Quantitative framework

Analysing potential bond contributions in a low-carbon transition

OECD

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EXECUTIVE SUMMARY

This analysis considers scenarios for the potential contribution of the bond markets to meet low-carbon investment financing needs in a 2°C energy pathway.[1] The IEA has estimated investment needs in the renewable energy, energy efficiency and LEV sectors to 2035, consistent with an expectation that countries will take policy actions leading to a 2°C emissions pathway or scenario ("a 2DS").

Building on these investment scenarios, this work applies assumptions based on current trends in regional financial markets to synthetically break down the aggregated investment needs by source of finance and type of financial instrument. The analysis converts investments into their constituent equity and debt components. Focusing on debt, the analysis considers the role that the bond markets can play to finance this investment.

Investment needs over the two decades are considered for renewable energy, the energy efficiency portion of building investments, and low-emission vehicles (LEVs)[2]. These three sectors accounted for 75% of outstanding labelled green bonds as of June 2015. For purposes of simplicity, the analysis refers to bonds issued in the renewable energy, energy efficiency and LEV sectors as "low-carbon bonds", and does not speculate on what portion will be labelled green in 2035.[3]

Other segments of labelled green bond and unlabelled climate bond markets relate to low-carbon public transportation, climate adaptation, clean water, waste management, agriculture, land remediation, industrial gas treatment and other key areas of environmentally-related investment. These sectors are beyond the scope of this analysis but are clearly important areas of green finance where the bond markets can (and do) play a significant role.[4]

The analysis covers debt securities markets in China, the EU, Japan and the US, which represent almost 70% of the global annual investment needs projected for the next five years. These markets currently have significantly more established debt securities markets than other regions, and are the largest globally, accounting for around 75% of the global debt securities markets valued at 97 trillion in 2014.[5]

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[1] The concept of "green finance" as used by the G20 Green Finance Study Group is broader than the concept of a 2°C energy investment pathway, as the former contains financing needs for addressing other environment challenges in addition to climate action. Nevertheless, low-carbon investment will be a central aspect of any green finance agenda.

[2] LEV includes hybrid vehicles, plug-in and electric vehicles and fuel-cell vehicles.

[3] In practice as of 2015, 11% of the wider "climate-aligned" bond market is explicitly labelled as green, and although the green labelled segment has been growing, reaching a conclusion as to the proportion of green labelling in 2035 is beyond the scope of this work.

[4] As perspective, in China approximately 40% of "green investment" needs will be for low-carbon projects (including public transport) in the period 2014-2020, with the other 60% being needed in these other sectors such as water (supply, savings and remediation), waste treatment, sewage, land remediation and industrial gas treatment.

[5] Debt securities outstanding from all sectors amounted to USD 39 trillion in the US, USD 21 trillion in the EU, USD 9.7 trillion in Japan and USD 4.3 trillion in China. New gross issuance in 2014 amounted to USD 19 trillion in these markets.

Debt (lending) and bond financing needs are estimated to continue to grow significantly in capital expenditure terms, while decreasing somewhat as a proportion of investment. Debt is seen as covering 60% of total investment needs between 2015 and 2025, while this ratio decreases steadily to 52% in 2035. The mix of financing types ranges significantly across the types of assets. For renewables, the debt to equity ratio remains about level at 75%. Current financing and purchasing trends show that a significant proportion of energy efficiency and LEV investment is done through consumer finance or equity. Assuming that this continues to be the case, and given the increasingly large size of LEV and energy efficiency investment needs relative to renewables over the period, equity and self (cash) finance are estimated to continue to make a large and growing contribution to financing low-carbon energy investment.

The role of bonds in financing investment depends on the maturity of the technology, the characteristics of the projects including the scale at project level, as well as the type of investor. The results of the analysis suggest that by 2035 in a 2DS, bonds for low-carbon energy investments have the potential to scale to as much as USD 4.7-5.6 trillion in outstanding securities globally and USD 620-720 billion in annual issuance in the markets studied. While these figures may seem large on an absolute basis, they are small (approximately 4%) relative to the scale of issuance in debt securities markets generally.

The analysis suggests that the 2020s have the potential to be the beginning of the “golden years” for bond issuance in the low-carbon sectors. As low-carbon technologies mature, they become more familiar to bond markets which can become substantial contributors to the financing and re-financing of new-build assets. As the costs of assets fall and as policy stabilises, the role played by bonds could expand rapidly. The analysis examines the potential for different types of bond to finance a range of sectors and sub-sectors of low-carbon investments studied; displaying a picture of the volume of outstanding securities through to 2035 and the speed at which they could potentially scale up.

Revitalising the concept of securitisation, which was tarnished during the 2007-2008 financial crisis is important to the scaling up of low-carbon infrastructure finance and has emerged as a key area of focus for policy makers generally. This revitalisation may be achieved in large measure by standardising the assets and by making the process, and the market activity it spurs, safer, simpler and more transparent. Accordingly, a need to activate and scale up issuance of asset-backed securities (ABS) is identified, with solar PV and leases of LEVs being seen as a particularly suitable target; as demonstrated by ABS issued in 2014-2016 from these sectors (e.g. SolarCity and Toyota).

By 2035 in the baseline scenario, almost a third of outstanding bonds from the low-carbon sectors studied could be in the form of ABS. Conservative assumptions used for these scenarios based on the literature available in 2015 suggest there is potential to “surprise to the upside” based on observed market activity in 2015-16 beginning to diverge significantly from forecasts (e.g. in LEV sales and solar PV deployment).

ABS have a disproportionately large potential to scale since they are less likely to be constrained by government fiscal and budgetary constraints in the case of government (i.e. municipal) bonds, and by balance sheet constraints in the case of corporate and Sovereign, Supranational and Agency (SSA) bonds seen as accounting for USD 240 billion and 640 billion (8% and 14%) of bonds outstanding in 2035. Efforts to support green securitisation must be undertaken in a prudent, judicious and transparent manner

so that green ABS markets emerge with integrity and with due consideration for any financial stability issues.

The results also reveal the prominent role loans play in financing low-carbon investment needs to 2035. Financial institutions are expected to continue to be the largest provider of loans to all three sectors given their specific expertise in the arranging of credit for the earlier stages of infrastructure development project cycle through to project operation, at which point other sources of debt capital including bond markets can be called on to re-finance the debt. While financial institutions have a major role to play in arranging the debt financing for low-carbon infrastructure through loans and through underwriting and investing in bonds, they notably also can act as issuers of "financial sector" bonds to raise capital AND fund their lending activities.

Financial institutions are expected to continue to use bond markets to raise capital to finance their low-carbon related lending, which can lead to financial sector issuance of bonds that finance this on-balance sheet lending (e.g. ABN AMRO's 2015 EUR 500 million green bond). This segment of the market has the potential to add up to USD 1 trillion to the total bonds outstanding in 2025 and over USD 1.7 trillion in 2035.

The scenarios highlight geographical variations and some similarities. For instance, financial sector issuance potential is seen as strong in all four markets accounting for the largest low-carbon bond sector in China, the EU and Japan.

In the US, a higher share of ABS is possible than in other markets in 2035 representing the largest share followed closely by financial sector bonds. This is due to the higher level of maturity of the financial markets in general and securitisation markets in particular. US utilities are among the most active users of bond finance, and are reflected as such in this analysis. Over time it is assumed that a portion of corporate borrowing by US utilities will be substituted by project bonds and ABS. US municipal authorities are also prominent issuers in bond markets to finance their infrastructure-related expenditure and this is expected to continue.

In the EU, ABS have the potential to be the second largest bond type, with the financial sector playing a more prominent role than in the US. ABS could accumulate a large market share but may cede some of this share over time to corporate and project bonds. The increase in project bonds reflects the Europe 2020 Project Bond Initiative which is targeted at increasing reliance on bond financing at the project level. Corporate bond issuance is likely to be significant given the active role European utilities have played in the EU corporate bond market. There could also be strong involvement of governments in raising funds through the bond market to implement energy efficiency and renewable energy programmes. Many options are possible in Europe and much will depend on the direction policy takes and the strength of corporate utility balance sheets, which have deteriorated in recent years.

In Japan, overall the assumptions drawn from the literature and used to examine the Japanese market's potential result in a low degree of securitisation and bond issuance in Japan. Investment needs for a 2DS in general are lower compared to the other three markets and bond issuance as a percentage of investment needs is also lower. In 2015-2016, a market for low-carbon project bonds emerged in Japan, and this is expected to continue to grow.

In China, corporate and project bonds may take the greater share while ABS expands alongside a maturing debt capital market. China has been largely successful in creating a market for infrastructure bonds. The prospect of participation by financial and corporate entities in China was realised in early 2016 following the release of guidance, regulations and requirements for green bond issuance by the People's Bank of China. As of April 2016, green bond issuance in China had already reached USD 5.3 billion, with forecasts for annual issuance surpassing USD 46 billion in 2016; a figure already close to that shown in the scenario for 2020 of around USD 52 billion in annual issuance potential.

The current policy push to reduce reliance on the banking sector in China could hasten the development of an ABS market and bond markets in general. Sub-sovereign development banks working in conjunction with policy banks, are seen as having the potential to play a pivotal role in the early development of a low-carbon bond market in China.

Bond issuance must occur at a scale, and in a format, with which institutional investors are comfortable. The analysis suggests that institutional investors have the potential to shift their asset allocations over time and absorb the increasing supply of low-carbon bonds.

The speed at which green bond markets develop and mature hinges on many variables, including policy and regulatory factors, market conditions and financing trends. Additionally, the evolving green bond market faces a range of specific challenges and barriers to its further evolution and growth. A key foundation for future market growth is that governments adopt policies supportive of expanded low-carbon project pipelines and bond market development. Banks, corporates and other market participants would then be in a position to scale up their investments in line with expanded physical asset deployment requirements envisaged under a 2DS. Project bonds and ABS can also play a vital role in helping to fill investment gaps directly and through capital recycling. The analysis suggests that if there is concerted attention by policy makers and market participants, the bond markets can be relied on as a critical foundation for raising the debt capital that will be needed for the transition to a low-carbon economy.

1. Organising Framework

1.1. Objectives

This analysis contains the first quantifications[6] of debt financing, and bond financing in particular, to meet the 2°C energy investment scenarios (2DS) set forth by the IEA.[7] The concept of "green finance" as used by the G20 Green Finance Study Group is broader than the concept of a 2°C energy investment pathway, as the former contains financing needs for addressing other environment challenges (such as water, air pollution and land contamination) in addition to climate action. Nevertheless, a 2°C energy investment scenario will be a central aspect of any green finance agenda.

The objectives of this analysis are three-fold:

1. To assess how much debt finance is needed to meet the IEA's 2DS between 2015 and 2035 in the four markets studied;

2. To assess how the bond market might evolve from 2015 to 2035 to provide part of these needs, taking into account projected policy and technology development as well as financial innovation; and

3. To analyse the implications of the transformation of the bond market for the institutional investors that have driven the growth of the green bond market to date.

1.2. Sectors assessed

The focus of this analysis is on bond financing for the renewable energy, energy efficiency and low-emission vehicle (LEVs) sectors. According to IEA (2014: 199), these sectors are key components of the low-carbon assets included in the 2DS (between 80-90% depending on the scenario as measured by total investment), and were selected because sufficiently granular data and assumptions for these sectors are available [to 2035]. The scope extends only to the energy efficiency portion of building investment though investment in other forms of energy efficiency such as in industry is another integral component of the 2DS pathway. Other elements of aggregate green building investment are also likely to have significant potential for bond financing, but could not be included in the analysis.

[6] OECD is working with Vivid Economics to build scenario models for market evolution.

[7] The IEA World Energy Outlook "450 Scenario" sets out an energy pathway consistent with the goal of limiting the global increase in temperature to 2°C by limiting concentration of greenhouse gases in the atmosphere to around 450 parts per million of CO2.The 2°C Scenario (2DS) is the focus of the IEA's Energy Technology Perspectives (ETP). The 2DS describes an energy system consistent with an emissions trajectory that recent climate science research indicates would give an 80% chance of limiting average global temperature increase to 2°C. It sets the target of cutting energy-related CO2 emissions by more than half in 2050 (compared with 2009) and ensuring that they continue to fall thereafter. The 2DS acknowledges that transforming the energy sector is vital, but not the sole solution: the goal can only be achieved if CO2 and GHG emissions in non-energy sectors are also reduced. The 2DS is broadly consistent with the World Energy Outlook 450 Scenario through 2035. (Source: IEA 2014, 2015)

Renewable energy, energy efficiency in building investment and LEVs accounted for 75% or USD 50 billion out of 66 USD billion in outstanding labelled green bonds as of June 2015, and 79% of annual green labelled issuance in 2015. Other segments of labelled green bond and unlabelled climate bond markets relate to low-carbon public transportation, climate adaptation, clean water, waste management, agriculture and forestry and other key areas of environmentally-related investment (CBI/HSBC, 2015). These sectors are beyond the scope of this analysis (and some sectors like adaptation are not included in the IEA's 2DS figures) but are clearly important areas of green finance where the bond markets can (and do) play a significant role. As perspective, the CCICED (2015) estimates that in China approximately 40% of "green investment" needs will be for low-carbon projects in the period 2014-2020, with the other 60% being needed for sectors such as water (supply, savings and remediation), waste treatment, sewage, land remediation and industrial gas treatment.[8]

For simplicity, the analysis refers to bonds issued in the renewable energy, energy efficiency in buildings and LEV sectors as "low-carbon bonds", and does not speculate on what portion will be labelled green in 2035. In practice, as of 2015, 11% of the wider "climate-aligned" bond market was explicitly labelled as green and this share has been growing (CBI/HSBC, 2015). It is, however, difficult to predict what this share may be in 2035.[9]

1.3. Geographic coverage

The quantification of the potential for low-carbon future bond financing presented in the analysis covers China, the EU, Japan and the US, which together represent 68% of the global annual energy sector supply investment needs (including fossil fuels) projected for the next five years and 52% in 2035 in a 2DS (Table 1.1). These four markets were chosen to analyse given they have significantly more established bond markets than other regions (along with sufficiently robust statistics that can be used for analysis). They are also the largest markets, accounting for 76% or USD 74 trillion of the global debt securities markets valued at 97 trillion in 2014. Debt securities outstanding from all sectors (government, corporate, municipal, ABS, etc.) amounted to USD 39 trillion in the US, USD 21 trillion in the EU, USD 9.7 trillion in Japan and USD 4.3 trillion in China.[10] New (gross) debt securities issuances in 2014 amounted to USD 19 trillion in these markets.[11]

[8] If sufficiently granular data and assumptions were to be made available, the framework constructed for the purposes of this analysis could in theory be applied to these other sectors as well.

[9] With increasingly clearer understandings of the economic benefits of the green label being applied to bonds (as discussed in OECD/ICMA/CBI/China GFC (2016), it may be reasonable to assume that the percentage of bonds labelled as green would increase in the future. For example, recent public sector-led efforts to grow a green labelled bond market in China and India suggest that in those markets, at the very least, the percentage of bonds potentially eligible for carrying a green label will be higher in the future than at present.

[10] By the end of 2015, outstanding bonds in China amounted to RMB 47.9tn (USD 7.4tn). Gross bond issuance in China in 2015 amounted to USD 3.4tn. Source: PBOC

[11] Gross issuance. OECD analysis based on IEA (2014, 2012), Climate Bonds Initiative (2015), BIS (2015), SIFMA (2015), ECB (2015), JSRI (2015), ADB (2015) and Goldman Sachs (2015).

Table 1.1. Annual investment needs for renewable energy, energy efficiency in buildings and low-emission vehicles in a 2DS compared to global all energy sector needs (2015-2035, 2012 USD)

	2015-2020 (1)	2021-2025	2026-2030	2031-2035
RE, EE and LEV investment needs in 4 markets (China, EU, Japan & US)	573 bn	1 315 bn	1 264 bn	2 262 bn
All global investment needs for energy supply and energy efficiency	839 bn	2 230 bn	2 404 bn	4 340 bn
Share	68%	59%	53%	52%

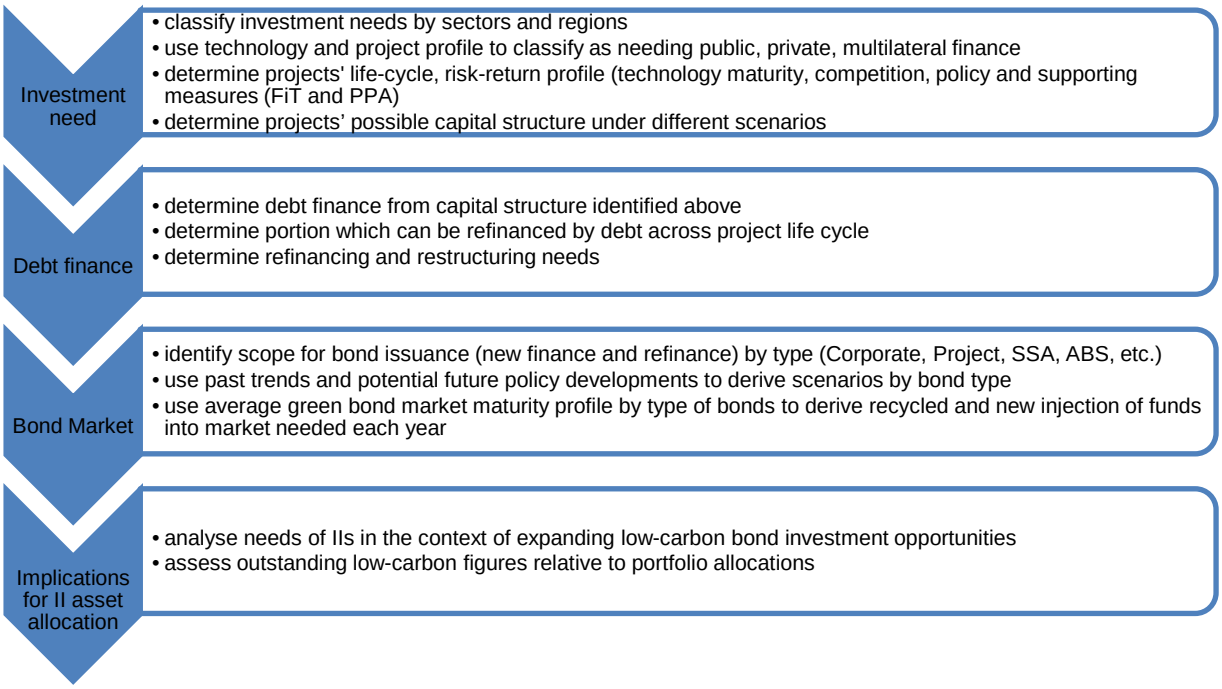
Note: (1) Figures are annualised over the five year periods.

Source: OECD analysis based on IEA (2014, 2012)

1.4. Methodology

In its World Energy Investment Outlook (2014) and Energy Technology Perspectives (2012), the IEA estimated investment needs in the renewable energy, energy efficiency and LEV sectors to 2035, based on scenarios in which countries take policy actions leading to a 2°C emissions pathway. Building on these investment scenarios, this analysis applies assumptions based on current trends in regional financial markets to synthetically break down the aggregated investment needs by source of finance and type of financial instrument (See Annex 1.A for methodology and assumptions). Figure 1.1 shows the steps of the decomposition and the main issues addressed in each step.

Figure 1.1. Flow diagram showing steps taken in developing a quantitative model and analytical framework

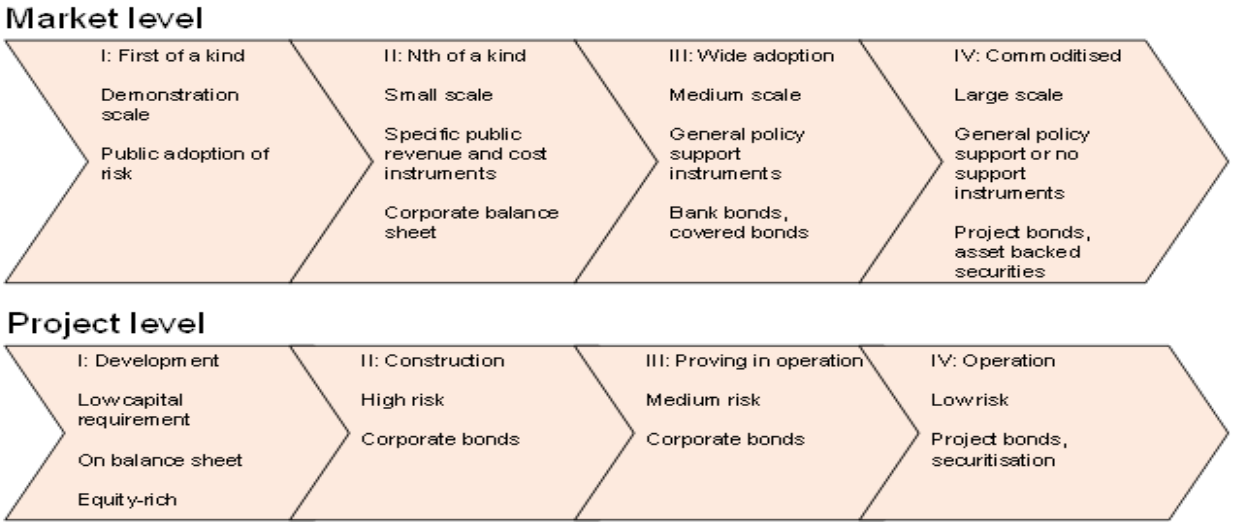


Note: FiT = feed in tariff, PPA = power purchase agreement, II = institutional investors

The input data for the scenarios discussed in this report relate to investment needs and capital structure (i.e. the shares of debt and equity needed, by sector and country). The investment data and decomposition by sector were provided by the IEA. A matching set of global assumptions were made (e.g. the split between utility scale and rooftop solar PV) and were referenced from a wide variety of public sources. These assumptions are set forth in Annex 1.A. The estimates presented here are a function of the assumptions made, and are subject to significant uncertainty around policy, current commercial and financial practice and future changes in these practices (Box 1.1). By setting forth these assumptions in a transparent manner, the analysis allows for close scrutiny and hopefully improved calibration of the model as updated assumptions become available.

