The transition to a green global economy:

The case of green finance and green bonds

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ABSTRACT

A wide consensus exists in the global community regarding the need for a transition to "greener", carbon-neutral, and energy efficient communities. Through the Conference of the Parties (COP) commitments have been made for the mobilization of finance for investment in mitigation, adaptation and other environmental investments. In practice, there is rather large investment gap between the allocated funds and the actual needs for a reaching the set targets. In this study, we will explore the current landscape of "Green Finance", which is finance directed to environmentally friendly projects, how the latest developments in the field like Financial Technology (fintech) could stimulate and drive demand, the available tools for investors, as well as barriers and relevant proposals for unlocking the true potential of green finance. In addition, we will explore in depth one of the most prominent green finance tools available, namely the green bonds. The green bond market's growth has been constant during the last years, but there are still various considerations and barriers that need to be addressed in order to achieve a clear, robust, global green bond market.

INTRODUCTION

At the 15th UNFCCC Conference of the Parties (COP 15) in Copenhagen in 2009, developed country Parties committed "to a goal of mobilizing jointly, $100 billion dollars a year by 2020 to address the needs of developing counties." The Parties agreed this funding would come from a "wide variety of sources, private and public, bilateral and multilateral, including alternative sources of finance." Two years later, at COP 17 in Durban, the Parties established a work program to analyze options for scaling up the mobilization of climate finance, while in 2012, COP 18 in Doha called on developed Parties to identify pathways for mobilizing the scaling up of climate finance [1], [2].

In a culmination of these efforts, in 2015, the world shown, clearer than ever before, its commitment to make a turn to a more sustainable future for all through the launch of the Sustainable Development Goals (SDGs) and the agreement reached at the Paris Climate Summit, the latter will help the world address the urgency of limiting the global average temperature increase to 2^{o} C above the pre-industrial level. These two landmark global initiatives established ambitious targets for transitioning the global economy along a sustainable pathway, defining the multilateral climate regime through 2020 [3].

One of the key themes emerging from both COP21, and the Global Cleaner Production Conference in Sitges in Spain on November 14th, 2015, is the pivotal role finance needs to play in enabling the green transition. A true transformation of our societies and economies can be achieved without throwing the weight of the global financial system and its various actors behind our ambitious targets and finding greener ways of doing business [3], [4]. Alas, the current financial system is not providing the required financing for the transition [5], [6]. The green investment gap seems to be really wide, while significant investments are needed estimated at US$5-7 trillion annually. Public funds alone will not be adequate – China, for example, estimates that 85% of green finance will need to come from private sources. Despite the upward trend of the last decade, a large gap still exists between the current amount of green investment and what would be temperature increase, agreed as an objective at the 2009 Copenhagen Conference [3], [7], [8]. UNEP (2011) calculated that the yearly additional investment required to deliver a green economy would be on average around 2% of the global GDP over the 2010–50 period ($1 to $2.6 trillion) [8].

There are various factors that are currently preventing economic flows to be directed in larger amounts to low-carbon sectors and projects in order to achieve the magnitude of investment required to meet the 2^{o}C objective. A first factor is the depressed macroeconomic environment; a direct result of the 2007 financial crisis, while a second is

their unattractive risk/return profile. In particular, the risks — either real or perceived — associated with them have always been large. Most importantly, green investments are still considered strongly dependent on public support, which unfortunately has not been as transparent and predictable as it has to be. Even if financing is provided, appropriate green investment projects have often not been available, or financing for green investments is not allocated properly. Other contributing factors that must addressed include regulatory and policy uncertainty and longer investment and payback horizons. In light of the aforementioned challenges, returns on green investments should be very high in order to attract investors, but in practice there is no empirical evidence that this is the case [8], [4].

Milton Friedman articulated that "[t]here is wide agreement about the major goals of economic policy: high employment, stable prices, and rapid growth. There is less agreement that these goals are mutually compatible or, among those who regard them as incompatible, about the terms at which they can and should be substituted for one another. There is least agreement about the role that various instruments of policy can and should play in achieving the several goals." Nowadays, most stakeholders would agree that sustainable development should be added to Friedman's list of major goals of economic policy, but the key challenge remains how to fund efforts to reach these goals. Disagreements persist regarding the appropriate policies that should be adopted to reach these goals, their compatibility and who should be in charge [9], [3].

"Green finance is a major opportunity. By ensuring that capital flows finance long-term projects in countries where growth is most carbon intensive, financial stability can be promoted. By absorbing excess global saving, equilibrium interest rated can be raised and macroeconomic stability enhanced. And by allocating capital to green technologies, the prospects for an environmentally sustainable recovery in global growth will increase."
Mark Carney, Bank of England Governor [31]

RESEARCH QUESTIONS

1. **What is green finance, who are the main actors involved and which are the main financial instruments available to them?**
2. **Which are the latest developments and which is the status of green finance?**
3. **What are the main issues facing green finance and which are the main recommendations for lifting these barriers?**
4. **What are green bonds and which are the types available to market actors?**
5. **Which are the main aspects of a green bond ecosystem and which are the main policy actions that would facilitate market growth?**
6. **Which is the status of the green bond market in Greece and what can be done to stimulate demand and growth?**

PART I: GREEN FINANCE

DEFINITION

The Paris Agreement on climate change was “an unmistakable signal to business and investors that the global transition to a low-carbon economy is urgent, inevitable, and accelerating faster than we ever believed possible,” according to the World Business Council for Sustainable Development [10].

Implementation of the agreement is expected to foster policies and technological innovation that will fast-track investment toward low carbon projects and assets. In addition, as part of the agreement, signatories to the agreement have produced nationally determined commitments to reduce greenhouse gas emissions that will inevitably boost or discourage certain economic activities [10].

The goals of climate finance are to reduce emissions, enhance greenhouse gas sinks, and maintain and increase the resilience of human and ecological systems to climate change. Climate Finance is about combining financial instruments at terms below market rates with the goal of overcoming barriers and mitigating risks, which prevent investment in mitigation and adaptation projects and assets. The principle of minimum concessionality should be applied at all times to avoid market distortions and crowding out of investments [11].

Green finance, on the other hand, can be defined as the financing of projects and assets that benefit environmentally sustainable development. These benefits include pollution reductions, greenhouse gas emissions (GHG) reductions, energy efficiency improvements from natural resources, biodiversity loss, resource efficiency, sustainable agriculture and forestry, as well as waste and water management and mitigation of and adaptation to climate change [5], [10], [12] .

The G20 uses the term “Green Finance” as a broad term that refers to the major shift in financial flows required to support projects that benefit the environment and society by reducing pollution or tackling climate change. It also entails greening the financial sector through the practices of due diligence, internalization of externalities and risk management to ensure that green projects, or projects generally, do not harm the environment [6], [13].

More specifically, green finance consists of these three aspects. First, as stated above, it encompasses the financing of both public and private green projects and activities. Second, it includes the financing of public regulations and policies that support environmental mitigation or adaptation investments (e.g. feed-in tariffs for renewable energy). Finally, it comprises the components of the financial system that are specifically geared towards green projects and investments, such as the Green Climate Fund or financial instruments for such investments, such as green bonds, including their specific conditions [6].

Green finance includes climate finance, but is not limited to it. However, while green finance covers a wider extent of projects and activities than climate finance, there is great overlap in terms of environmental externalities, risks to the financial system and the private sector, and the challenges and opportunities in financing both.
This is why, for the purposes of this study we do not distinguish between green and climate finance and most of the issues and proposals explored and presented herein are relevant for both [13]. [14].

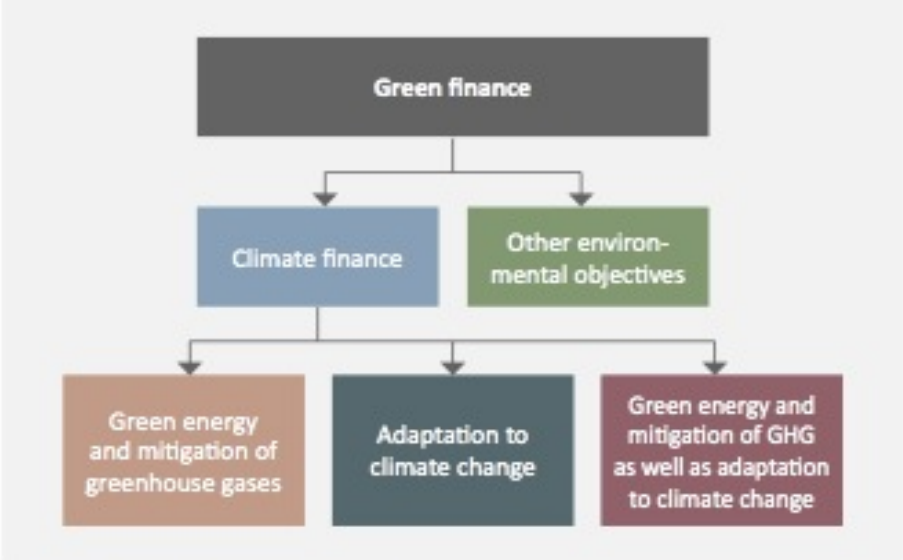

Figure 1: Green Finance Categories [2]

Green finance, if effectively implemented, can prove to be beneficial for the vast majority of the world's population, and can help improve the sustainable development of the global economy [15]. Nowadays, however, green finance remains a 'cottage industry'. The main challenge is to move beyond green finance as a cottage industry – effectively to "industrialize" it to achieve the necessary scale [3].

SDGs and GREEN FINANCE

A major finding of scholars from Brookings, New Climate Economy and the Grantham Institute for Climate Change has been that the agendas of sustainable development and ending poverty, as well as that of tackling climate change are so greatly intertwined that are destined to succeed or fail together [16].

In 2015, the UN General assembly adopted the Sustainable Development Goals (SDGs), which contain 17 goals including the eradication of poverty and hunger, the improvement of health, climate change, and the protection of biodiversity.

A study has shown that increasing the production of renewable energy (RE) can contribute to many of these SDGs. Thusly, any serious effort to achieve these goals will, as a result, generate a higher demand for RE. RE is connected to a great extent to the SDGs, mainly for three reasons.

First, it provides energy, which is a requirement for making progress on several SDGs. Energy can boost the productivity of agriculture and contribute to food security. In addition, it has been shown, that energy can enhance education and even to promote gender equality.

Second, RE does not cause the damage that coal or biomass causes on the local scale. As a result, it could promote both the health of local residents and the sustainable use of ecosystems, especially forests, by reducing the need to collect wood for fire.

Third, RE does not generate any CO_2, thus helping to tackle climate change, which has a direct effect on the long-term goal of reaching almost all of the SDGs. The negative effects of climate change as presented in the IPCC report are so broad and destructive, that failing to achieve progress on SDG 13 (i.e. climate change) could influence and negate progress on all the rest [17].

STATUS

As explained before, the multitude of different approaches, methodologies, standards and definitions used by various stakeholders, makes it impossible to actually track the green finance flows on the global level. As an approximation and in order to get a sense of the trends and volume of the flows, we will examine the green finance contributions by the International Development Finance Club (IDFC). The IDFC formed in 2011 and brings together 23 leading international, national and sub regional development banks from Europe, Asia, Africa, Europe, and Central and South America.

In its latest report, the IDFC divides its green finance commitments into two major categories: climate finance and other environmental objectives. Climate finance is composed of finance for green energy and mitigation of greenhouse gases (GHG), adaptation to climate change, and projects that include elements of both mitigation and adaptation [7].

In 2016, out of the $173 billion in green finance commitments made by the IDFC members, $159 billion was climate finance as can be seen in figure 2.

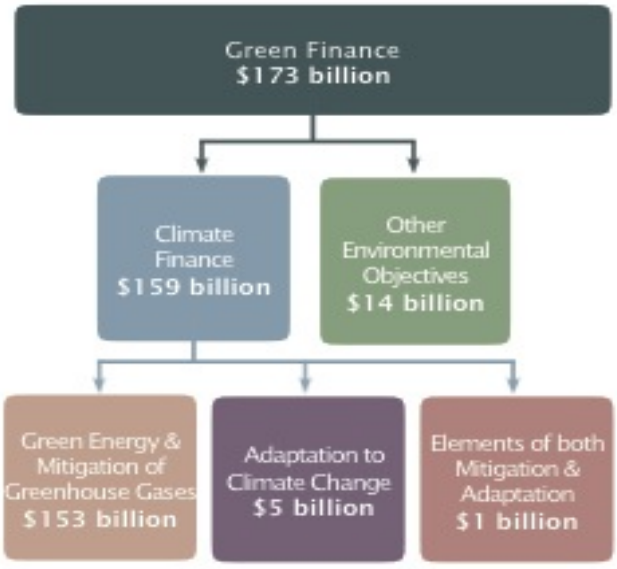

Figure 2: Breakdown of IDFC Green Finance Commitments in 2016 [2]

In 2016, loans amounted to the 99% of green finance commitments with concessional and non-concessional loans accounting for 26% and 73%, respectively (in 2015, the respective percentages were 27% and 70%). Grants consisted 2% of the green finance flows both in 2015 and 2016, while other instruments (e.g. equity) made up 0.2% of the green finance flows each year [7].

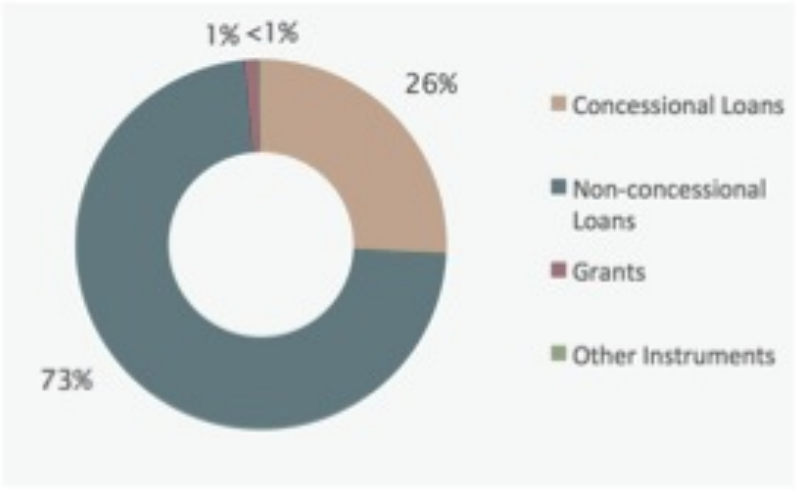

Figure 3: IDFC Green Finance Commitments by Instrument Type in 2016 [2]

Commitments on green energy and GHG mitigation reached $153 billion, increasing by $25 billion compared to 2015. Within mitigation, transport reached 52% of the total flows at $80 billion (compared to the 42% in 2015). The other key categories were renewable energy (24%) and energy efficiency (17%). Renewable energy flows reduced from $46 billion in 2015 but energy efficiency flows sawn an increase from $18 billion [7].

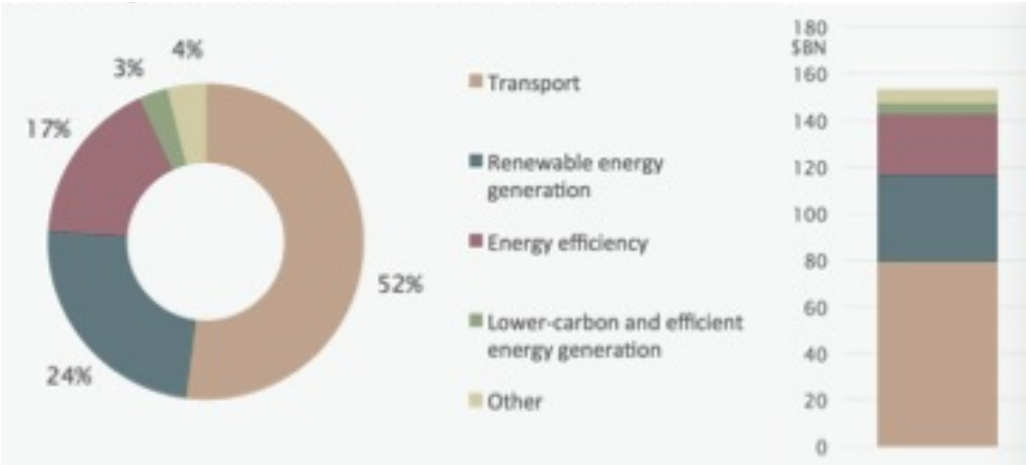

Figure 4: Share of Green Finance Commitments in 2016 [2]

Another example is the contributions made from the EU and its member states to support developing countries in reducing their GHG emissions and address the impacts of climate change.

In 2016, these contributions increased greatly, reaching €20.2 billion. This figure was confirmed on 16 October 2017 at a meeting of the EU Economic Policy Committee, ahead of COP23 UN climate change conference in Bonn. It includes climate finance sources from public budgets and other development financial institutions, as reported by member states in the context of the article 16 of regulation 525/2013 of 21 May 2013. It also includes €2.7 billion climate finance from the EU budget and the European Development Fund, and €1.9 billion from the European Investment Bank [18].

These contributions are an important step towards the implementation of the legally binding climate change agreement reached in Paris in December 2015. This figure highlights the EU's determination to keep increasing its international climate finance contribution towards the $100 billion per year goal set for developed countries by 2020 and through until 2025. Before 2025, the parties to the UN framework convention on climate change will set a new collective goal [18].

TRACKING

The G20 Green Finance Study Group, created in 2016 under the Chinese G20 presidency, focused on identifying and tackling the barriers that impede the growth of green finance. Its findings, presented a lack of consistency in market terms and green finance standards. While there is wide agreement on the sectors ripest for green finance, the tracking of such financial flows is inconsistent or nonexistent. This is why finding better ways of measuring progress across the financial system is of paramount importance. A more holistic understanding of the supply of green finance can provide all stakeholders with insights into the type of additional incentives that are required for green finance growth [12].

Based on the work of the G20 Green Finance Study Group, the IFC Climate Policy team has developed a new approach that focuses on the banking sector, aiming to track and assess green finance and to understand the status quo and give recommendations on how to align in a more efficient way different approaches to measuring green finance.

This bottom-up methodology, as a first step defines “green” at a project level, based on the intended use of the project in the real economy, via the use of estimates for the respective green share per project. Then the model aggregates the figures at the industry and country levels. The results can be compared to green finance needs to pinpoint gaps and recommendations for action [12].

Approach to finance from different actors

Even though there are no defined higher authorities that keep track of the application of green finance criteria in financial decision-making, various institutions and initiatives are making advancements in integrating green measures into financial product assessment and have started developing bottom-up tracking approaches.

Broadly speaking, these bottom-up approaches are spearheaded by industry participants or by non- profit or research organizations, not by regulatory bodies. Many of them build on existing definitions and corporate reporting initiatives and construe the available information in a way that is helpful for market participants.

On the other hand, top-down approaches in most cases attempt to measure the investment needed for sustainable development for different sectors or countries, with none focusing only on green finance. Organizations such as the Food and Agriculture Organization, the World Health Organization, the International Energy Agency, the G20, and the International Panel on Climate Change have made public estimates on the total amounts required to achieve certain SDGs [12].

