POLITECNICO
MILANO 1863

SCUOLA DI INGEGNERIA INDUSTRIALE
E DELL'INFORMAZIONE

# Green Bonds: European Taxonomy alignment and correlation with pricing

Tesi di Laurea Magistrale in
Management Engineering - Ingegneria Gestionale

Authors: **Tommaso Bonanno**
**Samuel Brunelli**

Student ID: 977496, 976243
Advisor: Prof. Giancarlo Giudici
Academic Year: 2021-2022

# Abstract

In recent years, abnormal and extreme weather phenomena have been increasingly recorded. It has become clear how human beings and in particular high-carbon activities are responsible for this climate crisis. Various initiatives have been taken by institutions to respond to this emergency, and it is in this context that the idea of sustainable finance fits. This latter aims to take into account environmental, social and governance factors in the decision-making process of the financial sector, in order to finance the shift to a low-carbon economy. In this regard, the most widely used financial instruments are Green Bonds. Alongside this tool, a fundamental classification system was introduced called EU Taxonomy, that establish a list of environmentally sustainable economic activities.

The objective of this thesis is to thoroughly analyse the Green Bond market in relation to the new standards established within the EU Taxonomy. Specifically, this study initially focused on a twofold dimension of analysis. On one side, an impact reporting analysis was performed in order to identify the actual player group and geographic area that are fostering the most important environmental impact. On the other side, alignment with the EU Taxonomy was analysed, in order to investigate the level of compliance with this new regulation. In this regard, this project aims to understand if a correlation between the pricing at the time of issuance of Green Bonds and their alignment with the EU Taxonomy already exist or not.

The results of the analysis disproved the presence of a correlation, thus rejecting our first hypotheses, while validating the second one. In the future, when the EU Taxonomy will be fully implemented, this analysis can be performed again and a significant correlation is more likely to be verified.

**Keywords**: Green Bonds, Taxonomy, alignment, impact, reporting

# Abstract in lingua italiana

Negli ultimi anni si sono registrati sempre più spesso fenomeni meteorologici anomali ed estremi. È ormai chiaro come l'uomo, e in particolare le attività ad alta emissione di carbonio, siano responsabili di questa crisi climatica. Diverse iniziative sono state intraprese dalle istituzioni per rispondere a questa emergenza, ed è in questo contesto che si inserisce l'idea di finanza sostenibile Quest'ultima mira a prendere in considerazione fattori ambientali, sociali e di governance nel processo decisionale del settore finanziario, al fine di finanziare il passaggio a un'economia a basse emissioni di carbonio. A questo proposito, gli strumenti finanziari più utilizzati sono i Green Bond. Accanto a questo strumento, è stato introdotto un sistema di classificazione fondamentale chiamato Tassonomia UE, che stabilisce un elenco di attività economiche sostenibili dal punto di vista ambientale.

L'obiettivo di questa tesi è analizzare a fondo il mercato dei Green Bond in relazione ai nuovi standard stabiliti nell'ambito della Tassonomia UE. In particolare, questo studio si è concentrato inizialmente su una duplice dimensione di analisi. Da un lato, è stata effettuata un'analisi di reporting di impatto per identificare il gruppo di attori e l'area geografica che stanno promuovendo l'impatto ambientale più importante. Dall'altro lato, è stato analizzato l'allineamento con la Tassonomia UE, al fine di indagare il livello di conformità a questa nuova normativa. A questo proposito, il progetto mira a comprendere se esista o meno una correlazione tra il prezzo al momento dell'emissione dei Green Bond e il loro allineamento con la Tassonomia UE.

I risultati dell'analisi hanno smentito la presenza di una correlazione, respingendo così la prima ipotesi e convalidando la seconda. In futuro, quando la Tassonomia Europea sarà pienamente implementata, questa analisi potrà essere eseguita nuovamente e sarà più probabile verificare una correlazione significativa.