The scenarios in this report are based on the results of quantitative modelling. The modelling translates existing investment projections into types of financial structure, segmenting the results into selected regional and sectoral markets, and takes into account the suitability of financial structures for assets of different risk profiles over the asset's life from development and construction through to operation (Figure 1.2). It is assumed that market actors will seek to optimise the capital structure and asset financing methods (and thereby minimise the cost of capital for their investments) wherever possible in line with prevailing and expected market circumstances and other economic variables that influence such decisions.

Figure 1.2. The phases of asset development at individual and market level



Box 1.1. Methodology

As detailed in Annex 1.A, models were constructed for the 4 geographic markets and assumption based scenarios were run to generate the output data. Input data and assumptions for the scenarios relate to investment need and capital structure. Data from current trends in regional financial markets are used to establish benchmark levels of leverage (measured as debt to equity ratios) and proportions of bond finance, by type, and for each investment class. The investment data and decomposition by sector are all provided by the IEA.

When a level of disaggregation proved insufficient, it was supplemented through a set of global assumptions, e.g. the split between utility scale and rooftop photovoltaics (PV), drawn from a range of sources (see Annex and References). Where data were unavailable, assumptions were constructed to simulate values and a sensitivity analysis was performed to determine the impact of these assumptions on key model outputs, then validated through consultation with market and industry experts. Consultation and sensitivity analysis of the variables and assumptions is ongoing and the OECD welcomes expert interest and input.

There are three principal areas of uncertainty in these scenario estimates. First, uncertainty lies in the strength and mix of support policy that will be adopted and the evolution of technology and performance costs.

Second, uncertainty exists in current data on financial structures and sources of finance. Some markets are better documented than others. Securities regulations generally require that public market transactions be thoroughly and publicly documented – and therefore easier to analyse. However, a substantial portion of financial market transactions are private or un-listed and have limited disclosure of deal specifics. In these cases, third party market analysis is the only option, rather than primary audited financial reports.

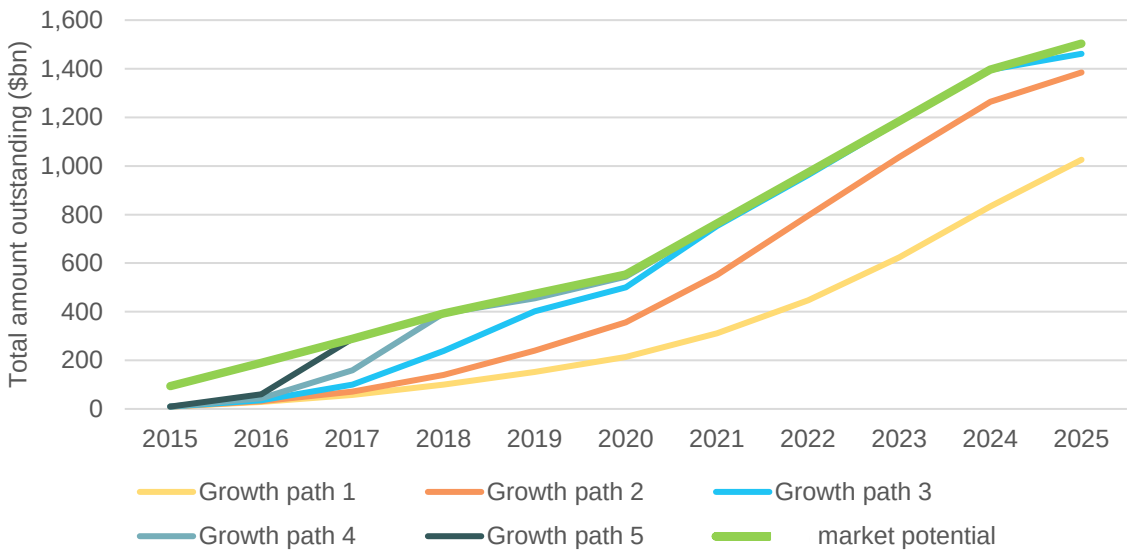
Third, financial practices may change. Although traditional financing structures may well continue, waves of financial innovation are often driven by changes in regulation, market preferences, corporate balance sheets, tax structures, financial crises and other factors. The types of financial structures deployed may be profoundly affected by such market shifts. For instance, China's debt markets have been characterised by banks providing significant lending to state-owned enterprises. These markets have experienced challenges and the financial system is undergoing significant change. As such, there are significant uncertainties regarding the future role of bond financing for low-carbon infrastructure. At the same time, the government has prioritised the development of green bond markets (UNEP, 2015).

Two main scenarios were modelled and are presented in this analysis and in the Annexes, with both assuming that the world is on a 2DS pathway: 1) A base-case scenario that uses conservative asset securitisation assumptions (projecting levels observed in the market in 2015 forwards); and 2) a scenario with a 10% increase in asset securitisation rate across all sectors (which represents a low-end growth assumption that could be achieved through basic policy and market enablers targeted at securitisation). Both main scenarios assume policy makers adopt supportive policies to overcome challenges as described by the OECD (2016, forthcoming) and in OECD/ICMA/CBI/China GFC (2016).

Figure 1.3 illustrates a further range of possible scenarios not described in the report. The green line illustrating the market growth potential represents the enhanced securitisation scenario 2, and represents a theoretical upper limit for the base case of low-carbon bonds outstanding in the sectors modelled if the world is on a 2DS, given capital structures and investment needs. The other coloured lines illustrate, over a 10 year period, the speed at which the theoretical potential might be reached, depending on how the bond market develops. If there is a concerted push in China, the EU, Japan and the US to develop a low-carbon bond market, the growth rate over the first five years could be in the region of 100 to 200%. The historical growth of other bond markets suggests that there is a catalytic element embedded in market growth, whereby successively deeper and more liquid markets serve to further accelerate growth.

On the other hand, if the policy and regulatory environment is not conducive to rapid market growth, actual low-carbon bond issuance will fall behind its potential and may never reach it, as growth path 1 illustrates. If governments do not set policies to drive a transition to a low-carbon economy or 2DS, bond financing, as a function of the level of low-carbon infrastructure deployment, would be even lower still. While policies enabling the use of bonds to finance renewable energy, energy efficiency in buildings and LEVs are important, they do not drive demand for investment. Fundamental drivers of investment include targets and support measures, carbon pricing, inefficient fossil fuel subsidy removal and reform, research, development and demonstration policies and other actions to facilitate investment in low-carbon infrastructure. Debt will necessarily play an important role in the financing of this infrastructure investment, and bonds could potentially make up an important portion of this debt. Ultimately, however, credible and consistent energy and climate policy and the economics of the sectors will be the drivers of investment over the next 20 years.

Figure 1.3. Illustration of scenarios for how the low-carbon bond market could evolve



Note: Chart ends at 2025 to highlight possible evolutionary pathways in earlier years. Growth paths 1-5 are illustrative.

2. High level quantitative results

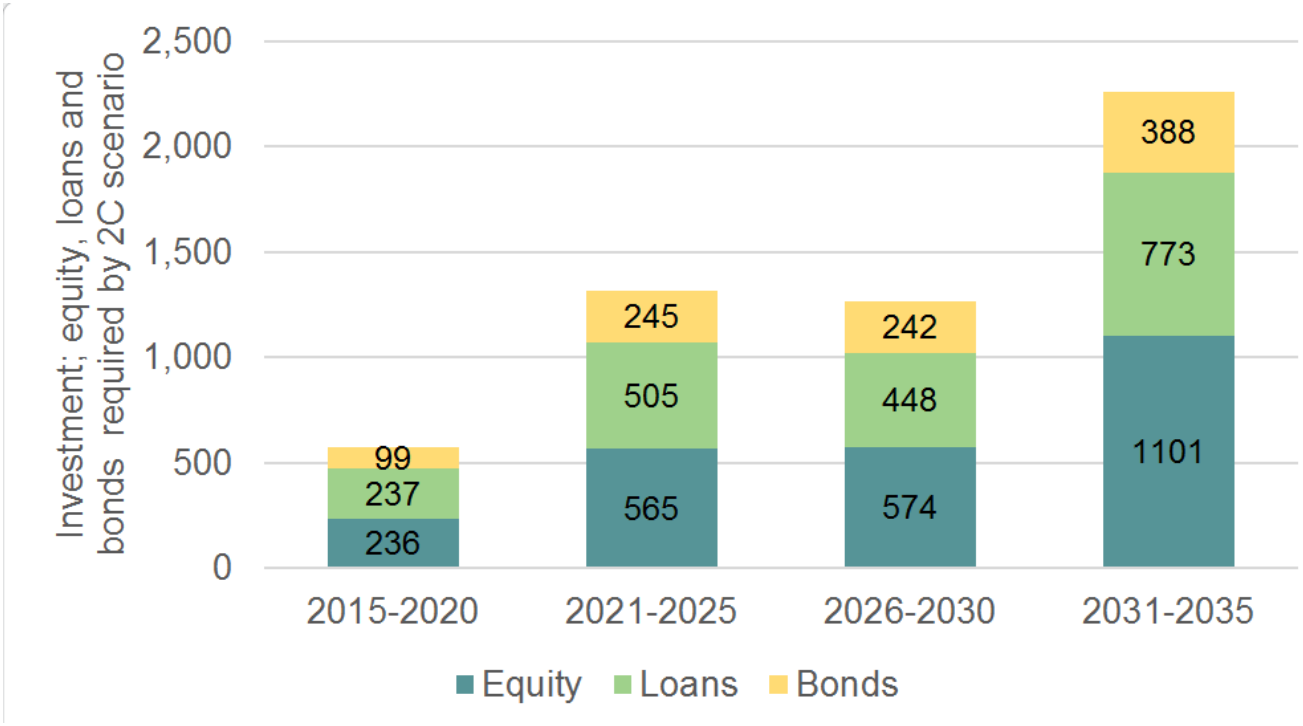
2.1. Debt to equity breakdown

Figure 1.4 shows how total investment needs are financed in the baseline scenario, which takes current financing practices for the sectors studies and projects them forward. Debt (lending) is seen as covering 60% of total investment needs between 2015 and 2025, while this ratio decreases to 56% in 2030 and 52% in 2035. The mix of financing types ranges significantly across the types of assets, and changes over time and is driven by increasing sectoral investment needs as technologies mature, for renewable energy but more significantly for LEVs which represent a disproportionately large share of future investment needs post-2025, according to the IEA (2015).[12]

Current trends in financing asset and durable consumption purchases show that a significant proportion of energy efficiency, distributed solar PV and LEV investment is done through consumer finance (i.e. loans provided to consumers by commercial banks and leases) or equity (i.e. "self-finance", such as an LEV purchased in cash without any financing). Assuming that this continues to be the case, and given the large size of LEV and energy efficiency investment needs relative to renewables, equity and self-finance are estimated to continue to make a large contribution to financing low-carbon energy investment.

[12] Due to the skew in investment needs caused by the dominance of the LEV sector in IEA figures and in these composite results, these investment needs may appear to diverge from some recent Chinese estimates for overall green investment (e.g. CCICED, 2015) which show that needs will peak in the next 5-15 years, and may decline after 2030. Further comparisons of LEV sector assumptions would be useful to undertake here in this respect.

Figure 1.4. Synthetic investment breakdown for the IEA 2DS by type of finance needed to 2035 (annual basis, USD 2012)



Source: OECD analysis based on IEA (2014, 2012)

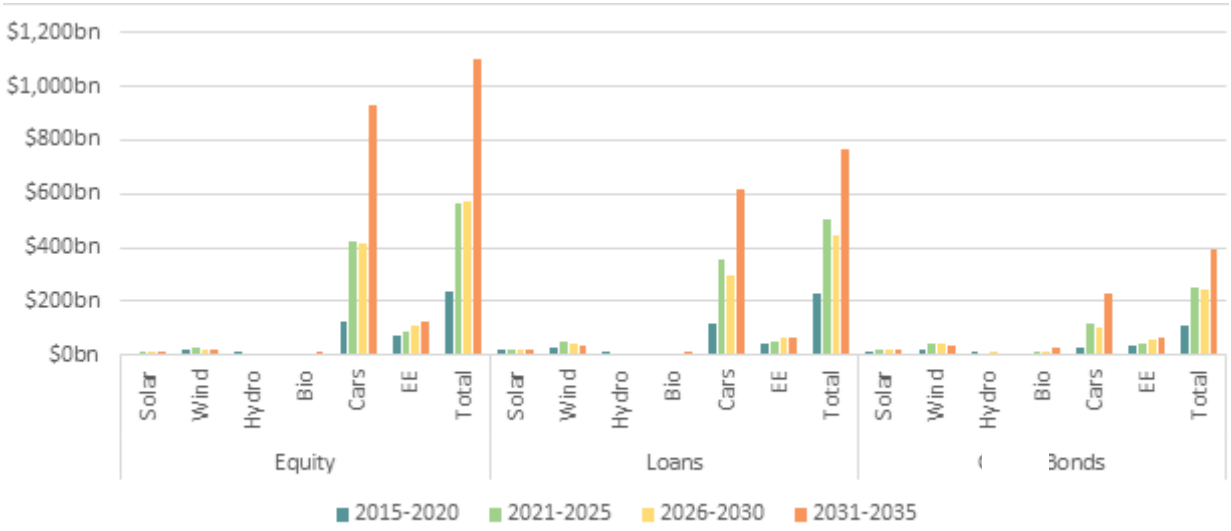
Note: Financial sector bonds that raise proceeds for on-lending not shown but represented in loan figures

The role of bonds in financing investment depends on the maturity of the technology, the characteristics of the projects including the scale at project level, as well as the type of investor. The scenarios break down the IEA's aggregate investment figures by type of asset (Figure 1.5). The use of debt to finance LEV and EE is around 50%, with a much higher proportion (around 75%) seen in the renewable energy sector. Bonds, as a form of debt capital, will therefore be able to play a more prominent role proportion-wise for renewable energy than for low-emission vehicles and energy efficiency. However, due to the sheer scale of financing needed, the USD figure for debt (and bonds) issued to finance LEV and EE is seen as significantly higher.

A large proportion of the investment needs in EE is estimated by the IEA to be needed for lighting and appliances. The IEA estimates that up to 60% of global investment needs in transport, buildings and industry-related EE will be self-financed (with cash). LEVs will also be financed largely by internal sources of finance, especially in China where car purchases by household and businesses do not materially rely on external finance.[13] Only 30% of the investment needs in LEVs by households in China are estimated to be financed through capital markets.

[13] Without more granular precision on the future evolution in China, a conservative assumption is used.

Figure 1.5. The mix of equity, loans and bonds vary across sector and by timeframe



Note: Financial sector bonds that raise proceeds for on-lending not shown but represented in loan figures. See Table 1.1 for the drivers of investment levels and investment needs as defined by the IEA (2014, 2012)

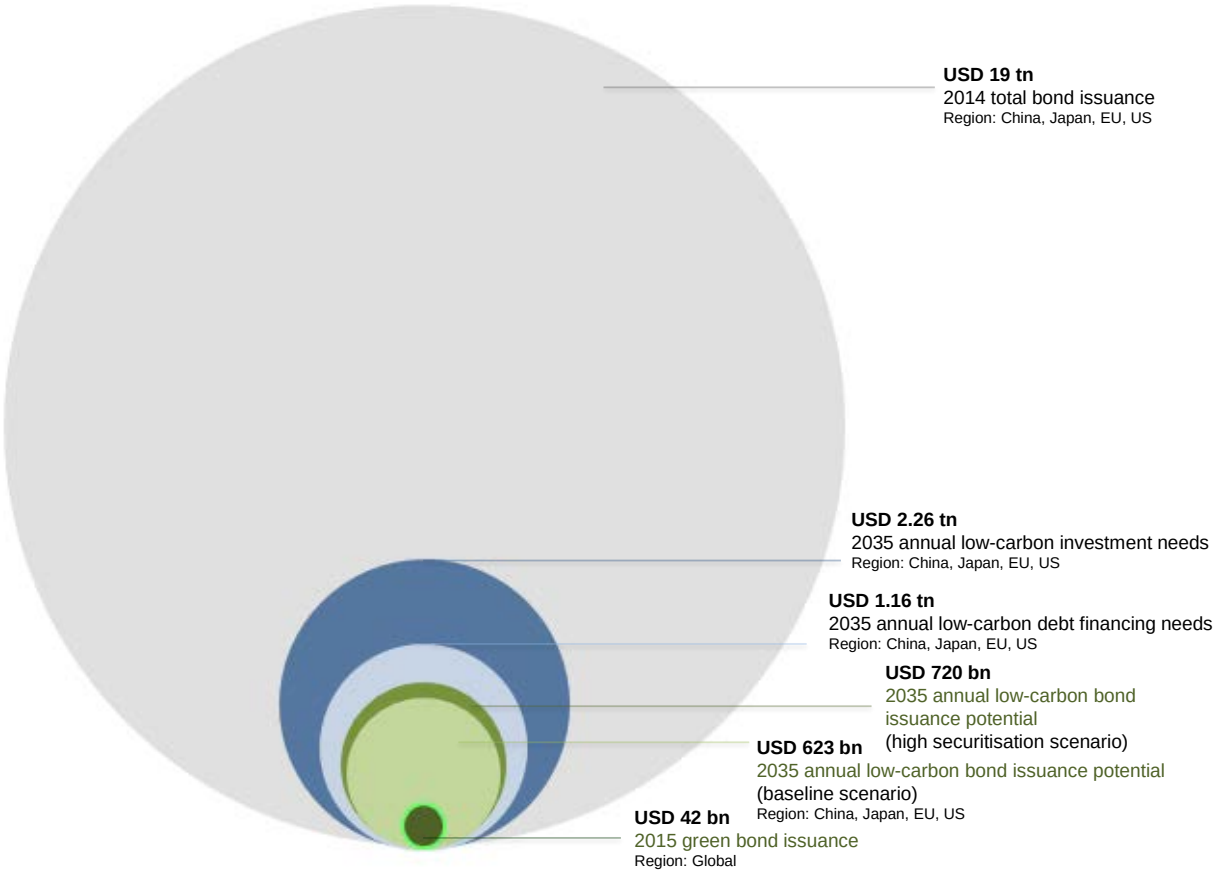
2.2. High level results in context

After having examined the aggregate debt, bond and equity proportions implied by the investment needs, the work then considers the types of debt instruments and bonds that would be suitable for each type of asset. The results of the analysis suggest that by 2035 in a 2DS, bonds financing and re-financing the three sectors in the four markets studied have the potential to scale to as much as USD 4.7-5.6 trillion in outstanding securities globally and USD 620-720 billion in annual issuance with the ranges representing a base-case "low securitisation" scenario and a "enhanced securitisation" scenario, respectively (Figure 1.6).[14] While these figures may seem large on an absolute basis, they are small (approximately 4%) relative to the scale of issuance in debt securities markets generally with USD 19 trillion of gross issuance in China, the EU, Japan and the US in 2014.[15]

[14] Note that while the model generates results down to the decimal place as a result of its calibrations, figures are rounded up in the discursive analysis to reflect the inherent uncertainties commensurate with technological, product and financial market evolutions over the next 20 years.

[15] OECD analysis based on data from BIS, SIFMA, ECB, JSRI, ADB and Goldman Sachs.

Figure 1.6. Scenario results to 2035 compared with low-carbon investment needs and new debt securities issuance (USD, annual)

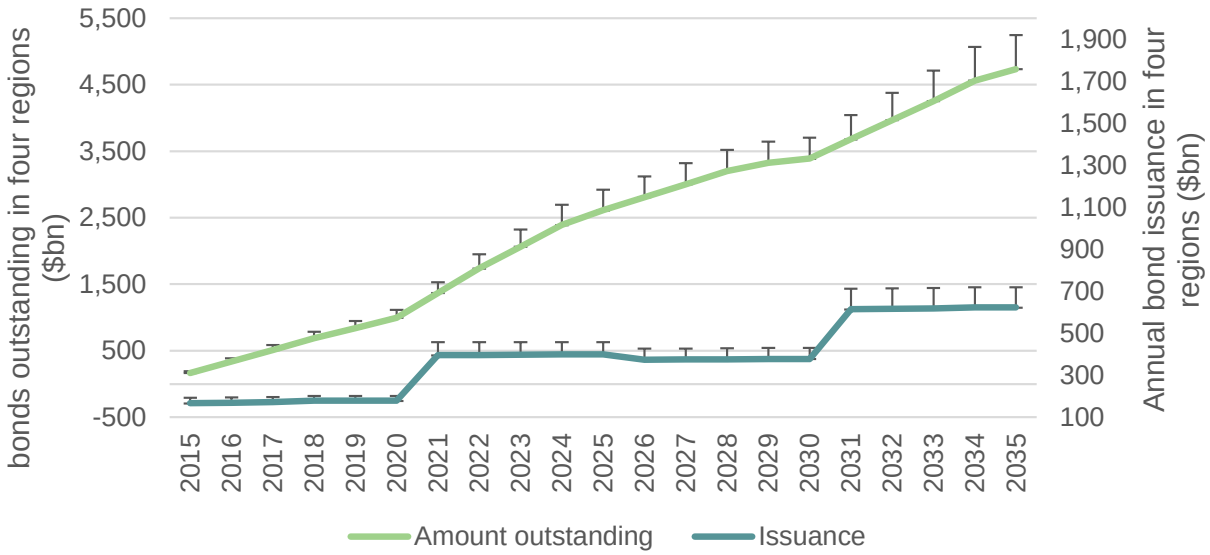


Note: OECD modelling scenarios and annual "low-carbon" investment needs in figure cover the renewable energy, energy efficiency and low-emissions vehicle sectors as estimated by the IEA (2014, 2012). The 2015 green bond issuance figure of USD 42 bn is provided as a reference point and extends to all sectors included in Climate Bonds Initiative database. No judgement is made as to the percentage of bonds from these "low-carbon" sectors that will be labelled as "green bonds". Annual total bond issuance is provided as an illustration and just as with green bond issuance, reflects "gross issuance" figures i.e. does not account for those securities that reach maturity or are redeemed from previous years (termed "net issuance"). It includes other types of debt securities such as notes and money market instruments.