Little progress has been made in closing the gap between top-down and bottom-up approaches. However, there are two initiatives that hold promise in this regard: the Sustainable Energy Investment Metrics Project, which is attempting to incorporate policy targets into the assessment of financial risk exposure of portfolios, and 2DII, which is combining information on physical assets held and their owners with specific policy targets.

The most relevant initiative for green finance tracking is the Portfolio Decarbonization Coalition. It focuses on discovering ways to measure and disclose and reduce the carbon footprint of portfolios. Another initiative that can help to increase transparency around green finance is the Climate Disclosure Standards Board Fiduciary Duty Statement. The statement encourages companies from all sectors to disclose information on climate-related corporate performance, risks and opportunities in tandem with mainstream corporate reports, pointing out that the economic impacts are tangible and have implications for the prospects of companies, sectors, and investment portfolios [12].

At the EU Level, the overall financing gap for reaching EU 2030 targets is estimated to be in the range of at least €179 billion per year in the period 2021-2030. Knowing this financing gap, it is paramount to monitor progress towards closing it, by tracking European domestic climate finance flows (historic, current, planned) [19].

One of the barriers towards that goal is that most countries and European or international organizations in many cases use their own definitions and scope for domestic climate finance (if they have a definition in general). While this may not be a problem for the individual tracking studies and exercises, when attempting to aggregate data and information on a European level (e.g. for tracking progress towards EU policy targets) this diversity of approaches and definitions makes it rather impossible to compare and/or combine figures [19].

To complicate the matter even further, there are also differences between mitigation and adaptation finance. The data availability for mitigation finance is better and more transparently tracked than finance for climate adaptation. Only three Member States have a systematic approach (i.e. Germany, France and Belgium) for tracking climate investment flows including any links to Low Carbon Development Strategies, National Climate and Energy plans and National Adaptation Strategies. The rest of the countries collect data in an ad-hoc way and have uneven data available at best [19].

Proper and dependable tracking of domestic climate investment and related financing flows, is called climate finance "landscapes". It is a tool for facilitating the development, and enforcement of national climate and energy policy, hence contributing to the transition towards to a sustainable economy.

Climate finance landscapes can be used together with other policy assessment tools (e.g. macro-economic modeling of alternative investment scenarios, cost-benefit analysis, cost-effectiveness analysis, etc.) as well as project assessment tools (e.g. return on investment analysis, financial risks analysis, environmental impact indicators, external costs of projects, cost-benefit analysis, etc.) [20].

Climate finance landscapes can be proven beneficial for a wide range of policy objectives, such as:

- Cost-effective design and implementation of Nationally Determined Contributions, Low-Carbon Development Strategies, Integrated National Energy and Climate Plans and National Infrastructure Plans.

- Assessing the status quo and magnitude of climate related financial flows and whether they are aligned with relevant policy targets;
- Bolstering domestic climate change policy-making processes and ensuring proper management of public funds and resources;
- Identifying opportunities and barriers for scaling-up domestic climate finance; and
- Assessing the impacts of low-carbon investments on job creation and economic growth and monitoring the effectiveness and efficiency of domestic financial flows [20].

Landscapes of climate finance are basically in depth studies that map climate financial flows. They illustrate how the financial value chain connects all the stages and actor of investments. The methodology has been developed by the Climate Policy Initiative (CPI) and has been used both by EU Member States and outside the Union [20].

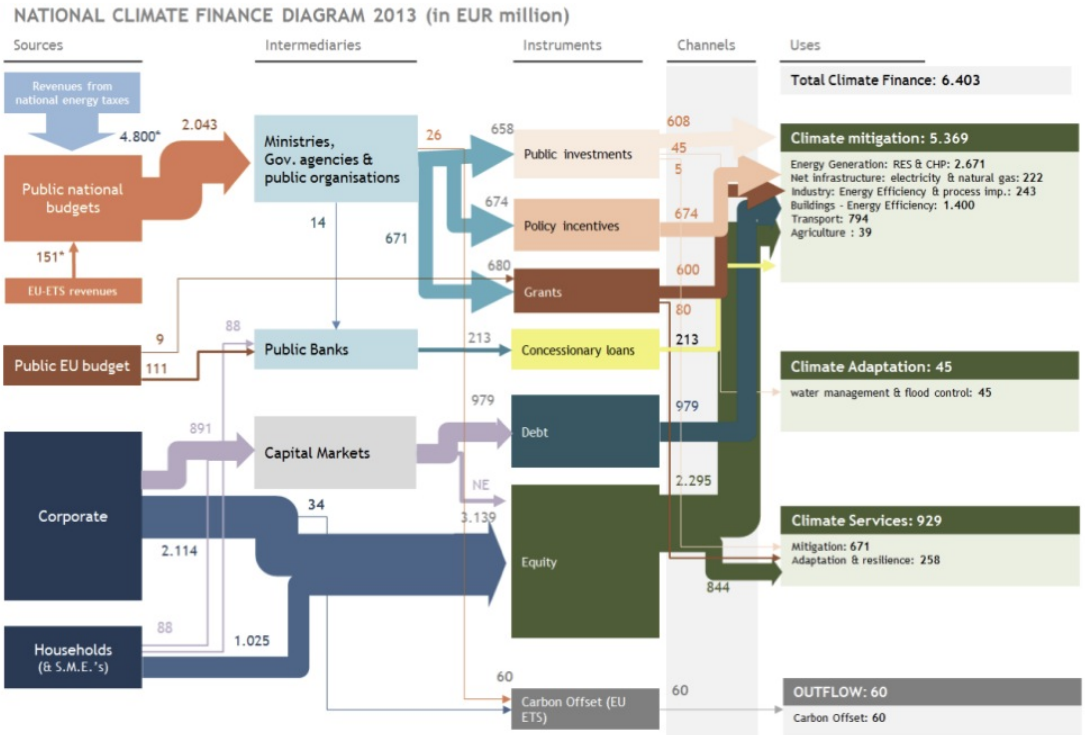

Figure 5: An example of a national finance Diagram [8]

The following can be concluded if data accessibility is compared for certain types of climate finance flows:

- For the majority of Member States, data concerning estimated investment needs is more easily accessible for mitigation compared to adaptation.
- Planned future expenditure information for both mitigation and adaptation is very limited. An exception to this data gap is the robust development of planned adaptation expenditure information available for Germany and Estonia.
- Publicly available information from private sources of finance is rather limited. Even though the private sector should contribute the biggest share of the climate-financing gap, it is characterized by the most glaring data accessibility gap for both adaptation and mitigation [20].

FINANCIAL INSTRUMENTS

A great variety of diverse financial instruments are available to both public and private investors in relation to green investments.

Concessional debt	Equity	Public-direct investments	Grants	Green bonds
Public-private partnerships	**Self-financing**	**Balance-sheet financing**	**Commercial market-rate debt**	**Policy-based incentives**

Table1: Financial instruments relevant for climate action finance

All these instruments serve different purposes and depend on the type of project and the type of stakeholder involved. Some of them have the main purpose of reducing the financial risk of an investment (e.g. guarantees, insurance, equity, subordinate loans) and others to provide capital / increase return on investment (e.g. debt, venture capital, grants) [19]. Debt and equity are the most widespread used financial instruments in green finance. Financial instruments have an array of features, such as level of seniority (junior equity vs. preferred stock), the terms of agreement, the channel through which the flow of finance is arranged and the intermediary actors (types of investors and investment vehicles), the origin of funds, etc. [14].

EQUITY: "*a stock of any other security representing an ownership interest. This may be in a private company (not publicly traded), in which case it is called private equity. Investment vehicle refers to any method by which individuals or businesses can invest and, ideally, grow their money*."

Equity financing, used in most cases in the first phases of a project's development, is the method of investing in a company stock in return for an ownership interest. Preferred stock and common stock are the two main categories of equity and have two main differences. First, if a company has to liquidate and pay all creditors and bondholders, preferred shareholders are the first to be paid. Common shareholders will be paid only if there is money left. Second, the dividends of preferred stocks are different from and often greater than those of common stock [14].

In green finance, many investments are in "junior equity", which refers to the common stock in a company. If the company has to liquidate, it would pay out preferred stockholders before holders of junior equity. Holders of company bonds are paid before holders of preferred stock. In practice, when investors would see an investment in junior equity, they would be more tempted to buy preferred stock since this would mean that they are entitled to first claim on distribution of profit, thus facing reduced risk [14].

Subordinated debt: "*a loan or security that ranks below other loans and securities with regard to claims on a company's assets or earnings. Subordinated debt is also known as a junior security or subordinated loan. In the case of borrower default, creditors who own subordinated debt won't be paid out until after senior debt holders are pain in full*."

Debt financing is mainly used at later phases of project development and many times together with equity. In this type of financing, investors lend funds to borrowers, who in turn pay back the amount with interest. If the event a firm has to liquidate, debt has higher priority than, or is "senior" to equity; hence the firm must first pay its creditors before it pays those who borrowed money to invest in equity. This means that more "senior" debt is more secure allowing for a lower interest payment compared to more junior security (also known as subordinated debt).

Two are the sources of debt financing: a loan from a lender or bonds from selling to the public. A loan is a transfer of money from a bank to an entity or individual, while a bond is a transfer of funds from the market (or the public) to a company that issues it.

Investments using debt are usually less risky than the ones using equity, hence they usually provide lower return on investment [14].

In order to be protected against loan default, investors manage risk by making use of loan/ credit guarantees from public finance institutions and by doing so transferring part of all of the risk from themselves onto the loan guarantor (i.e. the institution). This way, the party who lends the funds can charge investors a lower interest rate on the loan, lowering the investors' cost of capital and increasing their profitability.

Catalytic first-loss capital: "*socially – and environmentally- driven credit enhancement provided by an investor or grant-maker who agrees to bear first losses in an investment in order to catalyze the participation of co-investors that otherwise would not have entered the deal*."

Grants, equity, guarantees and subordinated debt can be used as catalytic first-loss capital to leverage private finance. Catalytic capital is provided by are governments, foundations, affluent private persons, Development Finance Institutions (DFIs) or any investor who is willing to take on the risk [14].

Market-rate debt, at $219 billion per year on average for 2015 and 2016, was the most widely used financial instrument pertaining to climate finance. More specifically, project finance debt accounted for the 35% of all climate finance flows, while the 19% was balance sheet debt raised by project developers to finance new projects internally. For the same two-year period, concessional debt by public stakeholders, (e.g. climate funds, DFIs, etc.) accounted for 10% of climate finance flows.

"Equity investments can take place through the balance sheet, or at the project level in which investments are paid back from project cash flows, with no-recourse or limited recourse to the project sponsors" [21]. In the time period examined above (2015-2016), equity investments via balance sheets reached 22%, and on the other hand equity investments at the project level made up 9% of total commitments. Lastly, grants comprised just 3% of the total [21].

Venture capital

For this study, Venture Capital (VC) encompasses all types of financing other than traditional corporate finance tools (e.g., banking loans, corporate bonds, public equity, etc.). Hence, it includes among others angel finance, public investments and grants, and private equity. VC is important to allow new companies to develop in emerging sectors such as biotech and the green sector. However, VC backing of companies in the green sector is more challenging compared to other sectors, due to gaps in managerial skills, long-term investment period, risky exit opportunities, and regulatory uncertainty [22].

The valuation method used the most by venture capitalists when trying to make a decision whether to invest in a project is the Discounted Cash Flow analysis (DCF), which is a net present value method based on cash flow projections. Those are rather theoretical for non-public and non-traded companies in high-risk ventures, making the use of this method quite uncertain. This is especially true in the case of green projects that have a long maturity time, high capital intensity and many times associated with goods for which a market might not yet exist.

Compared to other financial instruments used for the green sector, VC/PE (Private Equity) represents only a small fraction of the total flows. VC/PE is more important in countries where VC is already developed (e.g. United States), but it is also growing in developing economies (e.g. China, Brazil, etc.) [22].

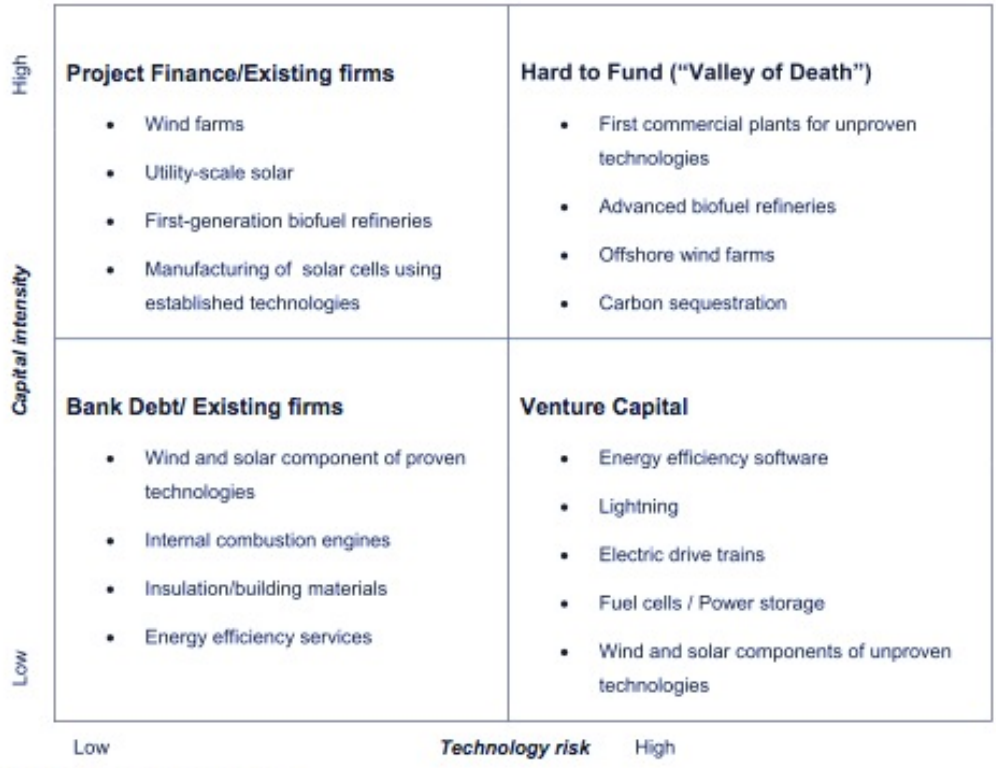

Figure 6: Taxonomy of green investments [9]

Investors and entrepreneurs are still facing financial barriers when trying to make the step from the laboratory phase to the actual development of the technology ("technological valley of death"), despite the existence of market demand and R&D support policies. Nevertheless, VC/PE has played an important role in facilitating companies' transition from the laboratory to the market [22].

As can be seen in figure 6, bank loans are more suitable for investments with low capital intensity and low risk profiles, whereas project finance is more suitable for investments with high capital intensity and high-risk profiles.

There are two main issues associated with the tracking of the financial flows from the aforementioned instruments. First, some of them cannot be easily measured in terms of money. A guarantee or insurance is only paid out if the investment defaults or has financial damage. Second, the effectiveness of these instruments in actually contributing to climate mitigation or adaptation cannot be expressed in monetary terms. This means that one dollar or euro invested via a guarantee may not mitigate the same amount of emissions as one dollar of euro invested through debt or equity. As a result, the quantification of green finance investments is a rather complex task, which often leads to different investment estimates [19].

MAIN ACTORS

In this section we will present the main actors who are behind the development of green finance. Among those, central banks and regulatory authorities will largely decide the speed at which the transition to the green financial system will take place, as the supervisory and legal regime determines the framework of the financial system [6].

Banks

Representing an important share of the world's financial assets, the assets of banks play an important role in the global financial system. Even as market-based financing gains a bigger share of European companies' financing needs, banks will continue to play an important role not only in terms of classic lending but also in a array of intermediary functions and in their role as investors [23]. Due to the upfront costs of green investments, companies are most of the times unable to finance them with their own money and have to rely on funds from external sources.

Three are the main sources of external finance:

- Bank lending
- Market debt
- Market equity

Among these, bank lending is of high importance, for two main reasons. First, bank loans are the most common source of external finance for companies.

Second, banks are very unique entities, having a critical impact on the functioning of financial systems. As a matter of fact, there is a main difference between banks and non-bank private investors. Investors conduct their business by reallocating the existing credit stock, whereas commercial and central banks are the only financial actors that are able to create new credit [8].

Funds can flow to productive activities in two ways. First, funds can be transferred from the financers to entrepreneurs, while the second way is to create it from nothing, which is a privilege of the private banking system. Credit is created through lending. Banks can just create a new deposit, just by typing it into the account of the borrower, instead of waiting for the deposit to come in. This is quite relevant for green finance because not enough funds are allocated to the green sector. The most important reasons why this is true are: the higher degree of risk, the focus of the global markets for short-term, liquid assets (characteristics that not define green investments) and a " credit market failure" that may not allow banks and investors to accurately react to market signals [6], [8].

This failure is caused because the focus of commercial banks on private interests is in contrast with the development goals a society is striving to achieve, the achievement of which is depending on the availability of funds and monetary stability.

The current time period is a clear example of this predicament. Banks are reducing their balance sheets and avoiding more risky investments instead of providing credit to productive activities and projects. This means that credit supply has been greatly restricted because private banks are trying to reduce their balance sheets.

Thusly, banks are just not willing to lend, whatever the price of central bank reserves is, and despite the existence of potentially profitable investments. In fact, economic actors often display herd behavior and irrational conducts. This can lead them to overestimate the risks of investments and hence make them focus on very secure assets (e.g. US government bonds).

During the last couple of years, banking regulators have been trying to correct this failure by reducing the private banks' autonomy in creating credit. The motivation behind this attempt was the need to avoid a repetition of the 2007 financial crisis, which was caused by an uncontrolled growth of bank credit. The policies considered have been named ‘macroprudential regulation’, with the ‘Basel III’ Accord being the most important among them. The Accord introduces stricter standards for banks on both the liquidity of their assets and the robustness of their capital [8].

The idea of using financial regulation and monetary policy to reward banks lending to green projects is gaining momentum. A good example of this is the introduction of differentiated reserve ratio requirements directed in favor of green sectors. Reserve ratio requirements relate the amount of reserves that banks possess — either in the form of cash kept in their vaults or as deposits held at the central bank — to the stock of their clients' deposits. Hence, the reserve ratio is a form of liquidity requirement and is an indication of how resilient a bank would be to an unexpected withdrawal of funds. Differentiating reserve requirements impose different requirements to different banks, depending on which sector they lend to. Concerning green differentiated reserve requirements, the reserve ratio that banks have to satisfy would be lower than average for loans provided to green projects. This lower reserve ratio expands the amount of credit a bank can create and because banks basically profit from lending, this policy could become an incentive for banks to lend more funds to the green sector [8].

Specifically, the policy would work like this: An investor is interested in green projects (e.g. energy production from solar power) and then shows the details of the project to an independent monitoring unit that estimates the amount of emissions not released to the atmosphere thanks to the proposed project and issues a corresponding amount of certificates. The investor then applies for a loan and, upon receiving it, gives these certificates to the bank. The final step would be for the bank to use these certificates at the central bank as part of its reserve requirement [8].

