²⁴ and they could potentially develop alternative dual recourse bond schemes where proper covered bond regulation has not yet progressed.

Partial Credit Guarantees

A second way to improve the risk profile of green bonds, particularly for larger issuers, is to use

²⁴ Following their mandate, national development banks can often provide a pipeline of green projects, suitable for cover pools, that can be financed or guaranteed with MDB resources. This in turn implies that strict supervision of the quality of these projects is in place, as per international standards, which provides an extra layer of confidence to investors on the assets backing the bond.

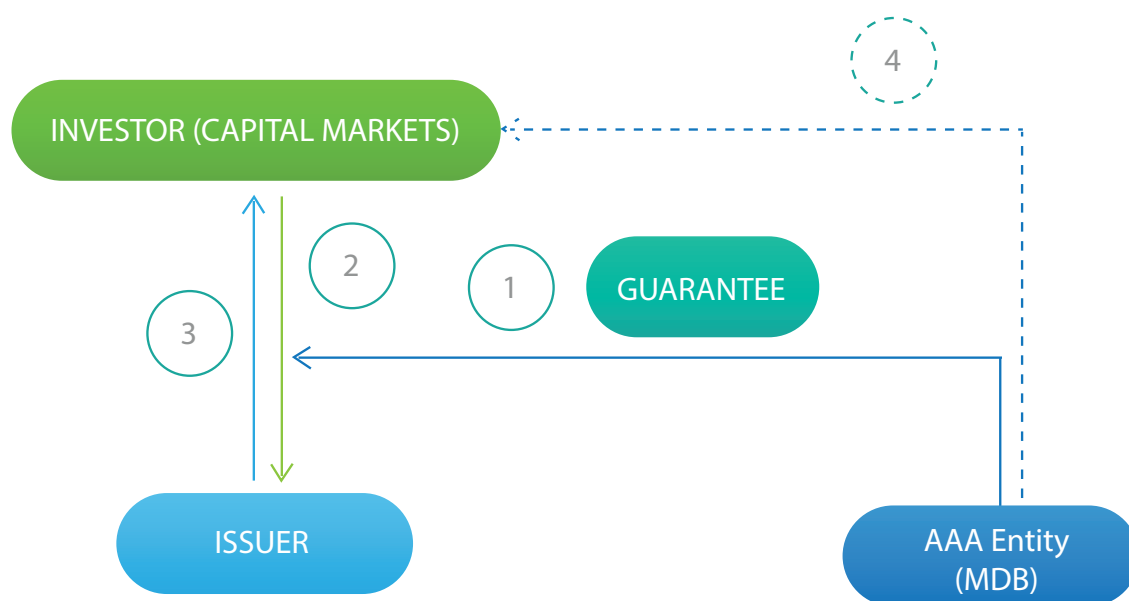
third-party-issued partial credit guarantees. Generally, when a financial obligation is enhanced by a credit guarantee issued by a AAA entity, the bond rating increases more or less proportionately to the percentage of the payments covered by the guarantee, thus reducing investors' perception of the risk profile of the issuance.

Guarantee schemes help manage the risks of a financial instrument by isolating those risks that are critical and transferring them to other actors that are better able to assume them. The instrument can be very effective in facilitating the flow of private investment to high-risk sectors. It also contributes to develop-

ping financial markets and using public funds efficiently, particularly in the infrastructure sector. While there are costs associated with the issuance of a guarantee, there are also benefits, specifically in terms of enhanced risk structure of the bond.

Leveraging an MDB's AAA credit rating via the use of partial credit guarantees can make green bonds a better fit with the risk profile of institutional investors otherwise unwilling to opt for a high-risk green bond. The guarantee support would allow new investors to become familiar with the opportunities in LAC, efficiently boosting local green bond markets (Figure 2.1).²⁵

Figure 2.1. Partial Credit Guarantee Scheme



1. Guarantee covers default risk. AAA rating of MDB enhances the rating of green bond issued by a private or public issuer. MDB charges the standard fee for the guarantee.
2. Issuer issues green bond in the local or international market with MDBs guarantee.
3. Issuer repays principal and interests
4. Partial or total default triggers a call on the guarantee.

²⁵ Green bonds issued in LAC between 2014 and 2017 have largely benefitted from guarantees or partial guarantees from the government and/or regional and multilateral banks. See ECLAC (2017).