Source: OECD analysis based on IEA (2014, 2012), Climate Bonds Initiative (2015), BIS (2015), SIFMA (2015), ECB (2015), JSRI (2015), ADB (2015) and Goldman Sachs (2015).

The analysis suggests that the 2020s have the potential to be the start of the "golden years" for bond issuance in the low-carbon sectors. As low-carbon technologies mature, they become more familiar to bond markets which will be substantial contributors to the financing and re-financing of new-build assets. The two main scenarios presented in Figure 1.6 represent the aforementioned baseline scenario and a "enhanced securitisation" scenario with a 10% increase in ABS-type bonds issued indicated by error bars in Figure 1.7 which shows issuance and outstanding bonds. The latter scenario is useful to consider because it could occur if certain policies targeted at enhancing securitisation markets (as discussed in OECD 2016, forthcoming) are adopted beyond those in the core scenario.

Figure 1.7. Potential for low-carbon bond issuance ranges between USD 620 billion and USD 720 billion per year by 2035

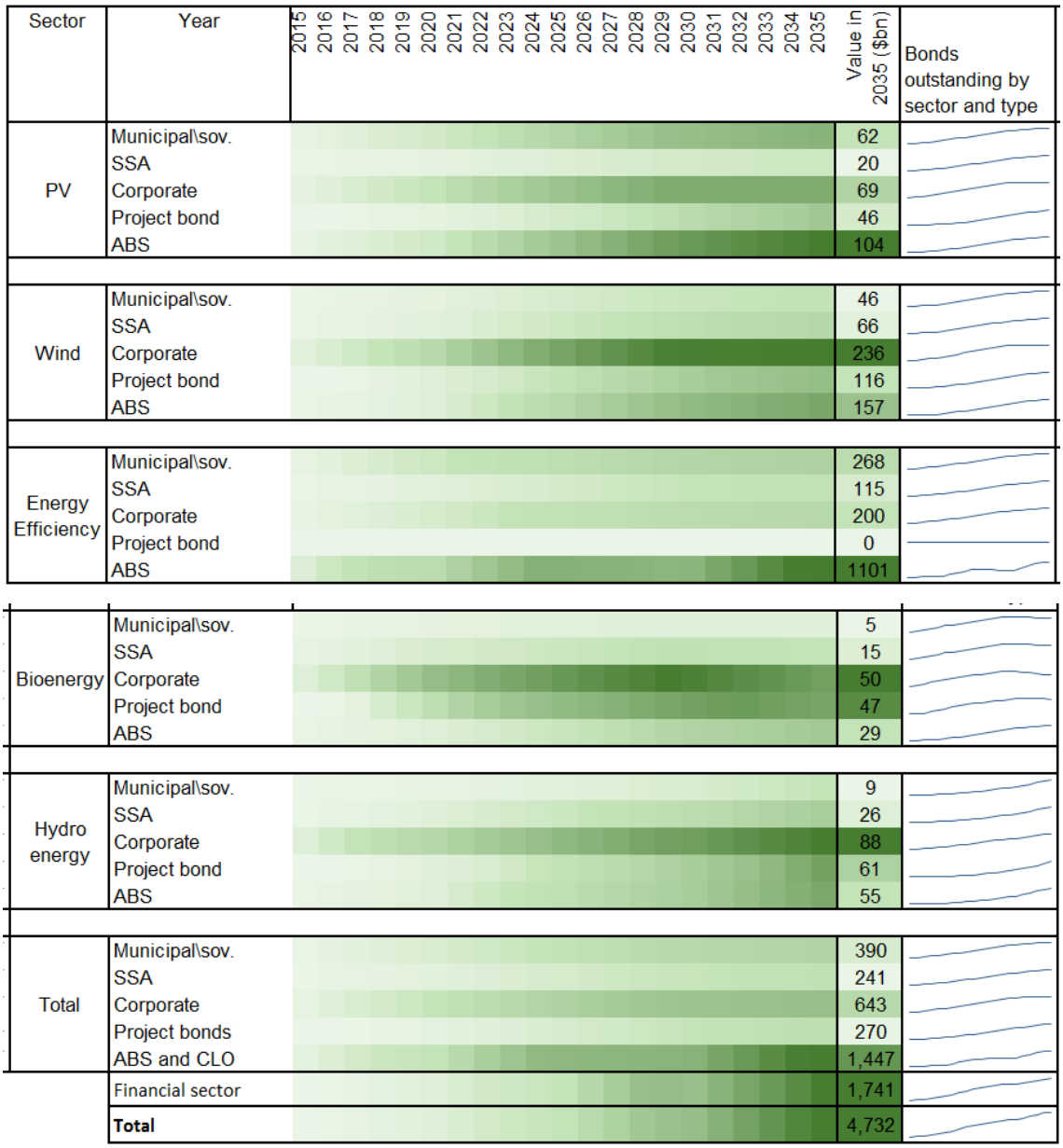


Note: Error bars represent the enhanced securitisation scenario, based on a 10% increase in asset securitisation rate across all sectors over the baseline scenario, which incorporates a more conservative asset securitisation assumption. "Outstanding" refers to cumulative amount of bonds issued that have not yet reached redemption or maturity.

As the risks of assets fall, as policy stabilises, and as the capital markets become more familiar with the low-carbon sector, the role played by bonds could expand rapidly as demonstrated by historical precedent throughout the traditional energy and infrastructure sectors (Dewar, 2011).[16] Figure 1.8 exhibits the potential for different types of bond to finance a range of sectors and sub-sectors of low-carbon investments studied. It displays a picture of the volume of outstanding securities through to 2035 and the speed at which they could potentially scale up.

[16] As described by Dewar (2011), accessing the capital markets to fund projects and infrastructure arguably dates to the 1800s with the US railroad expansion. The first modern private sector project bond offerings date to the 1980s and early 1990s, encouraged in part by changes in the US securities regulatory regime that facilitated bond offerings to institutional investors. The first wave of project bonds financed or re-financed independent power projects and quickly evolved to a broad range of electric, oil and gas, water and other power-related assets; as well as toll roads, railways, and eventually social infrastructure such as hospitals, schools and prisons.

Figure 1.8. Potential and speed of scale-up for bonds outstanding varies by type of bond, sector and sub-sector (Baseline scenario, USD bn)



Note: "Outstanding" refers to cumulative amount of bonds issued that have not yet reached redemption or maturity. Shades of green do not represent uniform values and are illustrations of magnitude of outstanding bonds as a share of the 2035 total for a particular sector and type of bond.

3. Results by type of bond[17]

3.1. Financial Sector Bonds

The results shown in Figures 1.4 and 1.5 reveal the prominent role loans can play in financing low-carbon investment needs to 2035. Financial institutions (including banks and non-bank intermediaries) are expected to continue to be the largest provider of loans to all three sectors given their specific expertise in the arranging of credit for the earlier stages of infrastructure development project cycle, from planning, to construction through to project operation, when other sources of debt capital including bond markets can be called on to re-finance the debt. While financial institutions have a major role to play in arranging the debt financing for low-carbon infrastructure through loans and through underwriting and investing in bonds, they notably also can act as issuers of "financial sector" bonds as is shown in Figures 1.9-1.12.

Financial institutions rely to a large extent on bonds to raise capital for their lending activities, with US and EU commercial banks currently maintaining a bond to loan ratio of 30% (McKinsey, 2015a; ECB, 2015). Commercial banks are among the most active and prominent users of bonds markets to raise capital for their lending activities. In the US and EU, 42% and 48% respectively of outstanding debt securities had been issued by financial institutions in 2014 (McKinsey, 2015a; ECB, 2015).

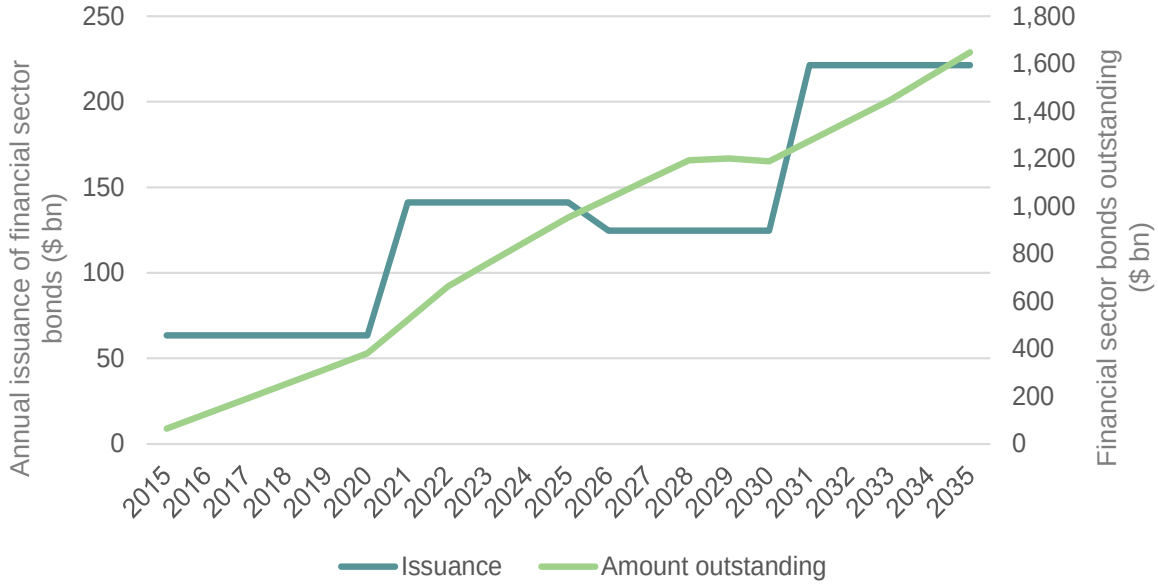
Financial institutions are expected to continue to use bond markets to raise capital to finance their low-carbon related lending, which can lead to financial sector issuance of bonds that finance this on-balance sheet lending (referred to as "on-lending"). An example of this type of bond in the market today is ABN AMRO's EUR 500 green bond issued in 2015 where the proceeds are used to finance and re-finance "Green Loans" that finance solar panels installed on residential buildings as well as commercial real estate loans for the construction and financing of energy-efficiency buildings.

Unlike ABS and Collateralised Loan Obligations (CLOs), bonds issued by bank treasuries will not be directly backed by green assets. However, as is seen in the case of "use of proceeds"[18] corporate bonds, a link can be established between the capital raised by a bond and how it is put to use in financing low-carbon investment. Figure 1.9 shows a scenario for bond issuance by the financial sector, keeping assumptions based on the market today constant, and the corresponding amount in outstanding bonds issued by financial institutions between 2015 and 2035. This segment of the market has the potential to add up to USD 1 trillion to total bonds outstanding in 2025 and USD 1.7 trillion in 2035 (out of a market of USD 4-5 trillion).

[17] Note that while the model generates results down to the decimal place as a result of its calibrations, figures are rounded up in the discursive analysis to reflect the inherent uncertainties commensurate with technological, product and financial market evolutions over the next 20 years.

[18] As defined by the Green Bond Principles: *www.icmagroup.org/Regulatory-Policy-and-Market-Practice/green-bonds/green-bond-principles/*.

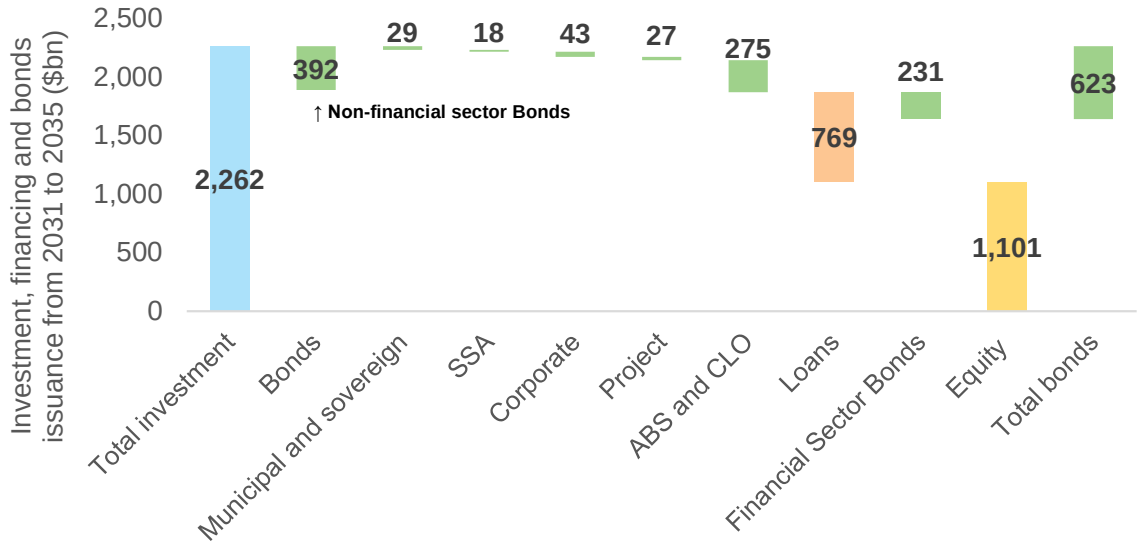
Figure 1.9. Bonds issued by the financial sector exhibit significant potential to scale



Note: Financial sector issuance of bonds assumes a bond to loan ratio of 30% in all modelled markets

Figure 1.10 presents a complete view of how almost USD 2.3 trillion of annual low-carbon investment needs in the sectors and markets studied in the period 2031-2035 could be financed. In order to distinguish between bonds which directly finance and re-finance investment needs (i.e. projects) from financial sector bonds which fund bank loans for projects, the figures for financial sector issuance are presented separately from other bonds and as a derivative of loans.

Figure 1.10. Financing in 2035 by type of capital and bond (baseline scenario)



Note: CLO: Collateralised Loan Obligation. Bonds coloured in green and financial sector bonds appear after loans to reflect issuance that finances on-lending via banks.

3.2. Asset Backed Securities

Revitalising the concept of securitisation, which was tarnished during the 2008-2010 financial crisis, is important to the scaling up of low-carbon infrastructure finance and has emerged as a key area of focus for policy makers (IMF, 2015). A healthy market for securitisation can deliver significant financial benefits[19], and efforts by policy makers geared at mitigating risks and ensuring that securitisation markets contribute to economic growth and financial stability is recognised and underway under the EU's Capital Markets Union Action Plan[20] as well as in the US through the Solar Access to Public Capital Initiative[21] and elsewhere, including in China (EC, 2016; CBI/LSE, 2015; U.S. DOE/NREL, 2015; IMF, 2015). This revitalisation can be achieved in large measure by standardising the assets and by making the process, and the market activity it spurs, safer, simpler and more transparent. Any efforts to support green securitisation must be undertaken in a prudent, judicious and transparent manner so that ABS markets emerge with integrity and with due consideration for any financial stability issues.

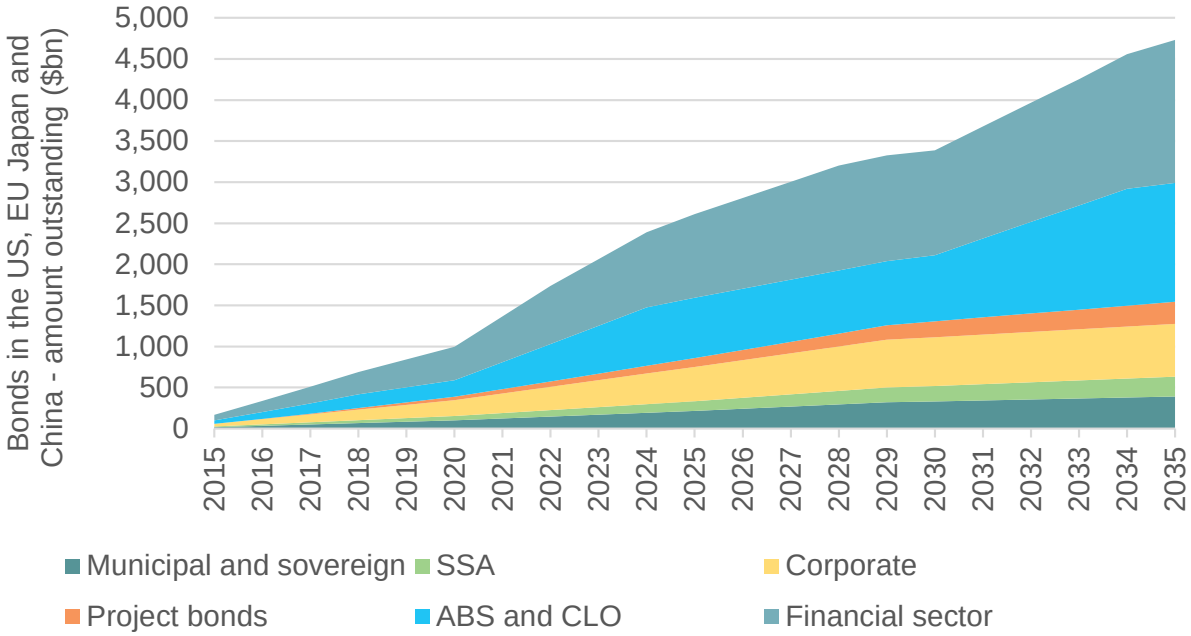
There is potential for a significant expansion in the origination and subsequent issuance of ABS as perceived risks fall. Standardisation of projects and policy support can enable pooling of individual loans to occur, which effectively ties bonds to a group of assets, rather than individual assets. Compared to project bonds that generally back individual projects (or collections of larger scale assets concentrated in wind and solar "farms"), ABS are more efficient vehicles for aggregating pools of individual loans.

[19] From a high level perspective, as a means of efficiently channelling financial and economic resources, securitisation supports economic growth and financial stability by enabling issuers and investors to diversify risk. By opening up new avenues for raising capital, securitisation can aid in diversifying the funding base of the economy. Securitisation can also help free up bank capital, which in theory allows banks to extend new credit to the economy. Source: IMF (2015)

[20] For instance, the European Commission's Securitisation Regulation will apply to all securitisations in the EU and include due diligence, risk retention and transparency rules together with the criteria for Simple, Transparent and Standardised ("STS") Securitisations. This is accompanied by a proposal to amend the EU Capital Requirements Regulation to make the capital treatment of securitisations for banks and investment firms more risk-sensitive and able to reflect properly the specific features of STS securitisations.

[21] The U.S. National Renewable Energy Laboratory (NREL) Solar Access to Public Capital (SAPC) working group was designed to open capital market investment for solar assets via securitization and other financial innovations. SAPC was a three-year initiative that ended in September 2015. SAPC membership included over 440 organizations such as top residential and commercial solar developers, law firms, investment banks and capital managers, rating agencies, independent engineers, and other key stakeholders in the solar finance space.

Figure 1.11. Asset-backed and financial sector bonds have the largest potential to scale up (baseline scenario)



Note: ABS = Asset-Backed Security; CLO = Collateralised Loan Obligation. Chart depicts the base case "low-securitisation scenario".

ABS have a disproportionately large potential since they are less likely to be constrained by government fiscal and budgetary constraints in the case of government (i.e. municipal) bonds, and by balance sheet constraints[22] in the case of corporate and SSA bonds seen as accounting for USD 240 billion and 640 billion (8% and 14%) of bonds outstanding in 2035. Annual ABS and CLO issuance is seen as having the potential to reach USD 280-380 billion in the 2031-2035 period in the baseline and enhanced securitisation scenarios, respectively (or between 44-52% of annual issuance).

The prominent role that could be played by securitisation and issuance of ABS and CLOs rests on two arguments. First, as new technologies mature and track records develop, the perceived risks of ABS and CLOs and need to assess risk on a project-by-project basis will decrease. Standardisation of technologies and contracts will allow for pooling of loans and leases, and for bonds to be backed by a group of assets, rather than individual assets. Second, there is a need to move away from the constraints of balance sheet financing in order to scale up investments to the quantum needed in a 2DS. If market forces and policy makers come together to facilitate and rejuvenate the securitisation process in a judicious and transparent way (see OECD, 2016 forthcoming), a pipeline of financially attractive projects (due to a mix of policies, policy support, standardisation and technology cost reductions) will emerge that can benefit from increased financing flows beyond the limits imposed by balance sheet constraints of a structural and regulatory nature on power companies and banks.

LEVs, distributed and small scale power generation have significant potential for asset securitisation. Projects within each of these categories share financial characteristics and can be

[22] I.e. limits on the amount of debt these entities can take on directly before risking a credit rating downgrade.

standardised and homogenised, allowing for pooling of projects. The automotive market is seen as having the greatest opportunity, driven by current trends in car loan and lease securitisation combined with large replacement investment needs in transport to 2035, except in China where there is an increase in vehicle ownership. Hence, the analysis indicates that ABS increases market share over time as the ABS market develops in China. Securitisation of LEV leases are seen as a particularly suitable target, as demonstrated by ABS issued in 2014 and 2015 from Toyota. Accordingly, by 2035 in the baseline scenario, almost a third of outstanding bonds from the low-carbon sectors studied could be in the form of ABS.

Securitised energy efficiency loans have the potential to make up 18% of ABS outstanding in 2025 and 13% in 2035. These are likely to constitute a minor part of the potential that green mortgages are thought to have to finance the full value of efficient buildings. Green mortgages could eventually be securitised into green Collateralised Mortgage Obligations (CMOs).