Banks' engagement in green finance has been a hot topic on public debate for many years. While most stakeholders recognize the importance of the banking sector as a key driver for sustainable development and believe that banks should increase their efforts in financing green and sustainable projects and activities, there are some of them that do not agree due to the mismatch between the short to medium-time horizon of the banking system and the long- term nature of green investments. They believe that this mismatch would create maturity mismatches on the balance sheet and cause other forms of financial stability concerns [23].

For the foreseeable future, it cannot be expected that the majority of short-term finance be switched to long-term finance. Long-term finance is hampered by a number of barriers that include regulatory requirements, issues to apply risk assessment for longer time periods, or demand for higher risk premiums. Some of these barriers can only be overcome by strategic policies and regulators that provide incentives to long-term green finance and their clarity will be a deciding factor for whether the banks will take part in long-term business models [23].

Impact investing

Impact investing is a further possibility for banks to invest in activities and projects with a high sustainability impact and a financial return. Some banks have set up impact funds, which only invest in social organizations in Europe, which lead to an environmental and social impact. Impact investing is especially relevant for smaller and riskier projects that cannot easily obtain funds through conventional sources.

Green revolving credit facilities

During the last years, some banks have started issuing green revolving credit facilities where the margins are directly linked to the sustainability performance of the borrower, thus providing an additional economic incentive to the borrower for improving the sustainability performance of the project [23].

Green investment banks

Besides greening the banking system, in order to overcome investment barriers some national governments such as the U.K., Australia and Japan, sub-national governments such as California, Connecticut and New York and cities (e.g. Masdar) have established green investment banks (GIBs). A GIB is a public capitalized entity that uses public capital to mobilize private investment into domestic green investments.

These GIBs have also tended to be established in countries that do not have a national development bank [16], [24].

For example, the GIB in the UK has been founded in 2012 with an initial allocation of £3 billion by the government, and has shown a good potential of crowding in private investments.

GIBs are not like grant-making public institutions, in that they focus on financial performance; in fact, some of them must be profitable and deliver a return on capital. In fact, the UK GIB was profitable in the second half of 2014-15 and is expected to generate an overall return of 9% when its projects are fully operational. In 2014, the Australian Clean Energy Finance Corporation generated a return of 4.15% (net of operating costs) and their portfolio of investments in 2015 was expected to generate an annual return of 6.1% once fully operational [8].

The GIB also uses loan loss reserves, guarantees and debt subordination to share risk depending on the private investors' willingness to risk and they mainly focus on domestic investments. As a result, GIBs in developing countries can be used to channel UNFCCC green and climate finance; they can reinvest such finance either in green investment vehicles (e.g. wind or solar funds), or directly in project development, working with local banks and other investors to support investment in the green sector [8].

While GIBs differ in name, scope and approach, they generally share the following core characteristics: a main focus on facilitating private green investment using tools and methods to reduce risks and enable transactions, innovative transaction structures and market expertise, independent authority and a degree of freedom to design and implement interventions, and a focus on cost-effectiveness. Other goals pursued by GIBs include improving capital market efficiency, lowering the cost of capital and meeting other (non-climate-related) environmental objectives.

Based on their unique national and local contexts, governments tailor their GIBs, which have diverse rationales and goals. Some examples are:

- The Connecticut Green Bank prioritizes reducing carbon emissions and lowering energy costs while creating local jobs through clean energy investment.
- Switzerland's Technology Fund focuses on scaling up innovative environmental and low-carbon technologies that face a deployment gap [24].

These goals are reflected in the wide array of metrics they use to measure and track their performance and demonstrate accountability: emissions saved, job creation, leverage ratios (i.e. private investment mobilized per unit of GIB public spending) and, in some cases, rate of return.

Governments have capitalized GIBs using a variety of funding sources:

- Appropriations (Australia)
- Carbon tax revenue (Japan)
- Reallocation of funds from existing programmes (New York)
- Emissions trading schemes revenue (Connecticut, New York)
- Utility bill surcharges, Renewable Portfolio Standards, Energy Efficiency Resource Standards (Connecticut, New York)
- Loans (Connecticut)
- Bond issuance (Hawaii)
- National government funding (UK, New Jersey)

Even though they are most often smaller than other public financial institutions, some GIBs (e.g. UK Green Investment Bank, Australia's Clean Energy Finance Corporation, etc.) have been successful in targeting institutional investors for co-investment in funds and other transactions. GIBs are mainly a tool to mobilize private investment, which can work together with green policies but cannot substitute for them. If enabling policies for green investment are in place – including a credible carbon price, fossil fuel subsidy reform and long-term climate policy goals – GIBs and other institutions can play a supportive role in addressing investment barriers [24].

Greening existing institutions versus establishing green banks

When the appropriate institutional and political support exists, "greening" existing financial institutions may be a better choice that to create new ones. For example, a number of countries have national development banks (NDBs) that focus on domestic investment.

GIBs may also not be suitable for all countries. For a country to establish a GIB the domestic circumstances are such that few interventions are enough to drive domestic private investment. In cases where domestic markets are properly developed for a GIB, market growth, capacity building and considerable subsidization (e.g. from MDBs), are often needed. However, the constant spread of green markets may make GIBs increasingly relevant for a large number of countries.

Some factors to take into account when considering the relative benefits of creating a GIB or "greening" existing institutions include **costs**, i**ndependence and authority**, m**andate and culture** and s**cale**.

But there is also a third option: bolstering domestic green investment programs. Governments could consider strengthening green investment programs that are already implemented and housed in different agencies or institutions [24].

Institutional investors

There is currently a large discussion regarding the potential role of institutional investors (i.e. pension funds, insurance companies, mutual funds and other non-bank organizations managing vast amounts of money on behalf of their clients) in providing green finance. It is now common knowledge that a large portion of the trillions of euros needed to finance the green transition has to come from institutional investors.

Some institutional investors choose to invest to the green sector for 'ethical' reasons. But as up to this point, institutional investors have little contribution as they only provide 0.45% of total green finance. In order for the green sector to amass the funds needed to start growing as expected, it is of paramount importance to attract the majority of investors who have only economic return in mind. However, they a faced by a number of barriers: green investments are not usually included in the relevant benchmarks of rating agencies as they do not have the track record needed to be assigned a rating. In addition, green projects are usually not achievable at scale due to the limited number of green projects available to the market. Most of the time, even if institutional investors would be willing to invest in long-term, sustainable activities, regulation prevents them from doing so, or allows it only in a very limited way because it requires conservative investment strategies [6].

Central banks and regulatory authorities

Central banks and other regulatory authorities could help turn markets towards more sustainable projects and practices by establishing adequate policies and regulations. They are considered key actors in financial system's transformation. The financial system of today is mostly driven by short-term returns and, consequently, the investment deficit for long-term sustainable projects is one of the most urgent problems facing regulators. Banking stress tests and standards of due diligence for financial institutions could place more emphasis to environmental risks in order to influence common investment behavior. Additionally, green financial guidelines and policies can avoid competitive distortions due to the higher costs related to green financial activities [6].

While green prudential regulation has proved to be an effective tool to green investments, there are many more examples of relevant green policies and guidelines; in many countries – including Australia, Brazil, France, Netherlands, Norway and Sweden – regulators require investors to include information on environmental, social and governance (ESG) aspects in their financial disclosures [6], [9].

On the other hand, one major problem with green policies and regulations in the financial sector has been that financial and environmental policy approaches have often not been coordinated. For example, finance ministries have not yet given bank directors the command to demand from banks and other financial institutions to report and disclose their environmental risks. China and Peru can be considered as some kind of leaders in this regard because they have coordinated their environmental and finance ministries as well as their banking regulators by, for example, exchanging information, and have assessed the adoption of environmental laws.

In addition to financial sector regulators and central banks, the Financial Stability Board (FSB) is a key multilateral actor in regulating environmental risks. This institution promotes global financial stability by coordinating the development of regulatory and other policies for the financial projects. Regarding green finance, the G20 Finance Ministers and Central Bank Governors instructed the FSB to gather stakeholders from both the public and the private sectors in order to assess the role of the financial sector in green transformation and to analyze financial stability against this green transformation [6].

CLIMATE FUNDS

Public finance can play a critical role in helping to ensure that the global costs of climate change mitigation and adaptation are met. Although the private sector controls the largest sums of capital, regulators have direct control over public finance. When used effectively, public finance can help mobilize private investment by stimulating markets, fostering innovation, and reducing risk. Public finance is also essential for providing public goods and meeting other needs that the private sector is unwilling or unable to support [25].

Public climate finance can be delivered via public financial institutions (e.g. MDBs and NDBs), bilaterally as part of aid programs or via multilateral and bilateral climate funds. In terms of UN Framework Convention on Climate Change (UNFCCC) climate finance, governments have expressed a preference for a significant portion of it to be delivered through multilateral climate funds [16].

In 2016, multilateral climate funds approved a record $2.45 billion of climate finance grants and loans, increased 40% compared to 2015. This sharp increase can mainly be attributed to the Green Climate Fund (GCF), established in 2015. In its first full year of operation, the GCF commitments accounted for 54% of the total flows from climate funds [16], [21].
These funds play a key role in facilitating the necessary shifts in investments by other finance institutions. The current structure of multilateral climate funds is not permanent, however, and the future of several funds is not clear due to resource constraints, evolving mandates, or unresolved questions pertaining to when they will close (e.g., when sunset provisions might be triggered). We focus on the funds that are associated with the UNFCCC, as well as the Climate Investment Funds (CIFs) [25].

Multilateral Climate Funds [16], [25]

Global Environment Facility (GEF): The oldest climate fund was established in 1991 as a pilot program in the World Bank. When the United Nations Framework Convention on Climate Change (UNFCCC) was adopted in 1992 it designated the GEF as the first operating entity of its financial mechanism. The GEF trust fund is replenished every four year in an intergovernmental negotiating process.
Green Climate Fund (GCF): Created in 2010 under the UN Framework Convention on Climate Change, it became the second operating entity of the financial mechanism of the UNFCCC, together with the GEF. The GCF was intended to play a key role in channeling funds to developing countries and mobilizing public and private climate finance. The GCF receives funding from country contributions through replenishment cycles. Its initial resource mobilization saw the fund capitalized at $10.3 billion from 43 countries, including 9 developing countries. It now seeks ways to receive funding from private investors.
Least Developed Countries Fund (LDCF): Established in 2001 at COP7 Marakesh, this fund is operated by the GEF. The LDCF had received $1.19 billion in contributions from 25 developed countries as of September 2016. LDCs that are parties to the UNFCCC are eligible to receive financial aid for adaptation under the fund. The LDCF provides grants to cover the agreed full cost of preparing national adaptation programs of action (NAPAs).

Special Climate Change Fund (SCCF): Established together with LDCF, was designed to finance climate change–related activities that complement those funded under the climate change focal areas of the GEF and is also operated by the GEF. All non–Annex I Parties to the UNFCCC (developing countries) are eligible to receive funding (GEF 2015d).

Adaptation Fund (AF): The Adaptation Fund (AF) was created under the Kyoto Protocol of the UNFCCC in 2001 to use funds from the Protocol's Clean Development Mechanism (CDM) to support adaptation in developing countries. It came into operation in 2009 and approved its first projects in 2010. This fund pioneered an innovative financing mechanism—a 2 percent levy from certified emission reductions (CERs) issued under the Kyoto Protocol's Clean Development Mechanism (CDM). Alas, the vast reduction of CDM carbon trading prices has meant that funding has not reached the anticipated scale and the fund has been reliant on voluntary government contributions.

CIFs: Clean Technology Fund (CTF): One of the two trust finds that comprise the Climate Investment Funds (CIF). The CIF were founded in 2008 to deliver concessional funding through the multilateral development banks (MDBs). At the pledging meeting for the CIFs, 10 developed countries pledged $6.1 billion to the two trust funds. A further pledge has brought the total capitalization to $8.3 billion from 14 countries. To receive CIF funding, countries must be eligible for official development assistance (ODA) nd have an active country program with one of the five MDBs.

CIFs: Strategic Climate Fund (SCF): The second of the two trust funds. The SCF has three targeted programs: the Forest Investment Program, the Pilot Program for Climate Resilience, and the Scaling-Up Renewable Energy Program.

WRI research has identified three factors required to create attractive markets for private investment: **liquidity, scale, and transparency.**

Climate funds have a variety of tools at their disposal to support these factors. These include: grant support for policies and project assistance, lending, equity investment and de-risking instruments such as loan guarantees, insurance, and foreign exchange facilities. Depending on the context, different financial instruments are needed. For example, grants for policy development may be more useful in countries that just started towards their sustainable transition, whereas emerging economies with well-established markets may require more debt and equity financing to increase green technology. Therefore, the instruments available to different climate funds will have a bearing on their ability to successfully address investment barriers [25].

Grants, loans, risk mitigation instruments and equity are offered by the GEF, the CTF, the SCF and the GCF. The other three have only grants available at their disposal.
Researchers [25] propose that these climate funds collectively need to pursue five key strategies in order to facilitate transformation while meeting the needs of developing countries.

- **Impact at scale**. Multilateral climate funds should focus on using their resources in mass to mobilize larger flows of funding to achieve systemic transformation.
- **Efficiency**. Funds should strive for greater efficiency in minimizing transaction costs, speeding up project delivery, and providing access to funds.
- **Country ownership**. Funds should ensure that finance flows to support domestic determined priorities and bolster national capacities to design, implement, and monitor climate activities.
- **Accountability**. Funds should ensure that activities achieve their targets and comply with relevant operational policies by improving processes.
- **Fair allocation**. Funds should be allocated in an equitable way by giving priority to developing countries with the greatest need.

Multilateral climate funds have taken different approaches to the amount of funding they provide. For example, some of them have established caps on funding per country. GEF, LDCF, SCCF, and AF contributions do not exceed $7 million on average, and LDCF and AF have established country caps [25].
The CIFs were created to fund larger projects. The CTF has provided funds that exceed $100 million, with the average contribution being $49 million. SCF funding for projects averages $14 million (the FIP's average is $14 million, the PPCR's is $16 million, and the SREP's is $9 million), which is significantly larger than most other funds that focus on adaptation, forestry, and distributed clean energy. Nevertheless, even the funds delivered by the CIFs and the GCF, however, are quite small compared to total climate finance flows that reach $700 billion a year. An average of $2.2 billion per year flowed from all multilateral climate funds in 2013–14 (25].

Even though funds are trying to increase their delivery, they are facing capacity constraints and as a result they can meet only a very small part of the needed climate finance. Thusly, to reach the required scale, they must be used in ways to mobilize other sources of finance. The GEF has the highest cofinancing ratio (dollar of cofinancing for each dollar of finance provided by the fund) of all the funds under examination. Previous analysis of the GEF and CTF portfolios over 2005–11 showed that cofinancing came primarily from domestic public resources [25].

The CIFs and the GCF have made mobilization of private finance the main aim in their governing instruments. The CIFs have been effective in mobilizing private investment by using concessional loans and risk mitigation instruments to support new markets and mitigate risk for private investors. When used in combination with grants for structural reforms, this approach has assisted in reducing technology costs for the developing counties where they operate.

It seems unlikely that regulators will make important changes to the funds in the foreseeable future, although changes to the funds' operations are possible. As policy discussions evolve and experience is gained with years of implementation, opportunities for closing or merge funds may become more realistic. To this vain, following are key operational and architectural recommendations that policymakers could implement over time.

Operational

Operational recommendations are applicable to all funds [25]:

- **Coordination**: Improving coordination among funds and between funds and countries can enhance their efficiency.
- **Harmonization**: Funds could adopt a consistent set of fiduciary standards, environmental and social safeguards, and gender policies that apply across all funds. This harmonization would need to adopt international best practices and reflect the current strongest policies implanted by the funds.
- **Support Shifts**: Achieving impact at scale is the most urgent priority facing the funds. Much greater emphasis is needed across all funds on supporting systemic change and taking programmatic approaches to funding.

Architectural Recommendations [25]:

- **Increase Specialization**: In the short term, a clearer division of labor between the funds could help address both inefficiencies and overlaps in they way the various funds treat different thematic areas, risks and project sizes.
- **Closing and merging**: In the longer term, establishing a greater division of labor may not be sufficient to address gaps and the overlaps between funds. Resources are constrained and developing countries face difficulties in making sense of the complex funding landscape. This is why, closing or merging funds may be needed, but it is important to ensure that each fund's key roles and responsibilities do not get lost in the process.

Multilateral Development Banks (MDBs)

In addition to the above, regulators have the option to lend directly to sectors of strategic importance via public development banks. These banks are institutions committed to supporting the process of economic growth, with Multilateral Development Banks (MDBs) being chartered by two or more countries. In contrast to private commercial banks, MDBs do not aim to maximizing returns for their shareholders, but instead set sustainable priorities like eradicating poverty and minimizing economic inequalities. Most of the times they lend at low (or no interest) or give grants to projects in education, infrastructure, energy and other sectors that promote sustainable development. They also provide technical assistance to the projects and foster engagement with political institutions and are subject to international law [8].
The major MDBs include:

- European Investment Bank
- World Bank
- Asian Development Bank

MDBs have the ability to borrow funds something that means the finance that have available for sustainability commitments can exceed the credit provided by their shareholders. Even thought the details are different for each bank, each MDB has various developed and developing country shareholders that provide funds called paid-in capital. The shareholders also commit to providing excess funds, callable capital, under specific conditions. In contrast to a private company's shareholders, a MDB's shareholders receive no dividends or interest on their capital.

Normally, MDBs are providing concessional finance to the least developed countries and non-concessional to wealthier countries. Concessional finance is mostly funded by developed country contributions and retained earnings, whereas non-concessional finance is mostly funded by money borrowed from global capital markets [26].

An MDB can borrow money from private lenders partly because, if needed, it could draw on its callable capital to repay the debt. In addition, it can borrow on favorable terms, partly due to the fact that some of the bank's shareholders from developed countries have very good credit ratings, and because the recipients from developing countries have a good history of repaying their debts. The MDBs are then able to lend to developing countries on more favorable terms compared to traditional institutions and then thy use the interest and principal payments by clients to repay their debt [8], [26].

Public development banks (both multilateral and national development banks) are key actors in financing the green economy, and many of them have already set up specific lending programs. Between 2007 and 2012, development banks have provided at least $425 billion to renewable energy production, energy efficiency and other green projects and activities. MDBs have also been very active in the proliferation of 'green bonds'.

It is understandable that the amount of finance made available from national and multilateral development banks is not negligible. However, they are severely restricted by the fact that they do not possess one of the most crucial characteristics of banks, which is the prerogative to expand their own balance sheets at will. The ability to create credit is forbidden to development bank and they have to limit the amounts they can lend to the levels they are able to raise on the secondary markets through issuing, among others, green bonds [8].

Despite the curbed effectiveness of their interventions due to their inability to leverage, development banks are likely to play a big role in the green transition.

Their focus of development makes them the most suitable among financial institutions to provide funds to sectors deemed socially useful. Development banks could assist in increasing the volume of resources channeled to green sectors, expand the green bonds market and act as a catalyst for the private sector investors.

