I4CE
INSTITUTE FOR CLIMATE ECONOMICS
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Green Bonds: Improving their contribution to the low-carbon and climate resilient transition

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Green Bonds Research Program Work Package 1

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Disclaimer

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Executive summary

To achieve the Paris Agreement's objective of limiting the rise of global mean temperature to +2°C compared to the preindustrial period, a shift in the allocation of private finance flows from carbon-intensive activities to investments compatible with a 2°C pathway will be necessary. Among all sources of private financial flows, institutional investors are seen as key as they do not currently face the same deleveraging constraints as corporate actors and banks. Among financial instruments, bonds are particularly well suited to access financing from institutional investors. Given the often high expectations around bonds, it is thus important to understand the role that this financial instrument can play in financing low-carbon, climate-resilient (LCCR) investments, and how the green bond market can help bonds contribute to directing additional flows towards LCCR assets.

This report presents key findings of Work Package 1 of I4CE's work program on green bonds

It looks at the challenges and opportunities to ensure financial additionality of the green bond market – and consists of three parts. The first part explores what categories of low-carbon, climate-resilient investment needs could theoretically be financed by bonds and where main financing gaps are lying. Second, the report analyses if the labelled green bond market could contribute in directing additional bond financing to LCCR investments in the future. Third, the report suggests and briefly analyzes some market-led and public-led measures that could help boost the contribution of the green bond market to the financing of the low-carbon transition. The different policies options are described and analyzed in varying detail in the report's annexes.

This report transparently assumes that the overall objective of developing the green bond market is to support the LCCR transition, and thus to bring additional benefits to LCCR assets compared to non-labelled climate-aligned bonds. Rather than only analyzing what measures could help accelerate the development of the green bond market, this study assesses how the development of the labelled green bond market could contribute in "shifting the trillions" and aligning financial flows with the objectives of the Paris Agreement as per its Article 2.1.c. It finally draws conclusions that could be applicable for other green instruments and provides a brief overview of how public policy might push for a better 'mainstreaming' of climate issues into financial decision-making.

A large part of the potential for bonds to increase their share in financing LCCR assets could come from asset-backed securities

Estimates of the volume of global low-carbon investments needed total up to USD 3.2 trillion per year. For comparison, current global annual investment in low-carbon investments is estimated at around USD 700 billion in 2014 and 2015 (OECD/IEA and IRENA 2017). Consequently, even if uncertainties on this Figure remain large, there is no doubt that a significant shift in financial flows from carbon-intensive to low-carbon sectors will be needed to close the LCCR investment gap. The main increase in LCCR investment will have to target energy efficiency actions, and notably low emissions vehicles and energy efficiency in buildings, which are mainly conducted by individual and SMEs.

On the other hand, the bond market is primarily an instrument suited for use by large (> USD 100 million), low-risk issuers or assets benefiting from good credit ratings, or homogeneous and standardized pools of small-scale assets as for asset-backed securities. As a result, even if in theory scenarios can be imagined where almost all categories of LCCR investment needs could be financed through the bond market, in practice the use of bonds to finance all types of actions may not be feasible.

In particular, investments carried out by individuals and most investments carried out by SMEs – representing a large part of the LCCR investment gap – typically are not able to directly access the bond market. From these categories only assets primarily financed through bank loans could indirectly reach the bond market, thanks to a refinancing through either financial bonds or asset-backed securities. As a result, a significant portion of the potential for the bond market to increase its share of financing for LCCR assets would come from asset-backed securities (ABS). Asset-backed securities are estimated to represent as much as 44% of outstanding bonds in 2035 according to OECD (OECD 2017); however this segment represented only 6% of the market in 2016 suggesting that significant efforts are needed if this is to occur.

The lack of a pipeline of "bankable" LCCR assets is the main obstacle to expanding issuance of LCCR bonds

In theory, the green bond market could help overcome some specific obstacles that are limiting LCCR assets from accessing bond financing. As in the case of the use of other financial instruments, the principal obstacles to finance for LCCR assets stem from how financial actors perceive the risks related to these assets – combined with the almost systematic short-term focus of financial analysis. However, market participants have indicated that there do not appear to be significant obstacles preventing LCCR assets to

access the bond market, compared to other assets with comparable characteristics. It is rather a lack of a pipeline of projects that is limiting the growth of the LCCR bonds market.

Therefore, to increase financial flows directed towards LCCR assets – whether using bonds or other financial instruments – the first step should be to put in place the economic policy frameworks necessary to increase the pipeline of projects with risk-return profiles accepTable to the financial sector. The green bond market itself could be used to expand the pipeline of "bankable" LCCR assets if it is able to improve the financial conditions compared to other forms of bond finance.

In the current regulatory and institutional context, labelling bonds supporting climate-aligned activities as green has little potential to contribute to provide additional financial flows to LCCR investments

In the current regulatory and institutional context, labeling those bonds supporting LCCR assets as green appears to have limited impact on the overall volume of finance directed towards LCCR investments. Many of the investments today supported by green bonds would have occurred whether or not the bond was labeled green. To contribute to increasing overall finance for LCCR investments, the use of the green bond market would need to improve the financial conditions for LCCR assets and modify the risk perception of LCCR bonds. Currently, labelling a bond as green carries a negligible price premium in the primary market – and might continue in the future. Green labelling does indeed not improve investors' perception of the credit quality of the bond.

Careful reflection is thus merited in terms of what value labelling bonds as green brings to support the LCCR transition and that the financial impact case is not over stated. The labelled green bond market does bring non-financial benefits contributing to the transition to a low-carbon and climate-resilient economy aligned with public policy objectives.

Labelling bonds as green can ease the process of tracking green investment opportunities for investors. Labelling can also contribute to accelerating the elaboration of a climate strategy in the issuing entity, or 'anchoring' this strategy in the organization and its processes.

As a result, public institutions and civil society should not expect the green bond market to contribute significantly to directly increasing the volume of financial for LCCR investments. Attention should rather be focused on the value that could be generated by using this instrument as a way to 'measure' and track the ambition and 'depth' of climate actions developed by issuing entities and investors.

Given this important informational benefit, public authorities could contribute to increase the volume of LCCR assets financed or refinanced by bonds by fostering the development of a market for LCCR asset-backed securities, and by pushing for a 'mainstreaming' of climate issues into financial institutions.

Public policies directed at the green bond market should focus on increasing the share of climate-aligned bonds labeled as green…

Given the current direct benefits of the green bond market, this report prioritizes public policies and measures to support the labelling of bonds financing LCCR or climate-aligned assets. First, public measures could aim at decreasing the additional transaction costs of green labelling. This could be achieved through direct subsidies in those countries and monetary zones that do not currently have an active green bond market. Furthermore, to expand transparency to the entire market policymakers in all countries could require that all bonds issued report and disclose whether they support LCCR assets.

Second, public measures could foster increased demand for green bonds, through policies such as a mandatory disclosure of climate strategies by investors – or more directly minimum quotas for investment in green bonds for specific regulated financial products such as life insurance products for example. This could result in investors being incentivized to increase issuance of labelled green bonds, notably through an engagement strategy put in place by financial institutions. Finally, both the supply and demand for green bonds should be supported in parallel to maintain a good supply-demand equilibrium in the labeled green bond market, and ensure smooth development.

… and when appropriate developing a market for green asset-backed securities

Given future low-carbon investment needs, priority could be given to public policy measures designed to support a securitization market for LCCR assets. First, measures could target potential ABS issuers to develop the pipeline of LCCR loans available for securitization, such as creating a warehousing entity for LCCR small-scale loans or introducing a requirement for banks to disclose the green share of their loan books. Second, other measures could target potential investors to incentivize investing in climate-aligned ABS and overcome the obstacle of a lack of historic data related to LCCR loans, notably through credit enhancement schemes. However such schemes should be backed by strong eligibility criteria, notably on the environmental integrity, and require high standards and transparency given public opinion and historical problems with the use of securitization.

More broadly, public policies could be designed to incentivize investors to favor green over 'brown' financial assets

The green bond market could be reinforced by broader public policies incentivizing investors to favor green over 'brown' financial assets. Notably, different measures for integrating climate issues into prudential and monetary policies are today subject to a heated debate – ranging from inclusion of a 'green supporting factor' into prudential regulation and green requirements into central bank collateral frameworks, to green quantitative easing. Further detailed analysis on these different options should be undertaken to formulate precise public policy recommendations on this topic.

This report presents an overview of the positives and negatives of many of the proposed policy options discussed today. The annexes of this report present summaries and an initial assessment of many of the policies currently being discussed. Further research – focusing on specific countries, regions or monetary zones – is needed to fully understand potential impacts and whether it can support the contribution of the bond markets to the low-carbon resilient transition.

Glossary

ABS	Asset-Backed Securities
FSB	Financial Stability Board
GHG	Greenhouse Gas
HLEG	High-Level Expert Group on Sustainable Finance
LCCR	Low-carbon climate-resilient
NDC	Nationally Determined Contribution
SSA	Supranational, sub-sovereign and agency
TCFD	Task Force on Climate-related Financial Disclosures

Introduction

Context: Shifting financial flows is crucial to achieve the 'LCCR' Transition

Adopted in 2015 at COP21, the Paris Agreement triggered new momentum in the fight against climate change and confirmed the global target of limiting the rise of global mean temperature to +2°C compared to the preindustrial period. The agreement defines an ambitious goal to orient countries towards developing low-carbon and climate-resilient economies and shifting to a carbon-neutral global economy before the end of the century. Among the objectives, the central role finance has to play to achieve this transition has been reaffirmed in Article 2.1(c): "Making finance flows consistent with a pathway towards low greenhouse gas emissions and climate resilient development". The scale of financing needs requires a shift in the allocation of both public and private finance flows from carbon-intensive activities to investments compatible with a 2°C or low-carbon climate-resilient (LCCR) pathway.

This has contributed to a major emphasis being put on "climate" or "green" finance since the signature of the Paris Agreement. This has expanded the climate finance discussion beyond the issue of transfers of public funds between developed and developing countries that has dominated the climate agenda since the COP in Copenhagen in 2009. For financial actors to redirect their support from carbon-intensive to low carbon assets, they need to understand and be able to track which assets are compatible with a 2°C pathway.

Consequently, market actors are increasingly enthusiastic about green bonds. The green bond instrument, as other green financial products, is structured so as to highlight products aimed at financing assets compatible with a low-carbon and climate resilient economy, referred in this note as "LCCR investments". The green bond market has grown rapidly, reaching USD 81 billion in annual issuance in 2016 (CBI 2017) and could reach USD 200 billion in 2017 (Moody's 2017).

Corporate actors and banks currently represent the largest share of sources of finance for LCCR investments (Climate Policy Initiative 2015). In the future, banks and corporate actors will certainly continue to provide a significant share of LCCR finance flows, particularly at early stages of project finance where the level of risk is higher. However, the scale of LCCR investments financing needs and the long-term maturity of most LCCR assets may exceed the capabilities of both corporate actors and banks. This is particularly true as the balance sheets of banks and corporate entities continue to be constrained since the financial crisis, with a pressure towards deleveraging (OECD 2015a).

It is therefore crucial to diversify the sources of finance for LCCR investments, and to tap into financial flows managed by institutional investors, which represent a large part of global financial flows. The issue of redirecting part of institutional investors' portfolios towards LCCR assets is thus crucial to ensure that a sufficient volume of financing will be available to LCCR investments. In OECD countries the volume of assets managed by institutional investors is expected to grow to USD 120 trillion by 2019 from around USD 93 trillion in 2013, and the same trend is expected for emerging and developing countries where institutional investors managed around USD 10 trillion in assets in 2013 (OECD 2016). Therefore, according to the consultancy McKinsey, with the right incentives in place private institutional investment in infrastructure – LCCR or not – could grow globally by USD 1 trillion to 1.5 trillion a year from USD 300 to 400 billion today – or more than a third of the infrastructure investment gap (McKinsey Center for Business and Environment 2016).

Bonds are financial instruments particularly well suited to tap into the major sources of capital and financial flows managed by institutional investors. Different bond products make up the largest share of institutional investors' portfolios, representing on average 53% of pension funds' portfolios and 64% of insurance companies' portfolios in 2013 (OECD 2015b). Institutional investors favor bonds as this instrument typically offers a lower risk profile than other financial instruments. Secondly, due to their fiduciary duty1 and the long-term time horizon of their liabilities, institutional investors look for financial assets that minimize risks – while ensuring sufficient performance.

Moreover, financing – or refinancing – LCCR assets through bonds could lower capital costs of LCCR projects. Use of bonds can provide a lower cost of capital compared to long-term banking debt given that the cost of project finance debt arranged by banks is often higher than the yield for investment-grade bonds in most jurisdictions. For instance, in the United Kingdom in November 2015 the all-in cost of a 20-year project loan with a BBB- credit quality was roughly 5% while the all-in cost of a project bond of a similar credit quality was roughly 4,5% (OECD 2015a).

1 *Fiduciary duty: Fiduciary duties are the legal principles that protect beneficiaries and society from being taken advantage of by fiduciary agents who are charged with investing assets for the benefit of third-party beneficiaries. Fiduciary duties exist because beneficiaries are forced to rely on fiduciary agents even though they rarely possess the information and expertise to evaluate the integrity and effectiveness of the agent's management services in a timely way. Source: http://www.reinhartlaw.com/wp-content/uploads/2016/01/Introduction-to-Institutional-Investor-Fiduciary-Duties.pdf*

BOX 1. WHAT ARE BONDS?

Bond: Debt instrument used to borrow the funds for a defined period of time usually at a fixed interest rate. On the contrary to bank debt, a bond is a tradable security that can be sold and bought on capital markets at any time during its duration.

There exist many types of bonds within the 'universe' of this financial instrument, often linked either to the type of issuer or the types of assets involved:

- Corporate bonds or 'use of proceeds' bonds backed by a corporate's balance sheet.
- Project bonds that are backed by a single or multiple projects.
- Asset-backed securities (ABS) or bonds that are collateralized by a group of projects.
- Covered bonds with a recourse to both the issuer and a pool of underlying assets.
- Supranational, sub-sovereign and agency (SSA) bonds that are issued by the IFIs and various development agencies.
- Municipal bonds issued by municipal governments, regions or cities.
- Financial sector bonds issued by an institution to finance 'on-balance sheet lending'.

Furthermore, the bond market may be even more advantageous for project loans with a maturity exceeding 20 years given that banks are generally not prepared to provide loans exceeding 20 years in maturity (OECD 2015a). As the cost of capital represents typically a very large share of LCCR investments, only a slight decrease in capital costs can significantly improve the economic performance of LCCR investments.

The financing LCCR investments through the bond market could be rapidly scaled up. The potential for scaling up the financing LCCR investments using the bond market is tremendous. According to a study from CBI and HSBC, in July 2016 there was a universe of around USD 700 billion of climate-aligned bonds, i.e. of bonds that reach the definition of climate bonds according to CBI but are not all sold as "green" to investors (CBI 2017). According to the OECD, the market of bonds financing LCCR investments has the potential to scale up to around USD 1 trillion outstanding in 2020 and to USD 5 trillion outstanding in 2035 (OECD 2017). These figures represent only a lower band of the potential of bonds to finance LCCR investments since it takes into account only 3 sectors – renewable energy, buildings energy efficiency and low-emissions vehicles[2] and 4 regions – China, the EU, Japan and the United States. The market of bonds financing LCCR investments therefore has the potential to scale up quickly if necessary conditions are in place, and thus could contribute in filling LCCR financing gaps.

I4CE's research program on green bonds

I4CE's prior research on green bonds has identified two key challenges for the market. First, the green bond market does not appear today to directly stimulate a net increase in green investments, e.g. through a lower cost of capital. Second, the spontaneous bottom-up manner of the development of the green bond market raises reputational and legal risks related to its environmental integrity. To realize its full potential to contribute to the LCCR transition, the green bond market must overcome these two challenges. I4CE's 2016 report suggested that at the very minimum the market has to avoid implosion – due to the lack of investor confidence – by ensuring the environmental integrity of green bonds. Furthermore, going beyond information transparency, the impact of green bonds needs to be enhanced by growing the pipeline of underlying low-carbon projects and potentially bringing tangible financial benefits. These two challenges echo the two key topics currently in discussion at the EU level – providing more information transparency and improving the contribution of the financial sector to sustainable development (European Commission 2017).

A number of measures and policies have been identified or suggested that could improve the contribution of green bonds to the low-carbon transition. Among these measures are, for example, public support schemes such as tax breaks and subsidies (CBI 2015), adjustment of risk weightings for green investments (Campiglio 2015), issuance of sovereign green bonds (I. Shishlov 2016), harmonization of green definitions (CBI 2016), the development of a European green bond standard (European

2 *Low-emissions vehicles refer to plug-in and electric vehicles, fuel cell and hybrid vehicles with emissions of less than 90 gCO_2/km.*

Commission 2016), and the establishment of a recognized dispute mechanism (Carney 2016), to name only a few. There is now a need for an objective assessment of the suggested schemes in terms of their feasibility and potential impact to inform policy makers and market actors.

Responding to this need, I4CE with support of the Climate Works Foundation launched a research program in 2017 consisting of two work packages:

- **WP1**: analysis of challenges and solutions to improve financial additionality of green bonds;
- **WP2**: analysis of challenges and solutions to ensure environmental integrity of green bonds.

The overarching methodology of the study is based on desk research and bilateral interviews with various public and private actors involved in the green bond market. To facilitate the discussion and exchange of ideas among relevant stakeholders, I4CE together with the World Wildlife Fund (WWF) and the European Investment Bank (EIB) also organized two practitioner workshops on 7 March 2017 in London and on 15 June 2017 in Paris.

This report presents key findings of the Work Package 1 on the challenges and opportunities to ensure financial additionality of the green bond market – and consists of three parts. The first part explores what categories of low-carbon, climate-resilient (LCCR) investment needs could theoretically be financed by bonds and where main financing gaps are lying. Second, the report analyses if the labelled green bond market could contribute in directing additional bond financing to LCCR investments in the future. Third, the report suggests and briefly analyzes some market-led and public-led measures that could help boost the contribution of the green bond market to the financing of the low-carbon transition.

Overall, this report transparently assumes that the overall objective of developing the green bond market is to support the LCCR transition, and thus to bring additional benefits to LCCR assets compared to non-labelled climate-aligned bonds. Rather than only analyzing what measures could help accelerate the development of the green bond market, this study assess how the development of the labelled green bond market could contribute in "shifting the trillions" and aligning financial flows with the objectives of the Paris Agreement as per its Article 2.1.c. It finally draws conclusions that could be applicable for other green instruments and provides a brief overview of how public policy might push for a better 'mainstreaming' of climate issues into financial decision-making. The different policies options are described and analyzed in varying detail in the report's annexes.

1. What low-carbon and climate-resilient investments could the bond market finance?

KEY TAKEAWAYS FROM THIS SECTION

- Estimates of needed global low-carbon investment range from USD 580 to USD 3.2 trillion. Nevertheless, there is no doubt that a significant shift in financial flows from carbon-intensive to low-carbon sectors – as well as to adaptation – will be needed to close the LCCR investment gap. The main increase in LCCR investment will have to be targeted towards energy efficiency actions, and notably low emissions vehicles and energy efficiency in buildings, which are mainly fulfilled by individual and SMEs.
- The bond market is primarily an instrument suited for use by large (> USD 100 million), low-risk issuers or assets benefiting from good credit ratings; or for homogeneous and standardized pools of small-scale assets in the case of asset-backed securities. Therefore, even if in theory scenarios can be imagined where almost all categories of LCCR investments could be financed by the bond market, in practice the use of bonds to finance or refinance the majority of LCCR actions may not be feasible for a number of reasons.
- Some areas where significant increases in financial flows for LCCR investments are needed – i.e. low emissions vehicles and housing energy efficiency – are suitable for asset-backed securities (ABS) or bank loans refinanced through financial bonds. As a result, a significant part of the potential for the LCCR bond market to increase would come from asset-backed securities. Nevertheless, the estimate by the OECD that this could represent 44% of outstanding bonds in 2035 is far from the 6% in 2016 indicating that significant actions to scale up this share is needed.
- There does not seem to be significant obstacles to the issuance of corporate or SSA bonds for financing LCCR investments compared to traditional investments. However, there is a lack of pipelines of LCCR investments, which in some case may result partly from high financial costs due to risk perception and other factors. In terms of other categories of bonds, obstacles to bond issuance specific to LCCR assets are:
  - the risk perception of LCCR investments relative to other investments, resulting in higher costs of finance for LCCR assets. This could have impacts on project bonds, as well as to some extent corporate bonds issued by pure-player project developers and asset-backed securities;
  - the generally long-term profitability horizon of LCCR assets suitable for project bonds and to some extent corporate bonds issued by pure-player project developers;
  - the lack of tagging of green loans in banks' balance sheets for financial bonds;
  - the lack of standardization of LCCR loans and lack of historic data on LCCR investments for asset-backed securities.

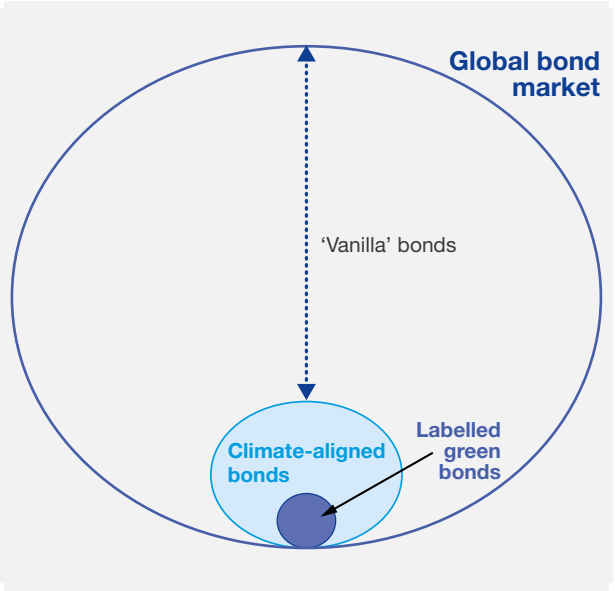
Improving the contribution of the green bond market to the LCCR transition could firstly come from an expansion of the types of low-carbon climate-resilient investments that can be financed using different types of bond issuance. This section analyses what categories of LCCR investments – and more specifically underlying project developers – could theoretically access the bond market; what LCCR investments are currently being financed by the bond market in general, and specifically the labelled green bond market (see **Box 2**); and finally a review of existing research on what segments of the bond market are expected to contribute in the coming years to close the LCCR investment gap.