**Parole chiave**: Green Bonds, Tassonomia, allineamento, impatto, reporting

# Executive Summary

## Introduction to Sustainable Finance and Green Bonds

The critical environmental issues affecting our planet are now fully understood by everyone. In this sense, climate change poses a serious threat to society as a whole. In addition to having a negative impact on people's health and well-being, this phenomenon also threatens the stability of the world economy and financial markets. In such a situation, all parties involved, from states and governments to corporations and investors, must contribute on their own to prevent even more severe repercussions. As far as the financial worlds are concerned, over the last years there has been an evident change in paradigm. The rise and development of so-called "sustainable finance" aims to direct increasing amounts of investments in order to finance the shift to a low-carbon economy. One tool in particular has emerged over the past few years among the many available to sustainable finance to accomplish the aforementioned goal: Green Bonds. Given the novelty of the instrument, a clear definition of the term is still ambiguous. But according to the International Capital Market Association, a "Green Bond" is any bond instrument whose proceeds are exclusively used to finance or refinance, in whole or in part, new and/or existing eligible green projects, i.e., projects that aim to mitigate climate change (ICMA, 2021).

Given their goal and the urgent state of the environment today, Green Bonds have grown significantly over the past few years. The Climate Bond Initiative estimated an average annual growth rate of about 95% since the market's start in 2007, with the total amount of green bonds issued crossing the USD 1 trillion mark in December 2020. The total amount of Green Bonds issued to date has almost reached USD 1.5 trillion, and the most recent projections indicate that by 2023, annual Green Bond issuance may surpass USD 1 trillion (Figure 1).

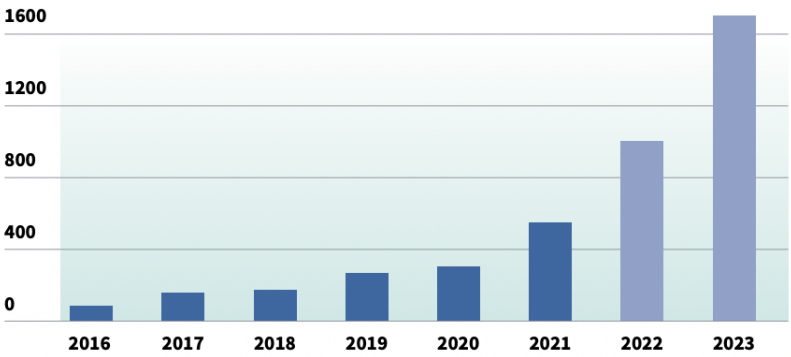



Figure 1: Green Bonds market expected growth ($bn).

Furthermore, a new, substantial branch of literature has emerged as a result of the exceptional relevance this phenomenon has taken on in academic and managerial research. Overall, this study aims to thoroughly investigate this novel phenomenon, analysing it under various perspectives, given the prominent role Green Bonds are playing and will continue to play in the near future, both from a market and academic point of view.

## Literature review

In order to gain an exhaustive understanding of which studies and analyses on this topic have already been conducted, a State-of-the-Art analysis of the literature on the subject of green bonds was conducted in the first phase of this study. This analysis helped identify any potential gaps that needed to be further investigated. Despite the topic's novelty, there is a robust research environment, which can be due to the incredible importance that these financing mechanisms are taking. The existing literature concentrates on three main areas of analysis:

- the existence of a green premium;
- the existence of a liquidity premium;
- the effects of a Green Bond on the issuer.

The majority of the present literature focuses on whether there is a green premium, which is the difference in the yield between a Green Bond and a conventional bond. The greenium, then, is the premium that investors are willing to pay in order to invest in Green Bonds rather than in conventional bonds. A higher bond price translates into a lower yield to maturity for buyers, which has an effect on the issuer's cost of financing. In general, a greenium exists if the price of a conventional bond is lower (or the yield is higher) than the price of a Green Bond with the same features. The existence of this green

premium has been the subject of countless investigations, but no definitive conclusion has been reached. Indeed, researchers are split into two major macro-groups: those who assert that greenium exists (such as Fatica, Panzica, and Rancan (2021), Hachenberg and Schiereck (2018), and MacAskill and colleagues (2020)) and those who believe it should be considered null (such as Hacömerolu et al. (2021), Lau, Sze, Wan, and Wong (2020), and Tang and Zhang (2018)).