SEVEN KEY OPTIONS TO SCAPE UP GREEN FINANCING

The G20 brings together the world's leading economies to promote sustainable growth, Green finance was incorporated into the G20 agenda for the first time under the Chinese Presidency of 2016 in the form of the Green Finance Study Group (GFSG), and was continued under the German Presidency of 2017. The process of dialogue and analysis was captured in a summary report welcomed by G20 Finance Ministers and Central Bank Governors, who concluded that "in order to support environmentally sustainable growth globally, it is necessary to scale up green financing." At the September 2016 Hangzhou Summit, G20 Heads of State welcomed seven broad financial sector options, "for voluntary implementation by countries in light of national circumstances", to achieve this goal. Key options are highlighted below [5]:

1. **Support policy signals and frameworks**

Strategic policy signals and frameworks help limit policy uncertainties for investments in the green sector, and thus help accelerate the development of green finance. Examples include:

- **EU**: the European Commission launched the High-Level Expert Group on Sustainable Finance to provide recommendations for a comprehensive EU strategy on sustainable finance as part of the Capital Markets Unions in December 2016.
- **France**: in February of 2017 France published a synthesis report on climate-related risks assessment in the banking sector, aiming to provide banks with a framework and instructions on ways to expand their expertise on the topic.
- **Internationally**: Launch of the OECD Centre on Climate Finance and Investment. Its mission is to facilitate the transition to a green global economy via effective policies, institutions and instruments for green finance.

- The World Bank Group and UN Environment have launched an initiative to develop a Roadmap for Sustainable Finance, released at the IMF/World Bank Annual Meetings in 2017.

2. Endorse voluntary principles for green finance

Voluntary principles build upon market-led opportunities that promote the expansion of green finance without the costs and delays associated with many laws and regulations. Investors have been most active in the development of voluntary principles. Indicative examples:

- **France**: France launched "the energy and ecology transition for climate" label to help identify green funds.
- **Internationally**: The SBN has initiated work on "Sustainable Banking Principles" for banks and banking regulators, as has the Sustainable Stock Exchanges Initiative (SSE), which has focused on stock exchange application.

3. Learning networks for capacity-building

Even though green finance is growing fast, there is a lack of awareness of its benefits and current best practices. Learning networks are able to help green finance activities and can improve analytical capacity. New platforms include thematic multi-stakeholder partnerships and platforms serving the green finance needs of developing countries. Examples:

- **UK**: the Bank of England is in dialogue with other UK financial regulators on green finance and climate-related financial risks.
- I**nternationally**: The SBN has expanded from 24 to 31 countries, and most market-led international networks including the Principles for Responsible Investment, the Sustainable Stock Exchanges Initiative and the UN Environement Finance Initiative are providing increasing capacity development support to financial communities in both developing and developed countries.

4. Support the development of local green bond markets

Local green bond markets are an additional source of long-term green finance besides bank lending and equity finance. This is extremely valuable in countries where demand for green

infrastructure investment is high but supply of long-term bank loans is limited (more information on chapter 2).

5. **Facilitate international collaboration to promote investment in green bonds across borders**

Opportunities for cross-border investment in green bonds can help reduce the funding costs of green bonds, possibly enhance the return of global investors and help the growth of local bond markets (more information on chapter 2).

6. **Encourage dissemination of knowledge on environmental and financial risk**

The connection between environmental factors and financial risks is rather complex and it involves the development of new capabilities, which can be challenging, especially for small and medium-sized financial companies. Sharing knowledge therefore has elements of public good. Examples:

- **Germany**: The Federal Ministry of Finance released a commissioned research report on the potential of climate change on financial market stability.
- **Internationally**: The TCFD published final recommendations in June 2017. Environmental scenario analysis is a key recommendation for understanding the financial impact of environmental sources of risk.

7. **Improve the measurement of green finance**

Policymakers and regulators need more clarity on green definitions, as well as the measurement of green finance flows and relevant impacts in order to achieve their goals. Currently, there are no robust methods for measuring progress on the greening of the financial system and limited relevant initiatives exist. Examples:

- **Switzerland**: The Federal Office for the Environment will offer all Swiss pension funds and insurance companies the opportunity to measure the 2oC alignment of their equity and corporate bond portfolios.
- **International**: The TCFD published recommendations in June 2017, "Metrics and targets" is one of four thematic areas covered.
- The EU non-financial reporting

G20 member	1. Provide Strategic Policy Signals and Frameworks	2. Promote Voluntary Principles for Green Finance	3. Expand Learning Networks for Capacity-building	4. Support the Development of Local Green Bond Markets	5. Promote International Collaboration to Facilitate Cross-border Investment in Green Bonds	6. Encourage and Facilitate Knowledge-sharing on Environmental and Financial Risk	7. Improve the Measurement of Green Finance Activities and their Impacts
Argentina	✔			✔			
Australia	✔			✔			
Brazil				✔	✔	✔	
Canada	✔			✔	✔		
China	✔	✔	✔	✔	✔	✔	✔
France	✔	✔		✔	✔	✔	
Germany	✔		✔	✔		✔	
India	✔			✔	✔		
Indonesia	✔		✔	✔		✔	
Italy	✔			✔			
Japan				✔			
Mexico	✔			✔	✔		✔
Russian Federation				✔		✔	
Saudi Arabia			✔				
South Africa	✔			✔	✔		
South Korea		✔		✔			
Turkey				✔			✔
UK	✔		✔	✔	✔	✔	✔
US				✔		✔	
EU	✔			(N/A)	✔		
International	✔	✔	✔	✔		✔	✔

Figure 7: Member summary table [5]

Three key trends emerge from the previous analysis that show that the momentum is growing in mainstreaming green finance into the architecture of financial markets [5], [15]:

1. **Growing systemic national action:** policymakers and regulators are striving to support and stimulate this process, by introducing measures to promote capital reallocation, improve risk management, enhance reporting, as well as clarify the responsibilities of financial institutions. Important developments include:
   - The Netherlands central bank has assessed the implications of climate change for its financial system.
   - China has launched a comprehensive set of guidelines to establish a green financial system, including banks, capital markets and insurance.
   - The UK is working on the potential implications of climate change for insurance companies.

2. **Increased international cooperation: i**nternational cooperation on finance and sustainable development is constantly rising, with several important concerns for developing countries are becoming more visible. These include financial inclusion, foreign direct investment, and great advances to be made through the adoption of financial technology.

3. **Market leadership on the rise**: Financial institutions and markets are focusing on innovations in order to respond to policy developments, market signals and technology advancements. So far there is limited understanding of the macroeconomic impacts of green finance and even though there is no metric that can showcase the scope and diversity of market developments, market-led based green finance activity is on the rise. Indicators, among others, include:
    - Record capital reallocation
    - Record issuance of green debt and use of green financial products
    - New tools: Finance stakeholders have introduced a wide range of new tools to support new product development and stimulate demand. For example, new risk management tools development by asset owners and investment banks (e.g. HSBC's Climate Risk Analysis Framework), new indices, listing requirements and Standards (ISO in partnership with 2 Degrees Investing will launch a standard to measure Investor's contributions to climate change goals).
    - The proliferation of dedicated green investment funds: Four new green bond funds were launched in Q1 2017 alongside a number of green private equity firms.
    - Green finance-related partnerships are on the rise across banking, insurance and investment. Membership of the Principles for Responsible Investment (PRI) has increased by over 185 members from 30 countries since June 2016 and represents over 50% of global assets under management (AUM).

The green finance developments listed above are not exhaustive. Many other areas have been developing, such as:

- Green insurance
- The role of public finance and development banks in green investment
- And the application of financial technology ("fintech") in green finance (will be presented on the next section in more detail).

FINANCIAL TECHNOLOGY

Recently, the world economy has been changing at a great speed, driven by the blending of digital, material and biological breakthroughs and leading to the concept of the Fourth Industrial Revolution. These technology innovations– covering wide-ranging fields such as AI, robotics, the IoT, nanotechnology, DNA editing, biomimicry, advanced materials science and energy storage will without no doubt create great risks and opportunities.

Digital finance, or innovative financial technology—*fintech*—is now a disruptor that is reshaping the world economy. The relationship between fintech and green finance is still largely unexplored. Incumbent banks and new fintech startups will likely engage in increasing cooperation and partnership, developing innovative products and services. As a matter of fact, the launch of fintech startups and the development of digital platforms have stimulated innovation and accelerated the transformation of banks. A good example of such teamwork is the introduction of the "Green Digital Finance Alliance" platform, launched to address the potential for fintech-powered business innovations to steer the financial system towards catering the needs of sustainable development [15], [23], [27], [28].

Whereas the use of technology in finance is not new, the new application and combination of a number of technologies is what makes this latest wave of disruption so special. The global financial system will become more accessible and efficient and less open to threats by the combined use of blockchains and cryptographic currencies, marketplace lending and AI services.

As a matter of fact, this disruption is already visible. In a series of three reports released in 2015 called "The Future of Finance", Goldman Sachs estimated that $11 billion of annual profits were at risk in the banking system. Actually, the new 'shadow banking' sector (i.e. non-banks) held 41% of the market in the six main US lending categories (i.e. personal, small business, student, mortgage, commercial real estate, and leverage lending) [27].

The rise and growth of Bitcoin and the associated blockchains, sidechains and altchains has been a disruptive force in the financial sector, a stark contrast to the current centralized and guarded model of financing. In practice, what it does is support the exchange of value without the need for intermediaries.

In a little more detail, blockchain has disrobed traditional finance models via:

- **Decentralization**: with the direct transfer of digital assets between two parties without the need of intermediaries, the costs are driven down.
- **Programmability**: it allows for the execution of pre-programmed smart contracts to when the necessary conditions are met.
- **Immutability**: it keeps a stable immutable audit trail and allows for irrevocable transactions that would clear and settle near instantaneously. At the same time, it creates a historical record of all transactions, lowering the cost of compliance to complex regulations in the process.
- **Cost/capital efficiency**: enables the simplification of current processes reducing the costs and increasing capital efficiency [27].

As a series of MIT papers have argued, we are in the still in the early stages of blockchain adoption. Blockchain coupled with the IoT is believed that it can drive innovations to strengthen trust and transparency in transactions through new business models such as asset financing models based on real-time activity versus fixed terms.

Exploring the current financial system's core functions that will be disrupted financial technologies and most notably by the IoT-AI-Blockchain Gearbox, we can better define the scope of fintech:

- Moving value
- Storing value and lending value
- Exchanging value
- Funding and investing in value creation
- Insuring value and managing risk [27].

Pertaining to sustainability, two are the main challenges facing global financial systems:

- **Mobilizing Finance for strategic sustainable development priorities:** Capital needs to be mobilized for several strategic sectors and priorities. These include the financial inclusion of specific groups in need (e.g. low income citizens), the development of sustainable infrastructure (e.g. energy) and the financing of critical areas of innovation (e.g. off-grid energy solutions, smallholder agriculture and sustainable fisheries).
- **Mainstreaming Sustainability:** Sustainability factors are incorporated at great pace into financial institutions' agendas. The base for this is safeguarding the integrity of the market (e.g. anti-corruption initiatives, market efficiency) and then moves to the incorporation of ESG factors into risk management (e.g. climate-related risk ratings of biological assets, etc.).

The connections between fintech and sustainable development are showcased in a new domain area termed '**fintech for sustainable development' (FT4SD)**.

In his 1937 paper "The Nature of the Firm", Coase identified three types of costs in the economy: the costs of search, coordination and contracting, proposing that a firm would expand until the cost of performing a transaction inside the firm exceeded the cost of performing the transaction outside the firm. Fintech will most likely disrupt several functions of the financial system by massively reducing Coase's information search, coordination and contracting costs.

Two drivers can explain why some researchers believe that the proper use of the "FT4SD" framework could promote the Sustainable Development agenda [27]:

- "*IoT and AI enable the 'animation of the physical world'; once we bring physical and natural assets, machines, and physical and natural infrastructures to life by interacting with each other and by sensing and responding to each other in real time*."

- "*Blockchain's smart contracts on the immutable distributed ledger allows real economy assets, infrastructures and processes to interact with the financial system in predictable ways and with business models that were unheard of ten years ago. Providing this two-way real-time interoperability between the real economy and the financial system will be disruptive*".

To shed some light on how a FT4SD portfolio could help address the financing challenges of the sustainable development agenda, a paper examines [27] a representative sample of case studies from this portfolio.

Some of the case studies pertaining to energy include:

- Pay as you go resource utilities
- Flexible energy supply and demand
- Renewable energy P2P

However, various transitional and more structural unintended consequences, with potential risks for sustainable development exist**.** The quick growth of fintech drew attention to policy questions concerning proper regulation and supervision, but normally financial system regulators focus on financial stability and not around fintech's many unintended consequences.

These consequences along with key dependencies and barriers are presented in table 2 Digital finance has the potential to deliver environmental outcomes and support a transformation in financing for sustainable development by, for instance, mobilizing capital for critical priorities and mainstreaming social and environmental factors throughout the financial system. Ultimately, the impact of digital finance will depend on a number of policy and regulatory innovations that enable scaling and minimize its potential negative unintended consequences [23], [28].

Dependencies	Barriers	Structural consequences	Transitional consequences
Need for industry-wide interoperability standards and network	Regulatory barriers	Cryptocurrency outsized energy footprint	Increasing several fold the cyber security risks of going fully digital
System-wide coordination barriers	Scalability of blockchain and technology robustness	Cashless society provides backdoors to privacy and control	Fintech AI-driven automation will create unemployment
System and process integration challenge across institutional borders	Security, privacy and resilience against cyber-attacks	Fintech commoditization destroying relationships	Accelerating regulatory knowledge gaps
Broadband connectivity requirements	High energy bitcoin network consensus cost	Ownership and governance of use of data	Alternative sources of finance with unmanaged risks
Enabling (pseudo)-anonymity	Governance of the network	Blockchain's immutability and the right to forget	Unintended killer apps for mobile money/ bitcoin exchanges

Table2: Dependencies, barriers and consequences of fintech for sustainable development [27]

ENVIRONMENTAL RISK ANALYSIS (ERA)

The objective of the G20 Green Finance Study Group (GFSG) is to "*identify institutional and market barriers to green finance, and based on country experiences, develop options on how to enhance the ability of the financial system to mobilize private capital for green investment*".

During 2017, the GFSG has focused on two themes: first, the **application of environmental risk analysis (ERA)** in the financial industry; and second, the **use of publicly available environmental data (PAED)** for financial risk analysis and informing decision-making in financial analysis [29].

Why ERA?

The identification, pricing and management of material risks are key features of an efficient and resilient financial system.

Private sector feedback received by the GFSG suggests that many financial institutions face challenges in identifying and quantifying environmental risks and applying analytical tools to assess the financial impact of these risks. ERA describes a portfolio of analytical tools and methodologies that could enable financial decision-makers to assess the financial implications of environmental risks and to integrate environmental risk into risk management and asset allocation decision-making.

Environmental factors are increasingly recognized by many as one of the important risk factors for sustainable growth of the global economy. The World Economic Forum's 2017 Global Risks Report named extreme weather events, water crises, biodiversity loss and ecosystem collapse (terrestrial or marine), major natural disasters, and the failure of climate change mitigation and adaptation among the top risks by impact [29], [30].

What is climate risk?

The G20's Financial Stability Board has identified three climate risk categories for the financial sector:

Physical risks include the impact on insurance liabilities and financial assets that result from climate and weather-related events such as floods and storms that damage property or disrupt trade. Consequences are greatest for the insurance sector, but also extend more broadly.

Liability risks occur when and if parties who have suffered loss or damage from the effects of climate change seek compensation from those they hold responsible. Such claims could come decades in the future, creating liabilities for carbon extractors and emitters and their insurers.

Transition risks are the financial risks that could result from the process of adjustment toward a lower-carbon economy. Changes in policy, technology, and physical risks could prompt a reassessment of the value of a large range of assets as costs and opportunities become apparent. And a particularly rapid re- pricing could threaten financial stability.

The extent and speed of the transition risk will shape how the financial system responds to the losses from holding stranded assets. The value of potentially stranded assets is estimated at approximately one- third of global equity and fixed-income assets.

Several leading insurance companies, asset managers and banks now recognize these physical and transition risks as potential drivers of financial losses as well as sources of increased market volatility and possibly financial sector instability [10], [16], [30].

Some financial companies in a number of countries have gradually increased the analytical scope their ERA efforts. They have started to consider a wider range of environmental factors, such as those from policy, consumer, market and technological responses, as well as the impacts of environmental events and physical risks on a broader range of asset classes (such as loans, bonds, and equities).

A wealth of practice by both financial institutions and financial authorities identified a portfolio of ERA tools and methodologies that can help decision-makers to understand and integrate environmental risk into risk management and asset allocation decision-making. The use of these tools pointed to: improved credit and investment policies; reduced portfolio and firm-level risk; product innovation; reallocation of capital; and enhanced stakeholder engagement. Case studies suggest that if financial firms do not effectively take environmental factors into account, they may not properly judge short- and long-term environmental related financial risks [10], [29].

The case studies that were reviewed indicate that financial institutions could combine two types of approaches to better assess environmental risks [29], [30]:

1. Strive to identify and understand the environmental sources of financial risks (e.g., wrong pricing of a pollution liability or natural disaster insurance policy could be a risk to liability, if the event probability is underestimated); and

2. Translating these environmental risk factors into quantitative and qualitative information to better understand the potential magnitude of financial risk and to aid management and investment decisions.

Challenges to the Effective use of ERA Tools

Research by GFSG knowledge partners and consultation with a number of private sector institutions suggest that challenges to wider adoption of ERA practices can include [29], [30]:

- **Policy Signals:** A lack of clear policy signals to encourage the alignment of the economy with environmental sustainability remains a source of uncertainty for financial institutions.
- **Technical Barriers:** Including limited availability and accessibility of ERA methodologies and relevant environmental data.
- **Capacity:** Many financial institutions may be subject to capacity limitations, such as a lack of expertise and best practice examples, limited budget to assess environmental risk, as well as a lack of incentives to build such capacity.
- **Time Horizons:** Some environmental risk factors may appear beyond the planning horizon of decision makers of financial institutions and regulators, thus reducing the incentives for them to take actions.
- **Terms of Investment:** Financial institutions may be constrained to address environmental risks based on real or misperceived requirements such as asset manager's obligations and duties.
- **Performance Incentives:** Current performance review mechanisms adopted in many financial institutions, which are largely short-term in nature, may act as a barrier to taking a long-term view. Also, a common language for ERA would require a common effort, which single financial institutions are not able or willing to provide on their own.

Options for Encouraging Voluntary Adoption of ERA

Based on inputs from knowledge partners and expert contributions from the private sector, the GFSG broadly agreed that G20 member countries and financial institutions could consider the following options for encouraging effective ERA for voluntary adoption [29]:

- **Ensure consistency of policy signals**. Member states could reduce business uncertainty by improving transparency on policy measures to be taken to align the economy and the financial system with environmental sustainability.
- **Raise awareness of the importance of ERA for financial institutions.** G20 members could consider encouraging financial institutions to enhance the understanding of ERA and its costs and benefits by sending signals on its importance, and where appropriate cooperating with country- and sector-level industrial initiatives (e.g., banking, insurance and asset management associations) in developing and/or adopting ERA methodologies.
- **Encourage better quality and more effective use of environmental data.** G20 members could consider voluntary options to enhance the quality of environmental data and to improve the availability and usefulness of such data.
- **Encourage public institutions to assess environmental risks and their financial implications in different country settings.** G20 members could consider, on a voluntary basis, encouraging public institutions to conduct research and assessments of environmental risks and their implications for the financial sector.
- **Review and, if appropriate, clarify financial institutions' responsibilities to consider environmental factors.** G20 members could consider reviewing experiences and best practice in this area, where appropriate, and seek to clarify institutional roles and contributions for considering environmental factors.
- **Enhance capacity building on financial sector ERA.** G20 members could encourage initiatives that focus on knowledge sharing and resource pooling for the development and usage of tools and methodologies for ERA. These initiatives would support the development and evaluation of ERA tools; help raise the awareness of the need for environmental risk analysis and build necessary capacity within the financial industry.