3.3. Project bonds

Project bonds are also likely to grow in line with the general expansion in low-carbon physical asset deployment, enhanced through specific policy support measures such as credit enhancement. Annual issuance is seen as having the potential to reach around USD 30 billion in the 2031-2035 period (accounting for 4% of all low-carbon bond issuance). While ABS are a more efficient investment vehicle for aggregating smaller projects and loans, project bonds can support large scale assets such as off-shore wind, geothermal, hydro and enabling infrastructure such as interconnectors, as well as larger wind and solar farms. As of 2016, all of these sectors had featured project bond financing.[23]

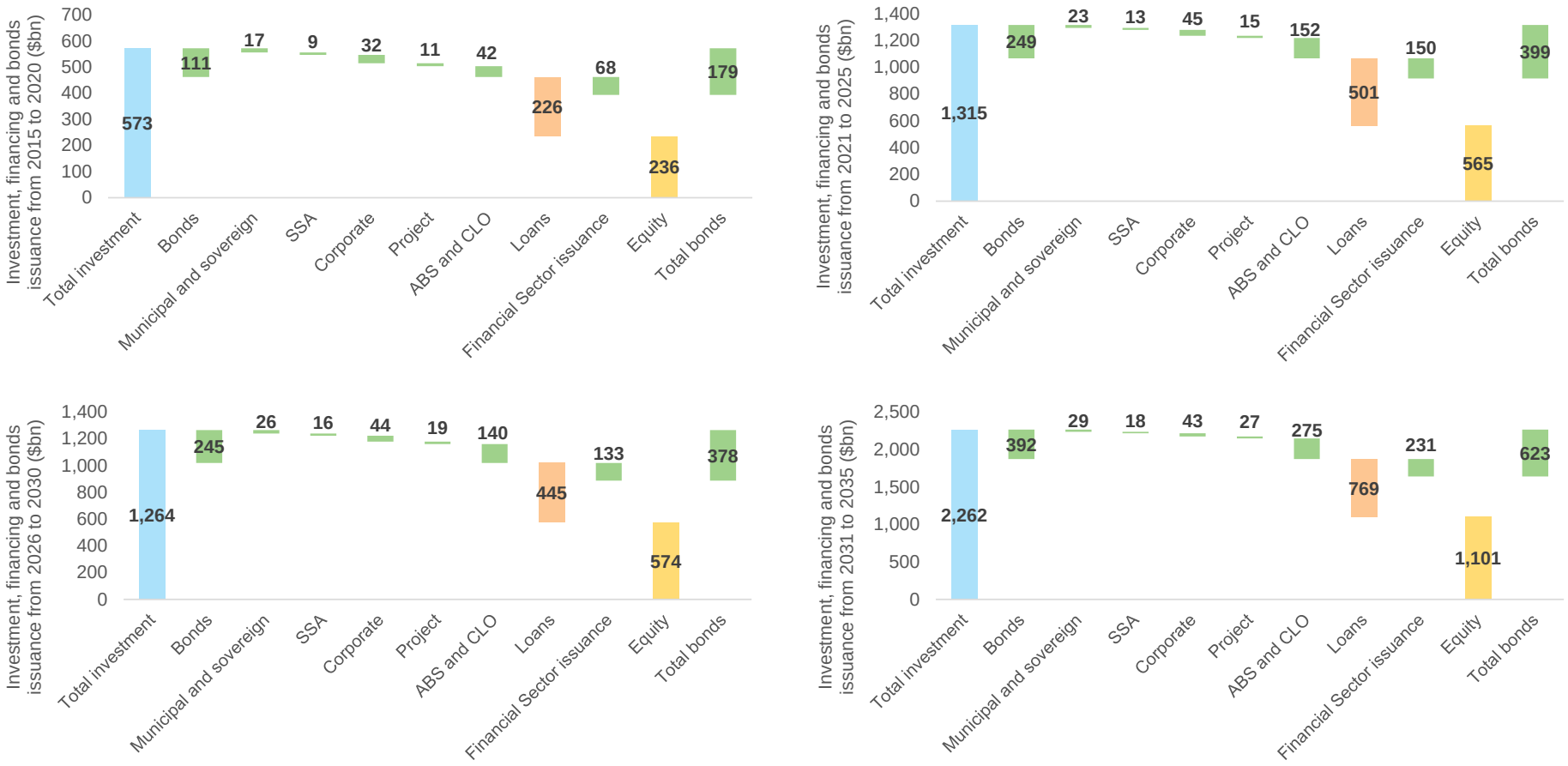
3.4. Sovereign, sub-sovereign, municipal and agency bonds

The share of municipal, sub-sovereign and sovereign bonds could grow over time but is seen as constrained by public finance limits and the fiscal capacities of governments. Annual issuance is seen as having the potential to reach around USD 50 billion in the 2031-2035 period (accounting for 8% of all low-carbon bond issuance). Public financial institutions such as development banks and agencies could theoretically increase their issuance if their capitalisation is increased, but this prospect is not modelled due to uncertainty. Efforts to expand the creditworthiness and ability of cities to issue bonds could positively impact these figures in emerging and developing economies.

The main use of public borrowing is seen as financing municipal programmes to improve energy efficiency of buildings and support renewable energy deployment. As of April 2016, a sovereign bond with proceeds ring-fenced for low-carbon purposes had yet to be issued, although this does not preclude the prospect of such issuance occurring. Figure 1.12 illustrates the growth and share of various types of bonds between 2015 and 2035.

[23] It should be noted that, in many jurisdictions, the attractiveness of financing via project bonds is affected by competition from the project finance bank lending and "term loan B" or mezzanine debt markets. Constructing a sensitivity analysis to address these issues was not possible due to lack of credible assumptions, but these factors could negatively or positively affect the potential for project bond financing shown in the analysis.

Figure 1.12. Annual investment breakdown by sources of finance and bond outstanding in the four regions (baseline scenario)



Further details are revealed in the waterfall charts shown in Figure 1.12. The share of bond issuance in total investment starts at 31% in 2015 and falls slightly to 28% in 2035 due to a higher share of vehicle finance. The share of equity rises from 41% in 2015 to 49% in 2035 while loans fall steadily from 39% to 34%. Corporate bonds including those issued by financial institutions have the potential to account for the largest share of bond issuance in the 2015-2020 period, with 56%, while ABS and Collateralised Loan Obligations[24] (CLOs) may account for 23%. However the amount of ABS and CLO issuance has the potential to rise significantly to 44-46%% of total issuance in 2035, whereas corporate issuance falls 44-41% in the baseline scenario and enhanced securitisation scenarios, respectively. SSA and government bonds are seen as falling from 14% to 8% over the period.

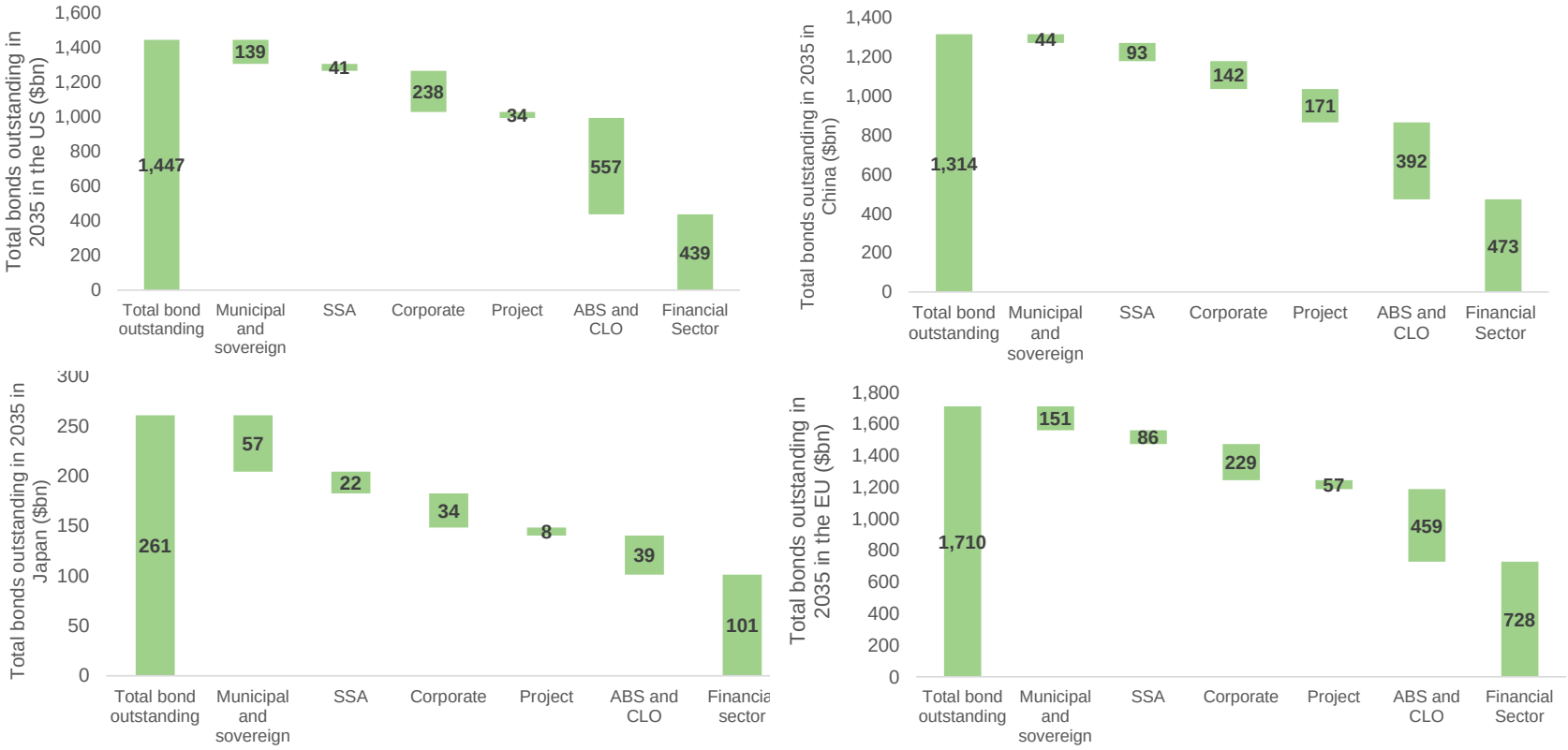
Corporate bonds are seen as continuing to play an important role, raising financing for a variety of assets. Corporate bonds could dominate the universe of bonds outstanding with a 60% share, during the early stage of market development. This share is also seen as falling to 50% in 2035 while ABS and CLO shares may increase from 20% at the start of the period to 30% in 2035. These trends illustrate a trend of early market development led by corporate issuance. However as markets mature the size of ABS and CLO markets will take a more prominent role, as is the case with many other debt securities markets. The reason for this change is embedded in both the higher securitisation rate in the later stages of market development and the greater prominence LEV investment will need to take toward the later stages of the period. Policy makers will need to play an important role to permit and facilitate this transition. They can do so by creating a regulatory environment that minimises risks (i.e. by ensuring that securitisations are done prudently and provide sufficient transparency), while helping to kick-start the market through certain methods (as discussed in OECD, 2016 forthcoming).

4. Geographic results and variations

Results obtained for individual markets highlight geographical variations and some similarities. For instance, financial sector issuance potential is seen as strong in all four markets, and the financial sector accounts for the largest low-carbon bond sector in China, the EU and Japan (Figure 1.13). The following section describes the potential for the market in 2035 in terms of outstanding bonds, and provides geographic overviews along with snapshots of the annual issuance potential by 2020.

[24] CLOs are ABS securities that consist of a portfolio of different loans.

Figure 1.13. Regional variations are significant across the four markets studied by 2035



Source: Source: OECD analysis

Note: Appendix 1.C contains detailed results for each market

4.1. United States

In the US, a higher share of ABS is seen as possible than in other markets in 2035 (which have much lower shares of ABS currently), with ABS representing the largest share followed closely by financial sector bonds. This is due to the higher level of maturity of the financial markets in general and securitisation rates and markets in particular in the US. The US Mortgage Backed Securities (MBS) market currently represents 60% of all mortgage debt outstanding in the US[25] and the US auto loan ABS market is also relatively mature with a 20% securitisation rate of total vehicle expenditure (SIFMA, 2015).[26] In practice, some challenges could impede growth of asset securitisation, for example in the solar industry. However, at least some of these barriers can be overcome through financial structuring (Lowder and Mendelsohn, 2013).

US utilities are among the highest users of bond finance, and are reflected as such in this analysis. Over time it is assumed that a portion of corporate borrowing by US utilities will be substituted by project bonds and ABS. The analysis suggests US utilities could be a more important contributor to corporate bond issuances than in other regions, account for 30% of US corporate bond issuance in 2025, declining to 25% in 2035. US utilities are very active in the efficient US corporate bond market today, but a question remains as to what extent corporate balance sheets (assuming the same universe of companies, without capital from new entrants) can sustain the incremental levels of investment required by a 2DS scenario. If balance sheets become strained by the amount of investment needed, substitution of corporate issuance with project bonds and ABS may become an attractive alternative.

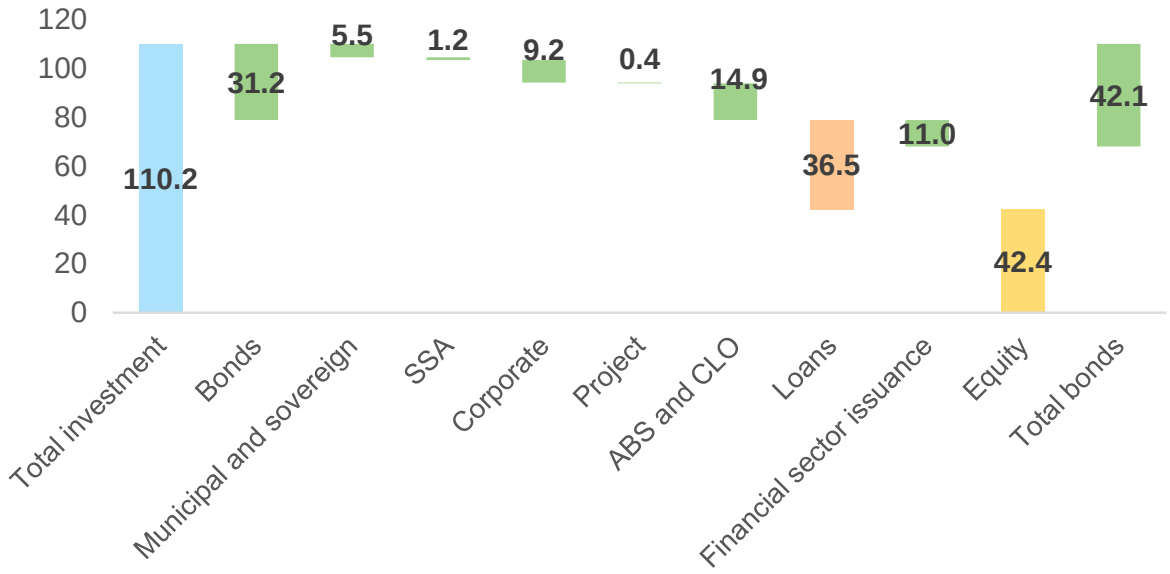
US municipal authorities issue bonds to finance their infrastructure-related expenditure and are expected to continue to do so. Similarly, SSA and development banks are seen as having a role to play with state-sponsored "Green Investment Banks" in Connecticut and Hawaii already active in mobilising the debt capital markets for low-carbon investment (OECD, 2016a). Budget constraints, however, are expected to prevent municipalities and SSA bond issuers from scaling up their issuances to match the pace of corporate issuers, and ABS securitisations. Municipal, [sub-]sovereign[27] and SSA issuances could account for 3% of total outstanding by 2035.

[25] According to SIFMA the amount outstanding of agency and non-agency residential MBS is USD 8 tn, while the Federal Reserve Financial Accounts statistics report a figure of USD 13 tn for residential mortgage debt outstanding.

[26] SIFMA reports a figure of close to USD 100 billion in 2014 for the outstanding amount of auto loan ABS, while the aggregate expenditure on new vehicles stood at USD 450 billion.

[27] To do date, no sovereign bonds have been issued specifically for low-carbon purposes.

Figure 1.14. Annual investment, financing and bond issuance potential in the US by 2020 (USD bn)

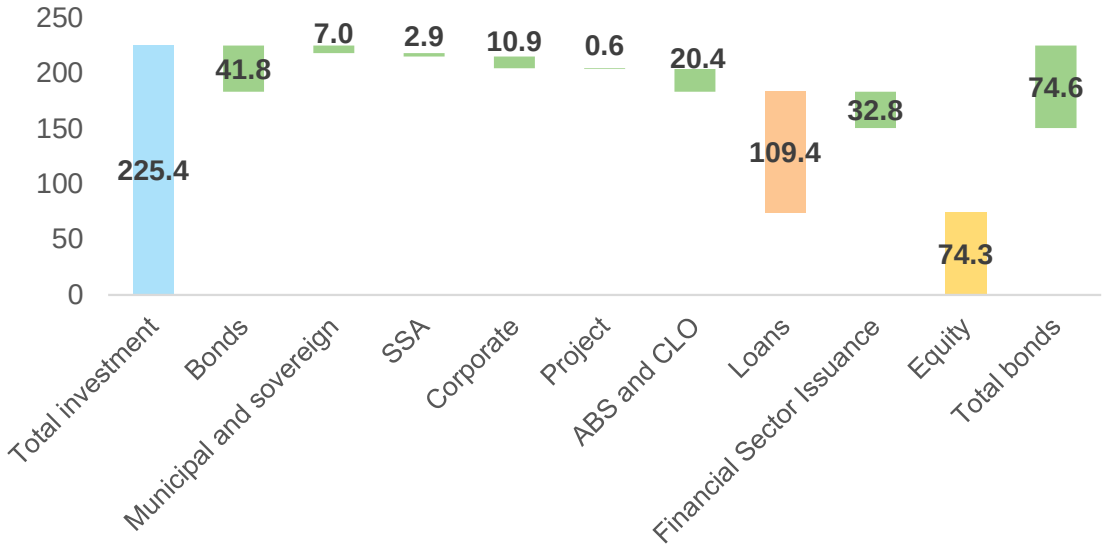


4.2. European Union

Similar to the US, the EU features strong potential for ABS, but the financial sector is seen as playing a more prominent role than in the US. ABS is seen as accumulating a large market share but cedes some of this share over time to corporate and project bonds. The increase in project bonds reflects assumptions that include policy support such as the Project Bond Credit Enhancement Initiative undertaken by the European Investment Bank and the European Commission, which is targeted at increasing reliance on bond financing at the project level.

Corporate bond issuance has the potential to be very significant given the active role European utilities have played in the EU corporate bond market. Governments could be strongly involved in raising funds through the bond market to implement energy efficiency and renewable energy programmes. Many options are possible in Europe and much will depend on the direction policy takes and the strength of corporate utility balance sheets, which have deteriorated in recent years.

Figure 1.15. Annual investment, financing and bond issuance potential in the EU by 2020 (USD bn)



4.3. China[28]

In China, corporate and project bonds could take the greater share while ABS could expand gradually alongside a maturing debt capital market. In 2025 half of the low-carbon bonds outstanding could be issued by corporates, particularly the financial sector. Currently Chinese non-financial corporates are predominantly reliant on bank lending. Only 6% of all debt outstanding in 2013 was in the form of debt securities, though this is projected to increase to 15% between 2014 and 2018 (S&P Capital IQ, 2014). China's state owned enterprises and the "quasi-public" sector including banks have been largely successful in issuing infrastructure bonds and creating a market for these bonds. Between 2009 and 2013, an estimated 80% of infrastructure debt was raised through infrastructure bonds. The prospect of participation by financial and corporate entities in China was realised in early 2016 following the release of guidance, regulations and requirements for green bond issuance by the People's Bank of China (PBoC). As of April 2016, green bond issuance in China had already reached USD 5.3 billion, with forecasts for annual issuance surpassing USD 46 billion in 2016; a figure already close to that shown in the scenario for 2020 of around USD 52 billion in annual issuance potential (PV Magazine, 2016).

The high proportion of bond finance for infrastructure projects and low reliance on bond finance by Chinese corporates is reflected in this analysis, which assumes an average bond proportion of 47% in the capital structure of renewables project finance and a 20% bond share in corporate finance by power utilities.

[28] The analysis of the potential for bond financing in other emerging market countries is beyond the scope of this analysis and would require enhanced data and assumptions to be made available for a rigorous assessment to be attempted. However, the results of the analysis of China's scenarios for bond market financing in a 2DS coupled with the similar investment needs profiles of other major emerging markets suggests that other emerging markets could follow a similar low-carbon bond financing trajectory, but with a delay of 5-10 years due to differing stages of financial market development and accompanying policy efforts.

Project bonds in China currently enjoy a boost to their credit rating since they are usually assumed to benefit from a guarantee from the state (Ehlers et al., 2014; Ehlers, 2014).