An Improved Framework to Reduce Transaction Costs

The second factor that reduces the attractiveness of green bonds from the standpoint of the issuer is that they have higher transaction costs than plain vanilla bonds. This is particularly the case for small or first-time issuers, as well as for issuances that finance large, diverse pipelines of projects, projects that are geographically dispersed, or projects in sectors for which monitoring is usually more costly, such as land use or agriculture. The increase in transaction costs is due to (I) the higher cost of compliance with regulations, (II) higher costs associated with structuring of green bonds, and (III) the cost of tracking and reporting on the underlying investments to bondholders.

Regulatory Environment

Policy and regulatory frameworks play an important role in incentivizing the growth and integrity of green bond markets. The type of regulation needed differs from country to country, depending on the level of development of the bond market, the local long-term investment framework, the local and international investor base, and other factors.

In China, for example, while self-regulation and voluntary principles still govern much of the international green bond market, government authorities oversee green bond issuance. Having established close policy exchange and dialogue with the ICMA and the CBI and using their standards as a reference, Chinese regulators worked together to enact regulation and provide better incentives. In 2015, the People's Bank of China (PBOC), China's central bank, released the first country-speci-

fic green bond issuance guidelines and taxonomy to guide local issuance on green bonds, which has seen exceptional growth since 2016. The National Development and Reform Commission regulates China's corporate green bond market in line with the PBOC's guidelines, and the Securities Regulatory Commission regulates listed companies. In 2017, India enacted regulations governing the issuance of green bonds locally. The Securities Exchange Board of India now establishes disclosure requirements for issuance and listing of green debt securities and categorizes projects and assets for eligible use-of-proceeds, in line with international practice.

Relative slower expansion in other large economies has been credited to a lack of regulation that establishes a proper green bond system—with clear definitions of what qualifies as green – and imposes stricter penalties for issuers who do not manage bond proceeds properly (Wang, 2018).

In Brazil, the government's stance has been to allow the market to develop its practices and principles and to establish a broad public-private dialogue on how regulation can facilitate the market. In this sense, a number of initiatives by the private sector have been leading the development of good practices and standards. The Brazilian Federation of Banks (Federação Brasileira de Bancos, or Febraban) and the Brazilian Business Council for Sustainable Development (Conselho Empresarial Brasileiro para o Desenvolvimento Sustentável, or CEBDS) have published a guide to issuing green bonds locally. The Guidelines for Issuing Green Bonds in Brazil 2016 presents recommendations to participants in the Brazilian fixed-income securities market on the process of issuing green bonds. It also

attempts to contribute to the development of this market in the country. The Guidelines, a non-binding document, sets forth eligible activities for green bonds in line with the GBP and the Climate Bonds Taxonomy. Brazil is also formally a participant in the ongoing discussions around the elaboration of international ISO methodologies, and the stock markets are developing a classification for green bonds. The Brazilian private sector is openly supporting these developments through the Brazil Green Finance Initiative (BGFI). Originally known as the Brazil Market Development Council, the BGFI is organized by the secretariats of the CEBDS and the CBI. It consists of 27 representatives from domestic pension funds, insurance companies, banks, major industry sectors and investors working together to strengthen the development of a local green finance market and attract international capital flows to catalyze opportunities for green investment in Brazil (see Box 2.2).

Mexico, the other largest green bond market in the LAC region, as of today has no separate regulatory framework governing the issuance of green bonds. Just like any regular bond, Mexican green issuances abide by the Securities Market Law and are regulated by the National Banking and Securities Commission. Only international guidelines (the GBP) are used to meet additional requirements related to the green use-of-proceeds.²⁶

In the rest of LAC, the limited development of capital markets at large inhibits the expansion of the green bond market. On the positive side, it could be said that a nascent state of these markets might facilitate the introduction of a comprehensive green bond framework into a broader financial market development strategy. For instance, recent OECD efforts with MDBs on a G20 Action Plan to support the development of local currency bond markets, could be further applied to green bonds (OECD, 2017).

To provide international investors with increased access and confidence to local markets, policymakers and regulators will need to address most aspects of the issuance process, including definitions and disclosure requirements, marketplaces (listings and trading), and clearing, settlement, and custody. They should also work with the stock exchanges, as they facilitate market liquidity, geographic diversification, and investor access. Exchanges can aid in the development of green bond listing criteria and indices, which make it easier for investors to discover and track the performance of green bonds (CBI, 2017b). MDBs can help establish a dialog with national governments and regulators, as well as collaboration with investors, issuers, and other relevant actors (rating agencies, certifiers, auditors), to develop regulatory environments that facilitate green bond issuance and are more conducive to the emergence of new mechanisms, such as covered bonds.