The Environmental Risk Analysis Toolbox

How to Price Environmental Risks?

When actors in capital markets, banks and insurers analyze the financial impacts of climate change and other environmental risks, two types of approaches need to be combined.

Environmental factors: A first step is seeking to understand how environmental factors may pose risks to financial assets, and how such risks may evolve over time. Such factors may

include the direct risks such as physical impacts of climate change to real economy assets, or indirect risks posed by policy and market responses to environmental factors. If firms are unprepared for either the physical impacts or for the low-carbon transition, they can be faced with credit, market, business and legal risks [30].

Financial risk analysis tools: Environmental factors have to be translated into quantitative measures of financial risk that can, in turn, inform risk management. For instance, an investor may not find it very useful to merely know that an area where an asset is located is likely to suffer from droughts. But once this is expressed as the potential impact on the valuations of agricultural producers and water-using electricity generation plants in that region, the investor can take it into account in their capital allocation decisions.
The following section provides an overview of these types of financial risk tools and metrics. Risk tool needs primarily depend on the different assets classes via which financial institutions may be exposed to direct and indirect environmental risk factors. Within a given organization, different levels of analysis will likely be performed: some teams will assess **individual assets**, while others perform **portfolio level risk analysis** while still others look at the **macroeconomic or systemic** level [30].

Individual Asset Analysis

- Equity analysts use valuation tools such as discounted cash flow (DCF) models, which take into account the riskiness of an asset. Environmental factors could be taken into account by adjusting either the expected future cash flow or adjusting the risk premium applied to future cash flows, impacting the valuation of an equity security.
- Analysts that look at the credit risk of bonds are focused on the issuing firm's capacity to repay the borrowed funds, and thus focus more on short-term financial buffers. These are key factors feeding into a bond-rating decision. However, for longer-dated securities, the impacts of environmental factors and impacts on future cash flow analysis receive more attention, including for rating decisions.
- When looking at loans extended by banks, credit risk analysts use tools such as expected loss (based on probability of default and loss given default). Similar to bond analysis, banks will have to judge how environmental factors affect the credit risk of the entities to which they lend, through reduced cash flows, higher costs or degradation of collateral value.

- Insurers have the longest track record in developing and applying models to estimate financial losses arising from environmental hazards, primarily to inform underwriting decisions.

Portfolio Level Risk Analysis

Beyond pricing the risk of individual assets, financial sector actors have started to price environmental risk on a more aggregate, portfolio level. This could either build on individual asset assessment that is then aggregated (such as done by ICBC) or start with some more aggregate risk factor that affects industries across the board [30].

Systemic Level Risk Analysis

Both private sector actors and regulators have an interest in how physical and transition risks could affect the stability of the system as a whole. Given their financial stability mandate, several regulators have started to analyze the exposures to climate-related risks of the institutions they supervise. This includes estimating the total exposure of the system but also analyzing whether there are pockets of the financial system in which risks are concentrated. Beyond the direct financial stability impact, system-level risk analysis can bring out what the risks to the economy as a whole are.

From the examples reviewed, and discussions held in GFSG meetings, a number of priorities for enhancing ERA practice emerge.

- **Integration into core processes**: Looking at the evolution of ERA practice within firms, a twofold process of integration takes place. First, action is taken to better understand environmental factors and their financial dynamics; second, this information is applied and then successively integrated into core risk assessment, management and governance systems.
- **Broadening risk scope**: The examples reviewed here illustrate that while attention has been concentrated on a specific set of climate and transition-related risks, efforts to assess other environmental factors (such as water) have been limited. Clearly, efforts will be required to deepen understanding of yet a further set of environmental factors.
- **Linking assessment across scales**: As methodologies advance, there is increasing recognition of the importance of linking risk assessment across scales: from project level, through sectors, institutions and finally financial market and system levels.

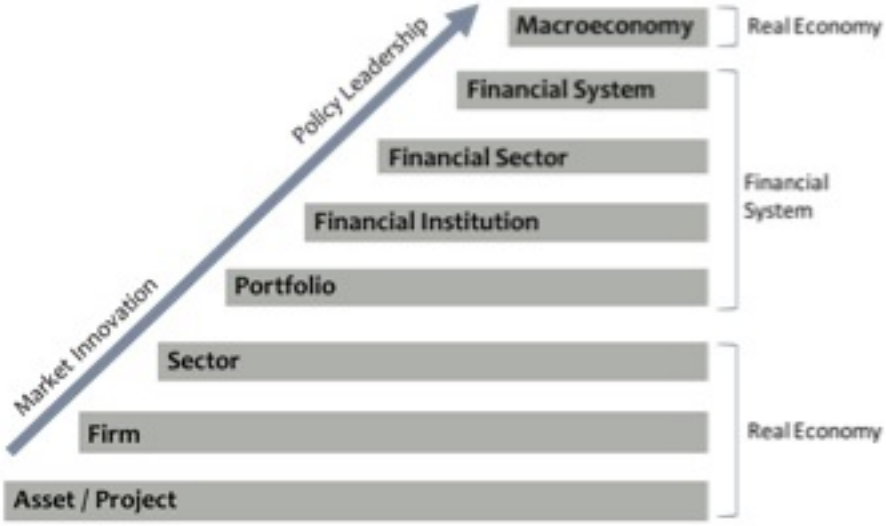

Figure 8: Risk assessment from the asset to the system levels [30]

- **Promoting coherence in scenario analysis**: There is a balance to be struck between accelerating learning through the provision of publicly available reference scenarios and not facilitating herding or acceptance of ready scenarios without putting thought into the assumptions.
- **Moving from a prudential to systemic view of environmental risks**: While important progress is being made using ERA to consider near-term, firm level prudential implications, the mobilization of private capital for green investments can be supported by institutions taking a wider view of systemic risks, and developing a high level, institution-wide, strategic framework to respond.

PUBLICLY AVAILABLE ENVIRONMENTAL DATA (PAED)

PAED is defined as environmental data that are reported by non-corporate entities, such as government agencies, international organizations, non-governmental organizations and science institutes, and that are useful for financial analysis. The work on PAED is also complementary to GFSG's research on ERA in 2017, as public data are also very important sources of information for conducting risk analyses by financial institutions.
Information is an important basis for the financial market to efficiently allocate resources across all asset classes.

Without proper environmental information, investors, lenders and insurers cannot assess a possible investment's the environmental performance. This can lead to inadequate understanding, pricing and management of environmental risks, and hence decision-making that is not optimal, which could in turn lead to volatility in asset valuations. [30].
Lately, a growing number of investors with an "ethical" agenda are focusing on the alignment of their funds to long-term societal goals, notably the Sustainable Development Goals (SDGs) and the Paris Agreement. However, this effort is quite challenging without proper and easily available environmental data. Government agencies that intend to provide incentives to green investments may also find it difficult to identify the right recipients for such incentives, when environmental information and the environmental cost/benefit analysis based on it are limited.
In addition, financial institutions constantly seek new investment opportunities, such as green projects or green assets that have positive environmental impacts. In this regard, PAED is also an important input for identifying and evaluating green financial opportunities [30].

Examples of PAED include [29], [30]:

1. **Physical asset (facility) level data**. Asset-level data refers to environmental information on physical assets, such as GHG emissions by power plants, oil operators (fields), refineries, and chemical plants, as well as SO2, NOX and wastewater emissions by facilities and factories. Such data are often collected as a mandatory requirement by the environmental authorities, and reported by either the collector or through a third party.
2. **Projections of water stress and other ecosystem pressures**. Water stress (shortage) situations may pose serious challenges to companies that depend on water supply. Rising scarcity of water implies higher costs of operations, and may result in asset impairment. Financial risk analysis and valuations of water-dependent sectors and companies therefore require quality forecasts of water demand and supply.
3. **Projections of natural disaster probabilities**. Financial firms commonly use climate change scenarios and estimations of the probability and severity/impact of natural disasters (such as flooding, droughts, windstorms, wildfires and hurricanes) for environmental risk analysis.

4. **Data on solar and wind resources**. Renewable energy has become a fast-growing green industry over the last decade. With the help of satellite technologies, many financial institutions are using data on renewable resources, such as maps of solar radiation and wind speed, to make projections on the financial outlook (productions, revenues and costs) of renewable projects.
5. **Database on existing green technologies**. Existing green/clean technologies that help enhance resource efficiency and reduce pollutions/GHG emissions can be readily applied in many countries, especially in developing countries, to speed up the pace of their green development. Information on green technologies is thus critical in generating green investment opportunities.
6. **Costs of air, water and land pollution and benefits of environmental remediation**: In assessing green investment demand, it is important to quantify the environmental benefits of green projects that can deliver environmental benefits, such as reductions in air, water and land pollution. On the other hand, air, water and land pollution from "brown projects" should be discouraged (e.g., by policy responses), based on estimated "costs" of pollution.

Challenges

As identified by the GFSG's consultation with knowledge partners and private sector institutions, a number of obstacles are constraining the effective usage of public environmental data in risk analysis and assessment of green investment opportunities [29], [30]:

- **Data presentation unsuitable to financial sector users**: for example, some meteorological data and forecasts are written in units that are not commonly used or understood by financial analysts and their economic implications are not well explained in technical reports. Further, some public data are not standardized or comparable.
- **Lack of comparable scenarios and uncertainty over future policy responses to environmental and climate challenges**: Some key assumptions for risk analysis are made by individual financial firms on an ad hoc basis, leading to potential communication problems and a lack of comparability across financial firms/industries/countries.

- **High search costs**: The analysis of risks and opportunities by financial institutions requires many different types of environmental data. However, these databases are typically located in many different sources, with some only existing in the text of certain publications.
- **Uncertainty over the business models for PAED provision**: despite having many characteristics of a public good, the public sector has not developed an effective or integrated approach in collecting, consolidating and disseminating relevant environmental data, while NGOs and many private data providers are also in an early stage of exploring ways to their provision.
- **Lack of capacities to collect and process adequate information for PAED**: In many countries, especially in some developing countries, the availability of PAED is still constrained by inadequate institutional capacity due to lack of adequate resources, and lack of investment in technologies, platforms, training and knowledge exchange.

Options for Improving the Accessibility and Usefulness of PAED on a Voluntary Basis

The GFSG, based on inputs from knowledge partners and a number of private institutions, broadly agreed that G20 members could consider the following voluntary options for further improving the availability, accessibility and relevance of PAED [30]:

- G20 members could work with other partners to promote the sharing of publicly available methodologies for ERA and for quantification of environmental costs and benefits.
- Governments could also support private sector efforts to improve the quality and user friendliness of PAED. Such efforts may include work on indicators, associated definitions and taxonomies, scenarios and forecasting methodologies and better mapping of PAED to financial assets.
- The GFSG could support the development of the UN Environment-OECD Catalogue of PAED. The PAED referenced in this Catalogue could include, among others, global databases on pollution, natural disasters, energy and other natural resources, and climate changes that are useful for financial analysis. This Catalogue, by providing the locations or web-links of PAED and being publicly available, will help reduce "information search costs" and provide a starting point for environmental risk and green investment analysis.

- Country authorities could consider encouraging domestic sharing of PAED with a focus on the need of financial analysis. For instance, they could focus on developing easier access to domestic PAED and improving its relevance to financial institutions in the local contexts.

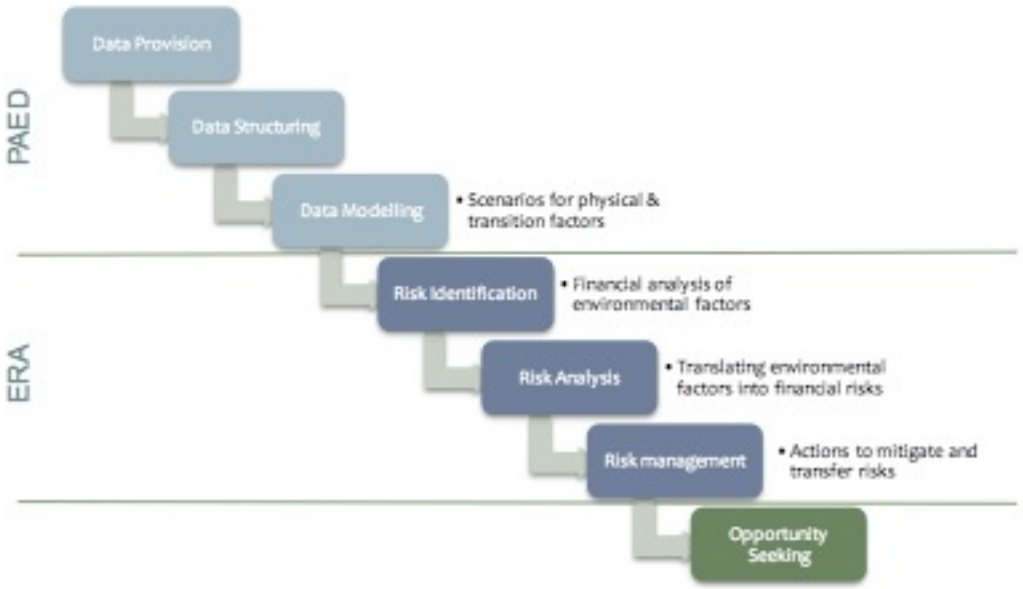

Figure 9: Seven steps to green capital mobilization [30]

Strategically, seven key steps can be identified that connect data, risk assessment and the mobilization of green investment [30].

GENERAL CHALLENGES TO GREEN FINANCE

A broad range of issues can present challenges in accessing climate finance, including [26]:

- Low levels of technical capacity to design and develop projects/ programs and to monitor and evaluate progress
- Difficulties in following the procedures of the funds to access finance, and
- Low levels of awareness of the need for action and available sources of funding.

Even taking into account the wide range of estimates of the financing needs of green investments, public financial sources will be insufficient to finance the green transformation. Hence, a significant amount of private capital is needed.
However, private green finance is still scarce due to a range of microeconomic challenges, including:

- Problems in internalizing environmental externalities
- Information asymmetry (e.g. between investors and recipients)
- Capacity concerns
- A lack of generally accepted green definitions
- Maturity mismatches.

The unclear definition of green finance leaves room for “green-washing”, with issuers of “green assets”, for example, making misleading claims about the environmentally friendly nature of their assets. Moreover, the short-term time horizon of investors does not match the long-term nature of green investment projects, which often extend over more than a decade. Moreover, many governments do not clearly signal how and to what extent they promote the green transition [6], [13].
These green finance challenges, especially internalizing externalities, exist as a result of decades of lack of awareness and political will on the part of central banks and regulators, who are captured by the fossil fuel lobby. For central banks, there is scope for exercising leadership in this area, and some countries have done so, as exemplified by China with its Green Credit Guidelines, even though such actions could raise questions about central bank independence. Regulators have largely neglected to regulate or guide banks and investors on best practices. To date, no international organization has a complete grasp of these issues [6], [13].

At he important actors for green finance should contribute to the further development and scaling up of green finance [3], [6], [13]:

- Banks should accelerate their green finance instruments, notably priority-lending requirements and capital adjustments. Banks and financial institutions should report and disclose their systemic environmental risks.
- All institutional investors should state in their annual report in which way their investment policy considers environmental, social and governance factors and disclose their carbon footprint.
- For mobilizing private capital for green projects, IFIs assume a crucial task because they can alleviate the environmental risks by offering risk-mitigating instruments and guarantees. In the same vein, IFIs are able to accumulate green projects for appropriate green financial products. In addition, IFIs, notably multilateral development banks, take on an important role in promoting the market development for green financial products.
- In order to ensure financial stability, central banks should assess the potential effects of climate change impacts, resource scarcities and other environmental issues on price and financial stability. Moreover, central banks could acknowledge high-rated (AAA) asset-backed securities as collateral for central bank loans to banks.
- Similarly, regulatory authorities should take into account environmental risks. Financial regulation such as Basel III and Solvency II should include exceptions with regard to capital and liquidity requirements for green investments.

In addition, the following are needed [3], [6], [13]:

- Clearer standards that harmonize products and lower costs across international markets.
- Smart use of concessionary public finance to lower the cost of capital for green projects, such as by: introducing an implicit government guarantee model; utilizing multilateral development banks' AAA balance sheets to raise capital for green projects; introducing "blended finance"; and offering tax-exempt status for green investments
- Extended pipelines of investable projects to apply green finance.

Role of Government

Robust and predictable policy environments are of critical importance, including everything from adequate enforcement of environmental regulations, to green-smart public procurement and through to country and international action to establish effective carbon pricing regimes. Similarly for policy action in greening financial markets, including:

- Broad policy signaling, such as through the Paris Climate Agreement, the universal adoption of the Sustainable Development Goals, and their incorporation into national plans and international processes such as the G20's investment and growth framework.
- Specific support in scaling green finance, such as through the development of standards and common metrics, by encouraging development finance institutions to harmonize their definition of what constitutes green finance.
- Encourage multilateral institutions to develop a common set of criteria for what constitutes green finance from a risk mitigation and return perspective.
- Setting specific investment standards to help grow the market and create investor certainty and mobilize investment capital.
- Demonstrating how climate shocks will affect the financial system.
- Develop government incentive programs that set clear goals regarding the investment criteria and risk appetite for green projects, with appropriate governance structures to ensure fraud protection.
- Introduce incentives to decrease the cost of capital for green projects, improve investor certainty, and mobilize investment capital into green investments [3], [6], [13].

Collaboration between government and the market can optimize the pathway to scale.
Collaboration is needed to identify opportunities and barriers, build on market innovations and design enabling policy interventions, design change pathways, and ensure robust yet flexible implementation through transparency, rapid impact feedback and ongoing dialogue.

- China's green finance plan emerged from the work of the Green Finance Task Force, co- convened by the People's Bank of China and UNEP, involved over 40 Chinese market and non-market actors, and benefited from access to international expertise.

- To improve transparency in the green finance market, utilize green indices, standardize in legal/regulatory policy "negative screens," and work with credit rating agencies to reflect the sustainability of green projects' cash flows in credit ratings (i.e. to show the pricing differential between green and non-green projects), all of which would help guide investor behavior [3], [6], [13].

Growth in blended finance vehicles to attract institutional investment

Analysis of submissions for the Global Innovation Lab for Climate Finance (the Lab), a public-private collaboration where ideas for new climate finance instruments are identified, analyzed, and stress-tested to scale up private investment, reveal that the most targeted source of private finance for new instruments are institutional investors.