Asset securitisation has only been introduced relatively recently in China, becoming an option after the 2005 People's Bank of China and China Bank Regulatory Commission administrative ruling for the Credit Asset Securitisation Program. While the global financial crisis has slowed down the development of asset securitisation in China, there has recently been a strong policy drive to develop an ABS market. The current policy push to reduce reliance on the banking sector in China could hasten the development of an ABS market and bond markets in general. In 2014 there were three types of asset securitisation products in China, however they were still relatively small in terms of yearly issuance (Ernst & Young, 2014):

1. Credit asset securitisation in the national interbank bond market.

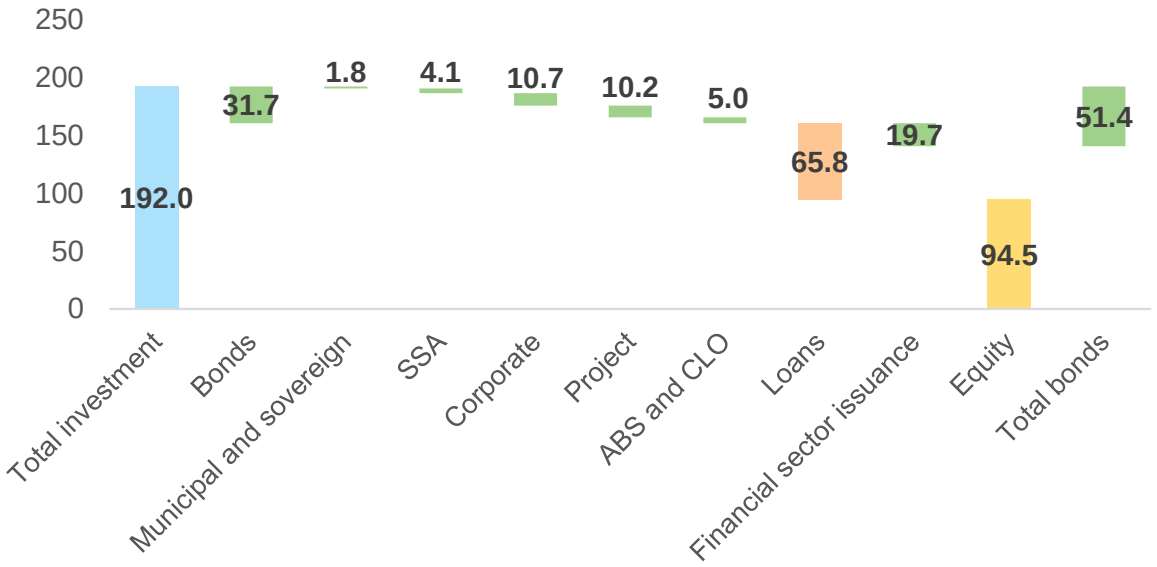
2. Asset securitisation of securities companies.

3. Asset-backed notes.

The Collateralised Loan Obligation market has seen USD 52 billion of issuance in 2014, with the most active issuer being China Development Bank whose loans mainly support infrastructure projects. These CLOs have mostly been repackaged railway construction loans with 86% of the assets backing CLOs cited as corporate loans (Wildau, 2015b). Thus, a large proportion of ABS issuance in the renewables, EE and LEV sectors are likely to come from CLOs. These instruments allow the large banking sector in China to move some of its assets into the broader capital markets. The current policy push to reduce reliance on the banking sector in China could hasten the development of an ABS market and bond markets in general. As such, efforts to support green securitisation should be undertaken in a prudent, judicious and transparent manner so that green ABS markets emerge with integrity and sound financial governance, and with due consideration for any financial stability issues. Limits on banking sector balance sheet capacity in China may lead to changes in financial markets, and could create a higher reliance on the bond market by both municipal borrowers and by corporates who currently rely on the market for syndicated loans from banks and SOEs.

Based on the prominent role that they play currently domestically, SSA actors could be an important driver of Chinese bond market growth, including for low-carbon bonds. International Financial Institutions, and Chinese sub-sovereign development banks working in conjunction with policy banks, have the potential to play a pivotal role in the early development of a green bond market in China. Municipal bond issuance is currently low given the traditional reliance of municipalities on bank loans. This is changing rapidly, however, due to government policy aimed at swapping municipal debt for bonds. In 2015 the Chinese government imposed a USD 160 billion quota on banks for loan to municipal bond swaps (Wildau, 2015a).

Figure 1.16. Annual investment, financing and bond issuance potential in China by 2020 (USD bn)



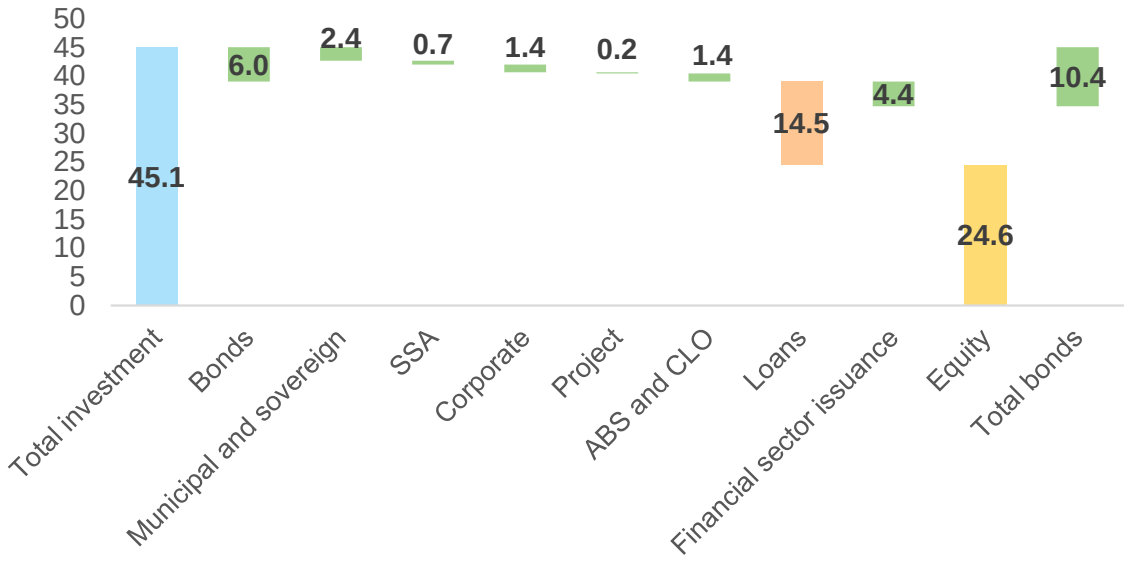
4.4. Japan

Overall when examining the Japanese market's potential, the result shows a low degree of securitisation but similar levels of other bond issuance in Japan. Investment needs in general are lower compared to the other three markets due to the scale of the economy and nature of the energy transition needed. The equity portion is seen as remaining large, as a high proportion of vehicle purchase is self-financed and is assumed to continue as such. The investment needs over the entire 2015-2035 period are estimated by the IEA (2015) to be USD 1.95 trillion.

The baseline scenario suggests that equity can account for 55% through to 2020, rising to 62% in 2035, while the debt portion is lower for Japan compared to the other three regions (60% in the US, EU and China compared to 40% in Japan). Bond issuance is seen as lower as well, at 23% of overall investment in 2015 decreasing further in 2035 to 19%. This is in contrast to the US, EU and China where the bond portion accounts for 32% to 28% of total investment. Yet the amount of low-carbon bonds outstanding is non-trivial, with potential to grow from around USD 25 billion in 2020 to over USD 260 billion in 2035, roughly double the size of the entire labelled green bond market globally in 2015.

In contrast to the other three bond markets, Japan's market is not expected to be dominated by ABS and CLO issuances since the assumed securitisation rate is significantly lower in Japan, reflecting current practice. On the other hand, financial sector and corporate issuance have the potential to account for the largest share of total bonds outstanding throughout the 2015-2035 period, reflecting the large Japanese banking and corporate sectors.

Figure 1.17. Annual investment, financing and bond issuance potential in Japan by 2020 (USD bn)



5. Detailed results by physical asset sector

The 2DS investment requirements suggest that by 2035, there could be scope for almost USD 100 billion and USD 65 billion in bonds issued annually by the renewables and energy efficiency sector respectively, while USD 230 billion could be issued to finance low-emission vehicles (LEVs).[29] Between 2015 and 2035, the potential contribution of bonds to the financing of renewable energy is the highest of the three sectors, 34% on average. Estimating the percentage of bond financing for the purposes of raising up-front capital and refinancing investment, and the time lags over which this might occur is beyond the scope of this analysis but would be very useful to examine. Bonds contribute only 16% to the financing of energy efficiency projects and 14% to the financing of LEVs.[30] The low rate of bond finance for LEVs is due to high assumed proportions of self-finance in Japan and low securitisation rates used in the models. This reflects the higher capital cost today of LEVs compared to conventional vehicles and the wealthier customer base.

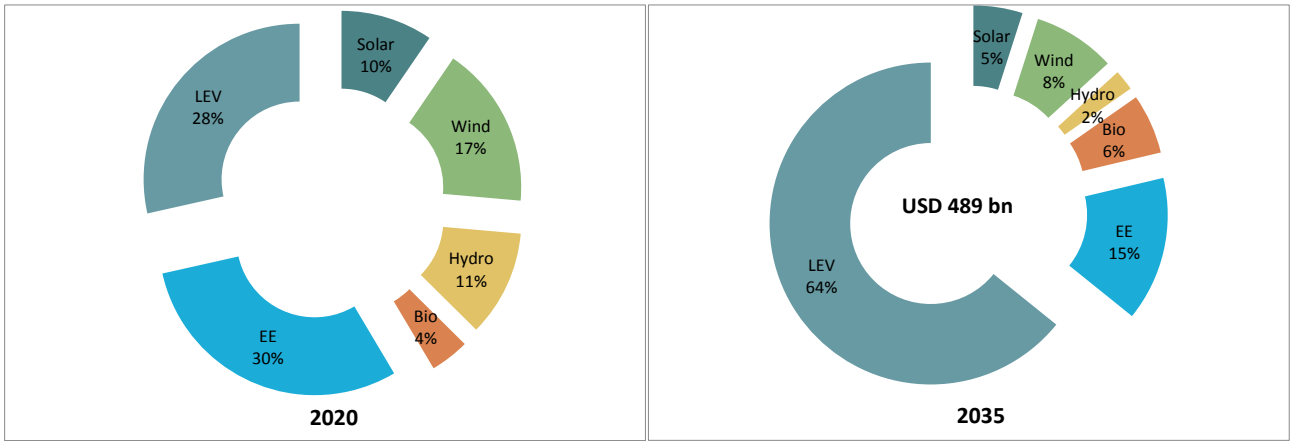
As LEVs become more affordable, debt financing rates could rise, but no robust assumptions were available to model this scenario. The same is true for any future automotive business model evolutions that could impact on investment needs in the sector (i.e. shared mobility – e.g., car sharing and e-hailing). As the model relies on IEA input figures (IEA, 2015), as these are updated to reflect emerging trends (and as assumptions on the nature of these changes become available) the aggregate investment needs could change. This issue is discussed further in paragraphs below. The difference in the potential role of bonds in the three sectors is partly due to the different roles played by debt finance overall, which is larger for renewable energy, at 75%, than for energy efficiency or low-emission vehicles, around 53%.

[29] Excluding the USD 230 billion in annual financial sector issuance (where proceeds are allocated to multiple sectors),

[30] Low-emissions vehicles are defined as plug-in and electric vehicles, fuel cell and hybrid vehicles with emission of less than [90] gCO_2/km, in line with the IEA ETP (2012) total transport investment needs figures for a 2DS.

However, the financing needs of the LEV sector are so large by comparison to other sectors that its issuance of bonds as modelled significantly exceeds that of other sectors. Of the investment needs in renewable energy, energy efficiency and low-emission vehicles, approximately 70% of investments will need to be made in electric and hybrid vehicles between 2015 and 2035 according to the IEA.[31] Consequently, of the USD 390 billion potential annual issuance in 2035, 64% is for LEVs.

Figure 1.18. 2020 and 2035 potential annual issuance volumes and shares, by physical asset sector



Note: Figures are annual over the five year periods shown and excludes financial sector issuance where proceeds are allocated to multiple sectors.

5.2. Low-emission vehicle financing and bonds

Rates of vehicle financing through leases and loans range significantly by country and by type of vehicle and owner, whether commercial or passenger. In Germany for instance, 87% of commercial vehicles and 64% of passenger vehicles are leased or financed through loans (with the remainder purchased with cash). A relatively new concept is to lease EV batteries under a separate contract given degrees of uncertainty over battery lifetimes and high costs of batteries themselves. The rate of securitisation of vehicle purchasing is between zero and 20% across the world. Assumptions used for the financing of vehicles through bonds, ABS and collateralised debt obligations (CDOs) are conservative. Vehicle purchase financing for the household sector in China is still at an early stage of development, but is growing rapidly. At present, the largest market for auto loan securitisation is in the US, where it is estimated to represent the potential for around USD 95 billion of annual ABS issuance, but this still only represents 20% of vehicle expenditure in the US.

The securitisation rate in the EU market is lower still, at 12% of European expenditure on vehicles. Given the high capital cost and low operating costs of LEVs compared to conventional vehicles, credit could become a more prominent method of financing vehicle purchases, either for the whole vehicle, or for the

[31] This investment reflects the financing cost of the vehicle incurred by end users – enabling infrastructure such as charging stations is excluded.

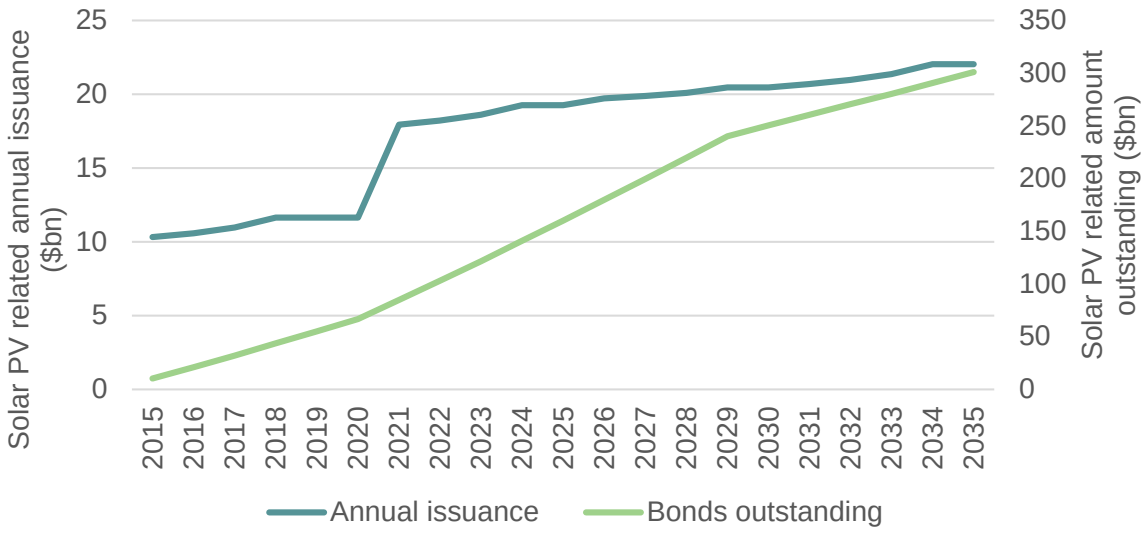
battery pack alone. The introduction of autonomous vehicles and vehicle sharing business models would increase the importance of credit even further. In the scenarios presented in this analysis, there is some increase in the proportion of vehicle investment which is bond-financed, but no disruptive changes have been accommodated.

Conservative assumptions were used in the model due to uncertainties particular to LEVs. The rate of LEV adoption and the financing and ownership models may change substantially through the 2020s as volumes and ownership takes off. As of April 2016, market forecasts and sales figures were already starting to diverge, significantly in some cases (Tesla, 2016; BNEF, 2016). Furthermore, very large changes are conceivable, arising from the adoption of autonomous vehicles, combined with urbanisation and the rise of "on-demand mobility services" (i.e. Zipcar, Uber, Lyft) leading to a potential disruptive switch from personal to fleet ownership, which would imply a much larger role for finance, but at a lower volume of vehicle sales. As such, ABS issuance and bond issuance generally, has possibly very significant upside potential compared to the view taken in the model. Given these uncertainties on how the vehicle market will develop, conservative assumptions were adopted to err on the side of under-calculating potential for future bond issuance.

5.3. Renewable energy bonds

Within the renewable energy segment, wind energy appears to have the potential for twice as much bond issuance as solar PV. As is shown in Figure 1.19, aggregate bonds outstanding from solar PV have the potential to reach USD 265 billion in 2035 with annual issuance of around USD 20 billion, while as shown in Figure 1.21, the potential for bonds to finance wind deployment is estimated at over USD 590 billion outstanding in 2035, with annual issuance of around USD 40 billion. Annual bond issuances in the wind sector could experience a boom around the year 2020, as the technology reaches a level of maturity and standardisation which enable it to be suitable for off-balance sheet bond financing. This result stems from a combination of increasing investment in the wind power sector as it becomes less-subsidy reliant and more dependent on market forces, and stronger penetration of bond finance.

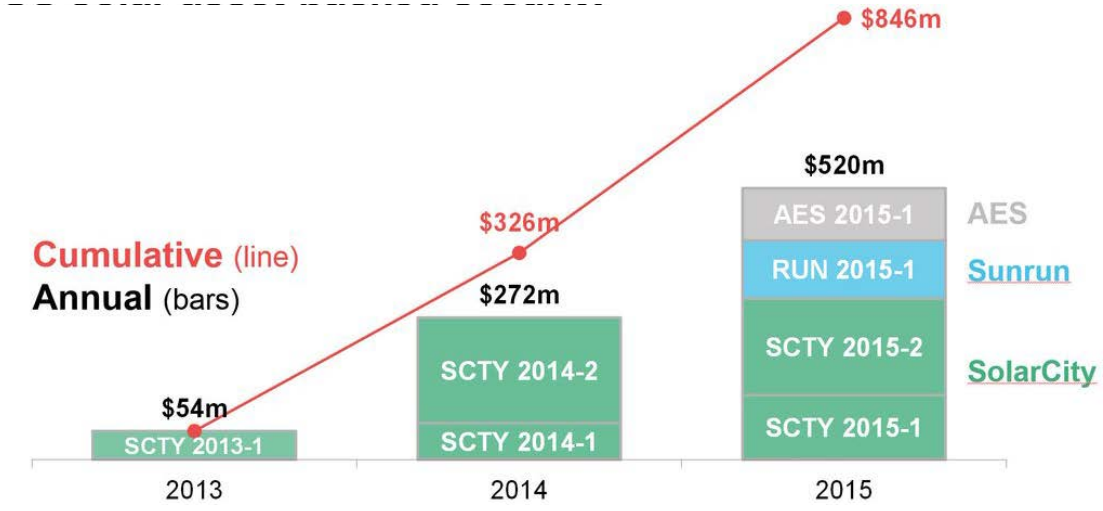
Figure 1.19. Bonds financing solar assets: issuance and amount outstanding



Solar PV may follow suit, creating the circumstances to make the 2020s the "golden years" of renewable energy bond finance. The potential for solar PV figures are smaller than those for wind due to fairly conservative current securitisation assumptions which have been drawn from the literature. Nevertheless, the residential and commercial solar PV sectors have the potential for very high levels of standardisation that leads to much higher level of securitisation. As of January 2016, there was already evidence of this type of asset securitisation by companies such as SolarCity.

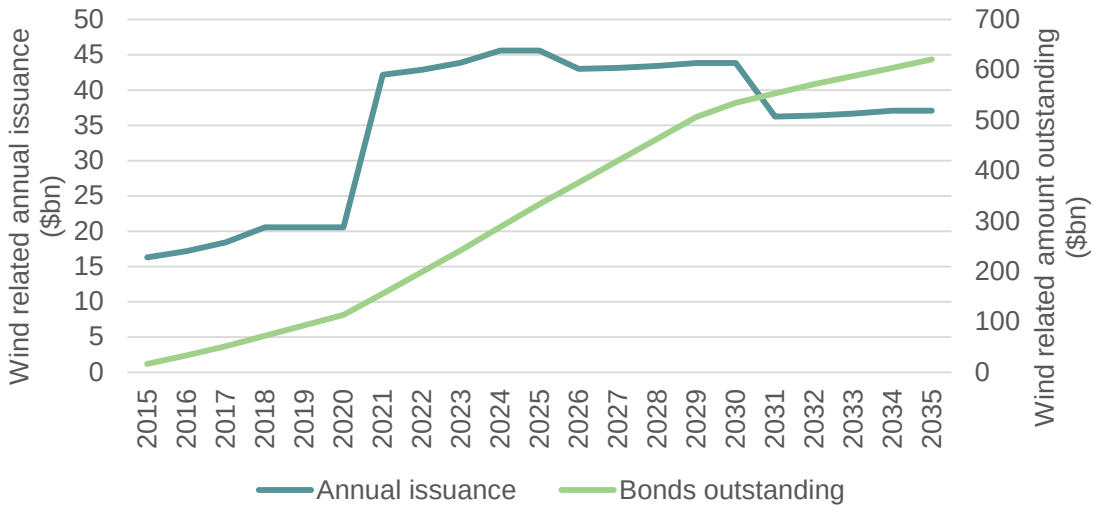
Advocates of distributed-solar securitisation argue that smaller deal sizes and fairly simple technology and permitting leads distributed small-scale solar to be a strong candidate for bond financing, with loan portfolios exhibiting risk diversification similar to mortgage backed securities (MBS), and very low idiosyncratic risk. This leads to very substantial up-side potential for solar PV ABS, and could be modelled as such if assumptions and data on future securitisation rates can be refined. Aside from photovoltaics, too few assumptions on financing structures were available to examine the potential for bond issuance from solar thermal (a technology at an earlier stage of commercialisation). Nonetheless, this sector is projected by the IEA (2014:45) to require USD 800 billion in capital over the period and could hold potential for bond issuance as well. These levels of investment will however only come to pass if the associated deployment levels are enabled through sustained research, development and demonstration.

Figure 1.20. US solar asset-backed security issuance (2013-15)



Source: BNEF (2016b)

Figure 1.21. Bonds financing wind assets: issuance and amount outstanding



6. Implications for institutional investors

Bond finance has the potential to play a significant role in mobilising additional institutional investors to support the low-carbon investment necessary to meet a 2DS by mid-century. However, bond issuance must occur at a scale, and in a format, that such investors are able to absorb. Other sources of potential bond demand exist, such as retail investors, banks and corporations. However, as institutional investor demand has driven the growth of the market to date, it is assumed that this condition would have to endure in order for much higher levels of issuance to be reached (see OECD, 2016 forthcoming for discussion, barriers and policy options for mobilising institutional investors and also OECD/ICMA/CBI/China GFC (2016)).