²⁶ Green Bonds – Ecosystem, Issuance Process and Regional Perspectives, GIZ and SEB, Brazil Edition (November, 2017) and Mexico Edition (January, 2018)

Box 2.2. Promotion of Favorable Green Bond Regulation: The Case of Brazil

Through the Financial Innovation Lab (LAB)²⁷ initiative, the Inter-American Development Bank (IDB) is assisting the government of Brazil to simplify procedures and develop regulation for facilitating issuance of green bonds. The LAB works on two main fronts:

- Creating a space for dialogue between regulators (central bank, Exchanges Commission, insurance and pension fund regulator), line ministries, banks, and investors' associations (including insurance and pension funds),²⁸ stock markets, and international players, such as CBI. The discussions focus on determining the role of regulators, making recommendations for regulatory changes and improvements, and
- Proposing good practices to be promoted in the market, based on thorough research and analysis provided as part of the program.
- Formally offering inputs to the government decision-level group, which discusses policy and regulation related to the capital markets.

The LAB has already submitted recommendation to alter Decree 8.874/2016 (Law 12.431/2011), which regulates the criteria for approval of investment projects considered national priorities by the federal government. The adjustment proposal would entail that infrastructure investment projects that qualify as attending to environment responsibility criteria or positive social impact in certain vulnerable communities, be treated as a national priority.²⁹ Similarly, the group has produced specific recommendation to the Exchanges Commission in order to adjust regulation for debentures that would be certified as green, increase flexibility in the way infrastructure investment funds are authorized to operate and stimulate green bond issuances.

The LAB has also helped assess those areas in which there is no need for government intervention. That is, it has provided evidence-based assurance to the government of the possibility of using existing international green bond metrics, rather than developing national ones. The IDB is replicating the LAB model in Mexico. It is expected to be launched by April 2019.

²⁷ The LAB was structured to stimulate the participation of the private sector in the creation of financial solutions for those markets that involve the supply of a number of services, including water, transport, energy, agriculture, infrastructure and financial services. It consists of four independent working groups: Green Finance, FinTech, Impact Investments, and Green Bonds. The overarching purpose of the LAB is for Brazil to become a reference in the promotion of solutions for adapting to climate change, addressing social impact, and stimulating digital finance.

²⁸ These include: Febraban, CEBDS, The Brazilian Development Association (ABDE), the Brazilian Association of Financial and Capital Markets Entities (AMBIMA), the Brazilian National Association of Pension Funds (ABRAPP).

²⁹ The treatment of this projects would follow the same line of the Investment Partnerships Program (PPI), created by Law in 2016 to "expand investment and employment opportunities and stimulate technological and industrial development, in harmony with the country's social and economic development goals." Ventures qualified for the PPI are treated as a national priority, which means the organs and entities involved must act so that the processes and acts necessary for the structuring, liberation and execution of the project occur in an efficient and economical way.

Structuring of Green Bonds

Even when proper regulation is in place, knowledge gaps and lack of bond structuring capacity can add costs to the task of putting together a green bond transaction. In LAC, most local issuers need to become acquainted with the specificities of green bond market transactions and develop the capacity to bring their green issuances to the market.

MDBs can assist at different levels. First, they can engage in broader activities around the fundamental building blocks of the green bond market, such as education and training of potential and existing domestic issuers, marketing and knowledge sharing with local and international investors, awareness of opportunities and requirements in international markets, and guidelines and methodologies for certification and standardization of cross-border definitions and processes. Second, at the operational level, they can assist issuers in all phases of the process: pre-issuance, launch, and post-issuance. These include: (I) identifying a pipeline of eligible green projects; (II) providing information and case studies on available options regarding bond structure, credit enhancement, and required documentation; (III) organizing road shows; (IV) implementing monitoring and evaluation criteria; (V) overseeing the procurement of financial advisory services, underwriting, rating agencies, second opinion providers, and audit firms. Support in these areas is particularly important in the case of specific sectors with high potential for investments that can qualify as green but do not yet have a defined framework in existing international guidelines. These include agribusiness, forestry, and aggregation of small business energy efficiency loans.