BOX 2. BREAKING THE GLOBAL BOND UNIVERSE INTO VANILLA, CLIMATE-ALIGNED AND LABELLED GREEN BONDS

This report differentiates between a) traditional bonds, b) bonds labeled as "green" at issuance, and c) bonds financing LCCR assets, but not necessarily labelled as being "green" using three terms. While they are not adopted by all market stakeholders, they nevertheless introduce clarity to discussions:

- The term **"vanilla bonds"** refers in this report to all bonds with no specific 'green' component, i.e. the entire bond market expect climate-aligned bonds and labelled green bonds.
- The term **"climate-aligned bonds"** is used in this report to refer to bonds financing or refinancing low-carbon, climate-resilient (LCCR) investments, no matter if they are advertised at issuance as being "green" or not. As such the market of climate-aligned bonds is much larger than the market of labelled green bonds (CBI 2017).
- The term **"labelled green bonds"** refers to a subset of climate-aligned bonds that were labeled as "green" at issuance. It includes both green bonds benefiting from a label such as the Green Bond Standard, as well as green bonds with no formal label, but whose green credentials have been reviewed externally prior to issuance. Please refer to I4CE's second report in this series *"Environmental integrity of green bonds: stakes, status and next steps"* (Igor Shishlov, Nicol, and Cochran 2017) for more information on the different processes for issuing a bond as "green".

FIGURE 1. BREAKING THE GLOBAL BOND MARKET INTO VANILLA, CLIMATE-ALIGNED AND LABELLED GREEN BONDS



Source: Authors

1.1. A LCCR investment gap exists: closing this gap will require financing to principally support investments or SMEs

Overall, estimates of annual global low-carbon investment needs range from USD 580 billion ((IPCC 2014) median of studies assessed) to USD 3,2 trillion (NCE 2014)[1]. Uncertainties are large concerning the volume of LCCR investments needed to achieve limiting global mean temperature increase below +2°C. However, it is recognized that most studies underestimate LCCR investment needs as they do not cover all sectors and types of actions that will be needed for the low carbon, climate resilient transition, notably for non-energy carbon emission reduction – agriculture and forestry mostly –, and for adaptation.

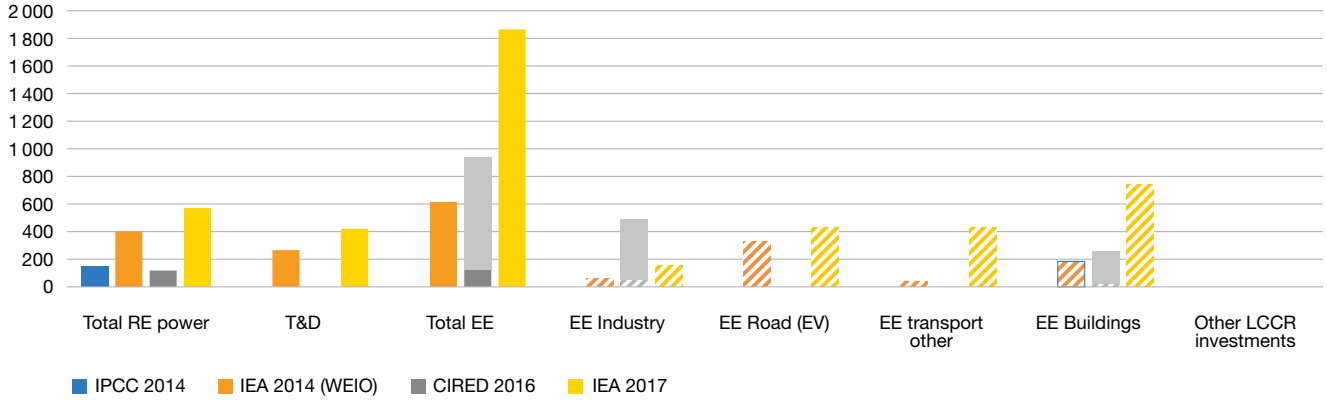
For comparison, current global annual investment in LCCR assets – comprising renewable power generation, T&D and energy efficiency, is estimated at around USD 700 billion in 2014 and 2015 (Climate Policy Initiative 2015) (OECD/IEA and IRENA 2017). This is therefore in line with, if at the lower end, of the projected annual low-carbon energy investment needs by 2030-2035.

However, given that it is thought that investment needs have been underestimated, there is nevertheless an investment gap that needs to be filled. To understand the capacity of bonds to contribute to financing these needs, this section will disaggregate estimates of LCCR investment needs by sectors – and by types of project developers.

1.1.1. Disaggregating LCCR investment needs by sectors

It is important to disaggregate investment needs by sectors given differences in how financing occurs in each sector. **Figure 2** presents a macro-sectorial split of these estimates of LCCR investment needs, where available from the existing studies. As described in detail in **Box 3**, it should be noted that all studies assessed exclude mitigation investment needs in agriculture and forestry, as well as adaptation investment needs and often clean transport infrastructure. Additionally, studies did not take into account the research and development costs necessary to trigger innovation, generate expected technological breakthrough and decrease the costs of a low-carbon and climate-resilient development. These actions, however, are implicitly integrated in the models developing 2°C roadmaps, even if they remain unpriced.[2]

FIGURE 2. ESTIMATES OF GLOBAL LOW-CARBON INVESTMENT NEEDS ACCORDING TO DIFFERENT STUDIES (IN USD BILLION PER YEAR)



NB: Figures correspond to annual global needs, calculated as total needs on the considered period divided by the number of years considered. Time horizons differ depending on sources – IPCC: 2010-2029, IEA 2014: 2014-2035, NCE 2014: 2015-2030, CIRED 2016: 2020-2035, IEA 2017: 2016-2050. Sectoral perimeters and methodologies also vary depending on studies. The light part of bars represent the gap between minimum and maximum estimates for reports synthetizing results from several studies or modelling (IPCC and CIRED).

Source: I4CE analysis based on data from (OCDE/IEA 2014), (OECD/IEA and IRENA 2017), (Bibas, Cassen, and Hourcade 2016), (Global Commission on the Economy and Climate 2014) and (Gupta S., J. Harnisch, D.C. Barua, L. Chingambo, P. Frankel, R.J. Garrido Vázquez, L. Gómez-Echeverri, E. Haites, Y. Huang, and R. Kopp, B. Lefèvre, H. Machado-Filho, and E. Massett 2014)

1 *This numbers used differs from the often-quoted Figure from NCE 2014 report of USD 93 billion over the period 2015-2030, or almost USD 6 trillion per year. The perimeter used in this analysis is indeed different: only low-carbon and climate-resilient – or "green" assets are taken into account, whereas the USD 93 billion Figure represents all infrastructure investment needs to achieve a 2°C trajectory, would they be low-carbon or not.*

2 *For an assessment of how climate-related investment is being financed in France, I4CE has been conducting the landscape of domestic climate finance in France for the last five years. More information and the related reports can be found here: https://www.i4ce.org/go_project/landscape-of-domestic-climate-finance/*

BOX 3. METHODOLOGICAL NOTE ON COMPARING TRANSITION SCENARIOS AND RELATED ESTIMATES OF INVESTMENT NEEDS

Results presented in **Figure 2** should be interpreted with caution, as:

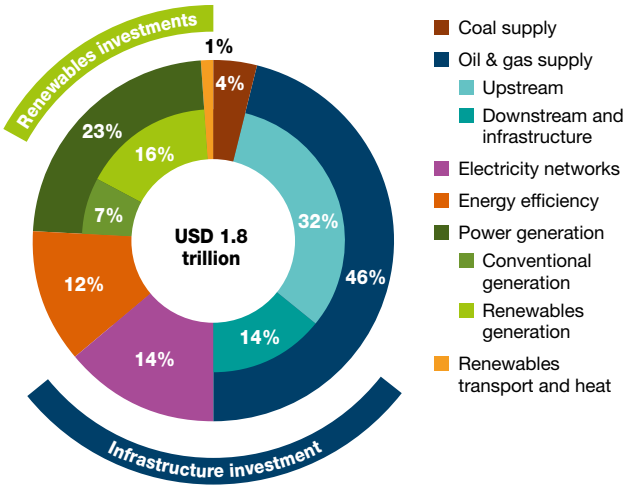
- To date very few 2°C scenarios model investment needs, and even fewer specify how much of these investment needs are specifically for low-carbon and climate-resilient assets;
- Results only include investment needs in renewable power generation, electricity transport and distribution for IEA studies. All studies exclude non-energy sector mitigation investment needs – notably in agriculture, forestry and other land-use issues; investment needs for adaptation – the "climate-resilient" part of LCCR assets; and investment needs for clean transport infrastructure (except the New Climate Economy reports, not represented in the graph since they do not provide a detailed split of LCCR investment needs per sector). All studies therefore significantly under-estimate the scale of LCCR investment needs, and uncertainties are high on the amount of LCCR investments that will be needed to achieve limiting global mean temperature increase below +2°C.
- Results are highly dependent on assumptions concerning macroeconomic conditions – notably GDP growth – and on assumptions on the speed of technological adoption and prices of different technologies.
- All analyses presented are modelled on different time horizons – therefore results are presented in the graph as average annual investment needs for allowing comparability, even if a strict comparability is not possible due to differences around time horizons;
- Analysis perimeters vary: the same economic sectors and subsectors are not taken into account in all studies;
- Calculation methodologies differ: notably for energy efficiency most studies only take into account the additional cost for higher energy efficiency (IPCC, IEA) whereas some studies take into account both the efficiency additional cost and the cost of the decarbonized asset (NCE, CIRED). As financial instruments are used to finance both the decarbonized asset and the additional cost for energy efficiency, it should be noted that that for estimating the level of financial flows needed for LCCR assets it appears to be more useful to include both the efficiency additional cost and the cost of the decarbonized asset in the calculation of investment needs.

Consequently, significant research is needed to better assess what it means to align financial flows with a 2°C trajectory. In turn, further work is also needed to identify which assets should be favored by financial actors to achieve the due shift in their portfolio allocation. Public institutions and policy makers could be associated to such research effort to ensure that conclusions are aligned with expected climate policies and to ensure relevant coordination between the mix of climate policies and climate strategies of financial actors.

Renewable energy investment needs

The studies analyzed estimated that USD 250 to 570 billion should be invested annually in renewable energy assets. In 2014 and 2015, investments in renewable energy generation were around USD 300 billion (Climate Policy Initiative 2015) (OECD/IEA and IRENA 2017). While there are some uncertainties on the volume of investment needed for renewable power generation, a shift in the mix of energy production investments will be needed. As seen below, the smaller scale of the shift needed is less that for in energy efficiency investments.

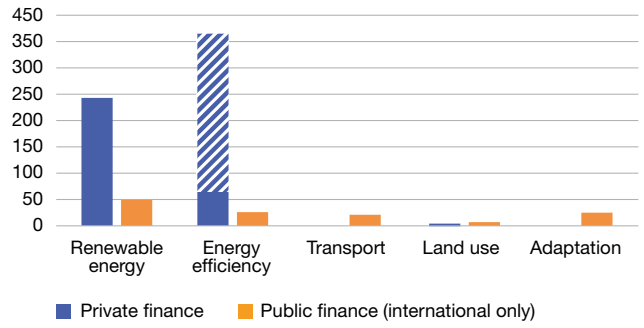
FIGURE 3. GLOBAL ENERGY INVESTMENT IN 2015 (USD)



Note: Coal supply here includes mining and transport infrastructure; electricity networksinclude transmission and distribution lines, and grid-scale storage. Key message: Half of energy investments today are in fossil fuel supply, having declined from 60% in 2014.

Source: (OECD/IEA and IRENA 2017)

FIGURE 4. ESTIMATES OF GLOBAL CLIMATE FINANCE FLOWS IN 2015 (IN US$ BILLION)



Source: I4CE, based on (Climate Policy Initiative 2015)

Energy efficiency investment needs

A major finding of the comparison of the different estimates of 2°C investment needs is that the largest share of needs typically are for energy efficiency efforts, rather than renewable energy generation. Energy efficiency represents from 57% to 88% of all estimated low-carbon investment needs.[3] The uncertainty surrounding of estimates are large since estimates of energy efficiency annual investment needs range from USD 140 to 1,900 billion, depending on models and perimeters assessed. Nevertheless, it is unanimously understood that investments in energy efficiency would need to be scaled-up dramatically and steadily as of now and at least until 2050, as illustrated in **Figure 5**, as they totaled only USD 120 to 390 billion in 2014-2015 (Climate Policy Initiative 2015) (OECD/IEA and IRENA 2017).[4]

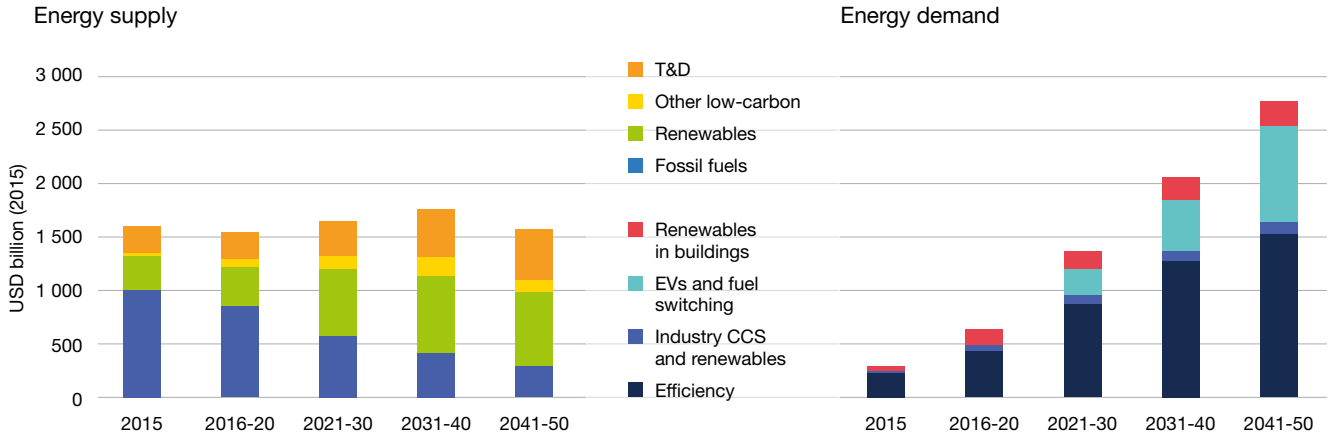
Two IEA studies (OCDE/IEA 2014) (OECD/IEA and IRENA 2017) provide a comprehensive sectorial decomposition of energy efficiency investment needs, presented in Table 1.[5] A key conclusion can be drawn from these two studies: investment needs are large in alternative energy vehicles and in energy efficiency in buildings, representing for each some hundreds of billions of dollars per year globally, i.e. around 40% of total estimated total LCCR investment needs. Notably, there exists a substantial gap between the annual investment need of around USD 380 billion between 2014 and 2035 for electric vehicles (EVs) and the amount of USD 4 billion invested in 2015 in EV sales ad charging stations (OECD/IEA and IRENA 2017).

3 *Excluding CIRED's estimates based on IEA technical visions-based scenarios, and excluding transmission and distribution [T&D] investment needs from IEA studies.*

4 *Regarding energy efficiency investments, uncertainties are large, even for past and current investment levels, due to difficulties in tracking such investments and to different perimeters and calculation methodologies used by study authors. Details on the perimeter and methodology of the study is lacking in most studies in order to be able to reconcile the different estimates.*

5 *Differences in results from both IEA studies stem from: the difference in scenarios – the carbon budget to be respected in the 2017 study is far lower, and macroeconomic and technology assumptions changes between 2014 and 2017.*

FIGURE 5. AVERAGE ANNUAL GLOBAL ENERGY SUPPLY- AND DEMAND-SIDE INVESTMENT IN THE 66% 2°C SCENARIO



Note: T&D = transmission and distribution; EVs = electric vehicles; CSS = carbon capture and storage.

Key message: the level of supply-side investment remains broadly constant, but shifts away from fossil fuels. Demand-side investment in efficiency and low-carbon technologies ramps up to almost usd3 trillion in the 2040s.

Source: (OECD/IEA and IRENA 2017)

TABLE 1. ESTIMATES OF SECTORIAL SPLIT OF ENERGY EFFICIENCY INVESTMENT NEEDS BASED ON IEA STUDIES

			Annual investment needs in USD billion					Share of each sector to total EE investment needs			
	2°C roadmap	Time horizon	Annual EE investment needs	incl. EE in industry	incl. EE in road sector (EVs)	incl. other EE in transport sector	incl. EE in buildings	Share of EE inv. in industry	Share of EE inv. for EVs	Share of EE inv. in other transport	Share of EE inv. in buildings
IEA 2014 (WEIO)	450 ppm	2014-2035	615	62	330	39	184	10%	54%	6%	30%
IEA 2017	66% 2°C Scenario	2016-2050	1865	154	430	430	743	8%	23%	23%	40%

Source: I4CE, based on data from (OCDE/IEA 2014) and (OECD/IEA and IRENA 2017)

TABLE 2. RANGE OF LOW-CARBON ENERGY INVESTMENT NEEDS BY CATEGORIES OF PROJECT DEVELOPERS

	Category of project holders	Range of annual investment needs estimated (in USD bn)	Range of investment needs estimated (in % of estimates)	
Renewable power generation	Utilities (public or private) and dedicated project developers	USD 250 to 570 bn	12% to 43% (excl. Scenarios A from CIRED 2016)	54 to 60% of total low-carbon energy investment needs
T&D	Utilities (public or private)	USD 270 to 420 bn	14% to 20% (incl. in IEA studies only)	
EE in industry	Industrial corporates	USD 60 to 150 bn	5% (from IEA studies only, total incl. T&D)	
EE in transport excl. EVs	Corporates and public institutions	USD 40 to 430 bn	3% to 15% (from IEA studies only)	
EVs	Individuals, and for some extent corporates	USD 330 to 430 bn	15% to 25% (from IEA studies only)	Up to 40% of investment needs
EE in buildings	Mostly individuals? (more research needed)	USD 180 to 740 bn	14% to 25% (from IEA studies only)	

Source: I4CE analysis based on data from (OCDE/IEA 2014), (OECD/IEA and IRENA 2017), (Bibas, Cassen, and Hourcade 2016), (Global Commission on the Economy and Climate 2014) and (Gupta S., J. Harnisch, D.C. Barua, L. Chingambo, P. Frankel, R.J. Garrido Vázquez, L. Gómez-Echeverri, E. Haites, Y. Huang, and R. Kopp, B. Lefèvre, H. Machado-Filho, and E. Massett 2014).

It thus appears that new investment – and supporting financial flows – for LCCR investment in general will include both renewable energy and energy efficiency – but be concentrated in the latter. Furthermore, a large portion of these actions will be small-scale in nature such as in buildings and road transport. The scale and number of projects will have an impact on what type of instruments can provide the needed financing to support investment.

1.1.2. Split of investment needs by categories of project developers

Assessing the use of different financial instruments for the LCCR transition requires an understanding of who will be conducting individual investments. The Table below identifies the types of main project developers for each sector of low-carbon investments. For this study, project developers are the entities (public, corporate or households) that initiate, conduct and secure financing for a given project. It also presents an estimate of the volume of investment needs by category of project developers. This is based on rough hypotheses and should be seen as a first, improvable estimate. As a next step, a more detailed and empiric breakdown of LCCR investment needs by types of investments and by project developers would be useful to better understand which policy measures could better trigger the investment decision among different types of project proponents. This initial assessment indicates that a large portion of investments will be made by relatively small and a large number of project developers. This has implications for how bonds could be used to fulfill these needs, particularly for households and SMEs.

According to this preliminary analysis, if no large-scale or aggregating programs are put into place individuals or households will need have to carry out up to almost 40% of global low-carbon energy investment needs: either through purchasing low-emitting vehicles, or improving the energy efficiency of residential buildings. Between 35% and 50% of total investment needs would be carried out by utilities, either private or public, or dedicated project developers, for renewable energy generation and

transmission and distribution infrastructure construction. Finally, a minor portion of these investment needs would have to be supported by non-utility large corporates or public organizations. Furthermore, it is likely that for those sectors not included into studies assessed, GHG mitigation investments in agriculture and forestry would be carried out mainly by small holders, either small enterprises or individuals, with some large agro-industrial corporate actors also potentially involved. Regarding adaptation investment needs, all categories of project developers could be involved. Further research would be needed to identify the types of actions and categories of project developers for both categories of LCCR investments.

1.2. Understanding what bonds as a class of instruments can – and cannot – finance

In practice, LCCR investment needs will be financed using a mix of equity, grants, transfers, financial instruments and debt products. Among private finance flows, different finance sources and financial instruments match different categories of investments, depending on characteristics of project developers and the project itself. This section explores what different types of bonds are, what they are currently used for and how they can – or in some cases cannot – fulfill in a straightforward and feasible manner the needs of different types of LCCR investments and project developers.