There are several initiatives, including the Lab, that work to tailor investment opportunities to these investors, and/or work to equip them with the tools needed to understand these investment opportunities, with a focus on opportunities in energy efficiency, water, land use, insurance, and adaptation sectors, specifically. Most of these opportunities, however, still require some public finance – in other words, they are blended finance vehicles – a point that underscores the continued demand for public risk-taking capital or co-financing [21].

Sustainable financial centers

Building strong and liquid markets for green and sustainable finance will require international cooperation between G7 and other financial centers to develop a playing field, and encourage a "race to the top". G7 and other countries could encourage the formation of an international network of sustainable financial centers to exchange experience and promote best practice. This network could help to inspire new financial centers to take action and also cooperate on a number of priority areas, such as definitions and measurement, strengthening the pipeline and market development [31]:

1. Build convergence on key definitions, principles and measurement: Financial centers could cooperate to build convergence on key definitions, principles and ways of measuring green and sustainable finance. As part of this focus measurement, a benchmarking tool to review the contribution of financial centers to the green economy could be developed.

2. Strengthen the pipeline of green assets: Financial centers could wok together to expand the pipeline of financial assets from across the green economy including priority segments such as SMEs. A particulate focus could be placed on place-based green asset pipelines within urban areas and the financial centers' host cities, such as buildings and real estate, energy, transport, water and waste.
3. Collaborate on developing sustainable financial markets: Centers could also collaborate on the development of key financial markets, including green bonds, green loans, green equities (such as sustainable infrastructure investment trusts), digital finance (such as crowdfunding), as well as sustainability labeling initiatives for financial products

Incorporate Environmental Risk into investment decisions: various voluntary frameworks have already been developed for reporting climate risk. These are important first steps however evidence suggests that this has had little appreciable impact on financing and investment decisions so far, but more is needed. The main reforms identified are the following [16]:

- Have mandatory disclosure by companies and investors of their exposure to climate risk including more consistency of reporting, better information of the risks to companies and whether companies have in place appropriate contingency plans.
- Ensure that accounting for climate risk is readily understandable and useful for investors. Companies should be required to identify strategies for responding to climate risk.
- Stress test financial assets and business plans against different climate outcomes and their impact on government policy.
- Incorporate climate risk into sell-side research

Improving tracking and data coverage

While each of the proposals listed in this each is important to increasing the scale of green finance, greater coverage and depth of green finance tracking can provide the necessary evidence to target green finance most effectively.

Expanding data coverage and tracking of climate finance flows will assist in capturing how finance is enabling a low-carbon and climate-resilient transition, providing decision makers with better evidence to frame policy and target finance more effectively in line with global goals. In particular, key challenges and recommendations include [12], [21]:

- Improving consistency in definition(s) across countries of what constitute green finance under the international agreements while at the same time catering for flexibility prompted by national differences. How they may relate to green finance and the Sustainable Development Goals offer the potential to greatly expand reporting and flow data.
- Formalizing processes for tracking of readily available climate finance data.
- Linking with other forms of public finance data related to future financial commitments embodied in support mechanism, (e.g. feed in tariffs to be paid until 2030 for an investment financed by a bank in year 2010).
- Expanding the scope to include the non-climate flows, i.e. financial flows supporting carbon-intensive infrastructure and projects. These flows include a potential for redirection at the country level.
- Capacity building, approached on country level, would be needed to ensure a more widespread uptake and use of the methodologies and tools underpinning climate finance landscapes across Europe.
- Finally, detailed analysis on the relationship between primary and secondary financial markets, specifically project finance and capital markets, is needed to understand how pools of capital flow into new, additional investments.

In closing, whether the ambitious climate and sustainability goals can be achieved, will depend significantly on the determination with which these actors drive the development of green finance forward.

PART II: GREEN BONDS

DEFINITION/HISTORY

As we saw in the previous chapter, at the September 2016 Hangzhou Summit, G20 Heads of State welcomed seven broad financial sector options, "for voluntary implementation by countries in light of national circumstances", to achieve this goal. Two of the options, namely option 4: "**Support the development of local green bond markets**" and option 5:"**Promote international collaboration to facilitate cross-border investment in green bonds**" focus on green bonds. In this chapter we will explore in detail the history, landscape and future of green bonds, as they hold the potential to spearhead the expansion of green finance.

BOND: "debt instrument in which an investor loans money to an entity (typically corporate or governmental), which borrows the funds for a defined period at a variable of fixed interest rate." [14]

There is no specific agreed upon definition of what a green bond is. For example, is a large hydroelectric project with the clear climate benefits of producing renewable energy with low or no greenhouse gas emissions green, even if there are negative environment or social impacts? Should nuclear energy be considered green? Given the diversity of opinions, it can be challenging to establish “standard” definitions of green. The World Bank defines green bonds as fixed income, liquid financial instruments that are used to raise funds dedicated to climate-mitigation, adaptation, and other environment-friendly projects [16], [32].

Green bonds are regular bonds with one distinguishing characteristic: proceeds are earmarked for projects with environmental benefits (e.g. renewable energy, energy efficiency, clean transportation, sustainable water management, climate change adaptation, sustainable agriculture and forestry, and pollution prevention and control [24], [39]. The green bond market is the most evolved financial instrument in terms of green finance definitions and tracking [12]. As financial institutions attempt to seize opportunities in green finance and move to originate more climate-smart assets, access to long-term capital will become a larger cause of concern. Green bonds are a natural solution [10].

During the past 12 years, the green bond market has seen a great increase in depth, including a growing diversity of issuers and an enabling environment that includes guidelines and disclosure frameworks for transparency and further growth. Given their development mandate and focus on green investments, MDBs have played a key role in driving the growth of this market [32].

The concept of earmarking bond proceeds for climate investments was introduced in 2007, when the European Investment Bank (EIB) launched its Climate Awareness Bond, an equity index-linked bond that was listed in 27 domestic markets in the European Union. In 2008, the World Bank issued its first green bond, which was designed in collaboration with Skandinaviska Enskilda Banken (SEB). The aim was to respond to specific demand from Scandinavian pension funds looking for a straightforward fixed-income investment opportunity to support the transition to a more climate-resilient world, considering their long-term investment horizon as pension funds. The World Bank green bond offered investors the opportunity to invest in an AAA rated bond that supported projects meeting the World Bank's environmental and social safeguards, without facing project risk.

The World Bank's first green bond received strong support from the original pension fund investors and great interest from both the market and the media. This led to additional expressions of interest from other types of investors, such as insurance companies and asset managers. As the market grew, non- governmental organizations, capital markets associations, international climate negotiators, standard setters, regulators, rating agencies and other market stakeholders became more engaged and contributed to growth of the market [32].

LABELED GREEN BONDS

When referring to green bonds, it is important to differentiate between labeled and non-labeled green bonds. Labeled green bonds refer to bonds being marketed as green bonds, while the non-labeled green bonds universe refers to bonds that are used for green investments, but are not marketed as green bonds [34].

Labeled green bonds are bonds that are used to fund green activities and are labeled accordingly by the issuer. The green label is a tool to meet climate targets by closing the gap between funding needs and investor demand. It is a signaling mechanism to investors – an easy way to identify that investments are green. In this way, the label reduces friction in the market and enables the flow of credit from investors to green projects since it enables the

identification of climate-aligned investments with limited resources for due diligence [10], [35], [43].

Green bond issuance in 2017 is likely to break new records with $57 billion issued by the end of Q2. 2017 may be the year that the market exceeds the $100 billion mark. 25% of the climate-aligned universe is now made up of labeled green bonds. This is a marked difference compared to 2012 where there were just $7.2 billion of labeled green bonds - less than 5% of the universe [10], [35], [43].

Strong demand for labeled green bonds by the investor community

Many indicators exist that showcase investors' ever-growing demand for labeled green bonds:

- Higher oversubscription compared with non-green bonds. This oversubscription allows green bond issuers to upsize their bond.
- Commitments from banks and insurance companies to invest into labeled green bonds and the investor community's willingness to facilitate the expansion of the labeled green bond market.
- Specialized green bond funds are being launched.

The labeled green bond market has been constantly growing during the last years, showcasing the bond markets' potential to become a reliable component of the green bond market. Labeled green bonds are bonds that fund projects that qualify as green; the "greenness" of the issuer is not examined [35].

This characteristic can explain the great surge of the market for the following two reasons. First, the market brings together a greater array of issuers and investors interested in green investments. Second, it allows labeled green bonds to have comparable financial returns to non-green bonds, because the bond's risk is assessed not by the green projects themselves but rather by the issuer’s’ full balance sheet. This has allowed green activities to achieve a grade rating that cover institutional investors' needs. For example, a development bank uses its robust balance sheet to borrow funds at low cost and then invest in strategic sectors, sectors that may seem risky to investors, where it has the necessary expertise. [35].

TYPES OF BONDS

In order to become more attractive and achieve higher credit quality, bond instruments are highly customizable on how they can be structured. As a result, it makes it easier for issuers to raise money at a lower cost and at the same time it helps investors be more confident about the risk of an investment.

These instruments can be divided into three main types: **direct issuance instruments**, **aggregation instruments**, and **credit enhancement instruments**.

A newly formed securities market focuses on an expanded issuer base, hence it usually begins with plain vanilla. As the market grows and expands and the country aims to leverage its capital markets to steer finance flows towards strategic sectors, it is necessary to launch more complex instruments [34], [35], [36].

Direct issuance:

- **Plain vanilla bonds:** The vast majority of green bonds are "use-of-proceeds" bonds, whereby the proceeds are earmarked for green investments in the issuer's portfolio, and the bond's recourse is to the issuer's entire balance sheet. This has the great advantage that these bonds are backed by the issuer's complete balance sheet. Consequently, credit-rating agencies do not rate individual bonds, but this type of green bond automatically receives the same credit rating as its issuer.
- **Project bonds**: A project bond is a fixed income security issued to finance, partially or in full, the debt obligations of a single-asset infrastructure project. The income from the investment is securitized and ring-fenced to ensure payment of the bond's interest and principal, generally on a non-recourse basis. This means the creditworthiness of a project bond is linked to the expected cash flows of the project rather than the balance sheet of the project sponsor. Creditworthiness of the bond is thus based solely on the ability of the project to generate the necessary cash flows to cover the cost of the bond and provide a return to the investors. Therefore, the organization that develops the project is not liable in the case that the project fails.

In practice, project bonds are more suited for brownfield compared to greenfield projects [34], [35], [36].

Aggregation:

- **Securitization**: Securitization is a method used by the financing sector to "package" together non-tradable assets, such as loans and receivables, creating new securities in the process and selling them to investors. The bond's credit quality depends on the performance of the underlying assets instead of on the entity's balance. Emerging markets are faced with various problems when trying to develop a securitization market. These include: lack of a sufficient pipeline of underlying assets to securitized and lack of data on historical performance of assets to be securitized.
- **Covered bonds**: Covered bonds are debt securities that have common characteristics with securitizations (e.g. they are collateralized by a pool of assets, which improves the bond's credit quality). They key characteristics that distinct them from securitizations are: the underlying assets stay on the issuer's balance sheet, investors have extra security because they have dual recourse to the issuer as well as the underlying cover pool, and can be issued only by banks and specialized credit institutions [34], [35], [36].

REFINANCING

Bonds address the financial needs of green infrastructure

The role of bonds in the capital pipeline (and consequentially the expected role of green bonds) is to re-finance existing projects, providing an exit strategy for equity investors and bank lenders, not to raise money for a project's initial phases of development.

As activities and projects reach the end of their development cycle, the risk involved lowers and hence their risk-profile becomes more suitable for bond finance, making it beneficial to move from bank finance to bond finance [35].

In fact, using bond finance to refinance bank loans offers firms a lower cost of capital. This alternative can be of a paramount importance for the majority of green investments that are characterized by rather high capital expenditures. For these types of projects the cost of capital is the main factor in deciding their economic viability. In addition, as bonds usually have longer tenors compared to bank loans, companies are able to secure financing for more years, helping them reduce any refinancing risks [35].

BENEFITS

First of all, green bonds can contribute to supporting the sustainable development of financial markets because they provide transparency on the assets.
In terms of lowering the cost of capital, the cost of bond financing is likely to be lower than equity investments and other debt based financing (e.g. bank loans). Corporate finance theory proposes that fixed income products are likely to be cheaper than bank loans due to the lower monitoring costs and dispersed ownership. Dispersed ownership translated to distributed risk, hence contributing to a lower risk premium and therefore lower financing cost. In addition, bonds offer a more compatible term structure for green investments compared to bank loans. Typical bond tenures range between 7 and 15 years, aligning with the payback periods for green projects [34], [36], [37].
Moreover, the flexibility of bond instruments allow for credit to be raised from investors from the whole risk spectrum, thereby expanding the total credit pool. While investors who are in general prone to take greater risks may invest in junk bonds with high yields issued by companies or projects with poor credit ratings, more risk-averse investors can choose to invest in bonds issued by organizations or projects with strong credit ratings. Also, since bonds offer the opportunity to disperse ownership of the debt across a group of investors, financiers find it easier to invest indirectly in the green sector through bonds as opposed investing directly through loans or equity ownership. Furthermore, the presence of a secondary market for bonds promotes liquidity, thereby offering financiers a short-term exit strategy, and a shorter payback period. This is of particular interest for investors with short investment horizons [34], [36], [37].
Continuing on, in most cases, issued bonds are “plain vanilla” bonds – the simplest version of a standard bond, distinguished only by the promise that the proceeds will be used exclusively for green investments while providing the same return. Thus, these bonds are relatively simple, familiar fixed-income instruments that are no riskier than conventional bonds. With these green bonds, investors can contribute to an additional positive environmental outcome without having to get exposed to additional risks. By purchasing triple-A-rated green bonds, investors can finance green investments but bear no additional risk, but on the other hand also receive no higher yields than on other bonds.
In addition, "vanilla" bonds issued by well-rated institutions can help to reduce climate risks in investment portfolios without exposing investors to the specific risks of green technologies.

Many investors are increasingly weighing the risks related to carbon-intensive investments when making up investment portfolios. As a matter of fact, in some countries, such as France, institutional investors are now required to disclose the carbon footprints of investments. The fear that assets could be stranded due to the growing political, economic and environmental risks related to fossil fuels increases the relative attractiveness of green investments [34], [36], [37].

Finally, the MDBs' "vanilla" bonds in particular usually have enough scale to be attractive to institutional investors, especially pension funds, which require issuances exceeding $500 million. For instance, one of the first International Finance Corporation green bond issuances of $1 billion even appealed to large institutional investors such as Blackrock, the California State Teachers' Retirement System and Ford Motor Company.

To sum up, these are the benefits of green bonds for both investors and issuers:

Benefits for investors [10], [33], [38]**:**

Green bonds can:

- Balance financial returns with environmental benefits
- Satisfy Environmental, Social and Governance (ESG) requirements or green investment mandates
- Enable direct investment in the 'greening' of brown sectors
- Enable hedging against climate policy risks

Benefits for issuers:

Green bonds can:

- Provide an additional source of green financing
- Match maturity with project life
- Improve investor diversification and attract buy and hold investors
- Enhance issuer reputation
- Closer engagement with investors
- Attract strong investor demand leading to oversubscription
- Raising awareness for an issuer's activities.

GREEN VERSUS REGULAR BONDS

Anecdotal evidence has suggested that green bonds are heavily oversubscribed and may price tighter than expected. Green bonds attract a broader range of investors but overall behave in line with vanilla equivalents.

One of the reasons why a bond buyer would be willing to pay a greenium is scarcity of the green label. Investors may be compelled to buy green bonds to meet a mandate. Treasurers and book runners are on record as saying that green bonds attract a higher number, and a broader range of investors than conventional bonds, which they believe, offers stability to their debt in times of market volatility. Green bonds are oversubscribed and price better than expectations, as one would expect in current market conditions. Interest rates have remained at historical lows therefore investors have been looking for yield. In this respect, green bonds perform no differently from other categories of bonds [39].

However, after generating good demand, and pricing tight, for many green bonds, spreads tightened materially in the first seven and twenty-eight days after the announcement date, both on an absolute basis, and when measured against a corresponding index. This suggests that many green bonds are underpriced at issuance. It is not yet known whether this market behavior will persist, but this could point towards tighter pricing in the future.

For the time being, this data should allay concerns among investors about longer-term underperformance by green bonds, since there doesn't seem to be any. There is certainly no penalty attached to holding green bonds as opposed to other bonds of the same issuer and, in some instances, our analysis suggests there may be a reward [39].

PERFORMANCE

In general, green bonds are priced very close to regular bonds. The market price of green bonds is determined like any other bond in relation to market conditions at the time of issuance (rates).

To compare a green bond with a regular bond would require the issuer to issue them almost simultaneously and with almost identical terms- including currency, structure, yield, and maturity. It is generally accepted that green bonds are priced very close to regular bonds; that is, investors are not willing to give up return or pay extra for the green aspect of the bond and related reporting. However, observers of this market point to growing demand and preference for green bonds by a growing number of mainstream investors.

Anecdotally, investors in green bonds have been able to sell at higher prices than conventional bonds because of the rarity of green bonds. Depending on demand and supply trends in specific markets, differential pricing for green bonds relative to other bonds could emerge in the future [38].

Since most green bonds in the market today carry similar financial characteristics as regular bonds from the same issuer (that is, they are backed by the full credit of the issuer), one could argue that they offer limited benefit to issuers. However, reaching different investor groups is valuable to expand funding sources. In particular, green bonds have attracted investors from the growing segment focused on sustainable and responsible investing (SRI) and investors that incorporate ESG (environmental, social, and governance) criteria as part of their investment analysis. In addition to reaching different types of investors, green bonds have proven to be an effective tool to raise awareness and open intense dialogue with investors about projects that help address climate change and other environmental challenges [38].

MARKET INFRASTRUCTURE

From the foundation of the green bond market, there has been a strong focus on the integrity of the green label. This includes both the green credentials of projects and assets financed, as well as reporting arrangements, management of proceeds, and external reviews. Issuers turn to a number of initiatives and approaches to reassure investors about the environmental credibility of their bonds issuers.

The Green Bond Principles were developed by a group of underwriters, issuers and investors, and are overseen by the International Capital Market Association. They are voluntary guidelines intended for broad use by the market that recommend transparency and disclosure, and promote integrity in the development of the green bond market. They have achieved broad market acceptance as well as recognition by policy-makers and regulators. The four GBP core principles cover: use of proceeds, processes for evaluation and selection, management of proceeds, and reporting [33], [37].

The **Climate Bonds Standard** offers sector-specific eligibility criteria for assets and projects that can qualify for green bonds certified by the Climate Bonds Initiative. Strict certification requires that underlying assets have corresponding methodologies for assessment.

The **Climate Bonds Initiative** is an investor-focused not-for-profit organization, promoting large-scale investments that will deliver a global low carbon and climate resilient economy. The Initiative seeks to develop mechanisms to better align the interests of investors, companies and government so as to facilitate investments at a speed and scale sufficient to avoid dangerous climate change.

A key component of the Initiative is the **Climate Bonds Standard & Certification Scheme ("Certification Scheme")**. The Certification Scheme allows investors, governments and other stakeholders to prioritize green investments with confidence that the funds are being directed to projects that facilitate a transition to a more sustainable world. A Scientific Framework defines which types of projects and assets can be considers as "climate resilient" and "green" and as a result can be included in a Certified Climate Bond.