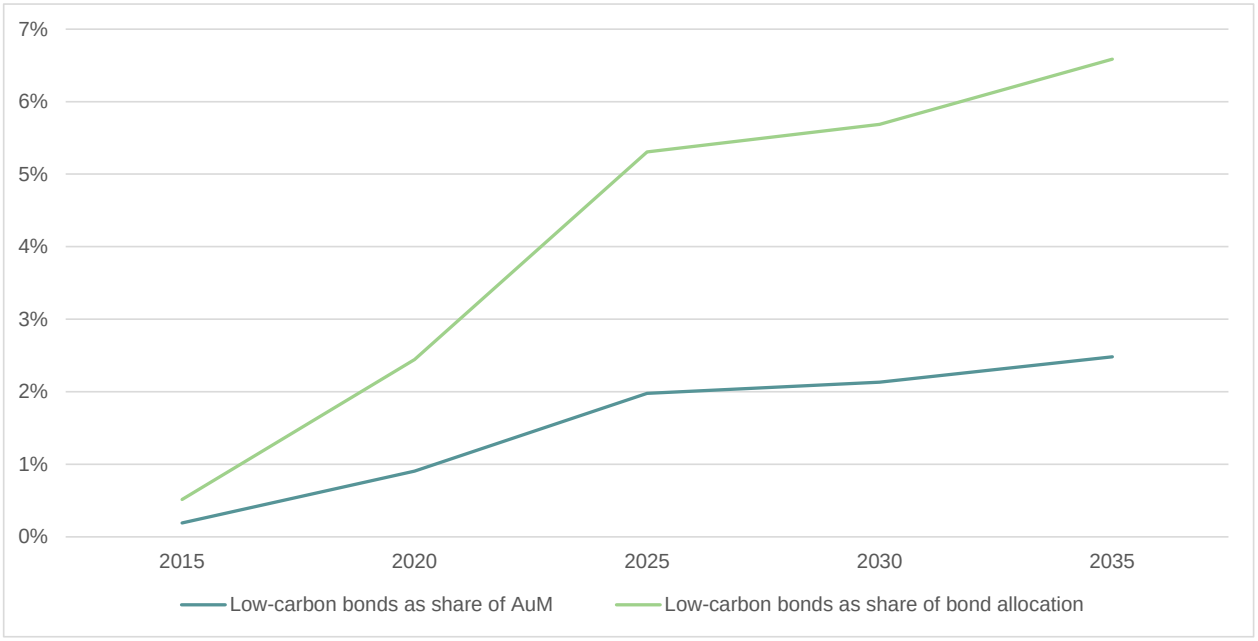
6.1. Implications for asset allocation

The following analysis uses data and projections on institutional investor assets under management (AuM) to 2035 to assess the potential scale of low-carbon bonds outstanding, relative to total AuM and bond holdings of the three main types of institutional investors, namely pension funds, insurance companies and investment funds. The results suggest that institutional investors in the OECD have the potential to absorb the increased supply of bonds, through shifting asset allocations in response to the increased percentage of low-carbon bonds as a share of the broader bond markets. This conclusion is based on two assumptions: 1) institutional investors have driven the green bond market growth to date and have shown appetite for low-carbon bonds more generally – this may be expected to grow in light of increasing attention on climate risks and opportunities in investment portfolios; and 2) as institutional investors tend to adopt and reflect broader market trends (given their share of the market) it is reasonable to conclude that they will shift allocations to reflect the increasing share of low-carbon bonds in the market as a whole.

Institutional AuM is projected to grow to over USD 120 trillion in 2019 (OECD, 2015d). Using a projection based on average growth rates adjusted for inflation, institutional AuM could be seen to grow to over USD 190 trillion by 2035. Weighted average allocation to bonds varies significantly by type of investor, with insurance companies allocating 50% to bonds, investment funds 36% and pension funds 24%. As

shown in Figure 1.17, institutional investors would need to allocate between 2.5% of assets in the base case and 2.8% in a high securitisation scenario, to absorb the bond supply covered in this analysis in 2035. Correspondingly, within the fixed income bond allocations of institutional investors, these low-carbon bonds would account for 6.6% - 7.3%. The analysis suggests that as these asset categories develop and mature as a share of the broader market, allocations could plateau in the late 2020s.

Figure 1.22. OECD institutional investor asset allocation to low-carbon bonds as modelled under the base case scenario



Source: Asset allocation statistics drawn from OECD institutional investor database.

The OECD has started to collect data on green bond investments and allocations in its annual Large Pension Fund Survey (OECD, 2016b). As context and as shown in Figure 1.32, a noteworthy trend amongst the funds that reported green investments was a general increase in the number of pension funds that invest in green bonds, and also in the relative size of their allocations. Four funds based in Sweden (Alecta, AP2, AP3, and AP4) all increased allocations to green bonds in 2014. Santander, based in Spain, reported green bond exposure for the first time in 2015, amounting to 1.1% of the total portfolio. AP2 and AP3 allocated 1.1% and 1.3% of their portfolios to green bonds, respectively. Note that these allocation figures can be assumed to underrepresent the exposure of these pension funds to the type of bonds discussed in this analysis, as they are allocations to *labelled green bonds*, and not to other "low-carbon" bonds that could be eligible for a green label.

6.2. Mapping channels for institutional investment in green bonds

Green bonds, including the low-carbon bonds examined in this analysis, appeal to institutional investors for a number of reasons as discussed in OECD (2015) and OECD/ICMA/CBI/China GFC (2016). They also offer the option to access low-carbon investments across a wide variety of channels and asset allocations. The OECD's "Mapping Channels to Mobilise Institutional Investment in Sustainable Energy"

report (OECD, 2015) introduced a "matrix frame" (updated and configured to show green bonds in Figure 1.23), which visualises a range of channels (boxes A-H) that represent typical choices institutional investors need to make when allocating capital to low-carbon investments. Institutional investors consider equity and debt opportunities through a series of lenses (composed of basic investment characteristics).

Figure 1.32. Green investments of select Large Pension Funds and Public Pension Reserve Funds in 2014 (% of total investments)

Country head office	Name of the fund or institution	Total investments in 2014 (in USD m.)	Green investments (as a % of total investments)				
			Green equity	Green bonds	Alternative green asset classes (1)	Other green investments	Total Green Investments
Australia	Health Employees Superannuation Trust Australia (2)	25,030	..	..	0.3	..	0.3
Brazil	FAPES - BNDES	3,189	0.2	..	..	..	0.2
Brazil	Previ (3)	62,733	..	..	..	0.1	0.1
Denmark	PFA Pension	46,075	0.4	..	0.3	..	0.7
Finland	Valtion Eläkerahasto	21,378	..	..	0.3	..	0.3
France	ERAFP (4)	25,587	24.7	0.0	..	..	24.7
Netherlands	PFZW	196,333	1.4	0.5	0.4	0.5	2.8
Netherlands	PMT	71,112	..	..	0.1	..	0.1
Netherlands	Stichting Pensioenfonds ABP (5)	473,569	1.5	0.3	0.8	4.0	6.7
New Zealand	New Zealand Superannuation Fund (6)	21,473	..	..	0.0	6.7	6.7
Norway	Government Pension Fund - Global	872,607	..	..	..	0.6	0.6
Romania	Azt Viitorul Tau	1,152	..	..	..	0.2	0.2
Spain	Endesa	1,923	..	0.2	..	..	0.2
Spain	Fonditel (7)	3,972	1.2	..	0.1	..	1.3
Spain	Santander (8)	205	..	1.1	..	..	1.1
Sweden	Alecta	88,330	..	0.3	..	..	0.3
Sweden	AP2 (6)	37,990	1.1	1.1	4.3	2.5	9.0
Sweden	AP3	37,271	..	1.3	0.0	0.0	1.3
Sweden	AP4	38,124	..	0.6	..	..	0.6
United Kingdom	USS (9)	62,972	..	..	0.3	0.1	0.4
United States	New York City Combined Retirement System	159,189	0.3	..	..	..	0.3
	United Nations Joint Staff Pension Fund	52,821	0.3	0.2	..	..	0.4

Note: Some funds have green investments (in "green" indices for instance) but cannot separate these investments from other portfolio investments, as is the case for Keva in Finland, and Illinois SURS in the United States (green private equity).

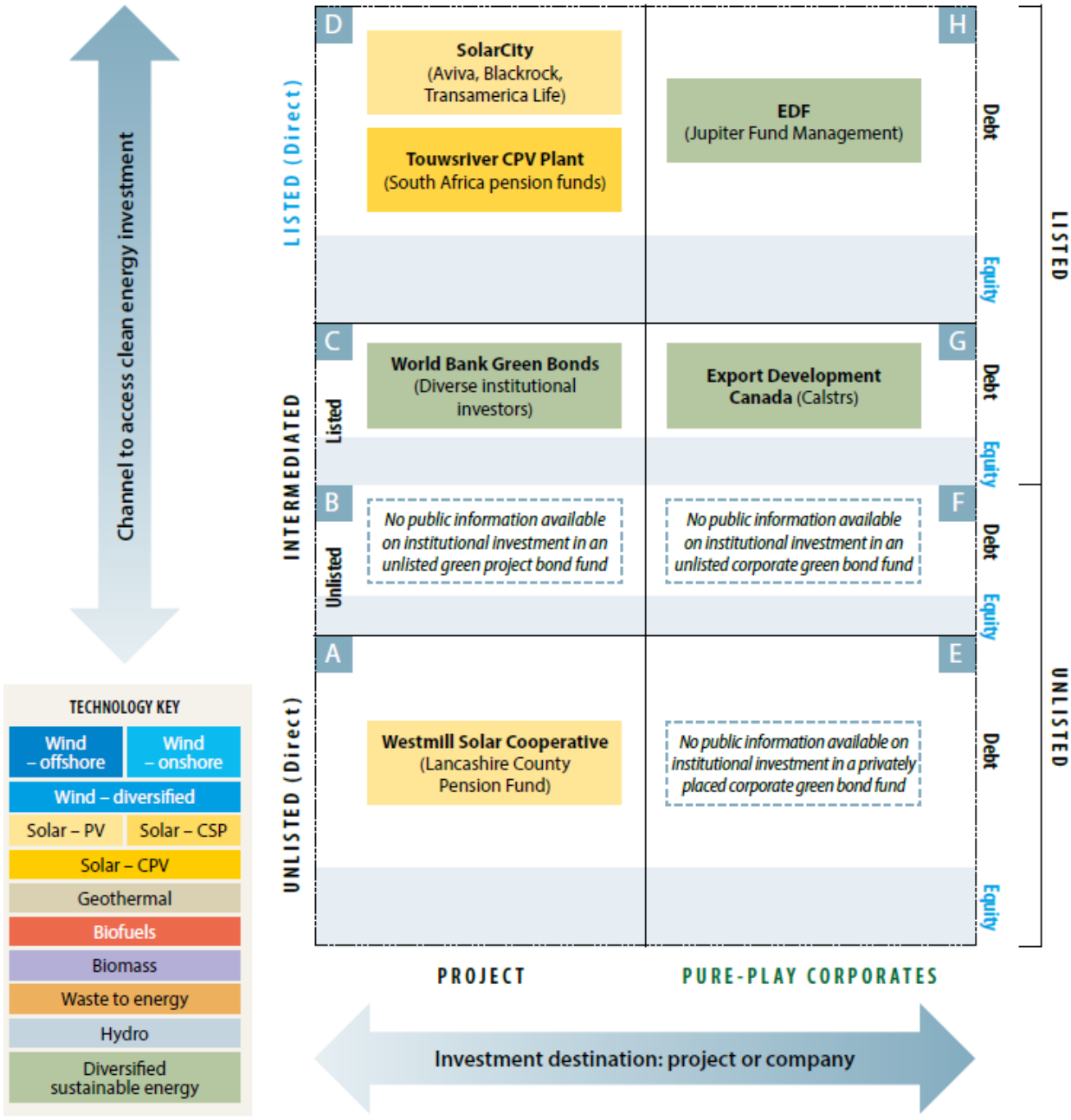
".." means not available.

(1) The alternative green asset classes include hedge funds, natural resources, private equity, infrastructure and inflation-linked bonds. (2) Includes investment in private equity clean technology. (3) Green investments are defined by Previ as assets (such as stocks, exchange-traded funds and mutual funds) in which the underlying business(es) are somehow involved in operations aimed at improving the environment. (4) If investments based on the FTSE4Good or similar methodologies are considered as green investments, all the investments in equity by ERAFP could be seen as green, since ERAFP applied an ESG best-in-class approach to all the equity mandates. (5) Other investments include green real estate, which are defined as properties with a GreenStar label in the GRESB Index, and that have an above average performance on sustainability. (6) Other investments include forestry. (7) Data refer to Fonditel's biggest pension plan: Empleados de Telefónica de España. (8) Reported values are as of September 30, 2015. (9) Other green investments include renewable and lower carbon infrastructure, cleantech private equity, and a listed environmental technology fund.

Source: OECD calculations based on responses to the OECD Survey of LPFs and PPRFs.

A first choice is whether the exposure desired is to projects, corporates, or both. Institutional investors can make green bond investments directly ("in-house") if they have the capability to do so, or they can outsource these investments via an "intermediated" channel such as a fund. Investments can be made on a listed or unlisted basis. Green bonds can theoretically be classified into each of these channels (Figure 1.23); in practice, however, a lack of publicly available information leads to certain channels appearing unoccupied in the figure (e.g. while institutional investors anecdotally invest in privately placed corporate bonds, no public record is currently available).

Figure 1.23. A "matrix frame" to map channels for institutional investment in green bonds



Source: OECD analysis based on methodology laid out in OECD (2015)

Note: Coloured boxes are examples of green bond investments by selected institutional investors (named in brackets where information is publicly available – bonds will have more than these listed investors). Detail on bonds contained in Annex 1.D. Colours represent technologies. Although not shown here, diversified corporates can also issue a green bond where the proceeds are reserved for "green projects or activities. "Pure-play" refers to entities focused on only one industry or product e.g. a solar PV company.

ANNEX 1.A METHODOLOGY, MODEL STRUCTURE, ASSUMPTIONS AND SOURCES FOR CAPITAL STRUCTURE DATA

The analysis aims to decompose IEA investment figures sequentially by sector, subsector, investor, project type and types of finance. Investment data is sourced from IEA World Energy Investment Outlook (2014), where the 450 scenario was used. When the relevant sectors are not available in the WEIO data, the IEA Energy Technology Perspectives (2012) was used. Only aggregated data by sector is available. The investment breakdown is carried out using relevant data found in the IEA reports as well as other sources, including industry reports. When the breakdown is available in the IEA reports, it is usually on a global scale. For example, 55% of solar PV investment will be utility scale, while rooftop PV will account for the remaining proportion. This ratio is then applied for all countries in the modelling. It is hoped that a more detailed breakdown of investment data will be available for the 2DS scenarios from both the WEIO and ETP.

Data on project finance is needed to validate assumptions about the likely breakdown of investment into sources of finance. Currently a global average of project finance structures is used, while relevant adjustments are made to account for different levels of usage of project bonds across regions, where the data is available. The analysis would benefit from regional data on the involvement of International Financial Institutions, including development banks, which is available from a few data providers including Thomson Reuters' Project Finance International database and IJGlobal database. Further data on how project finance is structured in different regions is sought-after.

Ehlers, Packer, & Remolona, (2014) provide data on the share of bonds and syndicated loans in financing infrastructure projects in the power sector in key markets. The level of government and International Financial Institutions involvement in project finance was obtained, for the global market, from IJGlobal Project Finance Infrastructure Review (2014).

Typical gearing ratios (the ratio of total debt to total equity) for US utilities was sourced from US Financial Accounts. The ratio of bond finance to debt finance is assumed to be equal to the aggregate ratio for the entire US corporate business sector, which was sourced from both the US Financial Accounts and S&P (S&P Capital IQ, 2014). For EU utilities, firm level financial accounts were available and used to compute a leverage ratio for the European power sector as well as the ratio of bond to debt finance.

The level of debt and bond finance was more challenging to determine for Chinese firms. S&P data shows that Chinese corporations have a low bond to debt ratio, while project finance data, especially in the power sector, show more substantial reliance on bond finance, as documented by Ehlers, Packer, & Remolona, (2014). The base line scenario was constructed using an average of these two ratios.

Corporate financing structure of energy efficiency projects is based on IEA WEIO (IEA, 2014), S&P report (Standard and Poor's Ratings Services, 2014) and IJGlobal report (IJGlobal, 2014).

The green vehicles financing model is based on analysis done by KPMG (Errington & Gilman, 2012). The cost of the entire vehicle is published in the IEA's 2012 ETP. Full cost is the appropriate investment figure in this context as well as for new-build residential and commercial building (data on the latter is currently unavailable). For other energy efficiency investment only incremental investment is considered.

The rate of asset securitisation is largely based on current market data published by the Securities Industry and Financial Markets Association (SIFMA), Association for Financial Markets in Europe (AFME) and European Covered Bond Council (ECBC) in conjunction with data on aggregate expenditure on motor vehicles from national accounts. While estimates and projections are largely absent from the literature, aggregate expenditure has the potential to change dramatically if new business models emerge that substitute for private ownership, offsetting some of the high capital costs.

Since the crash in securitisation in 2007, the rates have varied, but they are on an upswing as of Q3 2015. Auto ABS has recovered better than expected. A focus has been placed on the implication of different securitisation rates in the scenario analysis. Where data were unavailable, assumptions were constructed to simulate values. Annex 1.B contains further numerical detail for assumptions.

Finally, two financing models were considered for rooftop solar PV and distributed wind energy. In the first, third party ownership, the rate of bond financing is similar to the rate for corporate utilities, albeit issuance is assumed to be in the form of asset-backed securities. In the second, bank loan financing, a proportion of these loans reach the bond market via loan securitisation.

The analysis uses available data, conservative assumptions and acknowledges three important areas of uncertainty: policy, current practice and future changes in practice. First, as illustrated by the range of scenarios which the IEA publishes (in its WEO and ETP models), there is uncertainty in investment caused by uncertainty in the strength of policy adopted and uncertainty in how technology costs and performance will evolve, as well as the mix in which they will be adopted.

Second, there is uncertainty in the current data on financial structures and sources of finance. Some financial markets are better documented than others. Securities regulations generally require that public market transactions be thoroughly and publicly documented – and therefore easier to analyse. A substantial portion of financial market transactions are private, may be un-listed, and have limited disclosure of deal specifics. In these cases, third party market analysis is the only option, rather than primary audited financial reports.

Third, financial practices may change. Although traditional financing structures will certainly continue, waves of financial innovation are often driven by changes in regulation, market preferences, corporate balance sheets, tax structures, financial crises and other factors. The types of financial structures deployed may be profoundly affected by such market shifts. China's debt markets have experienced challenges and the financial system is undergoing significant change. As such, there are significant uncertainties regarding the future role of bond financing for low-carbon infrastructure. At the same time, the government has prioritised the development of green bond markets (UNEP 2015).