1.2.1. General characteristics of bonds

A bond is a debt instrument used to borrow funds for a defined period of time that is tradable on capital markets. Bonds represent a large share of global financial flows with around USD 100 trillion outstanding globally, of which around 75% was issued in developed countries – principally the United States (40%).[6]

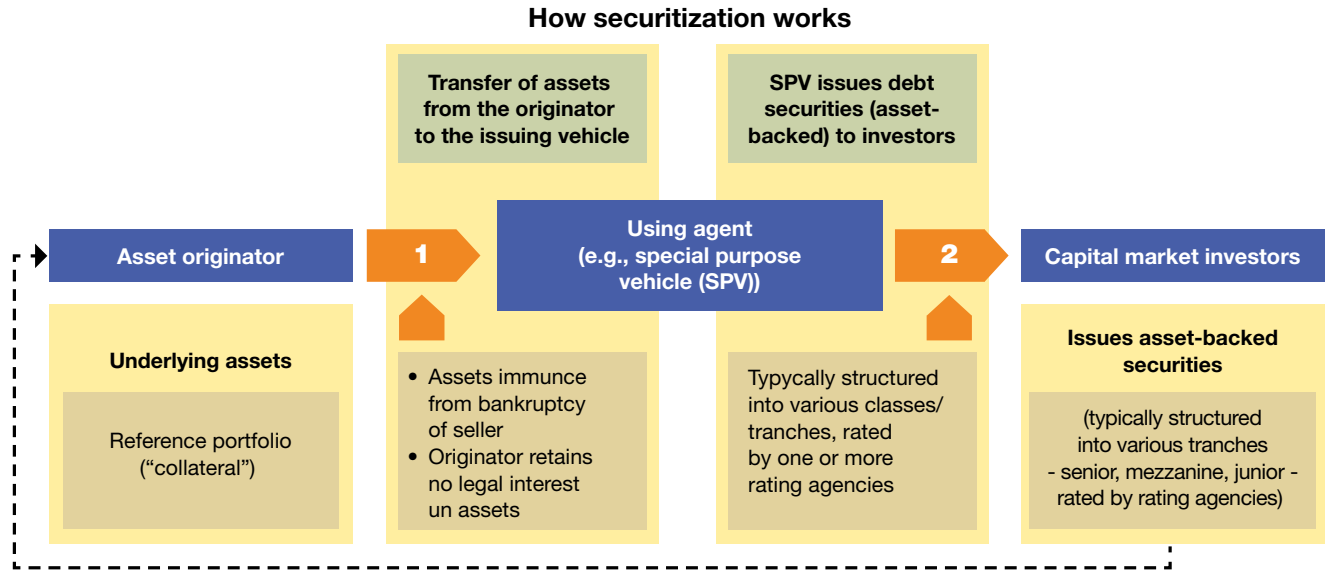
As described in I4CE's 2016 report, a wide range of types of bonds exist, each dedicated to different issuers or assets (I. Shishlov, Morel, and Cochran 2016):

- ***Sovereign, Supranational, and Agency (SSA) bonds*** are comprised mainly of treasury bonds or bonds issued by governmental bodies to fund their budget. It also includes bonds issued by the IFIs or development agencies. It represents the largest share of the bond market, with 45% to 75% of outstanding bonds depending on countries. Generally this category also includes municipal bonds, or bonds issued by local authorities.
- ***Financial sector bonds*** are issued by a financial institution to finance 'on-balance sheet lending': it represents the second largest share of the bond market, with 20% to 45% of the total bond market in main countries. ***Covered bonds*** are a sub-category of financial sector bonds with the specificity of adding recourse to a pool of underlying assets in addition to the recourse to the issuer. Covered bonds are thus less risky than equivalent financial sector bonds. Most of covered bonds are issued by European banks, representing 40% of EUR financial sector bonds issued in 2016. The US market for covered bonds was launched in 2007 and is growing.
- ***Corporate bonds*** or bonds issued by non-financial sector corporations: bonds backed by a corporate's balance sheet. Their share in the global bond market tends to increase but remains below 20% of the total bonds market. Corporate bonds are usually split between "investment grade"[7] and "high-yield" bonds – i.e. risky assets. Typically around 80% of corporate bonds issued have an "investment grade" rating. Corporate bonds tend to present long-term maturities; for example in the Euro bond market in 2016, around 65% of bonds issued had a maturity comprised between 5 and 12 years.
- ***Project bonds*** are non-recourse project-based issuances, generally with long tenors and investment grade ratings, suitable for large operating projects (typically larger than USD 450 million) with fixed price off-take agreements. It is still a niche market with around USD 50 billion issued globally in 2014.
- ***Asset-backed securities (ABS)*** is a financial security backed by a pool of loans, leases or receivables, all illiquid assets that become markeTable through a process called securitization (see **Figure 6**). Underlying assets of an asset-backed security have to be standardized and homogeneous in terms of the investment realized. This explains why the largest share of the global ABS market is composed of mortgage-backed securities, i.e. backed by housing mortgages, which present a large volume of homogeneous assets benefiting from a long track record of default rates. Asset-backed securities currently represent a small share of the global bonds market – with a cumulated volume in 2016 of less than EUR 100 billion in Europe and less than USD 400 billion in the United States. There are also sub-categories of asset-backed securities depending on underlying assets, typically home mortgages (MBS), automobile loans, credit card receivables, corporate loans (CLO). However, for the purpose of this report, all categories of asset-backed securities are grouped under the name "ABS".

6 *Data cited in this paragraph come from two sources: Bank for International Settlements (http://www.bis.org/statistics/c1.pdf) and Société Générale Corporate and Investment Bank (https://cib.societegenerale.com/uploads/tx_bisgnews/SG_CIB_-DCM_2016_Review_and_2017_Forecast.pdf).*

7 *Investment grade financial assets are rated as AAA, AA, A or BBB by rating agencies, meaning that they present a low level of risk for buyers.*

FIGURE 6. AVERAGE ANNUAL GLOBAL ENERGY SUPPLY- AND DEMAND-SIDE INVESTMENT IN THE 66% 2°C SCENARIO



Source: https://www.fimarkets.com/pagesen/securitization.php

TABLE 3. GENERAL CHARACTERISTICS OF MAIN BOND CATEGORIES

	Characteristics of issuer	Recourse	Size of underlying assets	Other characteristics of underlying assets	Risk profile	Approximate share of the bond market
SSA bonds	State or backed by state	Recourse on State	Budget financing, "all purpose"		Low risk, often considered as no risk	45% to 75% depending on geographies
Financial bonds	Financial institution	Recourse on the issuer	Generally not identified, "all purpose"		Typically 'investment grade'	20% to 45%
Corporate bonds	Corporate organization	Recourse on the issuer	Generally not identified, "all purpose"		Around 80% of corporate bonds issued are 'investment grade'	Below 20%
Project bonds	Special Purpose Vehicle (SPV) (owns (a) project(s))	No recourse ; only backed by revenue streams from the project	Large-scale project(s), typically > USD 450 million	Only available for mature technologies with a good track record	Higher risk profile but still mainly 'investment grade'	Around 0,5% globally
Asset-backed securities	Special Purpose Vehicle (SPV) (owns a pool of loans, leases or receivables)	No recourse ; only backed by revenue streams from pooled assets	Generally small-scale assets (loans, leases or receivables)	Need to have a sufficient track record of default for the same type of assets	Often 'tranches' to offer different risk profiles to investors	Less than 5%

Source: Authors.

As seen in Table 3, the bond market is primarily an instrument suited for use by large, low-risk issuers or assets benefiting from good credit ratings ("investment grade"), regardless of the type of bond. In terms of volume, individual bond issuance is rarely below USD 100 million, and to be included in main indices a bond has to be above £250 million in the UK and above EUR 500 million in Europe. While exceptions may exist, in general the bond market is not well suited to finance stand-alone research and development activities or assets

involving technologies or other activities with little to no track-record available. Furthermore, the bonds market is generally neither accessible to SMEs given transaction costs – notably to obtain a credit rating, and given that investors' expectations on risk profile and the volume of issuance is at stake. Using bonds to finance activities that do not clearly fit within these categories often either results in products of interest for principally niche 'impact-oriented' investors, or requires support from third-parties (i.e. public or other forms of guarantees).

1.2.2. Categories of LCCR investment needs with a potential for bond financing

To analyze which categories of LCCR investments could fit the bond market requirements, characteristics of LCCR investments are crossed with the general requirements of bond financing. Table 4 presents the results of this analysis. It should be noted that the "theoretical potential" of the use of bonds to finance each category of LCCR investments presented below is highly dependent on context. In most emerging and developing countries, where large corporates and even national governments do not have an "investment grade" credit rating, and where domestic bonds markets are small or even inexistent, financing LCCR assets using bonds might prove very difficult and relatively inefficient compared with other options.

The assessment conducted by the authors suggests that bonds as a family of instruments could be used to finance almost all types of investment needs. However, the areas where the largest increases in financial flows towards LCCR investments are needed – i.e. alternative energy vehicles, renewable energy on buildings and the construction of energy efficient housing – only specific types of bonds – such as asset-backed securities (ABS) or bank loans refinanced through financial bonds – appear suitable. In other areas, such as renewable power generation and electricity transport and distribution (T&D), a broader spectrum of bond instruments could be used, such as corporate bonds (for private utilities) or SSA bonds (for public utilities), or even project bonds for the largest projects. Regarding renewable energy projects owned by specialized project developers (mainly SMEs), access to bond financing may be more difficult, even if some examples

TABLE 4. POTENTIAL OF DIFFERENT GREEN BONDS INSTRUMENTS FOR DIFFERENT LCCR INVESTMENT NEEDS

Different bond instruments…		… for different investment needs	*Range of estimates of annual investment needs*
Corporate and SSA (Sovereign, Supranational, and Agency) **bonds**	Corporate bonds are bonds backed by a corporate's balance sheet (mainly large corporates).SSA bonds comprise treasury bonds and bonds issued by development agencies and local authorities.	• Renewable power generation	• *USD 250 to 570 Bn*
		• Electricity transport and distribution	• *USD 270 to 420 Bn*
		• Clean transport infrastructure	• *No specific estimates available*
		• Energy efficiency investments in industry and transport by large corporates	• *A portion of USD 100 to 580 Bn- further research needed*
Project bonds	Project bonds are project-based bonds issued by Special Purpose Vehicles (SPVs), with no or limited recourse to project holder	Same as corporate and SSA bonds, but only the largest projects *(> USD 100 Bn, indicative figure)*	*Further research needed*
Asset-backed securities	Financial bonds issued by a SPV and backed by a pool of loans, leases or receivables, all illiquid assets that become marketable through a process called securitization.	• Electric vehicles (and other alternative energy vehicles)	• *USD 330 to 430 Bn*
		• Energy efficiency in buildings	• *USD 180 to 740 Bn*
Financial bonds	Bonds issued by financial institutions to finance 'on-balance sheet lending' with recourse to the issuing financial institution.	All categories of investment needs when initially funded by banking institutions	*All investment needs*
No clear potential for green bonds		• Agriculture, Forestry and Land-use • Adaptation	*Further research needed on characteristics of needed investments and estimates of the volume of these needed investments*

Source: Authors

of corporate bonds in this area exist today.[8] Finally energy efficiency investments carried out by corporates and often held 'on balance sheet' could be financed through corporate bonds (or SSA bonds). Other options may be more difficult as EE investments are very diverse and may not offer a sufficient volume of homogeneous investments with the needed history of default rates to be securitized.

1.3. The bond market is already used to finance, if at varying scales, the majority of LCCR investment categories

Understanding what the bond market is already financing in terms of LCCR assets – and comparing this to the analysis of both the estimated investment needs and the feasibility of using bonds to fulfill these needs – can indicate the potential of bonds to contribute to the LCCR transition. This section looks at how bonds are being used to financing green activities – whether labeled or unlabeled compared to vanilla bonds. It suggests that due to the relative low levels of use of bonds in areas where the most potential for scaling up the use of this product exists (i.e. ABS for energy efficiency in homes and buildings), the feasibility and efficiency of using this instrument must be further analyzed

1.3.1. Which types of LCCR assets are currently financed using bonds?

This section presents how bonds are currently being used to finance LCCR investment needs. It is divided into an assessment of how climate-aligned bonds – i.e. bonds financing LCCR assets, but not necessarily today labelled as green bonds – and labelled green bonds are being used to finance LCCR investment needs (see **Box 2** for a detailed description).

Climate-aligned bonds

According to Climate Bonds Initiative in its annual review of climate-aligned bonds, the outstanding volume of climate-aligned bonds is of almost USD 700 billion as of July 2016, with transport assets representing almost 70% of bonds outstanding (CBI 2017). The graph and Table below illustrate the sectorial split of outstanding climate-aligned bonds:

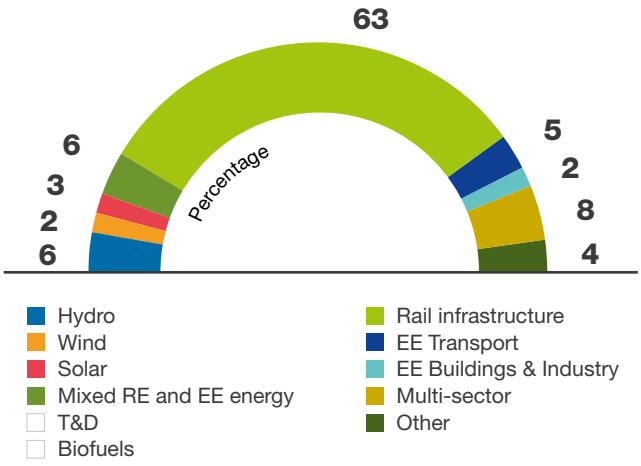
The cumulative amount of outstanding climate-aligned bonds dedicated to financing or refinancing renewable energy investments amounts to around USD 120 billion. The volume of renewable energy green bonds have therefore a good potential of scaling up, as annual financing needs for renewable energy projects could reach up to USD 400 billion, taking into account a typical 30/70 equity/debt ratio.

For energy efficiency investments, cumulative climate-aligned outstanding bonds amount to less than USD 50 billion as of July 2016 when rail infrastructure is excluded.[9] This is very low compared to global annual

8 *For example the French independent power producer Akuo Energy has issued three bonds since 2013 (private placements).*

9 *This is excluded as rail investments are often not included in most estimates of LCCR investment needs.*

FIGURE 7. TOTAL OUTSTANDING CLIMATE-ALIGNED BONDS UNIVERSE AS OF JULY 2016 (IN % AND IN USD BN)



Renewables	Hydro	40	Total RE = 120
	Wind	14	
	Solar	23	
	Mixed RE and EE energy	44	
	T&D	0	
	Biofuels	0	
Demand-side / Energy efficiency	Rail infrastructure	431	Total EE = 477
	EE Transport	32	
	EE Buildings & Industry	14	
	Multi-sector	57	
	Other	29	
	Total	**684**	

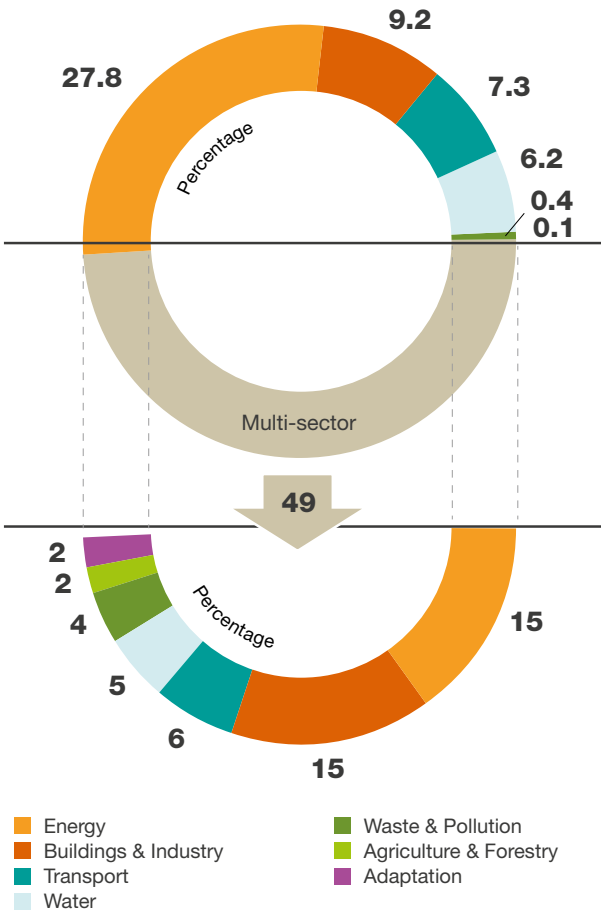
Source: I4CE, based on data from (CBI 2017)

investment needs in energy efficiency estimated at USD 300 to 1,800 billion, and when compared to the USD 200 to 400 billion currently invested annually in energy efficiency. As described in detail in Section 3, the small share of energy efficiency investments financed through bonds might be partly explained by a difficulty of tracking energy efficiency investments in the 'use of proceeds' of bonds, notably corporate bonds from industrials and financial bonds.

Labelled green bonds

The labelled green bond market, i.e. bonds advertised at issuance as green with or without a formal label, totaled USD 118 billion outstanding in July 2016, or 17% of the climate-aligned bonds universe. Labelled green bonds are already used to finance almost all of the categories of LCCR investment needs, if to varying degrees.

FIGURE 8. TOTAL OUTSTANDING LABELLED GREEN BONDS UNIVERSE AS OF JULY 2016 (IN% AND IN USD BN)



Source: (CBI 2017)

In terms of sectorial split, 43% of labelled green bonds are used to finance renewable energy investments. In 2016 around USD 30 billion of labelled green bonds issued were dedicated to financing renewable energy, representing less than 10% of the almost USD 290 billion of renewable energy investments that year (Climate Bonds Initiative 2017b).[10] Regarding energy efficiency investments in industry and buildings, there are only USD 20 billion of outstanding bonds, which is very low compared to investment needs in these sectors.

Finally, as noted and called for by many market participants, there is the potential to increase the total volume of the labelled green bond market just by labelling as green all climate-aligned bonds. However doing so would bring little to no 'new' investment in LCCR assets, but could contribute to other benefits for market actors as described in Section 4.

1.3.2. The green bond market could cover almost all categories of LCCR investments, but the greatest potential to increase lies in increased energy efficiency bond financing through ABS.

As seen in this section, in both theory and practice bonds – whether labeled as green or not – are being used to finance or refinance almost all of the categories of LCCR investments. However, an assessment of the current levels of the use of bonds indicates that this only occurs in circumstances when the characteristics of project developers and the project themselves corresponds to the use of bonds to finance activities in general. This suggests that expectations concerning the role that bonds can play to connect projects with financing must differentiate between sectors, types of developers, and the scale of projects.

To date limited quantified analysis has looked at this issue. The principal work is that of the OECD who has modelled the potential for scaling up the market of bonds financing LCCR assets based on IEA 2DS scenario on 3 sectors and 4 regions (OECD 2017). This work took into account the relevant shares of bonds in the financing of LCCR assets and the necessary gradual increase in volume of each product compared to today's levels. According to this analysis, the market of bonds financing LCCR investments has the potential to scale up to around USD 1 trillion outstanding in 2020 and to USD 5 trillion outstanding in 2035 (OECD 2017). By 2035, bonds would represent 17% of these LCCR investments – excluding financial sector bonds – the rest of financing sources being loans (34%) and equity or self-finance (49%). In terms of sectorial distribution, this analysis suggests that the focus

10 Source: Bloomberg New Energy Finance, http://www.climatechangenews.com/2017/01/12/global-clean-energy-investments-fell-in-2016-bnef/

should be put on growing the volume of bonds financing: low-emissions vehicles, energy efficiency investments in buildings and, in the renewable power sector, particularly wind projects.

In terms of bond instruments, one major finding from the OECD's modelling of the potential for the climate-aligned bonds (referred to as LCCR bonds by the OECD) market by OECD (OECD 2017) is that 44% of the potential outstanding volume of climate-aligned bonds in 2035 would be asset-backed securities. However as mentioned previously, ABS accounts for only 6% of issuance or USD 5 billion in 2016 (Climate Bonds Initiative 2017a). For the bond market to reach its potential in contributing to the financing of LCCR investments, the market of green ABS will need to grow quickly to be 45 times larger in annual issuance by 2035. The OECD's study also indicates that the issuance of financial sector bonds refinancing LCCR assets would need to be six times larger by 2035. At the same time, corporate and sovereign/sub-sovereign bonds would only double or triple by 2035 given constraints on their respective balance sheets according to the OECD. Given the low levels in these areas today of financing from the bonds market in general, and particular the labelled green bond market, a growth in the volume of these assets in the labelled green bond market could lead to an increase in additional financing flows available for LCCR investments in the coming years.

1.4. Specific challenges faced by low carbon, climate resilient investments for accessing the bond market

This section presents an overview of the challenges that exist for issuing bonds to finance LCCR investments – whether labelled green or not and what types of bonds appear to experience the most difficulties today.

1.4.1. A lack of pipeline of LCCR investments is seen as the main obstacle to the increase of climate-aligned bonds issued

The most cited obstacles to growing the pipeline of LCCR investments are misaligned policy signals that limit the economic viability of LCCR investments, such as insufficient carbon pricing, the presence of fossil fuel subsidies, or weak efficiency standards. This issue is central to a large body of literature and links to climate finance can be found in (OECD 2015b), (Kidney, Giuliani, and Sonerud 2017), (European Commission 2016) and (McKinsey Center for Business and Environment 2016). According to a small-sample survey carried out at a practitioners' workshop by I4CE in June 2017[11], the second biggest issue for growing the pipeline of LCCR investments lies in the difficulty in shifting strategies of large corporate entities towards more LCCR investments and activities. Thus, in addition to misaligned policy signals that may undermine the financial viability of some LCCR investments relatively to carbon-intensive investments, the organizational inertia often found within large corporations may add additional difficulties in developing the pipeline of LCCR investments (Grubb, Hourcade, and Neuhoff 2014).

Other frequently cited barriers to a strong pipeline of LCCR investments opportunities include:

- High upfront costs and higher cost of capital due to higher perceived risk negatively impact the bankability of LCCR investments;
- Lack of Power Purchase Agreements for renewable electricity in some markets that would provide sTable and certain revenues, and lack of revenue split frameworks between investors and operators or users for energy efficiency investments;
- Uncertainty on the evolution of public policies like feed-in tariffs and other incentives, which undermines confidence in the predictability of revenue streams linked to public incentives;
- Lack of a transparent LCCR infrastructure project pipeline at state and local authorities' levels, which would provide investors visibility.

Finally, as a more general note, discussions at the practitioners' workshop held by I4CE and during interviews for this report suggested that in practice viable LCCR investments suitable for bond financing have presumably no difficulty in finding investors and issuing bonds. On the contrary, investors are today competing for these assets. Similarly, the pipeline of LCCR loans or leases in a single bank's balance sheet is currently insufficient to see an increase in LCCR ABS issuance. This may be due to a lack of investment in these LCCR assets, a lack of loan financing of such investments, or an incapacity in tagging such assets in banks' and even corporates' balance sheets. Given that insufficient LCCR projects and investment opportunities are available given current investment environment, a first step should be putting in place the economic policy frameworks necessary to increase the pipeline of projects seeking and eligible to access financing, either through bonds, other financial instruments or different forms of technical or non-financial assistance.

11 This is the results of a survey completed "live" by participants to the practitioners' workshop on the future of the green bonds market organized by I4CE on June 15, 2017. Results should be taken as indicative rather than definitive. Comprehensive results are available in Annex of this report. 18 participants responded.

1.4.2. When opportunities exist, there are however no specific barriers linked to LCCR investments for issuing corporate or SSA bonds

However when a pipeline of project opportunities exist, and particularly when this pipeline is tied to a large-scale corporate actor or project developer, there are no specifically climate-related barriers for these actors to access bond financing. Nevertheless, variations in ability to access capital markets through bonds does tend to vary between 'pure players' – or those focusing specifically on a single business line or sector – and non-pure players. This variation, however, is often linked more to traditional barriers to accessing bond markets – such as size and track record of companies – rather than the green or climate-related nature of projects themselves.

For non-pure players

For non pure-player corporates and for the public sector, access to bond financing for LCCR investments is not necessarily different than for other uses – thus there are no specific obstacles for issuing climate-aligned bonds. Indeed the analysis carried out by investors on such bonds relates to the issuing corporate or public actor, and as such does not differ depending on what types of investments the bonds will be used to finance. Further research could help better understand the potential for bonds to support LCCR investment. An estimate of the share of LCCR investments that would be carried out by large "investment grade" corporate entities on the total of LCCR corporate investment needs could help clarify the share of investment needs that could be financed by bonds. This analysis could distinguish assets held by corporations from developed countries, emerging countries and developing countries, as the maturity of bonds markets differs largely and access to bonds financing might be complicated for corporates based in countries with no or small bond market.