The Certification Scheme includes frameworks for monitoring, reporting and assurance of compliance with the Climate Bonds Standard [40].

The Climate Bonds Standard & Certification Scheme's goal is help the green bond market to grow by providing the necessary trust and assurance needed by the finance sector. Activating the mainstream debt capital markets to finance and refinance climate-aligned projects and assets is critical to achieving international climate goals, and robust labeling of green bonds is a key requirement for that mainstream participation.

The Climate Bonds Standard sets out clear criteria to verify certain green credentials of a bond or other debt instrument. It aims to provide an approach to verifying that the funds are being used to finance projects and assets that are consistent with delivering a green and more sustainable economy [40].

The **Climate Bonds Standard & Certification Scheme** is a key step, moving from the broad integrity principles contained in the Green Bond Principles to create a universally accepted certification system. Key features include:

- Total alignment with the latest version of the Green Bond Principles
- Mandatory requirements for use of proceeds, tracking, and reporting
- An assurance framework with independent assurers and established procedures
- Certification by an independent Climate Bonds Standard Board.

For investors, the Certification Scheme is a screening tool that labels bonds as Climate Bond Certified. It saves investors from having to make subjective judgments or perform due diligence on the green characteristics of certified investments. For issuers, the Certification Scheme is voluntary and allows them to demonstrate to the market that their bond meets industry standards for integrity, transparency and management of proceeds. The requirements of the Climate Bonds Standard are separated into pre-issuance requirements, which need to be met for issuers seeking certification ahead of issuance, and post-issuance requirements, which need to be met by issuers seeking continued certification following the issuance of the bond.

TAXONOMY

- **Energy** (e.g. solar, wind, bioenergy, wave and tidal)
- **Low carbon buildings** (e.g. retrofit, commercial)
- **Industry & energy-intensive commercial** (e.g. data centers, manufacturing)
- **Waste & pollution control** (e.g. waste to energy, geosequestration)
- **Transport** (e.g. rail, mass transit, vehicles)
- **Information technology & communications** (e.g. broadband, resource efficiency)
- **Nature based assets** (e.g. wetlands, fisheries & aquaculture)
- **Water** (e.g. water treatment plants, flood defenses)

National green bond standards

In addition to these international standards, national standards have been put in place, for example in China, India, Brazil, and France. However, international and national guidelines for eligible green bond projects sometimes have big differences. For example, the Chinese guidelines established by the Peoples' Bank of China include some fossil fuel projects such as efficiency upgrades to coal- fired power plants; however, these are excluded from the Climate Bonds Standard and from some green bond indices.

On the one hand, local definitions and disclosure requirements for green assets are crucial to meeting local requirements because environmental challenges differ across countries. But on the other, it is also important to align local guidelines with global and regional ones, in particular if international investors are involved. Differences in definitions, as in the case of China, could generate higher transaction costs because investors need to assess these various standards [33], [37].

In addition, standards at the national level sometimes differ greatly. For example, China has even established different national green bonds standards. While different guidelines could be helpful in addressing the specific features of different bond issuers, it is difficult for investors to assess the various guidelines and to verify how green each respective bond is. In case diverse standards are needed transparency on the differences is key.

Second opinions" Before issuing a green bond, issuers can commission a second opinion on their green bonds. These evaluators assess the green credentials and the issuance framework of the proposed bond. The main second opinion- providers tend to be research institutes or consulting agencies such as CICERO (Center for International Climate Research), Oekom, Deloitte, EY (Ernst & Young), and Vigeo Eiris [33], [37].

Third-party assurance is available from approved verifiers, providing audit-style opinions ahead of issuance and throughout the bond's lifetime. If provided by accredited auditors, these audits will be carried out in line with industry standards dictating rigor and transparency [33], [37].

Regulatory guidelines have been published by China and India. The former, from the central bank, specifies which assets can be financed by green bonds issuance. The Securities and Exchange Board of India, meanwhile, has taken an approach closer to the Green Bond Principles, focusing on process rather than prescribing project types [33], [37].

Green ratings

Green ratings address an emerging demand for a graduated approach to 'greenness' where light green indicates minimal environmental benefit and dark green represents significant benefit. Credit-rating agencies assume a crucial role in promoting green bond standards because they monitor and verify green bonds continuously. This is important for investors with a medium-term investment horizon. Since most of these assessments have not been implemented over a longer time period, it is too early to evaluate the different methodologies. Internationally, this approach has been led by CICERO (Shades of green), Moody's (Green Bonds Assessment) and more recently Standard & Poor's [33], [37].

Stock exchanges

Stock exchanges constitute important actors in the growth of green bond markets. This is because they can: facilitate investor decisions by providing financial services such as guidance, training and tools for investors; provide access to a wide range of investors including large institutional investors such as pension funds, mutual funds and insurance companies as well as small and medium-sized institutions and even individuals and in addition, listing green bonds on exchanges gives issuers access to a deeper pool of investment capital; improve the liquidity of green bonds by enabling greater market connectivity and more centralized liquidity than the over-the-counter (OTC) market. Currently, 4 global stock exchanges have dedicated green bonds lists: Luxembourg Stock Exchange, Oslo Stock Exchange, London Stock Exchange and Bolsa Mexicana de Valores (BMV).

With their unique role, stock exchanges can facilitate the acceleration of the growth of the green bond market. They can promote green bond transparency by encouraging both the application and development of robust standards; develop green bond guidelines for reporting on the intended and actual use of proceeds and clarify criteria for the eligibility of projects; create a specialized green bond list or a dedicated segment that would enable investors to easily discover and invest in assets addressing climate change; support green bond indices and ETFs that could make it easier for investors to track the performance of green bonds, and compare returns and volatility with other investments; and implement market education and foster dialogue by providing educational resources and expert assistance [33], [41].

Index providers

Green bond indices enable the measurement of the financial performance of a portfolio of green bonds against that of regular bonds. Index providers can support green bond standardization by including or excluding entities from their indices based on certain rules. In this way, providers of green bond indices certify and continuously monitor them. Important green bond indices have been issued by Barclays MSCI, Bank of America Merrill Lynch, S&P, and Solactive. While each index adopts different methodologies for selecting green bonds for the index, their assessments have all been based on the GBPs and some of them also adopt the Climate Bonds taxonomy [33], [37], [41].

REPORTING

Most market guidelines require that use of proceeds reporting is disclosed at least annually after issuance. While impact reporting is not mandatory in any guidelines, it is increasingly being seen as best practice.

Why is reporting important

Post-issuance reporting is a core element of the Green Bond Principles, the Climate Bonds Standard and other guidelines. Post- issuance reporting is critical to ensure the integrity of the market.

Market accountability not only rests on promises made at issuance but also on how these are followed up on during the life of the assets or projects financed. By reporting, issuers have a unique opportunity to engage with bondholders, potential investors and other market participants by showing the positive climate impact that has been achieved through the green bond [42].

What is impact reporting?

The term 'impact reporting' is used to define any type of reporting that seeks to quantify the climate or environmental impact of a project/asset numerically. Impact reporting can be very helpful to investors as they seek to measure the positive externalities through their investments. Impact reporting is gaining prominence in the green bond market. Many market commentators see it as increasingly important as the issuer base widens - across geographic regions, across ratings bands, and as the asset base widens from the mainstays of renewable energy to fossil fuel companies. However, for many it remains a burdensome task that could have the potential to shy issuers away from the market. This section explores the topic of impact reporting and its usefulness in the market.

While numbers can be useful, they can also be misleading without a baseline or benchmark. For example - how much is a million tons of carbon saved or a million tons of water cleaned? Without baselines, numbers on their own can be meaningless. Big numbers do not always imply high impact when one does not know the local or sector context. Fossil fuel plants are a classic example where efficiency measures can reduce huge amounts of emissions, but also tend to extend the life of a plant – leading to entrenchment of a technology that is not in line with a low carbon economy [42].

There can also be a mismatch between the life of the bond and the life of the projects' operation. Absolute metrics do not always allow for the distinction between impacts over the life of the bond vs impact over the life of the project, as these are usually not the same. While impact reporting is increasingly seen as the best of best practice, investors have been cautious to expect impact reporting for all types of issuers and all types of projects. In particular, smaller issuers with small bond programs are not generally expected to provide impact reporting because of the resources that it takes to produce [42].

Further, in 'easy' sectors like wind power or solar power, the call for impact reporting is not as strong. Comparatively, applying clear metrics in other sectors such as the built environment can help differentiate an efficient building from conventional ones.

There is currently very limited consistency between metrics used in impact reporting.

For example, for greenhouse gas emissions some issuers report on net savings while others use intensity, and data varies from totally to monthly to bi-annual. The diagram above shows some of the most widely used metrics. If impact reporting is to become the norm, a more consistent group of metrics will be required.

The research and data conducted for this report indicates that while reporting is taking place in the market, much improvement needs to be made for the market to maintain its integrity, particularly in the following areas [42]:

1. Poor comparability

Reporting varies widely across issuers both in content and format. While issuers have their own reporting style and context, the range of reporting makes it difficult to compare and evaluate reporting across issuers or sectors.

2. Meeting recommended guidance

While reporting is good in some areas, reporting fails to meet some basic market guidelines. In particular:

- Percentage of proceeds allocated to refinancing and new projects
- Project-specific information
- Allocation of proceeds throughout the life of the bond
- How projects are in line with Green Bond Framework
- Timelines of reporting

3. Failure to report

While in the minority, there is still no reporting for around a quarter of bonds analysed - we hope to see this drop to almost zero in future reports. In particular, smaller issuers, private placements and U.S. municipal issuers reporting was lower than banks and government agencies. While reporting is less important for some assets or issuer types, all issuers should provide at least a basic level of reporting [42].

Clearer expectations from market guidelines

- One finding that became apparent during the research phase of this report is that while market guidelines have clear expectations of issuer disclosure at the point of issuance, it is not clear if the same or different disclosure is expected following issuance.
- Market guidelines, listing requirements and green bond regulations could promote good reporting by having clear guidance on what constitutes good reporting.

Database of reporting

- To increase investor access to reporting, a reporting library or database would be helpful to ensure that all reporting is in place, on time and very easy for issuers to access.
- Possible hosts of a reporting library could include ICMA and the Green Bond Principles, Climate Bonds Initiative, exchanges and/or regulators.

Template for basic reporting

- Regulators or standard setters could assist in the development of the market by publishing a basic reporting template or checklist that issuers can use when putting together reporting. This may also bring down the cost of reporting resources, which are necessary for issuers who can make use of template tools to standardize reporting [42].

STATUS OF THE MARKET

As mentioned in Part I, at the September 2016 Hangzhou Summit, G20 Heads of State welcomed seven broad financial sector options, "for voluntary implementation by countries in light of national circumstances", to achieve green finance growth. Two of the seven options focused on green bonds. These options are presented in more detail below:

Support the Development of Local Green Bond Markets

Green bond markets provide an alternative source of long term green finance, something that is particularly important for countries where demand for green investment is high but supply of long-term bank loans is limited. Governments have been playing an active role across a range of scales (e.g. national, municipal) and development banks are increasing their support. Partly as a result of government efforts in developing local currency bond markets, total green bond issuance in the world expanded rapidly. Examples of government and international initiatives include [29]:

- China: In 2016, after the launch of a domestic green bond catalogue and green bond guidelines, issuance of green bonds reached $34 billion compared to $1 billion in 2015. The China Security Regulatory Commission issued guidelines for green bonds issued by listed corporates in March 2017.
- France: The government issued (January 2017) a long dated (22 years) sovereign green bond (€7 billion) aiming to promote the consolidation of best market practices (especially in terms of evaluation and impact reporting) and support the development of the green bond market.
- Germany: besides the ongoing issuance activities of German Public Banks as well as investment activities (e.g., KfW Green Bond Portfolio), the Association of German Public Banks (VÖB) started the “Green Bond Initiative Deutschland” to raise awareness and support capacity building.
- Japan: the Metropolitan Government of Tokyo announced plans for issuing green bonds.
- Mexico: the Mexican development bank Nacional Financiera issued the first green bond in local currency and the Mexican Banking Association has been playing a critical role in scaling up a local market.

- Singapore: the Monetary Authority of Singapore introduced a Green Bond Grant scheme to encourage the issuance of green bonds. Under the scheme, qualifying issuances can offset the costs attributable to obtaining an external review for green bonds.
- Internationally: the IFC is developing the Green Bond Cornerstone Programme.

Promote International Collaboration

Cross-border investment can support development of local bond markets and reduce the funding costs. International collaboration has not being developing at the same pace as local green bond market development due to various barriers that include: inconsistencies in local definitions, disclosure requirements and capital controls. Most of the developments in this area are mainly driven by bilateral cooperation (particularly between developed and developing countries). Examples include [29]:

- Canada: the provinces of Ontario and Quebec issued their latest green bonds as global bonds, encouraging in practice cross-border investment. 40% of Quebec's issuance was purchased by international investors.
- France: The government authorized the launch of the first green bonds ETF tracking a portfolio of 116 investment grade green bonds (March 2017).
- South Africa: the Johannesburg Stock Exchange (JSE) is developing green bond listing requirements in line with international best practice.
- UK: collaboration with China led to the issuance of the first Chinese green covered bond listed on the London Stock Exchange (November 2016).

GREEN BOND MARKET DEVELOPMENTS

The first sovereign green bond was issued in late 2016 making sovereign green bonds the talk of 2017. Europe has been at the forefront of this development with Poland being the first sovereign to issue a green bond in December 2016. This benchmark-sized bond raised €750m and was quickly followed in January of 2017 by France who issued the largest green bond to date at €7 bn. We expect more sovereigns to issue in the coming months and year with Nigeria, Sweden, and Kenya all likely contenders [43].

Strong demand continues to drive the market with oversubscription being the norm.
Development banks have maintained a strong presence and leadership role in the market despite the fact that they have been outgrown by corporate and sub-sovereign issuers.
In some countries, corporates and commercial banks make up a large proportion of issuance – e.g. the Netherlands (69% by value) and France (65% by value). In other countries, it is lower – in Germany, corporates and commercial banks account for just 20%.
External reviews in the form of second opinions and third-party certification are vital for maintaining transparency and credibility in a market. Over the past few years there has been an increase in the percentage of bonds that have had external reviews. By value, the percentage of green bond issuance, which has received an external review, has been steadily increasing from 65% in 2015, to 77% in 2016 and to 82% so far in 2017 [43].
Of the bonds that have received an external review, Climate Bonds certification is gaining momentum with Certified issuance increasing from just 4% of total issuance in 2015 to 9% in 2016 and 11% in 2017 year to date.
The majority of the green bond proceeds has been allocated to renewable energy and green buildings projects that, combined, amount to 64% of the total. They are then followed by transport and water, which account for 14% and 10% respectively. Waste management, adaptation, and land use each account for 3-5% of use of proceeds. Transport and Water have seen the largest percentage increase from last year's report. One reason for this is the rising number of rail bonds this year in Europe as well as from numerous U.S. transit authorities [43].

Post-issuance reporting is improving but comparison remains challenging. For bonds issued before April 2016, 74% have post-issuance reporting publicly available. The quality of reporting is varied with more prolific issuers likely to have better reporting standards in place.

Top 3 actions the public sector took in 2017 [43]

1. Sovereign green bonds

Green sovereign bonds are seen as a key tool for governments to raise capital to implement infrastructure plans in line with NDCs. Determining how to finance NDC implementation strategies and laying out capital raising plans are the next steps towards meeting the targets. Besides raising capital, a sovereign green bond can attract new investors, improve collaboration between finance ministries and, most importantly, provide policy certainty within the country.

2. Country-level green Bond guidelines

In 2016, China was a clear example of how national green bond guidelines can stimulate market growth. Here are the latest developments:

• Japan's ministry of environment released green bond guidelines in March 2017, which form a foundation for future guidelines from financial regulators.

• Taiwan, the Taipei exchange, with oversight from the financial Supervisory Commission issued guidelines endorsing the Climate Bonds Standard and Green Bond Principles (GBP) to identify green bonds.

• Luxembourg's ministry of Finance has endorsed a new green bond label scheme launched by the independent non-profit Luxembourg finance Labeling agency (LuxfLaG).

• The Johannesburg stock exchange in South Africa and the Nairobi securities exchange in Kenya are undergoing stakeholder consultations for national guidelines.

3. International and regional collaboration

The EU has put finance and sustainability high on the EU policy agenda. Sustainability is now part of the financial stability and climate agenda. The EU high-Level expert Group on Sustainable finance has made preliminary recommendations that include establishing a standard and label for green bonds, and developing capital raising plans for sustainable infrastructure. Through the expert Group, the European Investment Bank (EIB) is also leading efforts together with Climate Bonds to develop a common EU taxonomy [43].

7 TRENDS TO WATCH IN 2018

Despite 2017 being a positive year, for global finance and its actors to be making a substantial impact on climate targets, the green bond market needs to reach $1 trillion by 2020 [44].

1. More sovereign issuance from developed and emerging economies as more governments look to finance climate resilient infrastructure and achieve their NDC commitments. The pioneers from 2016 and 2017 will be case studies to encourage potential participants.

2. Progress on common international standards and definitions for green bonds, with the launch of European Taxonomy for sustainable finance expected in H1 2018.

3. Sub-sovereigns will continue to drive market growth spearheaded by US Municipals.

4. Regulators will keep innovating with more guidelines, regulations and incentives being put in place. European Commission consideration of lower capital requirements for lending against energy efficient buildings and electric cars is an example.

5. Pressure to grow on the banking sector to lift green lending along with investor demands on the largest corporate emitters to demonstrate more brown-to-green financing to help meet Paris targets.

6. Increased linkages between green bonds, green finance and SDGs, particularly as a source of finance for goals 6, 7, 9, 11, 13 and 15.

7. 60% growth on 2017 figures. But the aim is to keep doubling labeled issuance volume to top USD1tn by end 2020.

GREEN CITIES/ MUNICIPALITIES

Bonds can be an important tool to helping cities and sovereign authorities to raise the finance required to meet sustainable development targets. Cities, responsible for 70% of emissions, have a major role to play in addressing the climate-friendly infrastructure challenge, especially now that the world becomes increasingly urbanized.
Bonds, some of which are labeled green, have been used by cities and related agencies to finance climate and other infrastructure for decades. Since the first labeled green city bond was issued in 2013, over 180 labeled green city bonds from 13 countries have come to market. This includes bonds from cities, municipalities, transport authorities, water utilities and municipal banks [35], [43], [45].

Green city bonds: Europe on the epicenter

Over the next 20 years, €180bn in additional annual investment will be needed to meet the EU's 2030 climate and energy targets. The biggest investment gaps relate to energy efficiency in buildings and transport, and are more substantial in Central and Eastern Europe. European cities were the first to issue green-labeled bonds with Nordic cities (Gothenburg) and French regions (Ile de france) being among the first. 19 separate cities and city-related entities have issued labeled green bonds in Europe. Pioneers have included Nordic municipality debt aggregators such as kommunalbanken. They enable small municipalities to access low cost capital by issuing senior unsecured bonds backed by a highly rated aggregator (owned by the sovereign government). The result is highly rated bonds and low cost of capital for small cities and municipalities [35], [43], [45].