Reporting on Underlying Green Investments

Transparency and reporting on underlying investments are an important distinguishing feature of green bonds. Transparent, accurate, and timely information on the use of proceeds is of essential value to investors, since they need assurances that the green bonds are having positive impact on the environment. Sometimes, when internationally qualified third-party institutions are not involved, investors may choose to undertake their own due diligence and analysis, adding costs to the transaction. In any case, it is clear that information management represents a potential source of costs for the issuer.

Fortunately, certain new technologies can be key in finding cost-effective ways to perform the required information management functions. For example, the rapidly evolving distributed ledger technologies (DLT), analogous to blockchain, could improve the way in which green bond tracking and reporting commitments are fulfilled, making the process more efficient and reliable. Under DLT, stored information and registered transactions become fundamentally unchangeable, incorruptible, and irreversible, which would ensure tracking integrity to investors. All relevant information would be available to all concerned on a timely basis. Finally, DLT affords improved overall security to the system relative to a centralized alternative.

The development of a transparent reporting and validation system requires periodical interaction among several key stakeholders participating in a green bond transaction, each holding different faculties and rights. A DLT-based model provides an efficient platform to reliably connect this network of actors—

issuer, validators, investors and regulators—in real time. It also enables a process flow that is defined based on sequential milestones that can confirm compliance of the use of proceeds, from construction/commissioning to implementation and operation of green projects backing the bond, including the associated environmental impacts. A milestone validation approach would also enable all actors involved to better understand where problems arise and potentially implement corrective measures for future issuances. See Annex 1 for a basic outline of how DLT-enhanced green bond reporting could work.

A secure and public platform where these project-level tracking, definition, and verification processes are registered provides accessible evidence that commitments were

fulfilled. It creates a track record for issuers and provides extra confidence on green bond markets at relatively low cost. With better access to reporting, investors will be better equipped to make informed decisions on their investments, and supervisors will be able to monitor these transactions with reduced due-diligence costs. Overall, green bond reporting can be simplified, and its costs reduced. This is particularly important for small issuers, who usually lack the resources to develop specific systems to fulfill post-issuance information commitments, as well as for bonds issued to finance larger numbers of small projects, projects that are geographically dispersed, or projects in sectors that are difficult to monitor or for which indicators are usually more complex, such as agriculture and small energy efficiency.

3. CONCLUSIONS

New approaches to risk design and technology-based approaches to monitoring and reporting are essential to untap the potential of green bond markets, particularly in LAC and other developing regions. Seizing international investors' appetite for green assets requires careful consideration of regulation. Local green definitions and standards should be aligned with internationally accepted guidelines to avoid confusion and reputational risk. More information, including databases and indices, should be provided to improve international investors' understanding of general bond market performance, and green bond performance, in the LAC region.

The incorporation of financial mechanisms such as covered bonds and guarantees can adequately address the risk of the issues, making the market more attractive for investors. An increased investor base may help lower funding costs for issuers and strengthen their financial position in future issuances. Issuers' concerns around transaction costs from

green labelling and associated certification and verification requirements can also be addressed via enhanced regulation and education. Leveraging efficiencies of new and evolving technologies, such as the DLT, can substantially reduce monitoring and reporting costs, while improving transparency in the use of proceeds and market integrity.

The ideas presented in this paper are intended to stimulate further dialogue with policymakers, regulators, and public financial institutions—the main drivers of green bond market development—that are looking for efficient ways to meet their goals with regard to green investment needs and capital market development. Green bond markets in the LAC region remain in a relatively nascent stage. Therefore, the guidance and support of a supranational institution with a proven reputation in the field, such as the IDB, are essential to provide the standards and assurance needed to attract investors internationally (Box 3.1).

Box 3.1. The IDB and Green Bonds in Latin America and the Caribbean

The IDB is recognized as a transformational champion in the promotion of green finance and technical assistance for implementing Paris goals (Wright et al., 2018). It is committed to aligning its operations to support countries in LAC to deliver their nationally determined contributions (NDCs), offering financial and technical support and encouraging cross-ministerial dialogue and policy consistency to translate NDCs into specific investments.