For pure-player project developers

Pure-player project developers, mainly SMEs, face the same difficulties in accessing the bond market as other SMEs, plus the difficulty of matching bond maturity with the very long-term horizon of their assets. Pure-player project developers currently principally invest in medium to large-scale renewable power assets. In turn, their credit rating and the analysis of their risk / return profile is dependent on the financial strength of the firm, as well as the market perception of LCCR assets. Typical issues taken into consideration concerning assets and activities of these pure-player entities are developed in the next section as they share common similarities as those found with project bonds. The obstacles related to the information taken into consideration about the issuing organization itself do not differ significantly from those of other SMEs: only a portion gain access to bond financing, generally with a below "investment grade" credit rating – and therefore at a higher coupon (or interest rate) than large corporations. Nevertheless, examples of pure-player SME project developers accessing the bond market exist, such as Akuo Energy, with issuances labelled as green bonds. As for other SMEs investing in relatively new technologies, potential investors in bonds have to be convinced of the financial strength of the firm over the entire lifetime of the bond. A specific difficulty for LCCR projects developers might however emerge from the need to issue long-term bonds to match with the long-term profitability horizon of such assets. The risk perception will therefore be higher than for other technologies with shorter-term profitability profiles.

1.4.3. The risk perception of LCCR assets is a barrier for increased issuance of project bonds, and to some extent pure-player corporate bonds

The risk perception of LCCR assets, however, may be a significant obstacle particularly for project bond issuance, increasing the cost of funding. Limitations on the ability of market actors to properly evaluate the risk profiles of LCCR projects could particularly hinder the use of project bonds to finance large-scale LCCR assets.

The key point is the capacity to analyze the risk / return profile of the underlying LCCR assets. Regarding these risks, the literature often considers that most of LCCR investments are perceived as presenting high levels of risk (OECD 2013) (OECD 2017) (European Commission 2016). LCCR investments may, in fact be riskier than investment in more conventional goods and services with the most frequently cited risks including less mature technologies and companies, and strong policy dependence on an uncertain or changing regulatory environment. But risk perception may be overstated as generally investors' opinions on an industry tend to be "a moving average of the last five years' information", and "when there is a sudden shift in a year or two, this average can become misleading" (OECD 2013). Moreover, risk ratings are based on historical data that may be misleading about future performance in a rapidly evolving environment.

The ability of the issuing organization active in renewable energy, for example, to secure fixed-price offtake agreements is key to minimize perceived risks for investors and financiers. The consequence of this higher risk perception is also that bond investors expect a higher return. The expected level of return from the bond might lead to an overall capital cost too high for the project to reach equilibrium or profitability. However, such assertions merit further study to evaluate the proportion of LCCR investments that were not carried out because of too high financial costs.

To contribute in increasing the pipeline of bonds financing LCCR assets, an improvement is needed in the risk perception of bonds issued, and consequently could decrease the cost of issuance.

1.4.4. The principal LCCR-specific barrier to increase volume of issuance of LCCR Financial Bonds is a lack of tagging of these assets in financial actors' balance sheets

Financial sector bonds are issued by a financial institution to finance 'on-balance sheet lending': it represents the second largest share of the bond market, with 20% to 45% of the total bond market in principal countries and regions. As for other corporate bonds, there is no specific barrier for issuing a bond related to LCCR assets. Indeed the risk / return analysis of a bond refinancing LCCR loans is no different than for a bond refinancing other assets, since what matters is the financial strength of the issuer, not the nature of the "use of proceeds". The principal difficulty for a financial actor to issue a bond with a "use of proceeds" directed to LCCR assets is to be able to identify and track LCCR assets already on its balance sheet. Today, no specific analysis of the LCCR nature of loans is carried out by banks and this type of information is not including in internal information systems or systematically tracked in portfolios by financial actors. When a financial actor wants to issue a green bond it has to "manually" identify in its portfolio LCCR assets. This can require significant time and resources, and does not ensure that all LCCR assets in the portfolio are identified.

1.4.5. Several barriers impede an increased issuance of LCCR Asset-Backed Securities

Asset-backed securities (ABS) are issued for refinancing a pool of standardized and homogeneous small-scale loans. The best examples of assets refinanced by an ABS issuance, and largest share of ABS market, are pools of mortgage loans and pools of auto loans. In both cases, assets are standardized and homogeneous, markets are mature and volumes of such assets are very large.

A first specific barrier of LCCR assets to an increased volume of issuance of asset-backed securities is a lack of standardization of LCCR loans. Furthermore, there is a lack of historic data on most of LCCR assets making it more difficult to assess the level of risks of these assets, even if a credit rating agency stated that they are already capable of rating ABS products backed on low emissions vehicles or green mortgage loans. Finally, and perhaps more importantly, issuing an ABS labelled as green requires that LCCR loans as tagged as green in banks' balance sheet and that volumes of available green loans are tracked, similarly to LCCR financial bonds as detailed before.

1.4.6. Conclusion on obstacles to bond issuance specific to LCCR assets

For the bond market to bring additional financial flows towards LCCR assets, it has to contribute overcoming the obstacles outlined in this section summarized in Table 5. In addition to the obstacles outlined above that are valid in all markets – including mature bond markets – some countries encounter other significant additional obstacles to developing bond markets, either "green" or "vanilla". These issues are not detailed in this report, as they are not specific to LCCR assets.

TABLE 5. OBSTACLES TO EXPANDING ISSUANCE FOR LCCR BONDS BY TYPE OF BOND

Type of Bonds	Principal Obstacles
Corporate or SSA bonds	The lack of pipeline of LCCR investments To some extent, the risk perception of corporate bonds issued by pure-player project developers
Project Bonds	The lack of pipeline of LCCR investments The risk perception of LCCR investments relative to other investments, and as a consequence, the cost of financing LCCR assets. The generally long-term profitability horizon of LCCR assets.
Financial Bonds	The lack of pipeline of LCCR loans The lack of tagging of green loans in banks' balance sheets
ABS	The lack of pipeline of LCCR investments and LCCR loans The lack of standardization of LCCR loans The lack of historic data on LCCR investments

2. What can be expected from the labelled green bond market to close the LCCR investment gap?

KEY TAKEAWAYS FROM THIS SECTION

- While there are a small number of cases where bonds could be used to drive new investment, in the current regulatory and institutional context labelled green bonds have little potential to contribute to increasing financial flows directed towards LCCR investments beyond what would have occurred without labelling. Indeed, labelling a bond as green does not currently – and may not in the future – carry a price premium in the primary market. Nor does it modify the risk profile of the bond for investors, or allow to 'make space' specifically for additional LCCR loans on banks' balance sheets.
- The labelled green bond market does nevertheless bring non-financial benefits contributing to the transition to a low-carbon and climate-resilient economy: it eases the process of tracking green investment opportunities for investors, and it contributes to accelerating the elaboration of a climate strategy in the issuing entity, or 'anchoring' this strategy in the organization and its processes.
- As a result, public institutions and civil society should not expect the green bond market to significantly contribute in increasing financial flows directed to new LCCR investments, but should instead focus on using this instrument as a way to 'measure' and track the ambition and 'depth' of climate actions developed by issuing entities and investors. They could also contribute to increase the volume of LCCR assets financed or refinanced by bonds by fostering the development of a market for LCCR asset-backed securities, and by pushing for a 'mainstreaming' of climate issues into financial institutions.

The previous section has demonstrated that in theory bonds could be a suitable instrument – if in some instance only in very small levels – to finance a number of types of LCCR investments. Furthermore, both climate-aligned and fully labelled green bonds are already financing types of LCCR investments. However, while bonds in many instances could theoretically be an appropriate financing instrument, the question of whether this is feasible in practice and would lead to a net increase in new investment in LCCR assets remains unclear. Many market and policy discussions currently focus on how the labelled green bond market can 'drive' finance to low-carbon investments coherent with long-term climate objectives. Nevertheless, the categories of LCCR investments that will need to grow the most to close the investment LCCR gap currently represent only a small portion of the labelled green bond market. In particular, there is much room for expansion for asset-backed securities financing low emissions vehicles and energy efficiency investments in buildings; and financial sector bonds refinancing LCCR loans in these sectors.

This section looks at the issues around the question of whether green bonds are bringing additional funding toward LCCR investments – or does it represent a 'green labeling' of those that would have occurred whether or not green labelling occurred. This question is important as the investment needs discussed in earlier sections clearly indicate that both a substantial redirection of financial flows to climate-coherent investments is needed – as well as a net increase in current levels of investment in some sectors. In other words, is there evidence to demonstrate that, as increasingly suggested, labelled green bonds are a solution for increasing the alignment of financial flows with a 2°C trajectory, as mandated by the Paris Agreement?

This section builds on conclusions from I4CE's previous study detailed in Box 4 that much of the investment supported by green bonds would have occurred at similar terms and pricing levels whether it was labeled green or not. This section looks at what additional contributions compared to the general or climate-aligned bond market the 'labelled' green bond market could bring to the objective of increasing financial flows directed to LCCR investments. It first explores the evidence of whether green bonds are directly unlocking new finance sources toward LCCR assets, or could do so in the future. It then presents other advantages the labelled green bond market can contribute towards the objective of redirecting financial flows towards the low-carbon transition.

BOX 4. BENEFITS OF THE GREEN BONDS MARKET. CONCLUSIONS FROM I4CE'S 2016 STUDY "BEYOND TRANSPARENCY. UNLOCKING THE FULL POTENTIAL OF GREEN BONDS"

In its previous study on the green bond market published in June 2016, I4CE analyzed the existing and potential benefits of green bonds. Main conclusions are listed above:

Existing benefits for issuers:

- Helping issuers communicate their sustainability strategy
- Expanding and improving relationships with debt providers
- Creating internal synergies between financial and sustainability departments

Existing benefits for investors:

- Helping investors to develop better-informed investment strategies
- Facilitating the implementation of investors' long-term climate strategies
- Helping responsible investors broaden their restricted investment portfolios.

In terms of the contribution of the green bond market to increasing the pipeline of green financial flows, the study concluded that for the moment "most of existing green bonds and their underlying projects were likely to have occurred whether the bond issued to finance them was labeled as green or not". In the future, "if green bonds are aimed at stimulating additional investments in the low-carbon transition, they would need to go beyond their current information benefits and help reduce the cost of capital for underlying projects". Indeed, reducing the cost of capital of LCCR investments is critical for their development, as the share of financial costs in the total cost of LCCR investments is generally high, and may be as high as 50-70% for renewable electricity generation (OECD 2015b). In the future, a growing committed demand from investors for green bonds could result in better borrowing conditions, if their green objectives were strong enough to imply discrimination between green and non-green assets. The cost of capital of small-scale LCCR assets could also be decreased through assets aggregation and securitization. However "this process can occur even in the absence of the labelled green bond market" as "it relies more on 'bonds' rather than on 'green'".

2.1. Can the labelled green bond market bring additional financing to LCCR investments beyond what the bond market would have leveraged in any case?

If in many instances the conditions, barriers and obstacles to issuing a bond for LCCR-related activities is similar to normal issuance, this begs the question of whether labelling the bond as green brings any added value to enable better conditions or increased direct financing. There are many expectations that the labelled green bond market – made up of those bonds that have been 'labelled' formally or informally as green – can help overcome these barriers among both market participations and policy makers. However, to overcome these barriers, the question remains of whether labeling a bond as green can help:

- Improve financial costs for LCCR assets to make more investments 'bankable', either directly or indirectly by altering the risk perception of bonds issued.
- Increase financial flows towards LCCR assets by 'making space' on corporates or banks' balance sheets.
- Pressure financial institutions and corporates to improve the tagging and tracking of their green activities and investments, and for a standardization of these assets.

This section will analyze how, if possible, the labelled green bond market could achieve these objectives to increase overall investment towards LCCR projects compared to what would have occurred without labelling.

2.1.1. What 'pricing premium' for labeled green bonds beyond the effects of a limited supply relative to demand?

An important contribution that the labelled green bond market could bring to shifting financial flows towards LCCR assets would be a decreased pricing of green bonds – or decreased coupon that has to be paid by the issuer to the investor – relative to an equivalent vanilla or non-labeled climate-aligned bond. A decreased pricing for labelled green bonds would indeed mean a decreased cost of financing LCCR investments, which would improve the overall profitability and 'bankability' of LCCR investments. This is important as the financing costs represent a significant share of overall costs of LCCR assets, as many are long-term investments requiring financing with a long-term maturity. Additionally, financial bonds and ABS labelled

as green could lower financing costs for LCCR assets if offered at better refinancing conditions to financial actors, and if in turn improved financial conditions were passed on improving financing conditions for LCCR investments, notably by decreasing interest rates.

Whether labelled green bonds are benefitting from a pricing premium is often the focus of discussions among both market participants and observers. Today, however, there seems to be no significant pricing premium on the primary market and a slight pricing premium in the immediate secondary market (Climate Bonds Initiative and IFC 2017) (Zerbib 2017). The slight pricing premium on the secondary market may be due to a higher demand for green bonds than available supply. The latest research has demonstrated some anecdotal evidence that green bonds are often heavily oversubscribed, and may therefore offer tighter pricing compared to vanilla equivalents thus sometimes providing slightly cheaper debt for issuers (CBI 2017d). However, these benefits might not be sufficient for some issuers to justify the additional time and effort as well as the certification costs – estimated at USD 18-41 thousand per issuance (Bloomberg 2017). Overall, the slight pricing premium is too low for the moment to entail a significant decrease in the cost of financing LCCR assets sufficiently enough to improve the profitability and bankability of LCCR assets and thus increase the pipeline of LCCR investments.

Similarly, labelling a financial bond as green does not for the moment lead to significant changes in bond pricing. Thus, labelling does not decrease the cost of refinancing for the issuing financial actor. Some actors suggest that labelling can enlarge the investors' base, which could be valued by issuing financial actors and passed on to customers carrying out LCCR investors. This does not however seem to be the case in practice, explained by a context of high liquidity of the global financial context. As this context changes, it would be interesting to see if the benefit of enlarging the investors' base does translate into better financial conditions for LCCR loans.

Discussions held with investors during interviews suggest that many market actors believe that there may not be a significantly higher premium for labelled green bonds in the future. The risk analysis carried out by investors leads to the same risk rating for labelled green bonds as for equivalent vanilla or climate-aligned bonds, so expected return is the same. Investors do not 'factor in' the value of a green label as an additional return for analyzing the risk / return profile of a potential investment. As a result, if labelled green bonds trade at a (significant) premium compared to equivalent non-labelled or vanilla bonds, investors might not invest in labelled green bonds. In other words, investors might not be willing to compromise performance over green credentials. Interviews suggest that investors might accept relatively lower returns from labelled green bonds if and only if:

- Their mandates obliged them to invest a share of their portfolio in labelled green bonds and there were a shortage of supply of labelled green bonds;
- Risk analysis integrated climate risks considerations and labelled green bonds were considered as less exposed to climate risks than other bonds.

Consequently, unless investors' mandates or risk analysis integrate climate considerations, the ability of labelled green bonds to decreasing the cost of direct financing for LCCR investments appears low.

2.1.2. How can labelling climate-aligned bonds as green improve risk perception?

Financial conditions for LCCR assets could be improved through the improvement of investors' risk perception using a green label. This is seen as being able to lead to improved pricing of bonds and other financial instruments. However, it is not completely clear under which conditions labelling a bond as green could improve its risk rating. In practice, the risk analysis for corporate, financial or SSA bonds is based on an analysis of the issuing organization, not on investments it is meant to finance. The risk rating of a labelled green bond is therefore the same as of a vanilla or climate-aligned bond with the same characteristics. In the same manner, labelling a climate-aligned project bond or climate-aligned ABS as green does not change the risk rating for the moment. Risk analysis in these cases is based on an assessment of the underlying LCCR assets; whether the bond is labelled as green does not change the characteristics of these assets themselves.

Consequently, to improve the risk rating of the bond issued in the case of corporate or SSA bonds or the risk rating of the issuing entity, the green label should provide investors with information on the 'greenness' of the issuing entity. In practice today, issuing a green bond indicates that the issuing entity performs some green activities, but it does not inform on its overall 'greenness'. Therefore, it does not directly inform investors on the reduced exposure of the issuing entity to potential climate transition risks. It thus, in turn, would not allow investors to improve the risk rating of the issuing entity in relation to lower climate risks. Indeed, in practice, if a non-pure play entity issues a green bond to finance or refinance the green portion of its activities without changing the overall balance between green and brown activities or assets, the greenness of the general-purpose bonds will be reduced, and the exposure to climate transition risks of the issuing entity will remain the same. This 'zero-sum' nature of green bond labelling raises the question of whether the core activity of an issuer and its commitment to the LCCR transition should be considered,

in addition to or in place of the 'use of proceeds' (for a further discussion of this point, of labelled green bonds is further detailed in Report 2 "Environmental integrity of green bonds: stakes, status and next steps" (Igor Shishlov, Nicol, and Cochran 2017)

This suggests that for green labelling to improve the risk rating of a labelled green bond compared to a similar vanilla bond, rating agencies and investors would have to take into account climate transition risks in their overall rating framework. Some research and initiatives have been developed to this effect, but for now this is not the case and the risk perception of bonds issued does not depend on its exposure to climate transition risks. As a result, even the risk perception of project bonds and asset-backed securities, for which the risk rating solely relates to underlying assets, is not improved thanks to the green labelling.

It thus appears that labelled green bonds could improve risk rating compared to a similar vanilla bond in relation to a lower exposure to climate transition risks only if:

- Issued labeled green bonds are indicators of a deepening commitment in the LCCR transition ;
- Investors take into account climate risks in their risk analysis;
- LCCR investments are considered as decreasing the level of climate risks an organization faces;
- Labelled green bonds are the tool used by investors to track LCCR investments within their portfolios.

If these conditions were met, then entities issuing a large share of labelled green bonds would, in theory, have a better risk rating relative to equivalent organizations not issuing labelled green bonds**.** However this is far from current market practice.

2.1.3. Under which conditions could labelled green bonds contribute to increasing financial flows to LCCR assets by 'making space' on corporates and banks' balance sheets for new LCCR investments?

Asset-backed securities and financial bonds could 'make space' on the balance sheets of financial actors and corporate entities by 'externalizing' existing LCCR loans to financial markets. In turn, this would allow issuers to finance additional LCCR investments with the 'freed-up' capital. As LCCR investments are currently financed primarily through bank loans or directly by corporate entities, refinancing LCCR financial assets using ABS and financial bonds could in theory contribute to directing an increased share of financial flows towards LCCR assets and contribute to the objectives of the Paris Agreement.

However, allowing financial actors and corporates to "make space" on their balance sheets by securitizing assets or issuing financial bonds does not necessarily ensure that the increased financing capacity will be directed to financing LCCR assets. Furthermore, the externalized assets do not themselves need to be LCCR. Rather, ABS and financial bonds appear to only have the potential to increase funding for LCCR projects when the 'greenness' of the bond is linked on its "use of proceeds" – or destination of the additional financing capacity allowed by securitization.

An example is the series of green ABS issued by Toyota since June 2015. This labelled green bond was structured as follows: Toyota Financial Services – i.e. the financial arm of the automotive maker that grants loans to customers buying Toyota cars – securitized standard auto loans with proceeds to be used for electric and hybrid car loans still to be granted to Toyota's customers. This means that this green bond entitles Toyota to allocate a certain amount of their loan capacity to buyers of electric and hybrid cars.

While most investors may still request information on the 'greenness' of the assets linked to the bond itself, combining this with a green label on the destination of the additional financing capacity represents a strong commitment of the financial institution to finance a certain volume of LCCR investments.

2.1.4. Overall, the theoretical potential of the labelling green bonds to create additional financial flows towards LCCR investments would have limited impact

As seen in this section, labelling a bond as green does not currently lead to a price premium or an improved risk rating for the bond. Therefore, green bonds do not currently bring improved financing conditions for LCCR investments and increase the pipeline of 'bankable' LCCR assets. It appears that labelled green bond issuance is serves principally to highlight green investments that would have been carried out in any case. The question thus remains of whether this will change in the future.

In terms of a price premium, the green bond market will remain a 'market' and thus subject to the impacts of supply and demand. Labelled green bonds could trade at a premium in the future if the mandates of financial institutions or regulation obliged them to invest a certain share of their portfolio in labelled green bonds, and there was a shortage of supply of labelled green bonds.

Labelling a bond as green could also change its risk profile for investors, and therefore improve its financial conditions. However this would occur if and only if climate risks were systematically taken into account into investors' risk analysis and if a green label was an indicator of the

alignment of the issuer on a decarbonization or LCCR pathway (see WP2 for a detailed description of this type of investment approach).

Consequently, the labelling of green bonds has little direct impact on increasing access to finance at preferential rate and increasing financial flows directed towards LCCR investments in the current regulatory and institutional context. However, this context might change quickly as financial institutions are increasingly mainstreaming climate considerations across their activities and some financial regulators are introducing requirements relative to climate disclosure – such as in France with Article 173 of the Energy Transition Law.

2.2. The labelled green bond market nevertheless brings other non-financial benefits compared to non-labelled bonds

The labelled green bond market brings non-financial benefits to aligning financial flows with a 2°C trajectory and a shift towards a low-carbon and climate-resilient economy. These additional benefits include facilitating the tagging and tracking of aligned or green investments, as well as fostering dialogue between financial and sustainability departments within all market participants. This section discusses these non-financial benefits.

2.2.1. Facilitating the tagging/tracking process of green investment and green finance flows across the entire economy

Using a labelled green bond compared to a non-labeled bond to finance LCCR investments can help formalize engagements made by the issuer to allocate these funds to finance or refinance LCCR assets for an amount equal to amounts raised. It can also be used to disclose ex-post the "use of proceeds" of the green bond. Given this disclosure, green bonds can be a useful tool for tracking these financial flows. Implementing better-informed climate strategies requires that investors have access to information on environmental impacts of underlying assets and green bonds can help provide at least part of this information. For example, SRI funds can use green bonds to expand the scope of investment and diversify portfolios by investing in specific assets from those issuers that could otherwise be screened out. Finally, investors could use green bonds to identify investments aligned with their climate risk management strategy as labelled assets will most likely be more aligned with the LCCR transition. In the case of asset-backed securities (ABS) or project bonds investors also get direct exposure to underlying green assets rather than the issuers' balance sheets.

The green label allows easier tagging and tracking of bonds financing LCCR assets, as well as provides useful information on the sectors and types of investment being financed. This is crucial as it tracks the part of financial flows directed towards LCCR assets, facilitating the assessment of the achievement of the objective of aligning financial flows with a 2°C trajectory contained in Paris Agreement. Second, this labelling of climate-aligned financial flows can facilitate the identification of actors that are investing in or financing LCCR assets and contributing to the decarbonization the economy. It can also raise awareness on the issue of investing in the low-carbon and climate-resilient economy. For example, as communication on labelled green bonds is growing, it contributes to putting pressure on corporate and financial actors to issue labelled green bonds and demonstrating their engagement in investing in or financing LCCR assets – even if this has no immediate direct financial benefits. Issuing a green bond is indeed seen by issuers principally as a communication tool on their green credentials (I. Shishlov, Morel, and Cochran 2016).