European investors are leading demand for green investment.

There are over 15 dedicated green fixed income funds for the European market. Some are dedicated to labeled green bonds while others include unlabeled climate-aligned bonds.

Furthermore, municipal bonds are one financing tool well suited to close the U.S. infrastructure investment gap. Different types of investors are attracted to the muni bond market, but individuals are the dominant investors, either directly as individual retail investors or through mutual funds, accounting for more than 70 percent of the market [45].

This is largely because the vast majority of muni bonds are issued as tax-exempt instruments: of the $3.7 trillion in outstanding muni bonds, only approximately $600 billion are taxable. Because individuals tend to have significant tax liability, tax-exempt muni bonds are attractive investment opportunities. Some federal programs also offer additional subsidies to attract tax-exempt investors, such as pension funds, to the U.S. muni bond market [45].

Green bonds combine the trusted municipal bond market with features that provide additional benefits to cities and investors.

The U.S. Green City Bonds Coalition—set up by the Climate Bonds Initiative, C40 Cities Climate Leadership Group, CDP, Natural Resources Defense Council, Ceres, and As You Sow—is part of a global partnership seeking to catalyze the growth of an active green bond market to help cities and municipalities take advantage of this opportunity. The Coalition offers educational materials, workshops, and seminars to cities in the United States and around the world [45].

Three reasons to issue green muni bonds

The momentum and strong demand from investors in the green bond market, together with the great number of municipal green infrastructure projects requiring financing, provide a good reason for an issuer to pursue the issuance of Green Muni Bonds. Green Muni Bonds offer an array of benefits, including [45]:

- **Attract more and different investors**. Green Muni Bonds attract investors that are not normally active in the muni bond market, funds that have green mandates, and other institutional investors searching for an environmentally positive way to earn income. For example, DC Water gained $100 million in orders from SRI investors for their $350 million inaugural green bond that their CFO stated they otherwise would not have received.
- **Involve residents**. Green Municipal Bonds help to showcase an issuer's commitment to long-term green growth, while at the same time allowing residents to invest in their own communities by taking part in a green bond offering. This represents a really attractive investment opportunity for residents, who receive the double benefits of tax-exempt income from the Green Muni Bond purchase along with improvements to their communities.

- **Increase collaboration between local government departments**. Issuing Green Muni Bonds requires finance, sustainability, and other departments of city and state governments to cooperate to plan and manage the process. Issuing green bonds has led to greater teamwork and synergies across different parts of government. In the longer run, the availability of green finance will lead to greater internal focus on green projects.

Yet, in many developing economies, sub-national entities are not yet ready for bond issuance. The following solutions can help them develop this market [35]:

- Capacity building to ensure robust fiscal and debt management policies and practices, as well as adequate and transparent financial management and accounting practices;
- Governments and multilateral institutions can provide credit enhancement; and
- Tax incentives for an initial period, could facilitate market growth.

FIVE THEMES OF THE GREEN BOND ECOSYSTEM

Having explored the history, benefits and current status of the green bonds, we'd be amiss if we did not present the challenges facing the green bond market, along with some key policy actions available that could help overcome these challenges. In order to stress that green bonds are not by any means perfect, we will present a small part the views of some market stakeholders, who are expressing their concerns for an EY publication regarding the green bond market [46]:

“A profound problem with the green bond market is the lack of additionality,” articulates Steve Waygood, Chief Responsible Investment Officer at London-based Aviva Investors, the asset management of the financial services firm. “Where is the new green infrastructure and renewable kit that has been financed with green bonds? Both investors and policymakers need to be aware that the vast majority is repackaging and refinancing existing projects.”

While this may be true, Sean Kidney, CEO of the Climate Bonds Initiative, remains unconcerned and says: “Bonds are not a project financing tool. What you use the bond market for is refinancing,” freeing up space on corporate balance sheets to allow new projects to be developed. What Kidney is more concerned about is governments stepping forward to bring new projects forward that they can then finance with green bonds.

Mathew Nelson, EY Asia-Pacific Climate Change and Sustainability Leader, has a more profound argument against those demanding that projects funded by green bonds be additional. “It isn’t the responsibility of the green bond market to push down emissions — that’s the responsibility of government policy,” he says. “The reason people should be investing in green bonds is because they see their potential for more attractive risk-adjusted returns over other debt instruments because the underlying assets will perform better in a low-carbon economy.

“The fundamentals of the green bond market are about financial return — otherwise, the danger is the market becomes part of the corporate responsibility agenda.”

The challenges and associated policy actions will be based on a study by the Climate Bonds Initiative [35], which divides the green bond market ecosystem in 5 categories/ themes. We have concluded from our research that this approach presents an accurate representation of the intricacies of the market and hence will facilitate understanding.

These **five categories that constitute a bond market ecosystem are [35]:**

A: **Market development and environment**

B: **Issuance**: facilitating supply

C: I**nstruments:** scaling up the deal flow suitable for green bond issuance

D: **Investment**: facilitating demand

E: **Cooperation**

A: MARKET DEVELOPMENT

Challenges [34], [35], [36]

For a green bond market to start developing, many different enabling conditions related to the broader enabling environment need to be in place. To begin, the foundation of a strong green bond market is the existence of clear and universally accepted guidelines and standards for defining what is green and what is not. This is due to the fact that both investors and government need to know that the risk of "greenwashing" is minimized. The former want to be sure that the green bonds they choose have indeed the advertised environmental benefits and the latter want the assurance that the green bonds will fund projects with a sufficient contribution towards meeting their environmental targets. Both of them want to be able to assess the "greenness" of a bond with a minimum spending of funds.

At the time of writing, there are no universally accepted standards for what constitutes a green investment. This means that any interested parties will have to spend a good amount of money and resources in assessing the green credentials of labeled green bonds. In addition, economies of scale that can help bring down costs to provide the coveted assurance to market stakeholders on environmental credentials cannot yet be achieved.

POLICY ACTION POINTS [35]**:**

- Provide assistance in standards development for labeled green bonds that would facilitate the compatibility of incentives and markets [34], [35]
- Promote and facilitate clear guidelines for reporting and an external assurance of adherence to the standards
- By demanding stricter reporting requirements on the green performance for all bonds, the costs of green bond disclosure and reporting will be reduced.
- Credit-rating agencies should ensure that green bond indices increase transparency on the green bond market by defining specific criteria.

B: ISSUANCE

Challenges

Issuance levels are not currently to the levels that would satisfy investor's demand. This demand still exceeds the current supply of green bonds.

Limited Bankable Green projects [35], [36]

The short supply of bankable green projects that can be considered fitting for financing is a key limitation of the labeled green bond issuance. A healthy pipeline of green investments can be achieved by trying to address the following: poor prioritization of strategic green projects by governments; low clarity about the green project pipeline (e.g. number and types of available investments) among investors does not allow them to perform sufficient planning. If investors believe investable green bond projects are rather limited, they will not go into the trouble of developing the necessary capacities that would allow them to invest. On the other hand, if governments see that investors do not possess the required capabilities, they will become less certain there will be investors ready to invest in green projects.

Capacity building for issuers

Convincing issuers who indeed have portfolios of suitable green projects to enter the green bond market constitutes an additional barrier.

There is a need to educate issuers on how to actually issue a green bond and about the advantages and disadvantages of green bonds compared to vanilla bonds.

POLICY ACTION POINTS [35]**:**

Category 1: Bolster pipeline planning and transparency:

- Facilitate pipeline planning and transparency
- Ensure pipeline transparency
- Encourage participation in the collaborative Green infrastructure Investment Coalition between investors, governments and development banks in order to provide guidance in the process of development a green project pipeline

Category 2: Support strategic green bond issuance from public entities

- Support national governments, municipalities, cities, development and green banks in issuing green bonds [35], [47].
- In order to make their access to the green bond market easier, provide capacity building and assistance on technical topics along with potential credit enhancement and/or tax incentives

C: INSTRUMENTS

Challenges

During the first steps in the development of a bond market, the existence of a multitude of instruments (e.g. municipal bonds, corporate bonds, project bonds, covered bonds, etc.) can provide diversification and scale as it allows more issuers to enter the market.

Small-Scale projects and lack of aggregation mechanisms

Developing aggregation instruments, such as asset-backed securities (ABS) and covered bonds - the most common aggregation mechanisms- remains an issue for green bond markets. This happens because green projects are usually smaller in scale compared to regular infrastructure investments.

Certain barriers exist on the supply-side that do not allow private market stakeholders from making using of ABS and covered bonds at a larger scale. In order to allow the securitization and covered bond markets to grow, there needs to be an adequate pipeline of underlying assets. In addition, developing countries are also faced with the key barrier of developing regulatory and legal frameworks to authorize both ABS and covered bonds as financial instruments.

Insufficient credit ratings

Furthermore, for many institutional investors to enter the market, they need to see that the risk-return of green bonds is at least at the same levels as the normal bonds'. How and to whom the risk of green projects is placed depends on the type of green bond. For example, green general obligation bonds place the risk with issuers, whereas asset-backed bonds place the risk with investors.

For green asset-backed securities, the rating is determined by the green project risk, and the possibly higher risk of green projects used in the market can be an important barrier for scaling issuance.

POLICY ACTION POINTS [35]**:**

i. Product development

- Development of standard contracts for green projects and assets
- Facilitate the use of standard contracts for green loans
- Creation of warehousing facilities for aggregation
- Further development of green covered bonds (especially for covered bonds for mortgages) and the inclusion of green assets in covered bond regulatory frameworks.

ii. Improving risk-return profile

- Development banks can use the existing credit enhancement toolkit available to them (Guarantees, first loss debt) to support the green bond markets
- Green banks, Climate Funds could offer credit enhancement and cornerstone investment to green bonds

- Government treasuries may offer sovereign guarantees by establishing green infrastructure guarantee schemes to credit enhance selected green infrastructure bonds
- Policy risk insurance could start exploring how it can address policy risk for investors

D: INVESTMENT

Challenges

Even though the investor demand for green projects currently exceeds the supply, this is mainly true in developed countries, due to the fact that the institutional investor base in developing countries is not as developed. Moreover, as the issuance grows, demand from investor must continue to grow. Hence, demand-side support from the public sector is important.

Capacity constraints

There are still many factors that would not allow investors to continue investing if the green project pipeline keeps expanding. The newness of the market and the limited understanding of the risk-return involved, can act as capacity constraints to investment in green bonds. Some additional constraints involve the lack of historic data and credit ratings.

Climate risk integration

Currently, risk assessments do not assign full weightings to climate change and other non-financial risks and tend to focus mainly of the financial part. This can be attributed partly to the lack of quantitative data that can showcase that some green assets outperform (e.g. the emerging evidence that mortgages to energy efficient homes have a lower default rate than other mortgages, controlling for factors such as income). In contrast, high-carbon assets can be considered riskier than currently assessed, because they could become 'stranded assets' as the world transitions to low-carbon.

POLICY ACTION POINTS [35]**:**

I. Capacity Building

II. Tax incentives [35], [36], [47]
    - Governments could include green bonds to current tax-exemption schemes
    - Establishment of specific tax incentives by governments for green bond issuers and investors
    - Governments should work together to harmonize tax incentives
III. Strategic green bond investment from public funds
IV. Central banks bond purchasing programs
V. Re-adjusting risk weighting for green bonds

E: COOPERATION

Cooperation applies to all the other categories presented above. Collaboration is key, not only between the different stakeholders at the national level – mainly between the public sector, investors and companies – but also on the global level.

Challenges

Cooperation among the most important stakeholders is a fundamental requirement of developing a robust green bond market, since the market is still developing and it evolves a wider array of stakeholders compared to the regular bond market. Especially in developing countries, where the development of the green bond market may take place in tandem with the development of the regular one, collaboration between all applicable interested parties is of paramount importance.

The need and importance of international collaboration for the development of the green bond market is getting higher, as various initiatives are launched in various countries. In order to achieve the intended impact, these initiatives need to developed in a higher paec and ideally coordinated.

PART III: GREEN BONDS IN GREECE

TERNA ENERGY is a member of GEK TERNA Group of Companies and was incorporated in 1997 as a subsidiary of TERNA S.A.

As described in the company website: "*TERNA ENERGY acknowledges and focuses on the priority that green energy has in achieving a sustainable world. They consider that energy is the key driver for the development of our society and they are committed in building a sustainable energy future by increasing the use of Renewable Energy Sources (RES) [51].*

TERNA ENERGY focuses on establishing a competitive position in the RES projects' chain, from development to energy production, building a robust portfolio of technologies, with a leading presence both in Greece and abroad.

The company's priorities are the following [51]:

- *To significantly expand the installed capacity.*
- *Further strengthening its leadership position in Greece and expanding its international presence.*
- *Holding a diversified portfolio of technologies, maintaining a strong position in wind and expanding in solar, hydro and biomass.*
- *Exploiting the GROUP's competencies in the RES value chain by gaining experience in areas such as sub-marine energy transmission cable laying, pumped energy storage and batteries.*

TERNA ENERGY has a solid position in Wind Energy, in Hydroelectric Projects, Solar Energy as well as Waste to Energy and Biomass Projects.

TERNA ENERGY is active in the RES production carrying out three distinctive as well as complementary objectives [51]:

- *The company invests its own capital in the development of new electrical energy production units.*
- *The company develops new installations by utilizing its specialized personnel and own infrastructure / equipment: for the wind measurement, energy capacity planning, permission and construction procedures.*
- *It owns and commercially operates its energy units*."

TERNA ENERGY's FIRST GREEN BOND

On March 2017, TERNA ENERGY announced the start of the procedure for the issuance of the first green bond in Greece. The public offering lasted till July 19th, 2017. In total, sixty thousand common bonds, priced €1,000 each were offered. TERNA ENERGY aimed to collect at least €60 million from this bond. The duration was designed to be five years and the main concessionaires were AlphaBank and Eurobank Ergasias. The range of the interest rate was set between 3,75% and 4,25% even though the company, with its top rating, could have achieved a lower rate. This strategic decision was made in order to make the bond extremely attractive to investors and to build a relationship of trust between the investor community and the GEK TERNA Group.

This bond was the first green bond issued in Greece, following the rising momentum of the green bond market all over the world. The capital raised from the bond's issuance was exclusively used for investment in the green sector, and more specifically for the construction of two wind farms in Macedonia, one wind farm in the United States and for the development of waste treatment facilities in Epirus and Peloponnesus through Public Private Partnerships (PPP) with these prefectures.

The bond was a big success since it generated great demand from the investor community. According to the main concessionaires' announcement, the registration on the offer book reached €154,4 million during the three days of the public offering. As a result, the company exceeded by 2,7 times the €60 million. Another important fact was the great demand by small investors. The final yield of the bond was set at 3,85%. The success of the bond highlighted the investor's trust and willingness towards green investments and the green sector in Greece.

GEK TERNA's GREEN BOND

Following the successful issuance of TERNA ENERGY's first green bond, GEK TERNA announced a public offer for a common bond worth up to €120 million on March 27-29, 2018. Under the plan, the company will issue up to 120,000 common, anonymous bonds. The yield range was set to be between 3,85% and 4,40%, and the bond's duration will be seven years. The proceeds will be used to finance the company's investment program and for the refinancing of its debt.

The investment program focuses on strengthening long-term, repeated income through investments in basic infrastructure and environmental projects.

At the time of writing, neither of the bonds has been labeled as "green" by the issuer. This means that the labeled green bond market in Greece remains nonexistent well into 2018. Drawing from our experience and our interactions with market actors, there is a demand for green bond labeling in the construction sector and is our belief that during 2018, Greece will have its first labeled green bond.

Now, examining TERNA ENERGY's first green bond, the proceeds of which were split 70% to wind farms and 30% to waste management facilities, assuming that the company wanted to certify it against the Green Bond Standard criteria, would that have been possible almost one year after issuance?
In this hypothetical scenario, the company would have to contact an external body that would provide an assurance statement to the Climate Bonds Standard, verifying that the bond was in accordance with the relevant criteria.
Examining the Climate Bond Standard's criteria for different types of projects, we observed that even though a set of criteria exist for wind farms, the criteria for waste management projects has not yet been issued. This would present a major hurdle in TERNA ENERGY's hypothetical attempt to certify its bond. In practice, after carefully studying the certification process, TERNA ENERGY would have to wait for the waste criteria to enter public consultation in order for them to become available to the external assurance provider. As of June 2018, we've contacted the Climate Bonds Standard and were informed that the waste criteria will probably become available in the next two or three months. This example showcased that even if a company had the desire to label its bond as "green", the conditions are not yet ripe as to fully facilitate investor desire to enter the green bond market.

By exploring the state of the green bond market in Greece, we can highlight the below key points:

- The investor demand for green bonds issued by respected, highly rated companies is very high since both green bonds were oversubscribed.
- Given this great demand, the market actors should firstly focus on the second out of the five themes examined in the previous sections, namely issuance.

- The supply of green bond investments and projects should be greatly expanded by encouraging strategic green bond issuance from public entities and fostering pipeline planning and transparency. Taking into account the ongoing economic crisis facing the country, there is great potential to be unlocked for municipal and city bonds. By utilizing bond instruments, authorities can start relying on residents who want to help make their communities greener rather than traditional financial institutions and their strict lending policies.

In closing, drawing from the example of China, who has been in the forefront of the green bond market from its conception, following are 9 policy tools have proven effective for stimulating growth in the Country and may prove to be beneficial in the case of the Greek green bond market [33]:

- **Simplify the approval process for green bonds.** Programmatic approval could take place, allowing approval of a large programme of eligible assets that could then be issued over a given period. This would enable financial institutions to respond to market changes quickly and issue when it is opportune.
- **Incorporate green bonds into the scope of collateral for Standing Lending Facility and Medium-term Lending Facility**. These allow banks to borrow from the central bank through repurchase agreements. They must be secured by assets such as qualifying bonds. Including green bonds will encourage banks to both generate and invest in them.
- **Lower the regulatory cost of green financial bonds** when conducting a Macro Prudential Assessment. The Macro Prudential Assessment system monitors financial risks in the market, aiming to ensure the stability of the monetary financial system.
- **Provide guarantees and credit enhancement.** A dedicated fund set up by a government body to provide guarantees for green bonds with lower credit ratings would provide external credit enhancement and make them more attractive to institutional investors with regulated risk requirements.
- **Require investors to have a minimum exposure to green bonds**. Regulators can set requirements for minimum ratios of green bonds within bond portfolios. This will ensure strong demand for green bonds.
- **Provide early stage incentives for green projects.** Green projects tend to have high upfront costs and long payback periods. Price support, interest discounts, and investment subsidies could be applied to qualifying green projects.

- **Harmonize green bonds standards and disclosure.** The coordination of policies to push for market standards for green bonds will simplify the issuance process and encourage new issuers. Harmonization should also be promoted between domestic and international guidelines.
- **Demonstration issuance from local government** could facilitate the transformation of local economic development and demonstrate the issuance process for smaller issuers and municipalities.
- **Attract foreign investors** through Qualified Foreign Institutional Investor (QFII) and Renminbi Qualified Foreign Institutional Investor (RQFII) systems. QFIIs and RQFIIs must currently comply with long capital lock-up periods, but shorter periods could be considered for green bonds to make them more attractive to international investors.

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