The IDB has already acquired extensive experience in the field. It has formed strong partnerships with political and financial actors in many countries in the region and with experts with thorough knowledge of and strong presence in the international green bond market. It has been working closely with countries in LAC to support them in assessing and structuring green and sustainable bond issuance in local and international markets (see www.greenfinancelac.org). With technical assistance programs funded by the Swiss (SECO), the German (IKI) and the Chinese governments, at least 10 institutions have benefited so far, with US\$480 million issued in Argentina, Colombia, and Mexico, including the first Mexican locally issued green bond associated with agribusiness. It is also helping to enable green bond markets via webinars, events, and a focused working group in Brazil—the LAB—that has produced an assessment of the local green bond market, a proposal for new regulation for green debentures, and good practice guidelines. The IDB is also exploring collaboration with other MDBs to complement their efforts aimed at providing financing for climate-friendly investments and NDC implementation with a focus on green bonds.

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ANNEX 1. FEATURES OF COVERED BOND JURISDICTIONS

The internationalization of the covered bond markets more than 15 years ago and the growth of mortgage lending activities in the European Union (EU) brought about the introduction of new and adapted covered bond legislation in many European jurisdictions (Asociación Hipotecaria Española, 2019; ECBC, 2018a; 2018b). Since the inclusion of the instrument by law in the 1980s, Spanish covered bonds have become the main funding instrument used by financial institutions to finance mortgages (cédulas hipotecarias). More recent figures show how this instrument has maintained its relevance in the market in the post-crisis period and over the past decade, representing 99 percent of the total issued volume for the sector in 2018 (equivalent to €20,000 million). Spanish covered bonds are subject to limits on the volume of issuance and over-collateralization of assets.

Other examples, such as the German Pfandbrief, demonstrate how covered bond legislation can be adapted in response to financial institutions' long-term funding requirements to support specific industry sectors. Between 2008 and 2009, German Pfandbrief legislation was adapted for shipping assets and aircraft. Although these represent a small portion of covered bond issuance, the principles that apply to the incorporation of new asset classes into legislation, associated reporting, and performance criteria demonstrate that structures such as the Pfandbrief offer enough flexibility to further adapt to green assets.

Sweden implemented a law for covered bonds in 2004, although a liquid market for mortgage bonds has existed since the 1980s. The outstanding volume of Swedish covered

bonds (€165,9 billion by end of 2017) is nearly twice as much as the outstanding volume of government bonds.

The European Commission's Capital Markets Union (CMU) is now exploring new ways in which the industry can support the growth agenda and provide long-term financing to the real economy. One of them is the role of European lenders in financing housing and small and medium-sized enterprise (SME) and developing energy-efficient mortgages and green covered bonds for the benefit of EU citizens and the environment.

In the LAC region, accomplishments with covered bonds have been very limited. Panama was the first country to issue a covered bond, in 2012, even though the country does not have a specific legal framework and these issuances are based on contractual agreements only. Covered bonds in Chile (bonos hipotecarios), supported by law finalized in 2012, are aimed at raising funds for the origination of mortgage loans (mutuos hipotecarios). Only residential mortgages are accepted as collateral, excluding commercial, public, or other types of assets, and the market still has a reduced, locally distributed issuance. In 2015, Brazil enacted Law No. 13,097, which outlined the main framework for Brazilian covered bonds (Letra Imobiliária Garantida), complemented by secondary legislation approved by the Brazilian National Monetary Council in 2017. The Brazilian legal framework provides assurance to covered bond holders on asset pool quality and claims in case of an issuer's default. The Brazilian Central Bank is in the process of issuing additional regulation (Table A1).

Table A1. Covered Bond Framework, Country Comparison

MARKET	CHILE	SPAIN	GERMANY	SOUTH KOREA	UNITED STATES
	Bonos Hipotecarios (BH)	Cédulas Hipotecarias (CH)	Pfandbriefe	SK Covered Bonds (CB)	US Covered Bonds (CB)
I. ISSUER					
Issuer	Specialized credit institution	Universal credit institution Specialized credit institution	Universal credit institution with a special license	Universal credit institution	Special Purpose Entities (SPE or SPV)
Bondholder recourse to the credit institution	Yes, direct	Yes, direct	Yes, direct	Yes, direct	No
Is the issuer the originator of the assets?	Yes	Yes	Yes	Yes	No
II. FRAMEWORK					
Special covered bond legislation	The General Banking Law (Ley General de Bancos, LGB): Article 69, n°2, BH issuances; and Articles 125, 126 and 134, special treatment of banking entities under bankruptcy	Law 2/1981 on Mortgage Markets regulation (1981), modified by Law 1/2013 and developed by Royal Decree 716/2009	PfandbriefAct (Pfandbriefgesetz, PfandBG) from 22 May 2005, which came into force on 17 July 2005; this Act was amended in 2009, 2010, 2013, 2014 and 2015	The Korean Covered Bond Act was passed by the National Assembly of Korea in December 19, 2013 and came into effect in April, 2014	No
III. COVER ASSETS					
Types of assets that may be included in cover pools	Exposures to public sector entities, Mortgage loans, Exposures to credit institutions	Mortgage loans	Exposures to public sector entities, Mortgage loans, Ship loans, Aircraft loans, Exposures to credit institutions	Exposures to public sector entities, Mortgage loans, Group originated Senior MBS, Senior MBS issued by third parties, Ship loans, Aircraft loans, Exposures to credit institutions	Exposures to public sector entities, Mortgage loans, Group originated Senior MBS, Senior MBS issued by third parties