As the green bond market grows and an increasing share of bonds financing LCCR assets is labelled as green, market actors may increasingly perceive green bonds as the bond instruments financing LCCR assets – and non-labelled bonds as financing only 'brown' activities and assets. As a result both governments and civil society could use green bonds as a way to identify actors committed to aligning their business strategy with a 2°C trajectory from those that have not made this shift. Thus, as the labelled green bond market grows and overcome its current state of niche market, issuing green bonds could become the norm. If this occurs, companies that are not issuing green bonds would be seen as 'laggards' and considered as not being able to issue green bonds because they are not carrying out any green investment.

In this scenario, if the labelled green bond market reaches a sufficient scale it could become an instrument to track the shift in financial flows but also a tool for orienting civil society's pressure on corporates making less efforts to decarbonize their activities. This future impact opportunity for the green bond market could be further accelerated if the 'greenness' of bonds issued was assessed based on both 'use of proceeds' and the issuer's strategy towards the low-carbon transition, as suggested in Section 3.1.2 of this report and Report 2 "Environmental integrity of green bonds: stakes, status and next steps" (Igor Shishlov, Nicol, and Cochran 2017).

2.2.2. Facilitating dialogue between financial directions and sustainability directions to scale up the alignment of investments with a 2°C trajectory

Another benefit of the labelled green bond market is that it can create a space for dialogue between financial and sustainability business units inside an organization, as well as deepen dialogue on climate-change issues with investors and internally in investors' teams. In doing so, in addition to raising awareness and building capacity on climate change issues and investment needs beyond sustainability departments of issuing organizations and in investors' teams, a labelled green bond issuance can help streamline the climate-change strategy in the organization. Indeed, several business units in addition to sustainability department are involved in both the processes of delimiting the bond's "use of proceeds" before issuance, and reporting and disclosing the "use of proceeds" after issuance.[12]

Moreover, the process of issuing a first labelled green bond usually leads to strengthened processes and information system for tagging existing and prospective LCCR investments and activities as it often requires the issuing organization to "manually" collect green data. Such improved processes for tagging LCCR activities can contribute to a better internal understanding of the overall alignment of an organization with a 2°C trajectory. Consequently, it can facilitate the process of shifting an entity's strategy toward the low-carbon and climate-resilient economy.

2.3. Today, the labelled green bond market's principal contribution is as a tool to facilitate the implementation of more ambitious climate strategies

As explored in this section, the green bond market does not currently improve the financing conditions for LCCR assets, whether in the case of use of bonds for direct financing or refinancing. While the green bond market itself is growing in terms of labelled volume today, this does not necessarily indicate that a net expansion of LCCR investments is occurring – rather it suggests that the pipeline of green investments suited for bond financing is growing – due to other reasons – and that a growing number of issuers are labeling these assets as green. As such, the labeled green bond market should not be expected to contribute significantly to an increase in financial flows for LCCR investment beyond what the vanilla or climate-aligned bonds can provide.

Nevertheless, the labelled green bond market does provide market participants, stakeholders and policymakers with a useful tool for tagging and tracking bonds financing LCCR investments. The labelled green bond market can thus play an important role by facilitating tracking and raising awareness within the financial sector. Investors, stakeholders and policymakers should therefore see the green bond market as a tool for identifying and differentiating those actors and assets that contribute to decarbonizing our economy. Additionally the green bond market should be seen as a mean to diffuse knowledge about the low-carbon transition across organizations and to build-up adequate processes for better informing investment decisions in light of green criteria.

These are key lessons for both public and private actors to take into account as they could have far-reaching implications in terms of what type of incentives and public support mechanisms should – and should not – be used to support the ultimate objective of redirecting and creating a net increase of finance flowing to LCCR investments. While scenarios do exist within which the labelled green bond market could go beyond non-financial benefits to contribute financially to improving terms of funding for LCCR assets, this would require significant regulatory changes**.** Bonds (green or not) are just one of the financial tools that can be used to support LCCR investments. Public sector efforts and attention should therefore not be diverted from improving the overall investment environment for LCCR investments through more ambitious climate policies to supporting a particular financial instrument.

This analysis suggests that public support measures and investors' efforts could be the most effective in the short to medium term by aiming to increase the impact of the labelled green bond market in two areas: first, by fostering the use of labelled green bonds to 'measure' the ambition and 'depth' of an issuer's commitments to aligning their investments with a 2°C trajectory; and second, by supporting the use of labelled green bonds as a mean to integrate climate-related criteria in financial actors' strategies. The next section will explore the potential policies and measures in detail.

12 See Report 2 "Environmental integrity of green bonds: stakes, status and next steps" (Igor Shishlov, Nicol, and Cochran 2017).

3. Ensuring support for the LCCR transition What role for market-led actions and public policies?

KEY TAKEAWAYS FROM THIS SECTION

- Market actors and policymakers could foster the contribution of the green bond market to aligning financial flows with the objectives of the Paris Agreement by pursuing three main Objectives: incentivizing issuers to label climate-aligned bonds as green, by fostering the development of a securitization market for LCCR assets, and more generally by pushing for the 'mainstreaming' of climate issues into financial decision-making.
- To support increased green labelling of climate-aligned bonds, suggested measures could first aim at decreasing the additional transaction costs of green labelling. This could be achieved through direct subsidies in areas without an active green bond market. In all areas, policymakers could require the same level of transparency and disclosure as requested for a green bond issuance to all issuances. Second, measures could aim at fostering an increased demand for green bonds, using for example mandatory disclosure of their climate strategy by investors or even minimum quotas for green bonds for specific regulated financial products. As a result, investors could push for the increased issuance of labelled green bonds, notably through an engagement strategy. Finally, both supply and demand for green bonds should likely be fostered in parallel, in order to maintain a good supply-offer equilibrium in the labeled green bond market, and ensure a smooth development.
- Several public policy measures could be designed to foster the development of a securitization market for LCCR assets. Some of them could target potential ABS issuers and aim at developing the pipeline of LCCR loans available for securitization, such as creating a warehousing entity for LCCR small-scale loans or introducing a requirement for banks to disclose the green share of their loan books. Some could target potential investors, to incentivize investing in climate-aligned ABS and overcome the obstacle of a lack of historic data related to LCCR loans, notably through credit enhancement schemes. Such schemes should be backed by strong eligibility criteria, notably on the environmental integrity, and require high quality and transparency in the securitization process, given the current reputation and history around securitization.
- Finally, the green bond market could also be reinforced by broader public policies incentivizing investors in favoring green over 'brown' financial assets. Notably, different measures for integrating climate issues into prudential and monetary policies are today subject to a heated debate. Further detailed analysis should be undertaken to formulate precise public policy recommendations on this topic.

The labelled green bond market has the potential to contribute to aligning financial flows with a 2°C trajectory first and foremost by facilitating the tagging and tracking of LCCR investments, increasing the pressure on issuers to grow their pipeline of LCCR investments, and fostering the implementation of internal climate strategies among market participants. Developing a green asset-backed securities market, where issuing financial institutions commit to recycle freed up capital to additional LCCR loans, could also contribute to increasing LCCR investment. Investors and policymakers can implement several actions and measures to foster these benefits. They can also implement broader policies to incentivize financial actors to favoring green over 'brown' financial assets. This section explores the potential measures market actors and the public sector could design to achieve these three objectives. It presents an overview of the public policy measures that have been proposed to date to support the development of the labelled green bond market – and alignment with the low-carbon transition. It does not identify what options appear the most feasible or have garnered the most support, but rather presents an overview and maps the current state of discussions. Detailed profiles of a dozen policy options is presented in Appendix 1.

3.1. Market-led actions and public policies to increase the share of climate-aligned bonds labelled green

One of the principal benefits from the green bond market is for the market to be a tool for the tagging of LCCR assets. One of the objectives sought by support measures should thus be to facilitate an increase in the portion of bonds financing LCCR assets that are labelled as green. A first step would be to contribute overcoming current obstacles to this labelling.

3.1.1. Four main barriers are hindering the labeling of climate-aligned bonds as green

According to Climate Bonds Initiative, only 17% of climate-aligned bonds were labelled as green in 2016 (CBI 2017). Four main barriers may explain that today the majority of bonds financing LCCR investments are not issued with a green label.

Higher transaction costs

The most often cited obstacle to the green labelling of a bond is the increase in transaction costs that this process implies (OECD 2017) (California State Treasurer 2017). This increased cost is at times difficult to justify as there is currently no direct financial benefit from doing so.

The Green Bond Principles and the Green Bond Standard, two of the principal international voluntary frameworks for green bonds, recommend that pre-issuance reviews, earmarking and tracking of the use of proceeds, and ex-post reporting become cornerstones of market labelling practice to ensure the 'greenness' of a bond. As discussed in detail in Report 2 "Environmental integrity of green bonds: stakes, status and next steps" (Igor Shishlov, Nicol, and Cochran 2017), a convergence of market practice on these different steps is the minimum necessary to minimize risks of 'greenwashing'.

However, these steps can induce additional transaction costs compared to conventional bonds. Typically, an external review entails an additional cost ranging between US$ 10 000 to 100 000. Additionally, earmarking and monitoring the use of proceeds requires dedicated time from staff to implement new processes. Nevertheless, interview have indicated that these green transaction costs appear to decrease for each subsequent issues as knowledge builds internally and processes are streamlined to take into account the requirement of tracking green investments. Furthermore, transaction costs specific to green labelling remain reasonable compared to overall accounting and financial mandatory reporting costs.

Lack of awareness of the benefits of green bonds

Some issuers may not be aware of the non-financial benefits that labelling an issuance as green can deliver (OECD 2017) (European Commission 2016) (CBI 2016)**.** Nevertheless, other issuers have noted several non-financial advantages of issuing a green bond instead of a conventional bond: it helps communicate on its sustainability strategy, it enables to expand and improve relationships with debt providers, and it creates internal synergies between financial and sustainability departments. It thus appears important for all issuers to be made aware of or identify a way of capturing these advantages.

Difficulty in identifying LCCR investments and activities

Organizations willing to label a bond issuance as green often have difficulties in defining LCCR assets within their investments and activities and identifying a suitable pipeline for earmarking the "use of proceeds". This can firstly stem from a lack of a common definition of what can be considered as green, and the need harmonization of indicators that can be used for assessing the 'greenness' of assets. A second reason is that organizations currently lack the means and processes to tag or track LCCR assets and activities on their balance sheets. Since climate change issues are relatively new for most economic and financial actors, internal reporting processes and information systems have not been redesigned to adequately track relevant information. Without these changes within data management systems, tracking eligible assets and securities manually may be seen as cumbersome, dissuading potential issuers in taking the needed steps to label their bond as green.

Insufficient volume of LCCR investments

Particularly in the case of non pure-players, some entities may be issuing bonds to finance both LCCR and non-LCCR assets. It requires a large volume of LCCR investments by a single organization to be able to issue a green bond (often totaling hundreds of millions of dollars or euros). This may not be feasible for most corporate entities depending on the stringency of the "greenness" definition and the sector in which the issuer is operating. For example for industrial actors, it may be difficult to find a sufficient volume of bond-financeable LCCR assets in their balance sheets even if their strategy and investments are aligned with a 2°C trajectory.

3.1.2. Potential market-led strategies for increasing the volume of labelled green bonds on the market

Many investors are beginning to see the potential value in having a broader and deeper labeled green bond market. An increase in the share of bonds financing LCCR investments labelled as green and held in their portfolios would allow investors to demonstrate their contribution in financing LCCR investments and the alignment of their strategy with a 2°C strategy. Demonstrating this internal commitment and strategy is important for investors in a context of growing pressure from civil society and some governments for all economic and financial actors to adopt climate strategies. For example, the French Energy Transition Law introduced in 2015 an obligation for investors to detail their strategy for aligning their portfolios with a 2°C trajectory. Labeled green bonds can reduce the costs for investors to track climate-aligned assets in their portfolios. As a consequence, investors may have a strong interest in seeing the share of bonds labelled green increase in their portfolios in the coming years. At the same time, investors are well placed, given their crucial role as sources of funding, to push issuing entities and organizations to make the necessary efforts to label their bonds as green. More generally, they are in a position to influence a progressive alignment of an issuer's strategy with a 2°C trajectory.

Investors could push for a greater share of bonds financing LCCR investments to be labelled as green firstly through an *engagement strategy*. A strategy of shareholder engagement consists for an investor to take a position on environmental, social or corporate governance issues in an investee company, and to request and follow improvements. In practical terms, such a strategy is implemented through regular and direct dialogue between the firm and its investor, requests for extended reporting, public communication, and the exercise of shareholders' rights such as raising issues during general annual meetings, tabling and voting resolutions. Investors could dialogue with financed companies on their ability on issuing green bonds to raise the company's awareness on the subject, and to push them to make necessary efforts for identifying suitable LCCR assets in their balance sheet and accept higher transaction costs for being able to issue a labelled green bond.

Second, investors could also request from all companies issuing bonds to *report on their LCCR investments and activities*, in the same format as provided for labelled green bonds. In this way, the difference in transaction costs between labelled green bonds and "plain" bonds would be minimized, only implying the additional cost of external review for labelling a bond as "green". As a result, all market actors would need to take the stapes to put in place the necessary processes to tag their LCCR investments and activities.

3.1.3. Policy measures to increase the share of climate-aligned bonds labelled as green

Governments have a strong interest in being able to tag green financial flows to check if national climate objectives are on track, and whether companies or other organizations within their jurisdiction are taking sufficient efforts to finance the transition towards a low-carbon and climate-resilient economy. The labelled green bond market is a powerful tool for ensuring this tagging for the financial market segment of bonds, and measures tested on the green bond market could then be extended to other financial segments like loans or equity. Governments, through hard regulations or soft incentives, could play a role in increasing the share of bonds labelled as green. Some measures governments could implement are summarized in Table 6, and details on each suggested measure are available in Annex 1.

Suggested measures pursue two main objectives: decreasing the additional transaction costs of green labelling (supply-side) and fostering an increased demand for green bonds (demand-side). For both objectives, a range of measures could be implemented from subsidies or 'soft' regulation to 'hard' regulation. Both supply and demand for green bonds should likely be fostered in parallel, in order to maintain a good supply-offer equilibrium in the labeled green bond market, and ensure a smooth development.

On the supply-side, public policies targeting the financial sector could contribute to overcome two of the main obstacles to green labelling: a lack of awareness of the benefits of green bonds, and higher transaction costs (see Section 4.1.1 for more details on obstacles to green labelling). While beyond the scope of this study, other public policies targeted at the real economy could help overcome the other two main obstacles to issuing a green bond – i.e. an issuer's insufficient volume of LCCR investments and a difficulty in identifying LCCR investments and activities.

The potential efficiency of suggested measures depends on the national context, and above all on the level of development of the domestic green bond market. Subsidizing the cost of labelling bonds as green might raise awareness of the green bond market and build a market for external reviews. However, this could entail high costs for countries with an already active market and a 'free-rider' risk. In areas with an existing and active green bond market, the main obstacle to green labeling is often the additional transaction costs it entails. These additional cost stems from ex-ante and ex-post external reviews, as well as perhaps more importantly, internal costs and human

TABLE 6. SYNTHESIS OF BENEFITS AND LIMITS OF POTENTIAL MEASURES TO INCREASING THE SHARE OF CLIMATE-ALIGNED LABELLED AS GREEN

Suggested measure	Benefits	Limits
Subsidize the cost of labelling bonds as "green"	• reduce 'green' transaction costs • push a systematic 'green' labelling • support the development of a market for external reviews • contribute to a standardisation of the 'green' labelling	• costly measure for countries with an already active green bond market • the risk of 'free-riding' needs to be limited, notably through the definition of a public standard for 'green'
Introduce mandatory reporting obligation on green assets to all firms or all bonds issued	• decrease the distortion in transaction costs between green bonds and 'vanilla' bonds • push firms structure discussions about their climate change strategy	• labor costs for mandated entities • may add an additional reporting burden that could be limited by an integration into existing reporting frameworks
Introduce mandatory disclosure on the "use of proceeds" of all bonds issued	• decrease the distortion in transaction costs between green bonds and 'vanilla' bonds • enable to tag 'brown' and 'green' assets and evaluate alignment with a decarbonization trajectory	• labor costs for mandated entities • additional reporting burden • could disadvantage bonds over other financial instruments due to increased transaction costs
Push for an increasing demand in green bonds: ***from mandatory disclosure of the climate strategy of investors to introducing minimum quotas for green bonds to specific investors or investment products***	• boost the demand for labelled green bonds, leading to investor engagement for a greater supply of green bonds and finally an increased pipeline of labelled green bonds	• need to be weighed against the risk of creating a 'bubble' of 'green' financial assets

Source: Authors

resource needs to tag green activities and assets within an issuer, the design a framework for eligibility criteria, and the implementation of adapted monitoring and reporting processes.

This second category of additional costs for green labelling relative to vanilla bonds would be offset if the same level of transparency was required for all bonds or from all firms. Requiring all bond issuers to disclose a 'use of proceeds' or all firms to disclose information on the alignment of their activities with Paris Agreement objectives would allow financial regulators and supervisors to contribute overcoming obstacles to green labelling. Such public policies would additionally contribute to broader goals of increased transparency on financial instruments and improved disclosure on climate-related issues.

3.2. Potential measures to increasing the pipeline of LCCR ABS, whether or not they are labelled as green

The largest potential for growth of the labelled green bond market lies in LCCR asset-backed securities (ABS) – notably backed on low emissions vehicles and energy efficient mortgages, as analyzed in Section 2 and (OECD 2017). Moreover, evidence suggests that securitization may ultimately lead to decreased borrowing costs for borrowers, on the contrary to other categories of bonds. Indeed, securitization allows to minimize risks for investors through risk diversification, and shall also provide them with "tranches" with different risk / return profiles. However, in 2016 the ABS segment represented only 5% of the labelled green bond market despite its large potential for growth.

This suggests that this means of financing LCCR projects may have significant potential and increasing the pipeline of LCCR ABS merits specific attention. A second focus after increasing the share of climate-aligned bonds labelled as green could then be to develop a market for asset-backed securities refinancing LCCR assets, where issuing financial institutions commit to recycle freed up capital to additional LCCR loans.

3.2.1. Main obstacles to the development of climate-aligned ABS

According to interviews, the main barrier for a significant increase in the securitization of small-scale LCCR assets is that today the volume of small-scale LCCR loans is too small to be securitized. This lack of pipeline may come from a combination of:

- a corresponding lack of small-scale LCCR investments;
- from an absence of tracking of LCCR loans by financial actors;
- or because small-scale LCCR investments are in a large part auto-financed by corporate entities or individuals.

Other obstacles to the development of the market of climate-aligned ABS include the lack of standardization related to LCCR assets and LCCR loans, lack of historic data on most of LCCR assets making it more difficult to assess the level of risks of these assets, and the perception of technological risks of most LCCR assets by investors.

3.2.2. Potential measures to increase LCCR ABS

Some measures from public and private actors could help overcome these barriers and increase the pipeline of LCCR assets and projects, and the labelled green ABS market. Given the current reputation and history around securitization, it appears essential that public actors are involved in the process from the beginning to insist both on quality and transparency in the securitization process. However a mature market for climate-aligned asset-backed securities could help directing additional financial flows to small-scale LCCR investments made by individuals or SMEs by overcoming current constraints on banks' balance sheets. Governments could target incentives to the development of this market. All of the suggested measures presented in Table 7 and detailed in Annex 1 are transaction enablers[13], targeted at both ABS issuers and investors.

The creation of a warehousing entity for LCCR small-scale loans and the introduction of a requirement for banks to disclose the green share of their loan books are measures targeted at potential ABS issuers and aiming at developing the pipeline of LCCR loans available for securitization. Indeed, the lack of a sufficient volume of LCCR loans at banks' level is a major hurdle to climate-aligned securitization. The creation of a public warehousing entity for small-scale loans would enable to ease and accelerate the process for banks to securitize their small-scale loans, since a public financial institution would provide the necessary infrastructure for securitization. Furthermore, a sufficient volume of LCCR loans could be achieved more rapidly by pooling LCCR loans from several banking institutions. A public warehousing entity would thus help overcome the obstacle of a limited pipeline of LCCR loans, provide incentive for standardization of LCCR loans, and would incentivize banks to better tag and track LCCR loans in their portfolios. To overcome the obstacle of a lack of tagging of LCCR loans in their book by banks, regulators could also introduce a requirement for all banks to disclose the share of green or climate-aligned loans in their credit portfolios. Such a requirement would provide a strong incentive for banks to develop the necessary processes and IT system adaptations necessary to tag LCCR financial assets. The feasibility and efficiency of the implementation of either or both of these measures would depend on the institutional and cultural national contexts, as well as the volume of climate-aligned loans already existing in banks' books.

Support for the development of climate-aligned securitization could also target potential investors, to incentivize investing in climate-aligned ABS and overcome the obstacle of a lack of historic data related to LCCR loans. This could notably include credit enhancement schemes for climate-aligned securitized assets, such as providing public loan guarantees, public financial insurance or policy risk insurance, public loan loss reserves and public investment in subordinated tranches of issued securities. Even if different in their implementation modalities, all these schemes would improve the credit rating of climate-aligned asset-backed securities and help constitute a track record for investors and supply the necessary historic data on default rates of LCCR loans. Such schemes should be backed by strong eligibility criteria, notably on the environmental integrity of securitized loans and on securitization transparency processes. It could therefore give a strong incentive for a standardization of the definition of green or climate-aligned financial assets, and a harmonization of such a definition at the level of investors, banks and the real economy.

However, policy makers should pay attention to providing incentives to both supply and demand in parallel, in order to maintain a good supply-offer balance of climate-aligned ABS, and ensure its smooth development. This is all the more important regarding the climate-aligned asset-backed securities market, as it is a nascent market where both the case for issuance and investment remain to be made.

13 *Measures that contribute in making financial transaction possible. They notably aim at making real-economy project developers and financial actors identify and bridge gaps between financial actors' expectations and project developers' needs.*

TABLE 7. SYNTHESIS OF BENEFITS AND LIMITS OF POTENTIAL MEASURES TO INCREASING THE PIPELINE OF LCCR ABS

Suggested measure	Benefits	Limits
Warehousing of small-scale LCCR loans	• gather more quickly a large enough pool of standardized 'green' loans for securitization • incentivize banks to tracking LCCR loans in their portfolios • build a track record on LCCR ABS	• fixed costs for the creation and management of the vehicle • need to ensure sufficient interest from partner banks, loan contract standardisation, transparent governance of the process
Provide public credit enhancement for green securitized assets	• strong incentive for banking institutions to securitize their portfolio of LCCR loans • indirectly push banks to tag LCCR loans in the portfolios • improve the risk/return profile of 'green' ABS and develop the necessary track record • ease tracking LCCR small-scale loans	• costly for the mandated public institution • risk profile of LCCR assets is not cited in the top obstacles to LCCR securitization
Introduce a requirement for banks to disclose the 'green' share of their loans' book	• the lack of tagging of LCCR loans by banks may be one top obstacle for increased LCCR securitization • enable to evaluate the alignment of loan portfolios with a decarbonization trajectory, as a first step to evaluating the exposure to transition risks of the banking system	• labor and IT costs for banks • may add an additional reporting burden that could be limited by an integration into existing reporting frameworks

Source: Authors

3.3. Potential prudential and monetary policies to incentivize investors to favor 'green' over 'brown' financial assets

As discussed in Section 3, the pricing for bonds labelled as green would decrease compared to vanilla bonds, and offer improved financial conditions for LCCR investments, only if pressure from civil society or regulation is high enough to make investors factor in climate issues in their investment decision, and if the tagging of the labelled green bond market is seen by investors as a tool for demonstrating climate commitment. Therefore, the ability of the green bond market to direct increased financial flows to LCCR investments depends on the achievement of the broader objective of 'mainstreaming' climate issues into financial institutions processes. This section briefly explores this issue and provides early suggestions on the role that central banks and supervisory entities could play to foster a realignment of investment strategies with Paris Agreement objectives.