Figure 1.A.1. Model structure

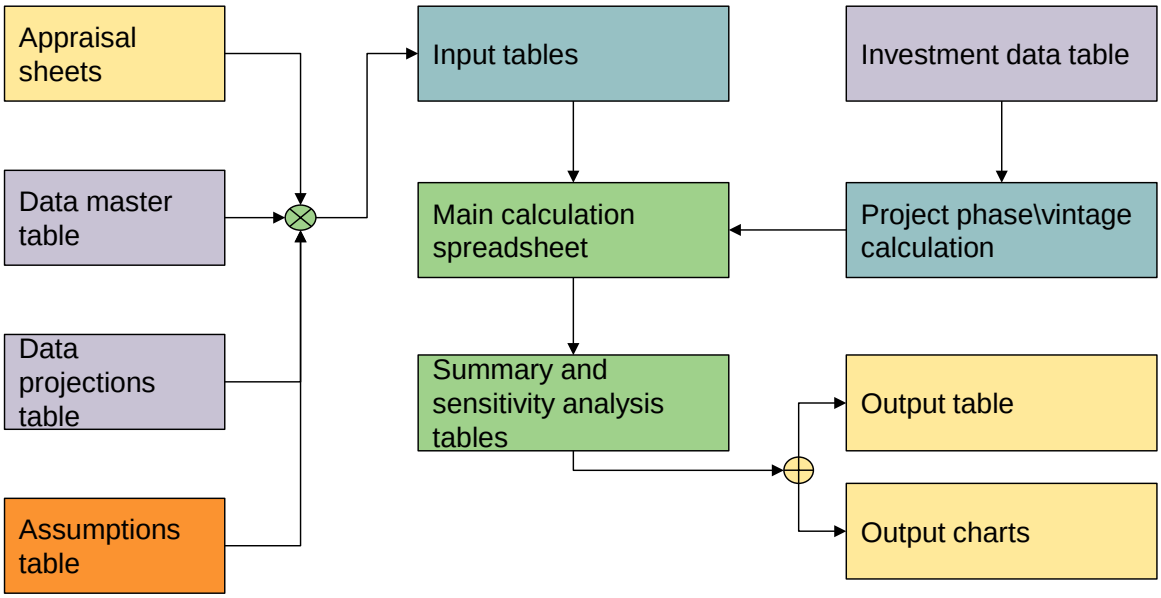
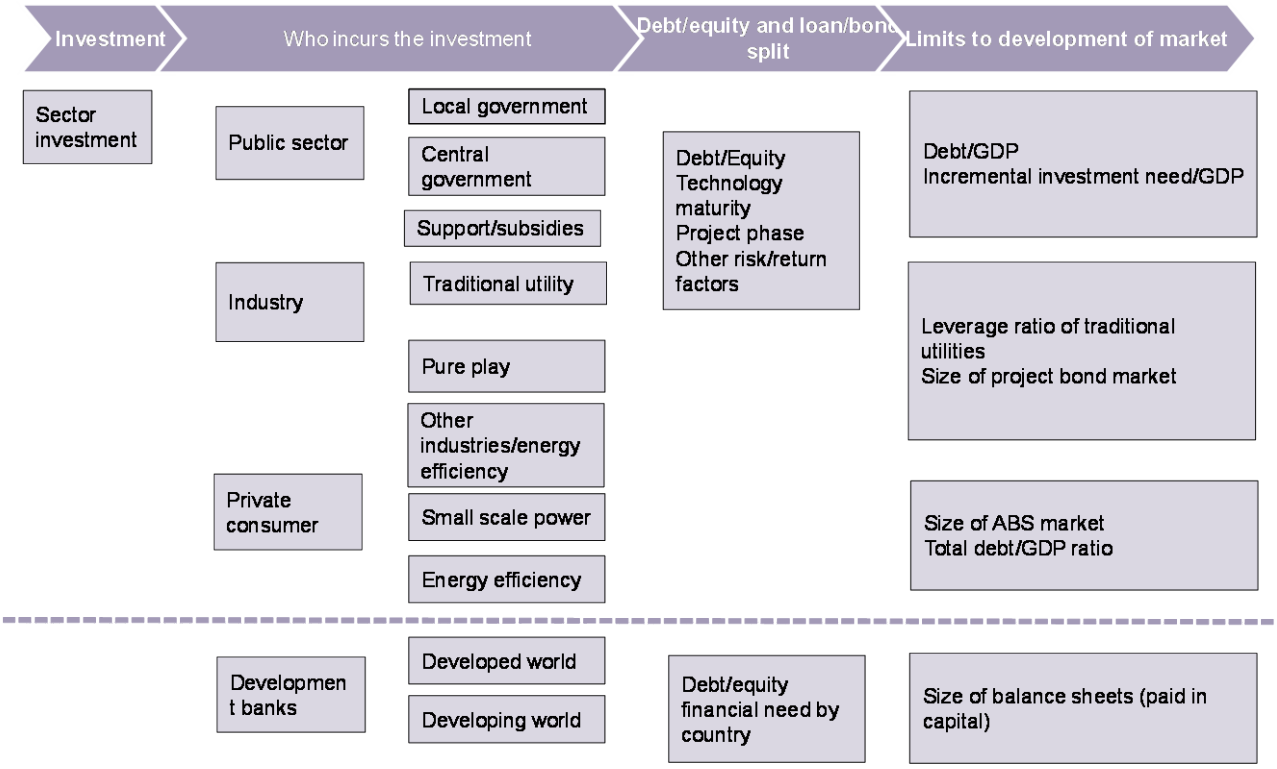


Table 1.A.1. Financial products and sources by sector

Sector	Subsector	Investor	Project type	Source of finance
Solar	Solar PV CSP	Utility scale	Project finance Corporate	Equity Syndicated loans Project bonds Corporate bonds IFI loans
	Solar PV	Rooftop Household Commercial Public sector		Equity/self-finance Leasing/PPA Bank loans
Wind	Onshore Offshore	Utility scale	Project finance Corporate	Equity Syndicated loans Project bonds Corporate bonds SSA loans
	Onshore	Distributed/small scale Household Commercial Public sector		Equity/self-finance Leasing/PPA Bank loans
Hydropower		Utilities Large Small scale	Project finance Corporate	Equity Syndicated loans Project bonds Corporate bonds SSA/government loans
Bioenergy		Utilities Industry Building	Project finance Corporate	Equity Syndicated loans Project bonds Corporate bonds SSA/government loans

Sector	Subsector	Investor	Project type	Source of finance
Energy Efficiency	Energy intensive industries			Equity/self-finance Loans Bonds
	Non energy intensive industries			Equity/self-finance Loans Bonds
	Transport Electric vehicles Other modes of transport Transport infrastructure	Investors Household Commercial Public Sector		Equity/self-finance Loans Bonds
	Buildings Appliances Heating and cooling Insulation Others	Investors Household Commercial Public Sector		Equity/self-finance Loans Bonds

Figure 1.A.2. Decomposition of investment figures



ANNEX 1.B FINANCIAL BREAKDOWN ASSUMPTIONS

Market: United States

variable	unit	2020	2025	2030	2035
Project finance					
Equity	%	20	20	20	20
Government	%	2	2	2	2
IFI	%	7	7	7	7
Commercial Loan	%	61	40	30	20
Bonds	%	5	15	20	30
Securitisation	%	5	15	20	20
Corporate Finance					
Equity	%	33	33	33	33
Debt	%	68	68	68	68
Bonds	%	41	41	41	41
LT loans	%	27	27	27	27
Loan securitisation	%	10	15	20	20
Bond tenor	years	15	15	15	15
Rooftop Solar PV (financing model)					
Third party ownership	%	60	60	60	60
Solar loan	%	40	40	40	40
Securitisation levels by types of finance					
Third party securitisation	%	41	41	41	41
Loan securitisation	%	12	36	36	36
Government financing inputs					
Government leverage ratio in RE	%	80	80	80	80
Government bond to loan ratio	%	100	100	100	100
Energy Intensive Industry					
Equity/Self finance	%	40	40	40	40
Bonds	%	36	36	36	36
Loans	%	19	19	19	19
Non-energy Intensive industry					
Equity/Self finance	%	40	40	40	40
Bonds	%	36	36	36	36
Loans	%	19	19	19	19
Green cars					

Households					
Equity/Self finance	%	5	5	5	5
Loans	%	95	95	95	95
Leases	%	0	0	0	0
Commercial					
Equity/Self finance	%	62	62	62	62
Loans	%	17	17	17	17
Buildings, residential					
Households					
Equity/Self finance	%	51	51	51	51
Loans	%	49	49	49	49
Buildings, services					
Commercial					
Equity/Self finance	%	51	51	51	51
Bonds	%	25	25	25	25
Loans	%	20	20	20	20
Government					
Equity/Self finance	%	51	51	51	51
Bonds	%	49	49	49	49
Loans	%				
Energy Intensive Industry					
Loan securitisation	%	10	10	10	10
Non-energy Intensive industry					
Loan securitisation	%	10	10	10	10
Green cars					
Loan securitisation	%	35	35	35	35
Buildings, residential					
Loan securitisation	%	36	36	36	36
Buildings, services					
Loan securitisation	%	26	26	26	26

Market: European Union

variable	**unit**	**2020**	**2025**	**2030**	**2035**
Project finance					
Equity	%	20	20	20	20

Government	%	3	3	3	3
IFI	%	10	10	10	10
Commercial Loan	%	58	40	30	20
Bonds	%	4	17	22	32
Securitisation	%	5	10	15	15
Corporate Finance					
Equity	%	33	33	33	33
Debt	%	68	68	68	68
Bonds	%	32	32	32	32
LT loans	%	36	36	36	36
Loan securitisation	%	10	15	15	15
Bond tenor	years	15	15	15	15
Rooftop Solar PV (financing model)					
Third party ownership	%	40	0	0	0
Solar loan	%	60	0	0	0
Securitisation levels by types of finance					
Third party securitisation	%	32	0	0	0
Loan securitisation	%	12	0	0	0
Government financing inputs					
Government leverage ratio in RE	%	80	80	80	80
Government bond to loan ratio	%	80	80	80	80
Energy Intensive Industry					
Equity/Self finance	%	40	40	40	40
Bonds	%	21	21	21	21
Loans	%	29	29	29	29
Non-energy Intensive industry					
Equity/Self finance	%	40	40	40	40
Bonds	%	21	21	21	21
Loans	%	29	29	29	29
Green cars					
Households					
Equity/Self finance	%	24	24	24	24
Loans	%	76	76	76	76
Leases	%	0	0	0	0
Commercial					

Equity/Self finance	%	43	43	43	43
Loans	%	35	35	35	35
Buildings, residential					
Households					
Equity/Self finance	%	51	51	51	51
Loans	%	49	49	49	49
Buildings, services					
Commercial					
Equity/Self finance	%	51	51	51	51
Bonds	%	17	17	17	17
Loans	%	22	22	22	22
Government					
Equity/Self finance	%	51	52	53	54
Bonds	%	49	48	47	46
Loans	%	0	0	0	0
Energy Intensive Industry					
Loan securitisation	%	10	10	10	10
Non-energy Intensive industry					
Loan securitisation	%	10	10	10	10
Green cars					
Loan securitisation	%	15	20	20	20
Buildings, residential					
Loan securitisation	%	25	25	25	25
Buildings, services					
Loan securitisation	%	20	20	30	30

Market: China

variable	**unit**	**2020**	**2025**	**2030**	**2035**
Project finance					
Equity	%	20	20	20	20
Government	%	3	3	3	3
IFI	%	10	10	10	10
Commercial Loan	%	20	20	20	20
Bonds	%	42	37	37	37
Securitisation	%	5	10	10	10
Corporate Finance					

Equity	%	30	30	30	30
Debt	%	70	70	70	70
Bonds	%	20	20	20	20
LT loans	%	50	50	50	50
Loan securitisation	%	0	5	10	10
Bond tenor	years	15	15	15	15
Rooftop Solar PV (financing model)					
Third party ownership	%	30	0	0	0
Solar loan	%	70	0	0	0
Securitisation levels by types of finance					
Third party securitisation	%	20	0	0	0
Loan securitisation	%	0	0	0	0
Government financing inputs					
Government leverage ratio in RE	%	80	80	80	80
Government bond to loan ratio	%	10	20	30	40
Energy Intensive Industry					
Equity/Self finance	%	40	40	40	40
Bonds	%	13	13	13	13
Loans	%	37	37	37	37
Non-energy Intensive industry					
Equity/Self finance	%	40	40	40	40
Bonds	%	13	13	13	13
Loans	%	37	37	37	37
Green cars					
Households					
Equity/Self finance	%	70	70	70	70
Loans	%	30	30	30	30
Leases	%	0	0	0	0
Commercial					
Equity/Self finance	%	85	85	85	85
Loans	%	15	15	15	15
Buildings, residential					
Households					
Equity/Self finance	%	51	51	51	51
Loans	%	49	49	49	49

Buildings, services					
Commercial					
Equity/Self finance	%	51	51	51	51
Bonds	%	6	6	6	6
Loans	%	33	33	33	33
Government					
Equity/Self finance	%	40	40	40	40
Bonds	%	30	30	30	30
Loans	%	30	30	30	30
Energy Intensive Industry					
Loan securitisation	%	10	20	20	20
Non-energy Intensive industry					
Loan securitisation	%	10	20	20	20
Green cars					
Loan securitisation	%	10	30	30	30
Buildings, residential					
Loan securitisation	%	10	20	20	20
Buildings, services					
Loan securitisation	%	10	20	20	20

Market: Japan

variable	**unit**	**2020**	**2025**	**2030**	**2035**
Project finance					
Equity	%	18	18	18	18
Government	%	3.25	3	3	3
IFI	%	9.75	10	10	10
Commercial Loan	%	58	49	49	49
Bonds	%	7	10	10	10
Securitisation	%	4	10	10	10
Corporate Finance					
Equity	%	14	14	14	14
Debt	%	86	86	86	86
Bonds	%	24	24	24	24
LT loans	%	62	62	62	62
Loan securitisation	%	10	10	10	10
Bond tenor	years	15	15	15	15

Rooftop Solar PV (financing model)					
Third party ownership	%	30	0	0	0
Solar loan	%	70	0	0	0
Securitisation levels by types of finance					
Third party securitisation	%	24	0	0	0
Loan securitisation	%	10	0	0	0
Government financing inputs					
Government leverage ratio in RE	%	80	80	80	80
Government bond to loan ratio	%	80	80	80	80
Energy Intensive Industry					
Equity/Self finance	%	38	38	38	38
Bonds	%	5	5	5	5
Loans	%	47	47	47	47
Non-energy Intensive industry					
Equity/Self finance	%	38	38	38	38
Bonds	%	5	5	5	5
Loans	%	47	47	47	47
Green cars					
Households					
Equity/Self finance	%	75	75	75	75
Loans	%	25	25	25	25
Leases	%	0	0	0	0
Commercial					
Equity/Self finance	%	89	89	89	89
Loans	%	11	11	11	11
Buildings, residential					
Households					
Equity/Self finance	%	51	51	51	51
Loans	%	49	49	49	49
Buildings, services					
Commercial					
Equity/Self finance	%	51	51	51	51
Bonds	%	6.37	6	6	6
Loans	%	32.63	33	33	33
Government					

Equity/Self finance	%	50	50	50	50
Bonds	%	50	50	50	50
Loans	%	0	0	0	0
Energy Intensive Industry					
Loan securitisation	%	6	10	10	10
Non-energy Intensive industry					
Loan securitisation	%	6	10	10	10
Green cars					
Loan securitisation	%	6	10	10	10
Buildings, residential					
Loan securitisation	%	10	10	10	10
Buildings, services					
Loan securitisation	%	6	10	10	10

ANNEX 1.C. MODEL OUTPUT BY BOND, GEOGRAPHY AND SECTOR (Baseline scenario)

ISSUANCE		Japan					China					EU					US			
		2015-2020	2021-2025	2026-2030	2031-2035		2015-2020	2021-2025	2026-2030	2031-2035		2015-2020	2021-2025	2026-2030	2031-2035		2015-2020	2021-2025	2026-2030	2031-2035
Investment	Solar	$7bn	$7bn	$6bn	$12bn	Solar	$13bn	$16bn	$14bn	$17bn	Solar	$11bn	$11bn	$20bn	$15bn	Solar	$9bn	$19bn	$13bn	$13bn
	Wind	$2bn	$9bn	$6bn	$3bn	Wind	$27bn	$39bn	$39bn	$40bn	Wind	$29bn	$40bn	$39bn	$33bn	Wind	$8bn	$39bn	$30bn	$20bn
	Hydro	$1bn	$3bn	$3bn	$3bn	Hydro	$32bn	$10bn	$8bn	$6bn	Hydro	$5bn	$8bn	$9bn	$8bn	Hydro	$2bn	$4bn	$3bn	$4bn
	Bio	$1bn	$1bn	$1bn	$3bn	Bio	$4bn	$8bn	$13bn	$10bn	Bio	$4bn	$5bn	$9bn	$38bn	Bio	$7bn	$11bn	$8bn	$8bn
	Cars	$21bn	$73bn	$70bn	$81bn	Cars	$83bn	$283bn	$332bn	$819bn	Cars	$116bn	$371bn	$277bn	$450bn	Cars	$42bn	$172bn	$132bn	$425bn
	EE	$14bn	$18bn	$22bn	$25bn	EE	$33bn	$42bn	$55bn	$66bn	EE	$61bn	$75bn	$86bn	$92bn	EE	$42bn	$53bn	$67bn	$72bn
	Total	**$45bn**	**$111bn**	**$108bn**	**$128bn**	**Total**	**$192bn**	**$397bn**	**$461bn**	**$958bn**	**Total**	**$225bn**	**$510bn**	**$441bn**	**$635bn**	**Total**	**$110bn**	**$298bn**	**$254bn**	**$541bn**
Debt	Solar	$6bn	$6bn	$5bn	$9bn	Solar	$10bn	$12bn	$11bn	$13bn	Solar	$8bn	$8bn	$15bn	$11bn	Solar	$7bn	$15bn	$10bn	$10bn
	Wind	$2bn	$8bn	$5bn	$3bn	Wind	$20bn	$30bn	$30bn	$31bn	Wind	$21bn	$30bn	$31bn	$26bn	Wind	$6bn	$30bn	$24bn	$16bn
	Hydro	$1bn	$2bn	$2bn	$3bn	Hydro	$24bn	$7bn	$6bn	$5bn	Hydro	$3bn	$6bn	$7bn	$6bn	Hydro	$2bn	$3bn	$2bn	$3bn
	Bio	$1bn	$1bn	$1bn	$3bn	Bio	$3bn	$6bn	$9bn	$7bn	Bio	$3bn	$4bn	$7bn	$28bn	Bio	$5bn	$8bn	$6bn	$6bn
	Cars	$5bn	$17bn	$16bn	$18bn	Cars	$23bn	$78bn	$92bn	$226bn	Cars	$85bn	$273bn	$204bn	$331bn	Cars	$27bn	$110bn	$85bn	$273bn
	EE	$7bn	$9bn	$12bn	$13bn	EE	$18bn	$23bn	$31bn	$37bn	EE	$31bn	$38bn	$43bn	$46bn	EE	$21bn	$27bn	$35bn	$37bn
	Total	**$21bn**	**$43bn**	**$41bn**	**$49bn**	**Total**	**$97bn**	**$156bn**	**$179bn**	**$319bn**	**Total**	**$151bn**	**$358bn**	**$307bn**	**$448bn**	**Total**	**$68bn**	**$193bn**	**$163bn**	**$344bn**
Equity	Solar	$1bn	$1bn	$1bn	$2bn	Solar	$3bn	$4bn	$3bn	$4bn	Solar	$3bn	$3bn	$5bn	$3bn	Solar	$2bn	$5bn	$3bn	$3bn
	Wind	$0bn	$1bn	$1bn	$0bn	Wind	$7bn	$9bn	$9bn	$9bn	Wind	$8bn	$10bn	$8bn	$7bn	Wind	$2bn	$9bn	$6bn	$4bn
	Hydro	$0bn	$0bn	$0bn	$0bn	Hydro	$9bn	$3bn	$2bn	$2bn	Hydro	$1bn	$2bn	$2bn	$2bn	Hydro	$1bn	$1bn	$1bn	$1bn
	Bio	$0bn	$0bn	$0bn	$1bn	Bio	$1bn	$2bn	$3bn	$2bn	Bio	$1bn	$1bn	$2bn	$10bn	Bio	$2bn	$3bn	$2bn	$2bn
	Cars	$16bn	$56bn	$54bn	$63bn	Cars	$60bn	$205bn	$240bn	$593bn	Cars	$31bn	$98bn	$73bn	$119bn	Cars	$15bn	$61bn	$47bn	$152bn
	EE	$7bn	$9bn	$11bn	$12bn	EE	$15bn	$18bn	$24bn	$29bn	EE	$31bn	$37bn	$43bn	$46bn	EE	$20bn	$26bn	$32bn	$36bn
	Total	**$25bn**	**$68bn**	**$67bn**	**$79bn**	**Total**	**$95bn**	**$240bn**	**$282bn**	**$639bn**	**Total**	**$74bn**	**$151bn**	**$134bn**	**$187bn**	**Total**	**$42bn**	**$105bn**	**$91bn**	**$197bn**
Loans	Solar	$4bn	$4bn	$3bn	$6bn	Solar	$7bn	$8bn	$7bn	$8bn	Solar	$5bn	$4bn	$7bn	$5bn	Solar	$3bn	$6bn	$4bn	$3bn
	Wind	$1bn	$5bn	$3bn	$2bn	Wind	$12bn	$15bn	$14bn	$14bn	Wind	$12bn	$17bn	$17bn	$15bn	Wind	$3bn	$15bn	$12bn	$9bn
	Hydro	$0bn	$1bn	$2bn	$2bn	Hydro	$13bn	$4bn	$3bn	$2bn	Hydro	$2bn	$3bn	$3bn	$2bn	Hydro	$1bn	$1bn	$1bn	$1bn
	Bio	$1bn	$1bn	$1bn	$2bn	Bio	$1bn	$3bn	$4bn	$3bn	Bio	$2bn	$2bn	$3bn	$9bn	Bio	$3bn	$3bn	$2bn	$2bn
	Cars	$4bn	$15bn	$14bn	$17bn	Cars	$21bn	$55bn	$64bn	$158bn	Cars	$72bn	$218bn	$163bn	$265bn	Cars	$18bn	$72bn	$55bn	$177bn
	EE	$4bn	$5bn	$7bn	$7bn	EE	$12bn	$14bn	$19bn	$23bn	EE	$16bn	$20bn	$22bn	$23bn	EE	$9bn	$11bn	$15bn	$15bn
	Total	**$15bn**	**$31bn**	**$30bn**	**$35bn**	**Total**	**$66bn**	**$99bn**	**$111bn**	**$207bn**	**Total**	**$109bn**	**$263bn**	**$215bn**	**$319bn**	**Total**	**$37bn**	**$108bn**	**$89bn**	**$207bn**
Bonds	Solar	$2bn	$2bn	$2bn	$3bn	Solar	$3bn	$4bn	$4bn	$5bn	Solar	$3bn	$4bn	$8bn	$7bn	Solar	$3bn	$9bn	$6bn	$7bn
	Wind	$1bn	$3bn	$2bn	$1bn	Wind	$9bn	$14bn	$16bn	$17bn	Wind	$9bn	$13bn	$14bn	$11bn	Wind	$3bn	$15bn	$12bn	$8bn
	Hydro	$0bn	$1bn	$1bn	$1bn	Hydro	$11bn	$4bn	$4bn	$3bn	Hydro	$1bn	$3bn	$4bn	$4bn	Hydro	$1bn	$2bn	$1bn	$2bn
	Bio	$0bn	$0bn	$0bn	$1bn	Bio	$1bn	$3bn	$5bn	$4bn	Bio	$1bn	$2bn	$4bn	$19bn	Bio	$2bn	$5bn	$4bn	$4bn
	Cars	$0bn	$2bn	$2bn	$2bn	Cars	$2bn	$23bn	$27bn	$68bn	Cars	$13bn	$55bn	$41bn	$66bn	Cars	$9bn	$39bn	$30bn	$95bn
	EE	$3bn	$4bn	$5bn	$5bn	EE	$6bn	$9bn	$11bn	$15bn	EE	$14bn	$18bn	$21bn	$23bn	EE	$12bn	$16bn	$20bn	$21bn
	Total	**$6bn**	**$12bn**	**$11bn**	**$14bn**	**Total**	**$32bn**	**$57bn**	**$68bn**	**$112bn**	**Total**	**$42bn**	**$95bn**	**$92bn**	**$129bn**	**Total**	**$31bn**	**$85bn**	**$74bn**	**$137bn**
Total finance		**$45bn**	**$111bn**	**$108bn**	**$128bn**		**$192bn**	**$397bn**	**$461bn**	**$958bn**		**$225bn**	**$510bn**	**$441bn**	**$635bn**		**$110bn**	**$298bn**	**$254bn**	**$541bn**
Bond type	Muni/Sov	$2bn	$3bn	$4bn	$4bn	Muni/Sov	$2bn	$2bn	$3bn	$4bn	Muni/Sov	$7bn	$9bn	$11bn	$11bn	Muni/Sov	$6bn	$9bn	$9bn	$10bn
	IFI	$1bn	$1bn	$1bn	$2bn	IFI	$4bn	$5bn	$6bn	$7bn	IFI	$3bn	$4bn	$6bn	$7bn	IFI	$1bn	$3bn	$3bn	$3bn
	Corporate	$1bn	$3bn	$2bn	$2bn	Corporate	$11bn	$10bn	$10bn	$10bn	Corporate	$11bn	$14bn	$15bn	$17bn	Corporate	$9bn	$19bn	$16bn	$13bn
	Project bond	$0bn	$1bn	$1bn	$1bn	Project bond	$10bn	$10bn	$12bn	$13bn	Project bond	$1bn	$2bn	$4bn	$10bn	Project bond	$0bn	$2bn	$2bn	$3bn
	ABS	$1bn	$4bn	$4bn	$5bn	ABS	$5bn	$31bn	$37bn	$78bn	ABS	$20bn	$66bn	$56bn	$84bn	ABS	$15bn	$52bn	$43bn	$108bn
	Total	**$6bn**	**$12bn**	**$11bn**	**$14bn**	**Total**	**$32bn**	**$57bn**	**$68bn**	**$112bn**	**Total**	**$42bn**	**$95bn**	**$92bn**	**$129bn**	**Total**	**$31bn**	**$85bn**	**$74bn**	**$137bn**
Fin. Sector bonds		$4bn	$9bn	$9bn	$11bn	Fin. Sector	$20bn	$30bn	$33bn	$62bn	Fin. Sector	$33bn	$79bn	$64bn	$96bn	Fin. Sector	$11bn	$32bn	$27bn	$62bn
Total Bonds	**Total Bonds**	**$10bn**	**$21bn**	**$20bn**	**$24bn**		**$51bn**	**$87bn**	**$101bn**	**$174bn**		**$75bn**	**$174bn**	**$156bn**	**$225bn**		**$42bn**	**$117bn**	**$101bn**	**$199bn**