Geographical scope for assets	Domestic	European Economic Area (EEA)	Public sector: domestic, multilateral development banks, EEA, China, United States, Canada, Japan Mortgage: Domestic, EEA, China, United States, Canada, Japan, New Zealand, Australia, Other	Domestic	Domestic Other
Are regular covered bond specific disclosure requirements to the public mandatory?	Yes	Yes	Yes	Yes	No
IV. VALUATION OF THE COVER POOL & LTV CRITERIA					
Valuation for LTV	Market value	Mortgage lending value	Mortgage lending value	Mortgage lending value	Other
LTV limits	Residential 80%	60% in the general case and 80% for residential. LTV limits do not apply to the cover pool but to the issuance	60% in all cases	No	Residential 75%

Sources: ECBC and authors' elaboration

ANNEX 2. DLT-ENHANCED GREEN BONDS

The model considered here has been developed to show how DLT can be used to improve the credibility and verification of the use of proceeds and impact commitments associated with green bond issuance. It is not aimed at the issuance process itself or the handling of secondary market transactions, clearing, and settlement. The model only focuses on green bonds issued against future pipelines.³⁰

The proposed model offers a means to reduce the cost of data validation and simplify the handling of annual progress reports owed to investors, thus promoting transparency and efficiency of these markets. Given this objective, the set of actors that participate in green bond transactions, and the lack of need for a public system with an in-protocol cryptocurrency, the model presupposes a permissioned DLT wherein participants are clearly identified, are pre-approved, and have specific permissioned roles. The basic structure is as follows:

- Protocol layer: configured under a permissioned DLT with the respective distributed consensus algorithm. As such, there is no need for a proof of work algorithm, and therefore it would not be energy intensive.³¹
- Network layer: peer-to-peer network set up to incorporate the main actors and respective roles and permissions.
- Application layer: user interface structured for several sequential validation's checkpoints or milestones for each green bond commitment.

The basic set of (permissioned) actors participating in the system and their respective roles are described in the Table A2.1.

The application would entail several validation layers, depending on each green bond's structure, commitments and participants, with the overall objective of providing trust and transparency of green investment claims to investors. The layers are as follows:

- Basic validation: A process flow would be established for each green bond considering (I) the green bond's profile or basic characteristics; (II) several specific and sequential milestones tailored to the underlying green project/commitments; (III) validation responsibilities, for certified validators; and (IV) a series of smart contracts which will determine if the validation process can continue if certified validators confirm achievement of each sequential green bond milestones, as established in the rules of engagement. Once a milestone has been validated by a certified radiator (through his signature) or several validators (through a multi-signature or multisig scheme), the process for the second milestone is triggered. This process is applied to each subsequent milestone until the entire process flow is completed, thereby showing compliance with commitments. For example, a milestone of a project can be the approval of specific designs or construction standards by one or several validators. To do so, validators would perform a review and if accepted, they would input their signature in the (multisig) smart contract

³⁰ Alternatively, bond proceeds can be allocated to refinance existing assets, the premise being that the freed-up balance from the refinancing would be allocated to new green lending. Reporting needs will vary if proceeds are fully allocated to the refinancing of existing projects rather than new projects, i.e., post-issuance reporting in the former will not require annual recounting on allocation and use-of-proceeds. Impact reporting, though increasingly being considered a best practice, is not yet mandatory in any green bond guidelines.