3.3.1. Obstacles to 'mainstreaming' climate into investment decision-making

As highlighted in the final recommendations of the *Taskforce for Climate-related Financial Disclosure*, financial institutions should carry out forward-looking scenario-based analyses of climate-related risks and opportunities for their portfolios. This can help actors to limit climate-related risks faced by the financial system and be able to capture opportunities created by the low-carbon transition. However, several obstacles related to the technical capacity to assess financial assets need to be overcome to achieve this objective, among which[14]:

- A lack of forward-looking information on underlying assets;
- Constraints of financial models, notably a focus on historic data rather than forward-looking analysis and a short-term time horizon;
- A need to adapt financial institutions' IT systems;
- A lack of training of financial analysts on climate-related issues.

Additionally, these technical and assessment barriers are paired with institutional and governance challenges to 'mainstreaming'. Governance challenges are related to the importance given to climate issues in the mandate of financial institutions, how it is prioritized among other issues and the confidence that it remains a high-profile issue over time[15].

14 See (Nicol and Cochran 2017) for more information on how financial actors could manage their climate-related risks.

15 See (Ian Cochran and Mariana Deheza 2017) for more information on the institutional challenges related to the integration or mainstreaming into the operations of financial institutions.

3.3.2. The suggested prudential and monetary measures today are subject to heated debates

Regulators, central banks and supervisory entities have been called in some cases to implement ambitious measures to push investors to take into account climate factors into their investment decisions. The public support measures presented below concern all financial instruments financing LCCR investments, and not just labelled green bonds. However, labelled green bonds may be in many instances an efficient indicator for investors and regulators to identify green financial assets.

Most measures presented in Table 8 are today subject to a heated debate, particularly 'unconventional' monetary policies (see **Box 5** for an explanation on 'conventional' and 'unconventional' monetary policies).

The supervisory and monetary policies suggested in Table 8 present different approaches to push financial institutions to take into account climate and energy transition issues into their investment decision-making or risk analysis. They present an array of potential solutions from direct supervisory requirement to indirect incentives to put in place necessary processes and tools. All aim at overcoming the main hurdle for climate 'mainstreaming', which relates to the cost of necessary adaptations of processes and IT systems, as well as internal 'change management', by providing a strong institutional signal from financial institutions' regulators and supervisors.

No analysis of the feasibility and impact of these measures is presented as the current state of the literature is insufficient and a detailed study would be required for each of them. Today, it is only possible to conduct a general overview of these potential public measures; further detailed analysis should be undertaken to formulate precise public policy recommendations. Nevertheless, a brief overview of modalities, potential benefits and limits of each of suggested measures is provided in **Annex 1**.

BOX 5. 'CONVENTIONAL' AND 'UNCONVENTIONAL' MONETARY POLICIES AS EXPLAINED BY LORENZO BINI SMAGHI, MEMBER OF THE EXECUTIVE BOARD OF THE EUROPEAN CENTRAL BANK

"Let me first clarify what we mean by 'conventional' measures. Nowadays, monetary policy mainly acts by setting a target for the overnight interest rate in the interbank money market and adjusting the supply of central bank money to that target through open market operations. To minimize the risk exposure of the central bank's balance sheet, all liquidity-providing operations normally take place in the form of reverse transactions against a menu of eligible collateral. In other words, in normal times the central bank is neither involved in direct lending to the private sector or the government, nor in outright purchases of government bonds, corporate debt or other types of debt instrument. […]

But in, so to speak, abnormal time's conventional monetary policy tools may prove insufficient to achieve the central bank's objective. […]

When conventional tools can no longer achieve the central bank's objective, policy-makers are confronted with a number of issues.

First, the unconventional tools include a broad range of measures aimed at easing financing conditions. Having this menu of possible measures at their disposal – which are not mutually exclusive ones – monetary policy-makers have to clearly define the intermediate objectives of their unconventional policies. These may range from providing additional central bank liquidity to banks to directly targeting liquidity shortages and credit spreads in certain market segments. The policy-makers then have to select measures that best suit those objectives.

Second, they should be wary of the possible side-effects of unconventional measures and, in particular, of any impact on the financial soundness of the central bank's balance sheet and of preventing a return to a normal market functioning.

In general, unconventional measures can be defined as those policies that directly target the cost and availability of external finance to banks, households and non-financial companies. These sources of finance can be in the form of central bank liquidity, loans, fixed-income securities or equity."

Source: Conventional and unconventional monetary policy, Lorenzo Bini Smaghi, Keynote lecture at the International Center for Monetary and Banking Studies (ICMB), Geneva, 28 April 2009, https://www.ecb.europa.eu/press/key/date/2009/html/sp090428.en.html

TABLE 8. SYNTHESIS OF BENEFITS AND LIMITS OF POTENTIAL MEASURES TO INCENTIVIZING INVESTORS IN FAVORING 'GREEN' OVER 'BROWN' ASSETS

Suggested measure	Benefits	Limits
Require financial institutions to integrating climate risks into mainstream risk analysis and internal notations	• entail better financing conditions for organizations more committed to the low-carbon transition • push financial actors in favoring 'green' financial assets	• requires major adaptations of risk processes and IT systems of financial institutions • models development needs to be carried out in close collaboration with climate research centers
Revise supervisors' guidelines for risk notation determining prudential requirements	• would result in a decreased Capital Adequacy Ratio for financial actors more invested in LCCR assets • incentive to favor 'green' over 'brown' financial assets	• an important research effort in close collaboration with climate research centers is needed to develop the necessary scenarios and models
Introduce a 'green' macroprudential policy	• would incentivize financial actors to favor assets less exposed to climate transition risks • strong incentive for banks to tag and track 'green' assets in their balance sheets • could help reduce the exposure of the financial system to climate transition risks	• may lead to an underpricing of risks relative to real risks carried by 'green' assets, and ultimately entail a 'green' bubble • detailed criteria for determining the exposure to climate transition risks should be carefully designed • should not lead to a global decrease in the Capital Adequacy Ratio of the banking system
Include green assets into central bank's collateral framework	A detailed analysis would be needed	
Implement a 'Green' Quantitative Easing	A detailed analysis would be needed	

Source: Authors

Annex 1: Details on suggested public support measures

1. Potential measures to increasing the share of climate-aligned bonds labelled as green

1.1. Subsidize the cost of labelling bonds as "green"

Objective: To decrease the cost of labelling, governments could directly grant issuers subsidies to support labelling bonds as green.

Modalities: Such subsidies could cover totally or partly the labelling costs, i.e. costs of the external reviewer services, and even the cost of internal resources needed for identifying the "use of proceeds" and carrying out the necessary ex-post reporting. Subsidies could be conditional on the achievement of certain standards either on assets financed or on the reporting content and process.

Benefits: Subsidizing green bond labelling would help overcome the obstacle of its cost for issuers and lead to a more systematic green labelling of climate-aligned bonds. It could also bring the additional benefits of developing and structuring a market for external reviews – particularly in markets where there has been few green bond issuances to date -, and of pushing issuers to sticking to defined standards.

Limits: Given the potential volume of subsidies needed in a market with already significant volumes of green bonds issuance, the cost for governments should be weighed against other alternative supporting measures. Costs for external reviews vary between USD 10 000 to 100 000 per issuance. Consequently, this measure may be more suitable for countries with an active "vanilla" bond market and where the labelled green bond market barely exists at the moment. Moreover, public institutions have to put in place safeguards to avoid 'free-riding', notably define a science-based standard for green, ensure labelled green bonds are respecting the standard's criteria through an independent review process and define a strict governance process including accreditation of labelling entities. For more information on how to ensure the environmental integrity of green bonds, see Report 2 "Environmental integrity of green bonds: stakes, status and next steps" (Igor Shishlov, Nicol, and Cochran 2017).

Existing examples: As presented in **Box 6**, the Singapore central bank launched in March 2017 a grant scheme to cover the costs related to green bond issuance.

BOX 6. SINGAPORE'S GREEN BOND GRANT SCHEME

In March 2017 Singapore's central bank announced the launch of a Green Bond Grant Scheme to cover the costs for external reviewers for green bond issuance. The objective of this support measure is to overcome the barrier of external review costs that often prevent organizations to carrying out a first-time green bond issue. This grant scheme applies to all issuances in any currency that are issued and listed in Singapore, but not restricted to Singapore issuers, have a minimum size of USD 200 million and have a tenure of at least three years. Qualifying issuances can offset 100% of expenses attribuTable to obtaining an external review for bonds, up to a cap of USD 100,000 per issuance, and issuers will be able to receive the grant multiple times. This grant scheme is limited in time: funding will take place between June 2017 and May 2020.

Source: Climate Bonds Initiative

1.1.1. Introduce mandatory reporting obligation on green assets for all firms or all bonds issued

Subsidizing the labelling of bonds as green may quickly cost some millions of euros for countries with an active bond market. In these countries, soft measures or regulation could be preferred to subsidies.

Objective: To minimize the distortion in transaction costs unfavorable to green bonds over vanilla bonds through an incentive to all firms to tag their green activities and assets and provide mandatory reporting on these green activities and investments. Indeed, additional costs for an issuer for labelling a bond as green includes costs of external review services, but first and perhaps foremost costs in terms of the internal resources necessary to tagging green activities and assets in the balance sheet and carrying out ex-post reporting.

Modalities: Introduce a requirement for mandatory tracking and reporting of green activities and assets for all firms, or at least all firms issuing bonds. Such a requirement could be introduced in general corporate reporting regulation, or could be specifically targeted at bond issuing organizations through information requested by supervisors in bond issuance documentation.

Benefits: Such a measure would decrease the distortion in transaction costs between green bonds and vanilla bonds since green bond issuance would not imply additional internal costs for tagging green assets and ex-post reporting. It could also present the co-benefit of helping firms structure discussions around their climate change strategy.

Limits: Introducing a new reporting requirement on green activities and assets to firms or bond issuers would not entail substantial costs for governments beyond those associated with enforcement. However, it would lead to some labor costs for concerned entities. A new reporting requirement would have to be added to existing regulation framework to ensure coherence and avoid implementing a heavy reporting process for firms.

Existing examples: Mandatory reporting on environment, social and governance issues has been progressively introduced in some jurisdictions and could be completed by a request to disclose information on green activities and assets. For example, in France the Article 173 of the Energy Transition Law published in 2015 requires firms to report on their climate change strategy and on their contribution to mitigating climate change in a "comply or explain" format. It does not explicitly, however, request disclosure on green activities and assets.

1.2. Introduce mandatory disclosure on the "use of proceeds" of all bonds issued

Objective: To minimize the distortion in transaction costs unfavorable to labelled green bonds over vanilla bonds and non-labelled climate-aligned bonds; and to limit the additional cost for labelling a bond as green to the costs of external review services.

Modalities: A mandatory disclosure on the "use of proceeds" of all bonds issued – whether green or not – before issuance and even ex-post. A disclosure of the "use of proceeds" could for example be required in the debt security prospectus sent to the supervisory authority before issuance.

Benefits: Such a measure would decrease the distortion in transaction costs between green bonds and vanilla bonds. Additionally, it could bring the co-benefit of allowing to tagging 'brown' assets, and enable to analyze if financial flows are aligning on a 2°C trajectory.

Limits: Introducing a new reporting requirement would not entail costs for governments. However, if this requirement only targets bonds and not organizations, bonds can then be disadvantaged against other financial instruments due to increased transaction costs. This might therefore have a negative effect on LCCR investments since bonds naturally fit these investments as demonstrated earlier.

Existing examples: The feasibility of such a measure has not been demonstrated at the moment.

1.3. Push for an increase in demand for labelled green bonds

Objective: The main challenge today is to increase the pipeline of bonds financing LCCR assets, as well as increase the share of those bonds issued with a green label to increase supply of green bonds in the market. Even if demand is higher than supply in today's green bonds market, an increased investors' demand could indirectly further incentivize issuers to issuing green bonds. Rather than regulating issuance, governments could incentivize investors to invest in labelled green assets, thus reinforcing a market-led drive to expand the labelled green bond market.

Modalities: Incentivize investors, and notably institutional investors that have a large share of their portfolios invested in bonds, to define a strategy for investing in labelled green bonds. This could range from a soft requirement that their strategy contributes to financing the low-carbon transition, a requirement to disclosure of green financial assets in their portfolios, or a requirement to invest a minimum share of their portfolios in green financial assets. Alternatively, public authorities could require investors to include a minimum share of green financial assets in the portfolios of specific investment products with advantageous fiscal conditions, such as for example life insurance products.

Benefits: Incentivizing or requiring investors, and notably institutional investors, to include a minimum share of green financial assets in their portfolios would boost the demand for labelled green bonds, which are the easiest way for investors to invest and report on green financial assets. In turn, they would need to engage with issuers for more labelled green bonds being issued, and issuers would be incentivize in tagging their green activities and assets, and in turn push to better align their activities to invest in LCCR assets.

Limits: Benefits of such incentives for green assets in general, and labelled green bonds in particular need to be weighed against the risk of creating a 'bubble' of green financial assets; particularly if the offer of green financial assets is not accompanied by an increase demand. If used, requirements on a minimum share of green assets should be progressive to allow a progressive increase in the demand for such assets.

Existing examples: Some evidence suggests that new ESG requirements introduced by Article 173 of the French Energy Transition Law have lead some investors purposely increasing their share of green bonds investments to demonstrate their climate commitment. However, a detailed impact analysis of Article 173 would be needed be undertaken to assess its effects on the green bond market.

2. Measures to increasing the pipeline of LCCR ABS, whether or not they are labelled as green

2.1. Private sector and/or public sector warehousing of small-scale LCCR loans

Objective: A warehousing entity for LCCR small-scale assets would enable the pooling of small-scale LCCR loans from several financial actors and thus create a volume of homogeneous LCCR loans large enough to be securitized. Such a mechanism would enable to decrease the cost for refinancing small-scale LCCR loans and ultimately decrease the cost of borrowing for small-scale LCCR investments.

Modalities: Warehousing small-scale loans refers to the creation of a vehicle – private or public – that aggregates homogeneous loans granted by several different financial institutions, generally to ease a securitization process. More precisely, several banking institutions, public financial institutions, and/or other lending actors would originate LCCR loans – i.e. lend money for a LCCR investment. These would then be sold to a third-party institution or dedicated financial vehicle, called a warehousing entity, that serves as an aggregator of these loans. The warehousing entity could acquire these LCCR loans through its own capital equity or a dedicated line of credit. When a sufficient volume of LCCR loans are aggregated in the warehousing entity, the portfolio, or part of the portfolio, could then be securitized and sold to capital market investors – typically institutional investors – as asset-backed securities (ABS) that could then be labelled as green bonds. Funds from the warehousing entity would then be "recycled" and used to buy new LCCR loans.

Public warehousing of small-scale LCCR loans could be coupled with other types of public support measures, notably credit enhancement through subordination: the public warehousing entity remains the investor of the higher-risk higher-yield tranche of the securitized portfolio as a subordinated investor, which allows it to offer private capital market investors with "investment-grade" securities. See 2.2 for more details on public credit enhancement measures.

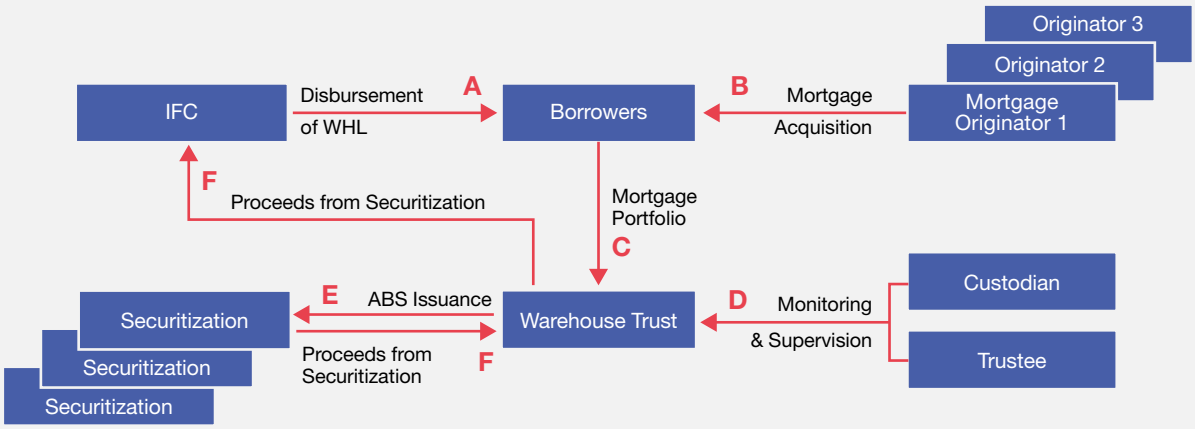
Benefits: Creating a warehousing entity would enable to gather more easily and more quickly a large enough pool of homogeneous and standardized green loans necessary for securitization. Securitization indeed requires that underlying financial assets are homogeneous and standardized – as it is the case for mortgage-backed securities which represent the largest share of the asset-backed securities market. Financial actors would also be incentivized to track LCCR loans in their portfolios since such a mechanism could allow them to remove these LCCR loans from their balance sheets and recycle them into new loan capacity. Compared to direct securitization, financial actors would not have to wait to have granted a large enough pool of LCCR small-scale loans before externalizing them. This would allow them in theory to increase the pipeline for securitization and improve the track-record of such assets – helping to develop the primary market for small-scale LCCR loans and building the secondary market for LCCR asset-backed securities.

Limits: There are fixed costs for the development and operation of a warehousing entity. These costs have not been estimated in this study as it would require a detailed analysis of a given financial architecture, notably dependent on the entities involved in the scheme. Preconditions for implementing a LCCR warehousing mechanism include: 1) the existence of an interest from a number of domestic private or public lending institutions to participate in the securitization program; 2) the necessary financial regulatory environment for securitization in general; 3) the design of an appropriate infrastructure for the mechanism to ensure transparency on securitized loans and their risk profile; 4) the implementation of necessary processes for tracking of LCCR loans at partner bans' level; 5) and the standardization of loan contracts.

Existing examples: The warehousing of loans is a mechanism relatively well developed for the individual housing mortgage market, notably in the US. **Box 7** provides details on a US warehousing mechanism for loans financing energy efficient housing renovation. **Figure 9** illustrates how warehousing mechanisms are currently used in the mortgage market.

FIGURE 9. HOW WAREHOUSING WORKS

The structure described below is a generic one, and it may be modified under different circumstances.



A. IFC provides warehouse line of credit to an eligible borrower for the purpose of acquiring and warehousing mortgage portfolio.
B. With the disbursement from WHL, Borrower purchases qualifying mortgage portfolio from a number of qualified mortgage originators; In the meantime, the mortgage portfolio is pledged to IFC as collateral under WHL.
C. Borrower packages and structure the mortgage portfolio into a bankruptcy-remote Special Purpose Vehicle for securitization.
D. A reputable financial institution is selected as a financial trustee to monitor and supervise the trust property. A reputable financial institution is also selected as a custodian of the trust property.
E. When a critical mass of mortgage portfolio is accumulated, the trust issues mortgage backed securities to capital market.
F. The proceeds from each securitization will be funneled through trustee back to IFC, thus replenishing WHL for subsequent use; IFC will continue to have full recourse to Borrower in the event that the proceeds from securitization of the underlying mortgage portfolio do not fully cover the debt obligation to IFC.

** Typically, a secondary mortgage institution, or mortagage aggregator.*

Source: IFC – International Finance Corporation. https://www.ifc.org/wps/wcm/connect/ca0c538049586197a70ab719583b6d16/HF-WHL.pdf?MOD=AJPERES

BOX 7. EXAMPLE OF THE WHEEL – WAREHOUSE FOR ENERGY EFFICIENCY LOANS PROGRAM IN THE UNITED STATES

Energy-efficient housing renovation present a particular challenge in terms of financing because it involves small-scale (typically below USD 20,000) diffuse investments that may present a long-term horizon of return on investment, and for the moment does not benefit from dedicated financial instrument. The WHEEL – Warehouse for Energy Efficiency Loans program was launched in 2014 as a public-private partnership to provide homeowners with low-cost financing solutions by facilitating a secondary market for residential clean energy loans. The WHEEL program is innovative as it brings together States, foundations and the private sector to help develop the market of housing energy efficiency loans. It has originally been launched by Renew Financial, the State of Pennsylvania Treasury Department, and Citibank, with an initial commitment of up to $100 million. Several other US States have since then joined the program.

A special-purpose entity, provided by Citi, purchases unsecured – i.e. without collateral on assets purchased – residential energy efficiency loans from loan originators, such as Renew Financial under the KeystoneHELP program that provides better financing conditions thanks to support from the state of Pennsylvania. These loans have a maturity of five, seven or ten years, and benefit from standardized homeowner and contractor underwriting. To fund the purchase of these loans, the special-purpose WHEEL entity obtains capital from public sources and borrows funds under a warehouse line of capital from private investors. Financing of the special-purpose WHEEL entity is structured so as public sponsor funds take a subordinate position to the private debt, thereby attracting investment-grade capital to the structure. This allows for low-cost, large-scale capital to flow to the programs WHEEL supports. Loans purchased by the special-purpose WHEEL entity are then pooled, and securitized and sold in the capital markets in the form of "investment-grade" asset-backed securities when a sufficient volume of loans has been aggregated. WHEEL successfully completed its first securitization in June 2015: almost USD 13 million of green bonds were issued backed by almost USD 16 million in energy efficiency loans, corresponding to 2,079 home retrofits.

Expected benefits of the WHEEL program are an increased market volume and liquidity for energy efficiency loans, a pooling of geographically diverse loans and the provision to the market of needed performance data and commercial track records that in turn should drive lower required returns.