USD outstanding		Japan					China					EU					US					4 markets					
		2015	2020	2025	2030	2035		2015	2020	2025	2030	2035		2015	2020	2025	2030	2035		2015	2020	2025	2030	2035		2015	2020	2025	2030	2035
PV	Municipal\sovereign	$1bn	$3bn	$7bn	$9bn	$11bn	Municipal\sovereign	$0bn	$1bn	$3bn	$6bn	$9bn	Municipal\sovereign	$1bn	$6bn	$10bn	$18bn	$19bn	Municipal\sovereign	$1bn	$6bn	$15bn	$21bn	$23bn	Municipal\sovereign	$3bn	$16bn	$35bn	$53bn	$62bn
	IFI	$0bn	$1bn	$2bn	$2bn	$3bn	IFI	$0bn	$1bn	$3bn	$5bn	$6bn	IFI	$0bn	$1bn	$3bn	$5bn	$6bn	IFI	$0bn	$1bn	$2bn	$4bn	$4bn	IFI	$1bn	$4bn	$10bn	$16bn	$20bn
	Corporate	$1bn	$3bn	$6bn	$8bn	$8bn	Corporate	$1bn	$5bn	$11bn	$14bn	$13bn	Corporate	$1bn	$7bn	$13bn	$21bn	$20bn	Corporate	$1bn	$8bn	$20bn	$26bn	$27bn	Corporate	$4bn	$24bn	$50bn	$69bn	$69bn
	Project bond	$0bn	$0bn	$1bn	$2bn	$3bn	Project bond	$0bn	$4bn	$10bn	$17bn	$21bn	Project bond	$0bn	$0bn	$2bn	$6bn	$12bn	Project bond	$0bn	$0bn	$2bn	$6bn	$10bn	Project bond	$0bn	$5bn	$15bn	$30bn	$46bn
	ABS	$1bn	$3bn	$6bn	$9bn	$11bn	ABS	$0bn	$2bn	$7bn	$13bn	$18bn	ABS	$1bn	$6bn	$13bn	$26bn	$33bn	ABS	$1bn	$6bn	$23bn	$35bn	$43bn	ABS	$3bn	$18bn	$50bn	$83bn	$104bn
Wind	Municipal\sovereign	$0bn	$0bn	$2bn	$2bn	$3bn	Municipal\sovereign	$0bn	$2bn	$5bn	$9bn	$12bn	Municipal\sovereign	$1bn	$5bn	$11bn	$16bn	$17bn	Municipal\sovereign	$0bn	$1bn	$7bn	$12bn	$14bn	Municipal\sovereign	$1bn	$9bn	$25bn	$39bn	$46bn
	IFI	$0bn	$0bn	$2bn	$3bn	$4bn	IFI	$1bn	$5bn	$12bn	$20bn	$25bn	IFI	$1bn	$5bn	$13bn	$20bn	$23bn	IFI	$0bn	$1bn	$7bn	$11bn	$14bn	IFI	$2bn	$12bn	$34bn	$54bn	$66bn
	Corporate	$0bn	$2bn	$7bn	$10bn	$11bn	Corporate	$3bn	$19bn	$39bn	$54bn	$55bn	Corporate	$5bn	$31bn	$64bn	$88bn	$84bn	Corporate	$2bn	$11bn	$52bn	$79bn	$86bn	Corporate	$11bn	$63bn	$163bn	$232bn	$236bn
	Project bond	$0bn	$0bn	$1bn	$2bn	$2bn	Project bond	$0bn	$14bn	$39bn	$72bn	$96bn	Project bond	$0bn	$1bn	$4bn	$7bn	$9bn	Project bond	$0bn	$0bn	$3bn	$6bn	$8bn	Project bond	$0bn	$16bn	$46bn	$87bn	$116bn
	ABS	$0bn	$1bn	$4bn	$6bn	$7bn	ABS	$0bn	$3bn	$14bn	$28bn	$41bn	ABS	$1bn	$8bn	$25bn	$45bn	$55bn	ABS	$0bn	$2bn	$22bn	$43bn	$54bn	ABS	$2bn	$14bn	$65bn	$122bn	$157bn
Energy Efficiency	Municipal\sovereign	$2bn	$10bn	$22bn	$34bn	$42bn	Municipal\sovereign	$1bn	$5bn	$10bn	$15bn	$19bn	Municipal\sovereign	$5bn	$31bn	$63bn	$94bn	$108bn	Municipal\sovereign	$4bn	$26bn	$53bn	$83bn	$99bn	Municipal\sovereign	$12bn	$72bn	$148bn	$227bn	$268bn
	IFI	$0bn	$3bn	$6bn	$9bn	$11bn	IFI	$2bn	$10bn	$21bn	$34bn	$49bn	IFI	$1bn	$9bn	$19bn	$31bn	$38bn	IFI	$1bn	$4bn	$8bn	$13bn	$16bn	IFI	$4bn	$25bn	$54bn	$87bn	$115bn
	Corporate	$0bn	$2bn	$3bn	$5bn	$7bn	Corporate	$2bn	$12bn	$24bn	$34bn	$45bn	Corporate	$3bn	$16bn	$35bn	$54bn	$65bn	Corporate	$4bn	$22bn	$46bn	$71bn	$85bn	Corporate	$9bn	$51bn	$108bn	$165bn	$200bn
	Project bond						Project bond						Project bond						Project bond						Project bond	$0bn	$0bn	$0bn	$0bn	$0bn
	ABS	$1bn	$3bn	$11bn	$13bn	$15bn	ABS	$4bn	$17bn	$115bn	$145bn	$315bn	ABS	$18bn	$81bn	$271bn	$224bn	$333bn	ABS	$13bn	$60bn	$196bn	$168bn	$439bn	ABS	$35bn	$161bn	$594bn	$549bn	$1,101bn
Bioenergy	Municipal\sovereign	$0bn	$0bn	$0bn	$0bn	$1bn	Municipal\sovereign	$0bn	$2bn	$3bn	$3bn	$2bn	Municipal\sovereign	$0bn	$0bn	$1bn	$1bn	$2bn	Municipal\sovereign	$0bn	$0bn	$0bn	$0bn	$1bn	Municipal\sovereign	$0bn	$3bn	$4bn	$6bn	$5bn
	IFI	$0bn	$0bn	$1bn	$1bn	$2bn	IFI	$1bn	$7bn	$9bn	$10bn	$6bn	IFI	$0bn	$1bn	$3bn	$4bn	$6bn	IFI	$0bn	$0bn	$1bn	$1bn	$2bn	IFI	$1bn	$8bn	$13bn	$17bn	$15bn
	Corporate	$0bn	$1bn	$3bn	$4bn	$5bn	Corporate	$4bn	$25bn	$30bn	$31bn	$13bn	Corporate	$1bn	$6bn	$13bn	$19bn	$20bn	Corporate	$1bn	$4bn	$8bn	$11bn	$12bn	Corporate	$6bn	$35bn	$54bn	$65bn	$50bn
	Project bond	$0bn	$0bn	$0bn	$1bn	$2bn	Project bond	$0bn	$18bn	$33bn	$41bn	$30bn	Project bond	$0bn	$0bn	$2bn	$6bn	$11bn	Project bond	$0bn	$0bn	$1bn	$2bn	$5bn	Project bond	$0bn	$18bn	$36bn	$50bn	$47bn
	ABS	$0bn	$0bn	$1bn	$2bn	$3bn	ABS	$1bn	$3bn	$6bn	$9bn	$8bn	ABS	$0bn	$1bn	$4bn	$8bn	$11bn	ABS	$0bn	$0bn	$2bn	$4bn	$6bn	ABS	$1bn	$5bn	$14bn	$24bn	$29bn
Hydro energy	Municipal\sovereign	$0bn	$0bn	$0bn	$0bn	$0bn	Municipal\sovereign	$0bn	$0bn	$1bn	$2bn	$2bn	Municipal\sovereign	$0bn	$0bn	$1bn	$1bn	$4bn	Municipal\sovereign	$0bn	$0bn	$1bn	$1bn	$2bn	Municipal\sovereign	$0bn	$1bn	$2bn	$5bn	$9bn
	IFI	$0bn	$0bn	$0bn	$1bn	$1bn	IFI	$0bn	$1bn	$2bn	$5bn	$7bn	IFI	$0bn	$1bn	$2bn	$4bn	$13bn	IFI	$0bn	$1bn	$3bn	$4bn	$5bn	IFI	$0bn	$3bn	$7bn	$14bn	$26bn
	Corporate	$0bn	$1bn	$2bn	$2bn	$3bn	Corporate	$0bn	$3bn	$7bn	$13bn	$16bn	Corporate	$1bn	$5bn	$10bn	$17bn	$40bn	Corporate	$2bn	$11bn	$23bn	$30bn	$29bn	Corporate	$3bn	$19bn	$42bn	$63bn	$88bn
	Project bond	$0bn	$0bn	$0bn	$1bn	$1bn	Project bond	$0bn	$2bn	$7bn	$15bn	$24bn	Project bond	$0bn	$0bn	$1bn	$5bn	$25bn	Project bond	$0bn	$0bn	$3bn	$6bn	$11bn	Project bond	$0bn	$3bn	$11bn	$27bn	$61bn
	ABS	$0bn	$0bn	$1bn	$1bn	$2bn	ABS	$0bn	$0bn	$3bn	$7bn	$11bn	ABS	$0bn	$1bn	$3bn	$7bn	$27bn	ABS	$0bn	$1bn	$6bn	$11bn	$15bn	ABS	$1bn	$3bn	$12bn	$27bn	$55bn
Total	Municipal\sovereign	$2bn	$14bn	$30bn	$46bn	$57bn	Municipal\sovereign	$2bn	$11bn	$22bn	$35bn	$44bn	Municipal\sovereign	$7bn	$42bn	$85bn	$131bn	$151bn	Municipal\sovereign	$6bn	$33bn	$77bn	$118bn	$139bn	Municipal\sovereign	$17bn	$100bn	$215bn	$330bn	$390bn
	SSA	$1bn	$4bn	$10bn	$17bn	$22bn	SSA	$4bn	$24bn	$48bn	$74bn	$93bn	SSA	$3bn	$17bn	$39bn	$64bn	$86bn	SSA	$1bn	$7bn	$21bn	$33bn	$41bn	SSA	$9bn	$53bn	$118bn	$188bn	$241bn
	Corporate	$1bn	$8bn	$21bn	$30bn	$34bn	Corporate	$11bn	$64bn	$111bn	$147bn	$142bn	Corporate	$11bn	$65bn	$135bn	$199bn	$229bn	Corporate	$9bn	$55bn	$150bn	$218bn	$238bn	Corporate	$32bn	$193bn	$417bn	$594bn	$643bn
	Project bonds	$0bn	$1bn	$3bn	$5bn	$8bn	Project bonds	$0bn	$38bn	$89bn	$145bn	$171bn	Project bonds	$0bn	$2bn	$9bn	$24bn	$57bn	Project bonds	$0bn	$1bn	$8bn	$20bn	$34bn	Project bonds	$0bn	$42bn	$108bn	$194bn	$270bn
	ABS and CLO	$1bn	$8bn	$24bn	$31bn	$39bn	ABS and CLO	$5bn	$26bn	$145bn	$201bn	$392bn	ABS and CLO	$20bn	$97bn	$316bn	$311bn	$459bn	ABS and CLO	$15bn	$71bn	$250bn	$261bn	$557bn	ABS and CLO	$42bn	$201bn	$735bn	$805bn	$1,447bn
Fin. Sector bonds	Fin. Sector bonds	$4bn	$26bn	$65bn	$88bn	$101bn	Fin. Sector bonds	$20bn	$118bn	$237bn	$323bn	$473bn	Fin. Sector bonds	$33bn	$197bn	$512bn	$606bn	$728bn	Fin. Sector bonds	$11bn	$66bn	$204bn	$261bn	$439bn	Fin. Sector bonds	$74bn	$447bn	$1,157bn	$1,450bn	$2,078bn
																									Total outstanding	$174bn	$1,035bn	$2,750bn	$3,560bn	$5,069bn

ANNEX 1.D ANNOTATIONS FOR FIGURE 1.23

A) Direct unlisted investments in projects

Direct unlisted project debt

The Westmill Solar Cooperative refinanced its 5 MW Watchfield solar PV plant in Oxfordshire with a GBP 12 million bond privately placed with UK Lancashire County Pension Fund (Lancashire County Council, 2013).8

B) Intermediated unlisted investments in projects

Intermediated unlisted project debt

No public information available regarding institutional investment in an unlisted green project bond fund.

C) Intermediated listed project investment

Intermediated listed project debt

The Nordic Investment Bank (NIB) issued a 5-year SEK 1 billion NIB Environment Bond (NEB), the third and largest Swedish Krona-denominated bond at the time of issuance in April 2015 (Nordic Investment Bank, 2015). Swedish pension fund Storebrand and Danish pension fund PKA invested in the issuance (Nordic Investment Bank, 2015).

The African Development (AfDB) issued a 5-year SEK 1 billion fixed rate green bond in March 2014. The transaction was placed with 16 investors including AP2, AP3, Landstinget Västmanland, SAAB Pensionsstiftelse, SEB Fonder, SPP/Storebrand, Svenska Kyrkan, and Systembolaget AB (AfDB, 2014).

The Asian Development Bank (ADB) raised USD 500 million in its inaugural green bond issuance in March 2015. The 10-year 2.2% coupon bonds will fund ADB projects that promote low-carbon and climate-resilient development in Asia (ADB, 2015). The bonds were sold to 44 investors including: The bonds were sold to about 44 investors including AP2, AP3, AP4, Baloise Insurance, Banque Syz & Co SA, Blackrock, Calvert Investments, Donner & Reuschel Asset Management, Mirova, Nikko Asset Management Europe Ltd, Nippon Life Insurance Company, Omega Global Investors on behalf of Local Government Super, Praxis Intermediate Income Fund, SEB Wealth, State Street Global Advisors, and TIAA-CREF (ADB, 2015).

Bank of America Corporation issued a three-year, fixed-rate USD 500 million green bond in November 2013. Proceeds will be used to finance green investments such as renewable energy and energy efficiency projects. Bank of America viewed this issuance as an opportunity to expand its investor base and participating investors include the following: AP4, BlackRock, Breckinridge Capital Advisors, California State Teachers' Retirement System, Calvert Investment Management, Pax World Management LLC,

Praxis Intermediate Income Fund, State Street Global Advisors, Standish Mellon Asset Management Company LLC, TIAA-CREF, Trillium Asset Management, LLC (Bank of America, 2013).

The World Bank issued a EUR 30 million 30-year fixed rate green bond in February 2015 to fund projects that meet low-carbon and climate-resilient criteria (World Bank, 2015). The World Bank issued the bond in response to demand for longer maturities from Zurich Insurance Group and as a 30-year bond it is the longest maturity fixed-rate green bon issued by the World Bank to date (World Bank, 2015).

In 2010 Nikko Asset Management launched two green bond funds, one targeted at Japanese investors and another for international investors, that will invest 100% of its portfolio in World Bank-issued green bonds in 2010 (World Bank, 2010a). The World Bank issued ten new green bonds for the fund launch denominated in a ten different currencies including Australian dollars, Colombian pesos, Russian roubles, Turkish lira and South African rand (World Bank, 2010b). In the two years after the fund launch, Nikko Investment Management raised more than USD 500 million from Japanese retail investors and USD 40 million from European and US institutional investors. Notable investors include Silicon Valley Community Foundation and Truestone Impact Investment Management (World Bank, 2012).

A diverse pool of institutional investors has purchased green bonds issued by the World Bank to fund diverse projects that support climate change adaptation or mitigation. Since 2008, the World Bank has issued approximately USD 4 billion in green bonds (World Bank, 2013). Notable pension fund investors include Sweden's AP Fonden 2 and AP Fonden 3, CalSTRS, New York Common Retirement Fund, and UN Joint Staff Pension Fund (World Bank, 2013).

The World Bank issued their first AUD-denominated Kangaroo Bond in 2014.Australian superannuation fund UniSuper was the cornerstone investor for the issuance, purchasing AUD 100 million of the total AUD 300 million offering (Fernyhough, 2014).

D) Direct (in-house) listed project investments

A listed green project bond can provide financing for a single project, a portfolio of similar or standardised projects (such as wind farms or rooftop solar panel installations), or a portfolio of diverse sustainable energy infrastructure projects.

Solar Star Funding, LLC, a wholly-owned subsidiary of MidAmerican Energy Holdings Co., issued a USD 1 billion project bond in 2013 linked to the 580 MW Solar Star PV project which at the time of the issuance was the largest renewable project bond every issued (BNEF, 2014). US pension fund CalSTRS invested in the issuance (CalSTRS, 2014).

SolarCity issued a 4.80% USD 54.4 million solar-backed asset-backed security in November 2013. The underlying assets are 44 MW of solar PV across 5 033 projects in the United States, 71% residential (BNEF, 2014). Investors in the issuance included Aviva, Blackrock, Angel Oak Capital Advisors, Transamerica Life and Accordia Life and Ann (BNEF, 2014).

Toyota Financial Services, the financial services arm of the Japanese automaker Toyota, issued a USD 1.75 green billion bond in March 2014. The bond was the first auto industry asset-backed (ABS) green bond. Proceeds will be used to fund new retail finance contracts and lease contracts for Toyota and

Lexus vehicles that meet specific green criteria related to emissions and fuels efficiency (Toyota Financial Services, 2014). The green bonds are a standard auto loan-backed ABS where cash flow is linked to repayments of outstanding loans for the company's cars. Asset managers and pension funds investing in the issuance included TIAA-CREF, Vanguard Group, Northern Trust, SEI Investments and CalSTRS (BNEF, 2014; CalSTRS 2014).

The Soitec project bond was issued to finance the Touwsrivier solar power plant using concentrated photovoltaic (CPV) technology. The South African bond was issued in local currency and attracted a diverse pool of investors including South African pension funds and asset managers (Soitec, 2013).

A publically listed solar project finance bond was issued by Solar Power Generation Ltd to fund two 5 MW solar PV plants in England. The UK Pension Insurance Corporation purchased the entire GBP 40 million offering (PIK, 2012).

E) Direct unlisted investments in pure-play corporates
Direct unlisted (private) corporate debt

No public information available on institutional investment in an privately placed corporate green bond.

F) Intermediated unlisted pure-play corporate investment
Intermediated unlisted debt provision for pure-play companies

No public information available regarding institutional investment in an unlisted corporate green bond fund.

G) Intermediated listed pure-play corporate investment
Listed pure-play corporate debt

Export Development Canada (EDC) issued its inaugural USD 300 million green bond in 2014 to fund provide loans to companies who are active in fields of preservation, protection or remediation of air, water, and/or soil, or the mitigation of climate change (EDC, 2014). Californian pension fund CalSTRS invested in the issuance (CalSTRS, 2014).

H) Direct (in-house) listed corporate pure-play investment
Direct (in-house) corporate pure-play listed debt

In November 2013 EDF issued a EUR 1.4 billion green bond with proceeds used to finance the development or construction costs associated with new renewable energy projects developed by EDF Energies Nouvelles (EDF, 2014). Asset manager Jupiter Fund Management invested in the issuance (Kelly, 2013) and as of December 2014 the funds contributed to the financing of 13 renewable energy projects (wind, solar PV, biogas) in France, Canada and the United States (EDF, 2014).

PNE Wind AG, a German wind farm project developer, issued a EUR 100 million 8% corporate bond to expand offshore and onshore wind activities. Institutional investors invested EUR 33.7 million in the issuance (PNE Wind, 2013).

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