³¹ There are several algorithms that can be used in permissioned systems such as Proof of Authority or Practical Byzantine Fault Tolerance.

to indicate approval and enable the second milestone. Following the example, the actual construction outcome would be the following milestone, and so on. The smart contracts can be designed to decide how many validators (i.e., signatures) are needed to move forward to the next milestone.

A fully complete process (i.e., all milestones were completed, allowing the process to be finalized) will not only provide investors with the certainty that the green investments happened as expected, but it would also allow issuers to develop a track record that would be relatively easy to confirm. Moreover, the milestone approach would also allow investors (and issuers) to better understand where problems arise and how to potentially find corrective measures.

- Conditioning disbursements to the achievement of milestones: If issuers/investors wish to provide/obtain

even more certainty, the disbursement of a bond's tranche can be structured to be subject to the compliance of previously defined milestones. If such milestones are completed, the smart contract can automatically execute the disbursement.

Depending on the project, potential validators can be international or standard-setting organizations, internet of things (IoT) devices,³² or approved engineering or legal firms, among others. Validators can participate in multisig smart contracts, and more than one validator can be included for a particular milestone. Several validators could be included depending on the level of confidence required. All validators will need to be certified and have the applicable credentials to operate/participate in the system.

All relevant documentation will be in a separate repository. A hash of all related projects would be included in the system for verification purposes and to ensure transparency throughout the process.³³ Investors would use all these tools to track progress.

³² IoT devices are nonstandard computing devices that connect wirelessly to a network and have the ability to transmit data. IoT devices include wireless sensors, software, actuators, and computer devices.

³³ A hash is a function that converts an input of data (letters and numbers) into an encrypted output of a fixed length. It is created using an algorithm, and is widely used in cryptography, as makes input data easy to verify but difficult to reconstruct (if unknown), providing a means to assure integrity of transmitted data.

Table A2.1. Main Actors and Roles

Actor	Main Role
Green bond issuer	Responsible for uploading evidence/documentation to demonstrate compliance with commitments
Certified Validators	Responsible for validating evidence/documentation provided by the green bond issuer Validators need to be certified in order to have the permission to participate in the system
Issuer(s) of validators' certificates	Certify validators, providing them with credentials needed to write/participate in the DLT system An entity with this authority would need to be identified and established
Green bond issuer	Can access the system to examine documentation reported and respective validations in order to monitor performance of a specific green bond Green bond investors would be able to read and track documentations and the respective validation for each milestones of the respective green bond they invested in.
Key public sector entities (e.g. Central Bank, Ministry of Finance)	Can access the system to examine evidence/documentation reported and respective validations. Monitor the overall system
Other key stakeholders (e.g., IDB, MDBs, Latin American Association of Development Finance Institutions)	Can access the system to examine evidence/documentation reported and respective validations. Monitor the overall system

Figure A2.1. Main Actors and Roles (simplified)

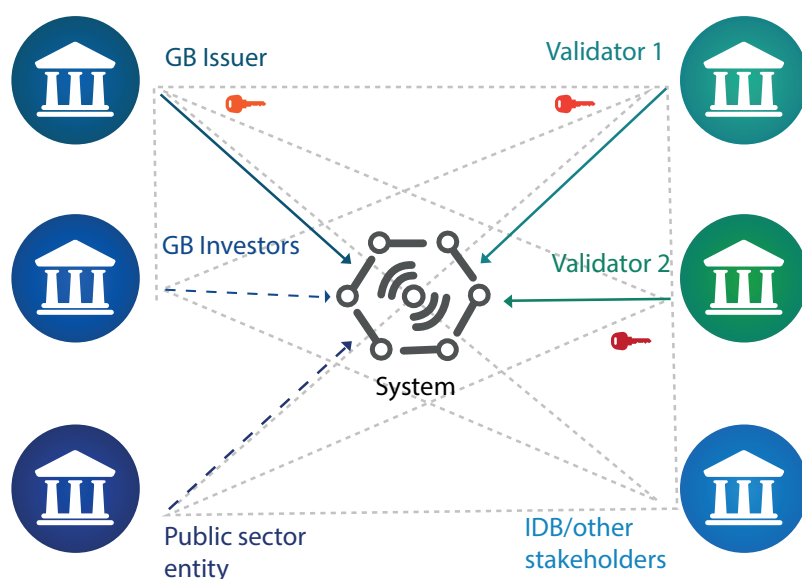


Figure A2.2. Validation Components (simplified)