Source: (EPC – Energy Program Consortium 2017), NASEO: https://www.naseo.org/Data/Sites/1/documents/committees/financing/documents/WHEEL_Primer.pdf

2.2. Provide public credit enhancement for green securitized assets

Objective: Green securitization aims to decrease borrowing costs for LCCR assets, improve associated risk / return profile, and ultimately contribute to an increase in the pipeline of LCCR investments. However, an obstacle to LCCR securitization today is the absence of tagging of LCCR loans on the balance sheet of most banking institutions. Public credit enhancement of LCCR ABS could be used to incentivize banking institutions to tag LCCR loans in their balance sheets.

Modalities: Public credit enhancement has been proposed as means for public financial institutions to enhance the credit rating of asset-backed securities by absorbing some of the risks associated with the investments, thus making them attractive for private investors. Several credit enhancement measures could be implemented (European Commission 2016) (OECD 2015b):

- ***Guarantees***: public financial institutions can provide loan guarantees at the initial stage of loan contracting, or provide partial or full guarantees to investors at asset-backed security issuance stage;
- ***Insurance-related options***: Public financial insurance may be provided for the principal and coupons of green asset-backed securities to enhance the rating of securities issued. Such measures also include policy risk insurance schemes that compensate investors if a policy on which investment decision is based is reversed or revised;
- ***Loan loss reserves***: A public reserve fund could be created to set aside capital to cover potential loan losses: if a borrower defaults, the lender is – fully or most often partially – repaid using the reserve fund;
- ***Public investment in subordinated tranches***: the securitization process often involves the disaggregation of the asset pool into tranches to offer different risk profiles to investors with different risk appetites. If public institutions purchase the subordinated tranche of a bond – i.e. the riskier tranche -, the public entity agrees to bear the first loss of capital, in case of losses. As a result, senior tranches – i.e. tranches presenting lower risks – receive a better rating and are more attractive to private investors;

Benefits: Public credit enhancement is thought to be able to a strong incentive for banking institutions to securitize their portfolio of LCCR loans, and indirectly push them to identify, tag and track in their portfolio relevant LCCR assets. It could also enable the improvement of the risk/return profile of green ABS and develop the necessary track record on such assets. Finally, it could ease the tracking by public authorities of the development of the green ABS market.

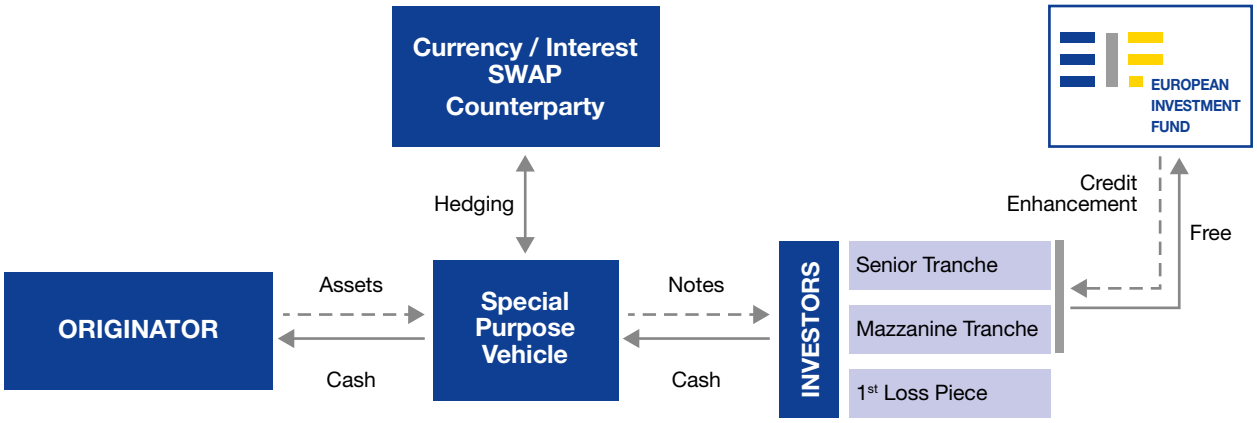
Limits: Most existing credit enhancement schemes generate fixed costs for management – except for public investment in high yield tranches – that can represent a significant cost expense per ABS issuance depending on the success of the scheme. Moreover, in the case of a rapid development of green ABS, the total cost of the credit enhancement scheme could be high due to the necessary capital provisions to be made for each supported issuance and potential losses to be covered by the scheme. Therefore a termination clause should be included from the beginning to stop the credit enhancement scheme for new issuances once a certain volume of green asset-backed securities has been issued under the scheme. In addition to limits related to the costs associated with credit enhancement schemes, policymakers should carefully weigh the impact of credit enhancement compared with other support schemes, notably benefitting directly LCCR assets owners. Indeed, the first obstacle to a significant development of green securitization appears today to be the lack of an appropriate pipeline of LCCR loans rather than on a lack of demand for climate-aligned asset-backed securities or a lack of willingness from banking institutions to securitizing such assets. As a result, a more important first step could be to design support schemes benefitting project developers, to contribute to the development of a pipeline of climate-aligned loans available for securitization.

Existing examples: Credit enhancement is for example provided by the European Investment Fund (EIF) to enhance access to finance to small- and medium-sized enterprises (SMEs) in the EU Member States and Candidate Countries as well as in the European Free Trade Association countries.

BOX 8. EIF CREDIT ENHANCEMENT OF SECURITIZATION OPERATIONS

The European Investment Fund (EIF), part of the EIB group, offers guarantees to banks and financial institutions to facilitate the securitization of their portfolios of loans, lease and trade receivables and guarantees provided to SMEs. The European Investment Fund (EIF), part of the EIB group, offers guarantees to banks and financial institutions to facilitate the securitization of their portfolios of loans, lease and trade receivables and guarantees provided to SMEs. EIF can provide various types of guarantees (bilateral guarantees, credit default swaps…) on senior and/or mezzanine tranches of risk. This allows improving the rating of asset-backed securities (ABS) issued, typically from a BB rating to an AAA rating, and consequently decreases the expected return on these ABS by investors.

FIGURE 10. THE EIF CREDIT ENHANCEMENT MECHANISM FOR SECURITIZATION



Source: EIF, http://www.eif.org/what_we_do/guarantees/credit_enhancement/index.htm

2.3. Introduce a requirement for banks to disclose the green share of their loan book

Objective: To grow the pipeline of loans identified as green in banks' portfolios, regulation or supervisory bodies could introduce a requirement for banks to disclose the green share of their loans' portfolios. Banks would then be in a position to identify the pool of loans that could be securitized.

Modalities: Introduce in existing regulatory disclosure frameworks for banking institutions a requirement to disclose the green share of their loans' book. For banks, such a requirement would entail to put in place processes and the information system allowing them to tag green loans. This requirement could be advantageously complemented by a public warehousing facility, as, at least in a first phase, single institutions may not have enough climate-aligned loans in their book for green securitization to be feasible on their own. This would require the regulatory body to issue a clear definition of green and 'brown' assets and apply it within compliance assessments.

Benefits: A mandatory disclosure of the green share of loans book would oblige banks to tagging and tracking such loans in their portfolio. In doing so, they would overcome one of the principal obstacle hindering the opportunity for a securitization of these assets. In addition, this disclosure would enable public authorities and civil society to track the alignment of banking activities with a decarbonization scenario, and more easily perform a transition risk analysis of the banking system.

Limits: For banking institutions, it would cost the adaptation of the IT system, as well as some labor costs, whereas boosting their LCCR transition strategy. A new reporting requirement would have to be added to existing regulation framework to ensure coherence and avoid implementing a heavy reporting process for banking institutions. Beyond the technical abilities to track green loans, interviews with market participants indicated that banks may not have in general high levels of green assets currently on their balance sheet as a whole.

Existing examples: No existing measure have been identified in the context of this study.

3. Potential prudential and monetary policies to incentivize investors in favoring green over brown financial assets

3.1. Require financial institutions to integrating climate risks into mainstream risk analysis and internal ratings

Objective: A 'soft' way of pushing financial institutions to take into account the green component of financial assets and favor actors committed to investing in LCCR assets could be to require them to integrate climate issues in their investment decisions.

Modalities: As a first step, supervisory authorities could require financial institutions to integrate climate-related transition risks into their mainstream risk analysis and internal notation. Consequently, everything else being equal, organizations conducting more LCCR investments and activities would benefit from a better risk notation than equivalent, more carbon-intensive organizations.

Benefits: Ultimately, such a measure would have two main impacts. It could lead to better financing conditions for organizations more committed to the low-carbon transition, since they would be rated as less risky everything else being equal. Second, it could push financial actors to favor green financial assets to minimize their risk exposure.

Limits: While a number of approaches are currently being tested to undertake this type of risk integration, it remains partially theoretical in practice.[1] A requirement of integrating climate-related transition risks into mainstream risk analysis would need to be enforced progressively, as it could entail major adaptations of risk processes of financial institutions, adaptation of models used for calculating risks, and changes to IT systems. The adaptation of models and the development of indicators should be carried out in close collaboration with climate scientists, in order for these developments to benefit from state-of-the-art climate science.

Existing examples: No such specific requirement has been enforced yet, even if it corresponds to the overall ambition of the Article 173 of the French Energy Transition Law without mandatory guidelines. However several research programs are currently ongoing to develop models and indicators for a scenario-based analysis of climate transition risks, which could as a second step be adapted to fit constraints of risk analysis and internal risk rating. An example of such research program is the Energy Transition Risks & Opportunities (ET Risk) program[2].

3.2. Integrate climate-related issues into micro and macroprudential policies

3.2.1. Revise supervisors' guidelines for risk ratings determining prudential requirements

Objective: Supervisors' guidelines for the internal risk rating of investors do not currently include reference to climate-related risks, even if climate-related risks are increasingly recognized as entailing risks on the stability of the financial system. A first step to integrating climate-related risks into financial supervisory frameworks could be that supervisory entities provide financial institutions with guidelines on how to take into account climate-related risks, and notably transition risks.

Modalities: Supervisors could provide investors with guidelines outlining how to include climate-related risks into the internal risk rating system that is used for the assessment of the Capital Adequacy Ratio.

Benefits: These guidelines, if implemented by financial institutions, would result in a comparatively lower Capital Adequacy Ratio for financial institutions more invested in LCCR assets – everything else being equal, but without introducing changes in the prudential regulation and without introducing sectorial biases in the prudential regulation. Ultimately, financial institutions would favor "green" over "brown" assets to decrease their Capital Adequacy Ratio and decrease their financing cost.

Limits: The necessary technical approaches, scenarios and models for achieving a transition risk analysis are still in development phase. The adaptation of models and the development of indicators should be carried out in close collaboration with climate scientists, in order for these developments to benefit from state-of-the-art climate science.

Existing examples: No such guidelines exist yet, and research projects that would help supervisors develop guidelines are still ongoing. As a first step, supervisors should work in close collaboration with specialized research

1 *See I4CE's three recent policy briefs on the integration of climate related risks: https://www.i4ce.org/download/three-notes-on-the-management-of-climaterelated-risks-by-financial-actors/*

2 *Members of ET Risk Consortium: 2°C investing initiative, I4CE, University of Oxford, Carbon Tracker initiative, CO-Firm, KeplerChevreux, S&P Global. L'objectif de ce programme de recherche de 3 ans est de développer un cadre d'analyse des risques de transition adapté aux titres financiers cotés.*

centers to develop the necessary background data and information.

3.2.2. Introduce a green macroprudential policy

One of the main pillars of the Basel III Accord, followed by virtually all countries globally for setting their banking regulation, is the exigence of a minimum capital adequacy ratio: banks should have a certain level of equity capital based on a risk-weighted assessment of the assets on its balance sheet. Consequently, the cost in capital for banks to finance riskier assets is higher.

Objectives: Proponents of such a measure argue that since climate-friendly investments decrease the climate-related risks faced by the financial system, their lower risks should be taken into account in prudential regulation to incentivize financial actors to issue green financial assets such as green bonds or invest in green assets.

Modalities: To do so central banks could integrate criteria related to climate transition risks in the calculation of the capital adequacy ratios. It could reduce the level of capital requested for assets presenting lower climate transition risks and/or increase the level of capital requested for assets presenting higher climate transition risks. Several modalities could be explored, non-exclusive from each other:

- Introduce a 'brown-penalizing factor', i.e. raise capital requirements towards assets presenting strong climate transition risks, as suggested in the July 2017 Interim Report of the European High-Level Expert Group on Sustainable Finance (High-Level Expert Group on Sustainable Finance 2017);
- Introduce a 'green-supportive factor', i.e. decrease capital requirements towards green assets, considered as being less exposed to climate transition risks, as advocated by the French banking industry association "Fédération Bancaire Française[3]";
- Require banks to hold increasing amounts of capital as the outstanding volume of carbon-intensive assets in their balance sheet increases, or introduce direct limits to credit extension for carbon-intensive businesses, as suggested by NEF (New Economics Foundation 2017).

Benefits: Reducing – in relative terms – the level of capital requested for assets presenting lower climate transition risks would mean decreasing the refinancing cost for banks. It could ultimately lead banks to decrease borrowing costs or expected returns for such assets and could incentivize them to favor assets less exposed to climate transition risks. Introducing a 'green-supportive factor' could in addition constitute a strong incentive for banks to tag and track green assets in their balance sheets. Introducing a 'brown-penalizing factor' could, according to HLEG, "yield a constellation in which risk and policy considerations go in the same direction". Finally, these measures could help reduce the exposure of the financial system to climate transition risks and curb the threat of a carbon bubble.

Limits: Opponents of a "Green Supporting Factor", among which central banks often find themselves, contend that it remains to be demonstrated that green assets present a lower level of risk. Furthermore, they contend that such measures may blur risk considerations and lead to an underpricing of risks relative to real risks carried by these assets. Moreover, prudential regulation should not introduce a sectorial bias, which could lead to a green bubble. In practice, the detailed criteria for determining the exposure to climate transition risks must be carefully designed. For instance for the moment a green or 'climate-aligned' financial asset such as a green bond does not necessarily lower the investor's exposure to climate transition risks when there exists a recourse to the balance sheet of the issuer, as the green relates to the 'use of proceeds' and not the alignment of the issuing entity on a LCCR trajectory. In some cases, a 'brown-penalizing factor' could be easier to design and "to rationalize as capturing the risk of sudden value losses due to 'stranded assets'". Finally, such a measure if implemented alone could risk causing a net global decrease in the capital adequacy ratio of the entire banking system. Ensuring a sTable buffer for financial stability could require that a "green supporting factor" should be coupled with a "brown-penalizing factor" to balance out any net impacts.

Existing examples: No example of a green macroprudential policies currently exists. Nevertheless, a similar "SME-supportive factor" has been introduced in Article 501 of the European Capital Requirements Regulation (CRR) and implemented since January 2014. This was implemented to support the recovery of SME bank lending that was particularly negatively impacted by the 2008 financial crisis and following regulatory changes. It consists in a deduction in capital requirements for exposures to SMEs by applying the SME SF of 0.7619 to capital requirement, i.e. a 24% capital discount in the current capital charge of eligible entities. As of Q3 2015, the impact of this measure has been an approximately EUR 11.7 billion of capital for banks freed up for additional lending (European Banking Authority 2016). However, the 2016 EBA study suggests that "there are no evidence that the SME SF has provided additional stimulus for lending to SMEs", nor that financing conditions for SMEs has improved more than for large firms. The EBA recognizes, however, that it may be too early to draw conclusions.

3 *Source: Mémo Banque n°03, Fédération Bancaire Française, September 2016, http://www.fbf.fr/fr/files/AE8B4T/Memo-banque-03.pdf*

3.3. Introduce climate-related issues into monetary policies

The idea that central banks have a role in aligning financial flows with a 2°C trajectory has gained momentum in the last months. Central banks are a key part of the monetary system as they both create new money themselves, and influence the financial system through regulatory interventions affecting the flow of money and credit created by commercial banks (New Economics Foundation 2017). Central banks' decisions affect financial markets, notably through frameworks for providing banks with money or liquidity, such as collateral frameworks. Indeed, for banks it is necessary to be able to access sufficient central bank money at any time (Nyborg 2015). Therefore, it is increasingly seen as crucial that monetary policies support, or *a minima* do not prevent, an alignment of financial flows with Paris Agreement objectives. In addition, increasing the involvement of central banks for aligning flows with the Paris Agreement objectives would send a strong signal to the financial community.

3.3.1. Include green assets into central bank's collateral framework

Objectives: The collateral framework set by central banks determines what assets owned by banks can be used as a collateral for obtaining overnight liquidity from the central bank. For some observers, the collateral framework introduces a bias in the allocation of banks' portfolios, as they may favor assets eligible for collateral over other assets since collateral frameworks determine the terms at which banks can obtain liquidity from the central bank (Nyborg 2015). Consequently, to incentivize banks to favoring green bonds and other green financial assets, central banks could specifically include green assets into collateral frameworks.

Modalities: Include green assets – meeting central banks' requirements in terms of credit quality – in the list of eligible assets in collateral frameworks. This would require a specific definition of what assets are considered as green.

Benefits: This measure could incentivize financial institutions to invest into green assets and there would be an increased demand in 'green assets'. In turn, it could create pressure on issuers to be able to issue green assets corresponding to the established eligibility criteria, and it could lead to increased LCCR investments.

Limits: To date only limited assessment has assessed at this issue. Unexpected effects could exist could occur; however a detailed impact study would be needed to detail benefits and limits of this measure. Main arguments opposed to this proposed measure are:

- the collateral framework is designed for monetary policy purposes and should not be used for other policy objectives;
- 'green assets' is not at the moment an asset class and there are some methodological difficulties in defining which assets can be considered as green (see above paragraph on 'green macroprudential policies' and Report 2 "Environmental integrity of green bonds: stakes, status and next steps" (Igor Shishlov, Nicol, and Cochran 2017) for more details on methodological obstacles to defining green).

Existing examples: No example of the implementation of a similar measure was found in the context of this study.

3.3.2. Implement Green Quantitative Easing

Quantitative easing (QE) operations consist of the creation of new money by central banks to purchase financial assets from commercial banks and other financial institutions. This is thought to stimulate the economy by providing liquidity in financial markets. QE programs implemented by the US Federal Reserve, the Bank of England and the European Central Bank were launched after the 2008 subprime financial crisis and are still operating today. In Europe since 2016, Eurosystem national central banks have directly purchased more than 75 billion worth of corporate bonds.

Currently, a number of studies have indicated that existing QE programs may contain a bias in favor of carbon intensive assets. Notably, the share in the purchases of Eurosystem corporate bonds of the sectors of manufacturing and electricity and gas production – which represent 2/3 of Eurozone GHG emissions but only 18% of GVA – has totaled up to 2/3 of total purchases. For the Bank of England, manufacturing and electricity production – responsible for 52% of UK GHG emissions – make up almost 50% of the eligible benchmark, but only 12% of GVA (Matikainen, Campiglio, and Zenghelis 2017). The potential bias of these QE programs in favor of carbon-intensive assets raises concerns of an unintended impact on favoring additional debt issuance and increasing prices for carbon-intensive sectors compared to low-carbon ones.

Several civil society organizations and policymakers are today advocating for the implementation of green – or maybe more adequately 'de-browning' – QE programs as a way to push for the necessary shift in financial flows towards alignment with the Paris Agreement objectives.

Objectives: To increase financial flows directed towards green investments or at a minimum decrease the actual bias towards carbon-intensive assets of current QE programs, by targeting the additional liquidity provided to financial institutions through QE to the financing of green assets.

Modalities: In order for QE programs not to undermine signals created by climate policies, some suggest several measures central banks could implement in the framework of existing QE programs:

- Central banks could start by disclosing the same level of information on the climate risks borne by their bond purchases as requested from private actors in the recommendations of the Task Force on Climate-Related Financial Disclosures, early recommendations of the European High-Level Expert Group on Sustainable Finance, or Article 173 in France;
- After conducting an analysis of the alignment of their current bond portfolio with climate objectives, central banks could introduce eligibility criteria for their bonds purchase programs to achieve an allocation coherent with a low-carbon trajectory;
- On a more ambitious scale, the ECB's QE programs could be used to drive a structural transition to a low carbon economy. To do so, it would provide indirect guidance on what investments and activities should be prioritized and support. This has been suggested in the research report (Green/EFA Group in the European Parliament 2015);
- Another proposal relies on the use of carbon certificates (Aglietta, Espagne, and Perrissin Fabert 2015): Companies with a green project would receive certificates matching the value of GHG emissions reductions created by the project compared to a baseline. These credits could be redeemed at commercial banks against loans to cover part of the project's total costs. The central bank, responsible for backing and refinancing the certificates, would provide banks with financing on par with the value of certificates collected as part of its QE program.

Benefits: A detailed impact study would be needed to detail benefits and limits of the different options to implement these measure. However, the overarching principal benefit of such measures is that it could contribute directly in increasing financial flows directed towards LCCR investments in the real economy. Moreover, some advocate that as the recourse to financial markets is limited in such schemes, it reduces the risk of speculative bubbles. Finally, it could be relatively easy to implement a green QE program in the US, the Eurozone and the UK, where QE programs are currently in place and where 'only' a green component would have to be added to existing programs. (Ferron and Morel 2014)

Limits: An important limit to green QE is that quantitative easing is not expected to be a permanent policy, but is today considered as an unconventional tool used when conventional tools are not efficient enough to achieve central banks' objectives. A massive purchase program of green bonds by central banks could lead to a yield effect: their pricing in the secondary market would increase, encouraging private investors to sell them and discouraging private investors for new purchases of green bonds, since they would be overpriced against their risk profile. In the long-term, it might then lead to reduced sources of private funding for LCCR investments. However, such a yield effect could be offset by a risk effect, i.e. a decrease in the risk premium for green bonds, which may attract new investors. (Ferron and Morel 2014).

Existing examples: No green quantitative easing program has been implemented or tested to date.

Annex 2: Literature review of global low-carbon energy investment needs

The following pages provide an overview of available estimates of low-carbon energy (supply- and demand-side) investment needs.

Estimates of investment needs synthetized in IPCC AR5 WGIII[1]

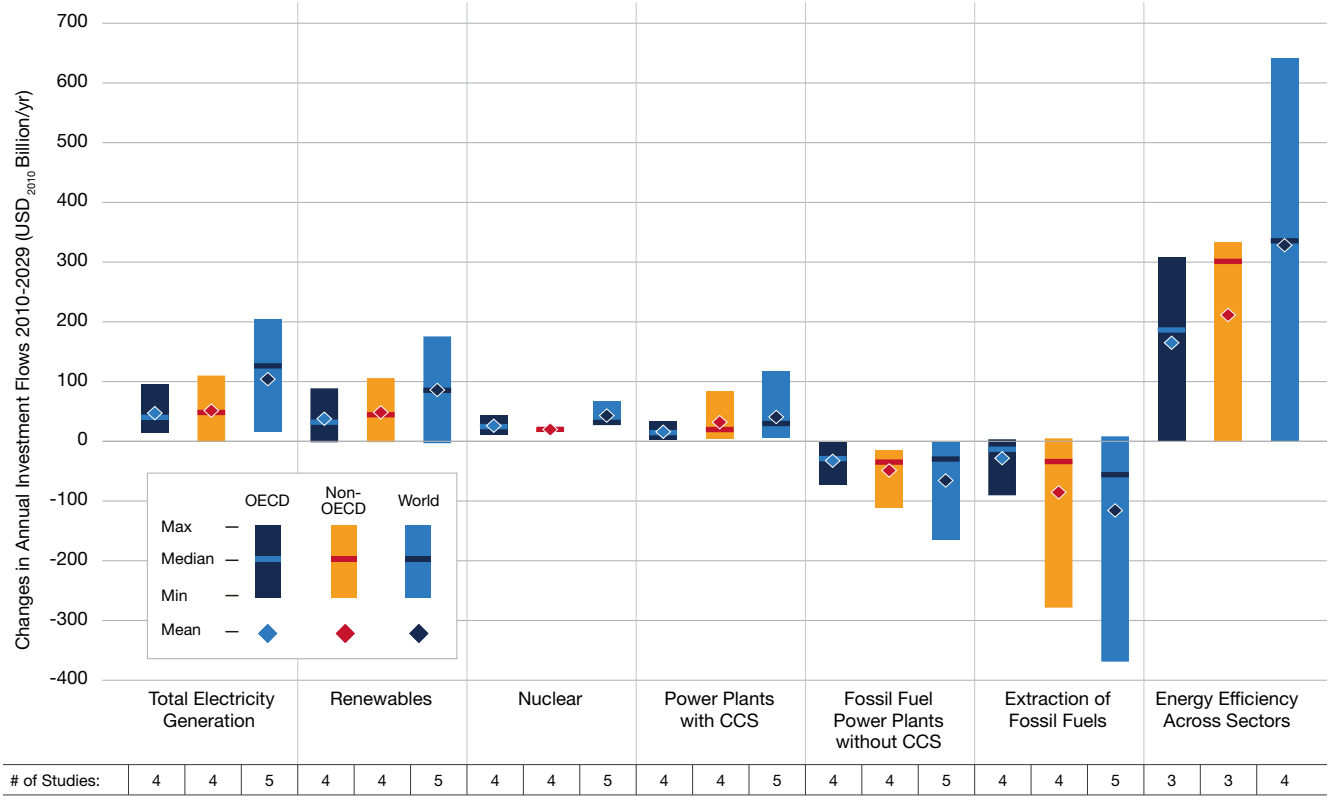
Chapter 16 of IPCC Assessment Report 5 "Mitigation of Climate Change" published in 2014 gives first estimates of incremental investment needs in a 2°C pathway compared to a reference scenario in 2010-2029 and 2030-2049. It doesn't take into account adaptation costs and economic costs of future climate change. On the contrary to other sections of this report, estimates of investment needs are based on few studies, and IPCC states that these results should be taken with caution, in particular regarding investment in end-use technologies – i.e. energy efficiency investments.

Based on IPCC review of existing studies, total low-carbon investment needs between 2010 and 2029 would be around almost USD2010 450 billion per year (mean value) with a maximum of almost USD2010 850 billion per year. Total low-carbon investment needs between 2030 and 2049 would be around USD2010 1 trillion per year (mean value).

A split between low-carbon electricity generation and energy efficiency is provided in the graphs reproduced below:

1 *Gupta S., J. Harnisch, D.C. Barua, L. Chingambo, P. Frankel, R.J. Garrido Vázquez, L. Gómez-Echeverri, E. Haites, Y. Huang, and R. Kopp, B. Lefèvre, H. Machado-Filho, and E. Massett 2014)*

FIGURE 11. CHANGES IN ANNUAL INVESTMENT FLOWS 2010-2029 ($ BN PER YEAR)

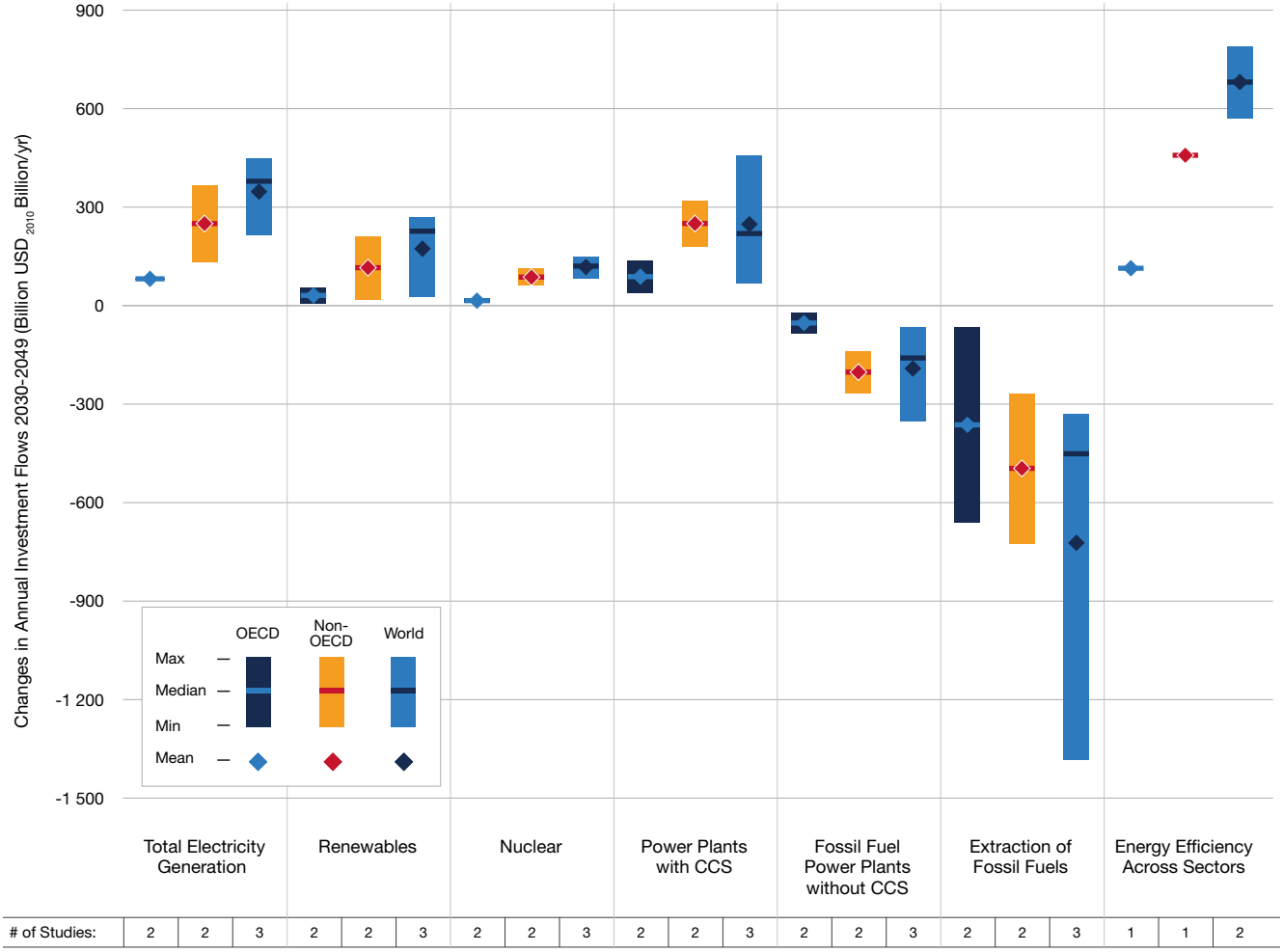


# of Studies:	4	4	5	4	4	5	4	4	5	4	4	5	4	4	5	4	4	5	3	3	4

Change of average annual investment in mitigation scenarios (2010–2029). Investment changes are calculated by a limited number of model studies and model comparisons for mitigation scenarios that stabilize concentrations within the range of 430 – 530 ppm CO_2eq by 2100 compared to respective average baseline investments. Note: The vertical bars indicate the range between minimum and maximum estimate of investment changes; the horizontal bar indicates the median of model results. Proximity to this median value does not imply higher likelihood because of the different degree of aggregation of model results, low number of studies available, and different assumptions in the different studies considered. The numbers in the bottom row show the total number of studies available in the literature. Sources: UNFCCC (2008). IEA (2011): 450 Scenario (450) relative to the Constant Policies Scenario (CPS). The CPS investment in CCS is also included under Coal and Gas (retrofitting); World investment in biofuels includes international bunkers; investment in solar photovoltaic (PV) in buildings is attributed to power plants in supply-side investment. Riahi et al. (2012): the Global Energy Assessment Mix scenario (GEA-Mix) relative to the GEA reference scenario. Carraro et al. (2012): 460 ppm CO_2eq in 2100 (t460) relative to reference scenario. McCollum et al. (2013): the Low Climate Impact Scenarios and Implications of Required Tight Emission Control Strategies (LIMITS), RefPol-450 scenario (2.8 W/m^2 in 2100) relative to the reference scenarios, mean of six models. McKinsey (2009): data obtained from Climate Desk, S2015 scenario with full technological potential, 100% success rate, negative lever of costs, beginning of policy in 2015 | Regions: OECD, non-OECD, and World.

Source: IPCC, 2014

FIGURE 12. CHANGES IN ANNUAL INVESTMENT FLOWS 2030-2049 ($ BN PER YEAR)



Change of average annual investment in mitigation scenarios (2030-2049). Investment changes are calculated by a limited number of model studies and model comparisons for mitigation scenarios that stabilize concentrations within the range of 430-530 ppm CO_2eq by 2100 compared to respective average baseline investments. Note: The vertical bars indicate the range between minimum and maximum estimate of investment changes; the horizontal bar indicates the median of model results. Proximity to this median value does not imply higher likelihood because of the different degree of aggregation of model results, low number of studies available, and different assumptions in the different studies considered. The numbers in the bottom row show the total number of studies available in the literature. Sources: Riahi et al. (2012): the Global Energy Assessment Mix scenario (GEA-Mix) relative to the GEA reference scenario. Carraro et al. (2012): 460 ppm CO_2eq in 2100 (t460) relative to reference scenario. McCollum et al. (2013): the Low Climate Impact Scenarios and Implications of Required Tight Emission Control Strategies (LIMITS), RefPol-450 scenario (2.8 W/m^2 in 2100) relative to the reference scenarios, mean of six models. Regions: OECD, non-OECD, and World.

Source: IPCC, 2014

It is to be noted that assessments included in this IPCC review are confronted to a main methodological limitation, as they are based on the levelized costs of technologies over the duration of projects and do not designate the time profile of upfront investments. As explained in (Bibas, Cassen, and Hourcade 2016) this means for example that if the cost of a renewable project is 30% higher than that of a coal plant, 130% has to be invested in this renewable project but only 30% is taken into account into assessments illustrated above. Therefore low-carbon investment needs might be higher than estimates presented in IPCC AR5 report.

Estimates from New Climate Economy reports and working papers

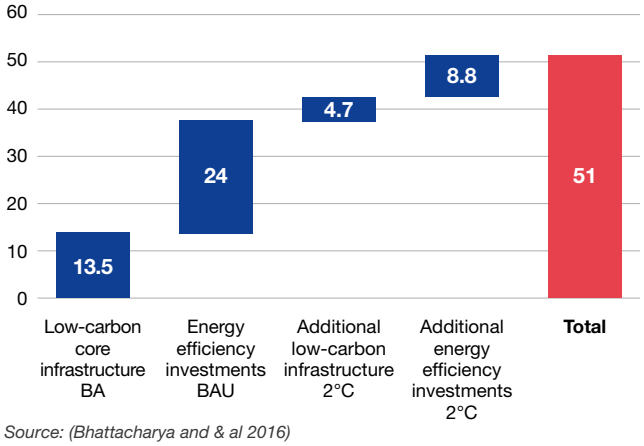
The flagship report "Better Growth, Better Climate: The New Climate Economy Report" (Global Commission on the Economy and Climate 2014)[2] estimated that around US$ 93 trillion will have to be invested in infrastructure –

2 *The Global Commission on the Economy and Climate is a major international initiative to examine how countries can achieve economic growth while dealing with the risks posed by climate change. The Commission comprises former heads of government and finance ministers and leaders in the fields of economics and business. The project is undertaken by a global partnership of research institutes and a core team led by Program Director Helen Mountford.* http://newclimateeconomy.net/

including energy efficiency investments – over the next 15 years under a 2°C pathway, against US$ 89 trillion under a business-as-usual pathway. This represents around US$ 6 trillion per year, to be compared with the current US$ 2,5 trillion invested globally each year in transport, power, water and telecom infrastructure (McKinsey Global Institute 2016). To be noted that these figures exclude adaptation investments and additional costs for climate-resilient infrastructure.

A working paper (Bhattacharya and & al 2016) that fed last New Climate Economy report provides further precisions on the share of low-carbon investments in NCE's total Figure of US$ 93 trillion of infrastructure investment needs. Low-carbon core infrastructure investment needs – i.e. low-carbon renewable energy, nuclear, carbon capture and storage, transport, water/sanitation as well as adaptation infrastructure – represent US$ 13,5 trillion between 2015-2030, that is to say 18% of all core infrastructure investment needs. To these core infrastructure investment needs has to be added around US$ 24 trillion of energy efficiency investments. To sum up around US$ 39 trillion of low-carbon investments will be needed between 2015 and 2030 in a business-as-usual case. Additional low-carbon investments of US$ 13.5 trillion will be needed to be compatible with a 2° trajectory. This raises total LCCR infrastructure investment needs to US$ 52 trillion or US$ 3.5 trillion per year under a 2°C trajectory.

FIGURE 13. LCCR INVESTMENT NEEDS UNDER A 2°C TRAJECTORY 2015-2030 (IN US$ TRILLION)



Source: (Bhattacharya and & al 2016)

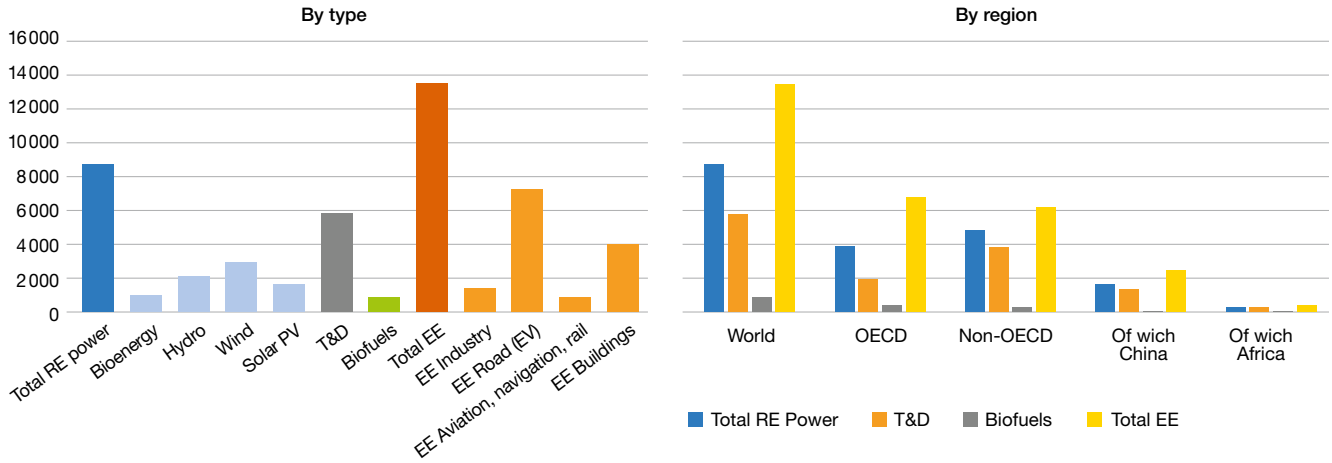
This working paper does not provide further sectoral or geographical disaggregation of low-carbon investment needs. It however provides sectoral and geographical split for total investment needs – LCCR or not – between 2015 and 2030. Energy sector demand constitutes there 43% of infrastructure investment needs, followed by transport sector with 29% and water supply and sanitation with 21%. In terms of geographical spread, 52% of infrastructure investment demand would originate from middle-income countries, 46% from high-income countries, and only 2% from low-income countries. Nevertheless these figures cannot be directly extrapolated to low-carbon investment needs figures because sectorial and geographical split may vary widely between low-carbon and carbon-intensive investment needs.

Estimates from IEA, « World Energy Investment Outlook 2014 » (OCDE/IEA 2014)

In 2014 IEA published estimates of investment requirements in energy supply and energy efficiency between 2014 and 2035 under its 450 scenarios, which corresponds to a 2°C trajectory. Total global low-carbon investments needs in the energy system – i.e. renewables, transmission and distribution and energy efficiency investments – as estimated in this report are US$ 29 trillion between 2014 and 2035.

This report provides splits of these investment needs between macro-sectors and between countries, which are reproduced in the graphs below:

FIGURE 14. CUMULATIVE GLOBAL LOW-CARBON INVESTMENT NEEDS BY TYPE AND BY REGION (450 SCENARIO), 2014-2035 (US$BN)



Source: Authors based on data from (OCDE/IEA 2014)

Estimates from the latest IEA/IRENA 2017 report (OECD/IEA and IRENA 2017)

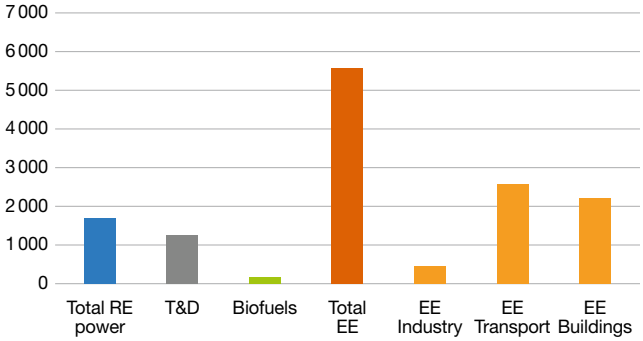
This new report presents a new International Energy Agency (IEA) analysis of a pathway to limit the global mean temperature rise to below 2°C with a probability of 66% and includes an assessment of the associated reallocation of investment capital. This analysis is generated using the IEA's large-scale World Energy Model (WEM), the same model used to produce the well-known 450 ppm and NPS scenarios. Scenarios developed in this new study are nevertheless far more ambitious in terms of the timing and scope of required energy emissions reductions for meeting the 2°C goal than previous scenarios modelled by IEA (450 ppm or 2DS scenarios). This comes from 2 main assumptions:

- There exists no possibility to delay CO_2 emissions reduction until negative-emissions technologies are available at scale – so it is not modelled that it will be possible to remove CO_2 from the atmosphere, on the contrary to most scenarios assessed in IPCC AR5 ;
- The available carbon budget is limited to an energy sector only CO_2 budget – this budget is of 790 Gt, to be compared with NDCs implications that until 2050 the energy sector would emit almost 1,260 Gt.

Respecting above conditions would require according to this study a carbon price of USD 190 per ton of CO_2 by 2050 in all developed countries, and CO_2 prices would also be necessary in all other countries (between USD 80 and USD 170 by 2050 depending on the level of development). It would also require the phase out of fossil fuel subsidies by 2025 in all countries and a comprehensive and coordinated mix of other emissions reduction policies.

Total global low-carbon investments needs in the energy system – i.e. renewables, transmission and distribution and energy efficiency investments – are estimated in this report to around USD 100 trillion between 2016 and 2050, i.e. 2,9 trillion per year. This report also provides a split of investment needs by sectors, as illustrated in the graph below:

FIGURE 15. CUMULATIVE GLOBAL LOW-CARBON INVESTMENT NEEDS BY TYPE (66% BELOW 2°C SCENARIO), 2016-2050 (US$BN)



Source: Authors based on data from (OECD/IEA and IRENA 2017)

***NB:** Although already high, the amount of investments needed for energy efficiency included in this study only takes into account the additional cost of buying assets with higher energy efficiency compared to a reference scenario which is 2014 average efficiency. Since in practice both are financed as a single investment in an asset, global financial flows to demand-side low-carbon assets would have to be higher than those presented in the graph above.*

***NB 2:** in this report IEA distinguished between energy efficiency measures and direct emissions reduction technologies, including CCS in industry, renewable technologies in the buildings and industry sectors, and alternative fuel vehicles for the transport sector. Although split into two categories in (OECD/IEA and IRENA 2017) we chose to aggregate all these demand-side investments into energy efficiency, for the sake of clarity and comparability with other studies.*

Estimates of energy investments needs modelled using IMACLIM-R scenarios

In the context of the SEI metric project, CIRED produced estimates of energy investment needs in low carbon roadmaps based on a set of scenarios elaborated with the IMACLIM-R model (Bibas, Cassen, and Hourcade 2016). The IMACLIM-R model is a hybrid energy-economy model of the world economy, which captures behaviors under imperfect foresight and covers twelve sectors and twelve regions. 10 scenarios were elaborated, which can be grouped in 2 main categories: the first (scenarios A) groups 8 IEA technical visions-based scenarios, the second (scenarios B) groups alternative scenarios conducted with IMACLIM-R that take into account the new current economic context, more elaborated climate policies, all economic feedbacks and envisage two oil prices trajectories over the long run.

A major finding of this set of simulations is that uncertainties regarding low-carbon investment needs are huge since "we are not confronted to one investment roadmap toward a 450ppm objective by 2035 but to a corridor of roadmaps" and depends on hypotheses on the rhythm of technology adoption and on economic feedbacks of climate policies, notably on GDP growth.

Results of scenarios A – IEA technical visions-based scenarios – and scenarios B – alternative scenarios taking into account all economic feedbacks – are summed up in the Table below:

TABLE 9. RESULTS ON ANNUAL LOW-CARBON INVESTMENT NEEDS (MEAN 2020-2035) OF 8 SCENARIOS ELABORATED WITH IMACLIM-R MODEL

	Renewable power			Energy efficiency
USD billion	Total RE power	Incl. wind	Incl. solar	In BTP, industry and services (excl. transport)
Scenarios A				
• Minimum	491	184	166	124
• Maximum	507	190	172	155
Scenarios B				
• Minimum	118	62	25	846
• Maximum	133	102	160	946

Source: I4CE from Bibas, Cassen, Hourcade, "Energy investments in low carbon roadmaps", 2016

NB: These results exclude low-carbon assets in the transport sector, for which no estimation of investment needs are available in this report.

NB 2: The huge difference in investment needs for energy efficiency between scenarios A (IEA technological visions-based scenarios) and scenarios B (alternative IMACLIM scenarios) is due to the difference in definition of energy efficiency. IEA counts as energy efficiency investment only the additional cost of efficiency but not the overall investment needed, whereas IMACLIM counts as energy efficiency investment both the efficiency cost and the decarbonized investment. The latter is a better indicator of the overall "green" financial flows needed, as energy efficiency costs are generally not covered by a different financial instrument than the financing of the decarbonized asset itself.

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