Regarding the second dimension of analysis, the current literature concentrates on the analysis of the existence of a liquidity premium for Green Bonds. The presence of a liquidity premium can be explained by two key factors: the Green Bond market's disproportionate thinness and the unknown solvency profile of these green debt instruments. Contrary to predictions, the data revealed that Green Bonds are more liquid than conventional bonds.

The final major area of study included in most of the existing literature is the impact of a Green Bond issue on the issuers themselves, both financially and environmentally. In literature, we can find different papers and research aimed at analysing this topic (Tang and Zhang (2018), 2022 (Yue Wu)and Fatica and Panzica (2021)). Regarding the environmental perspective, the research appears to agree on the presence of a beneficial impact on issuers' environmental performance, both in terms of real physical emissions and the ESG score assigned to the company itself. On the other hand, regarding the financial perspective, despite the fact that the majority of the literature is inclined to affirm the existence of a positive relationship between the issuance of Green Bonds and a company's financial performance, there is a small branch of literature that claims that the issuance of a Green Bond has no impact on a company's financial results.

## Green Bond Market and Regulatory Framework

Since the day the European Investment Bank (EIB) issued the first Green Bond in 2007, the global market for Green Bonds has grown incredibly. Indeed, Despite a necessary slowdown in 2020 caused on by the Covid-19 crisis, this encouraging path has permitted for the achievement of the $1.6 trillion cumulative issuance milestone in 2021 (Figure 2).

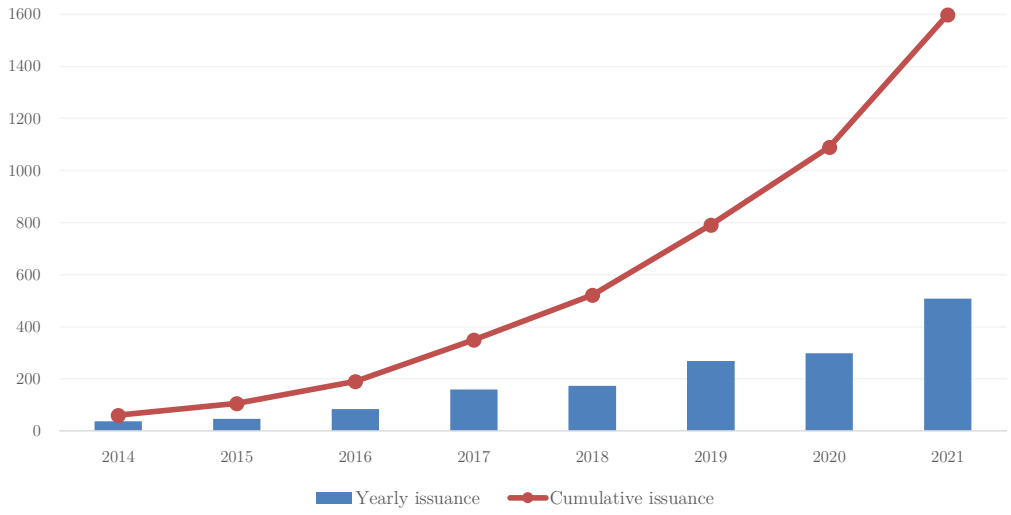



Figure 2: Green Bonds annual and cumulative issuance (2014-2021).

In particular, despite all the uncertainty that Covid-19 brought, in 2021, annual Green Bond issuance surpassed $500 billion for the first time (a 75% increase over volumes in the previous year).

Shifting the discussion to the geographic scope, the United States has historically been the largest emitter, with a cumulative emission value of almost EUR 304 billion, followed by China, France and Germany. Despite this result, on a regional level, Europe and Asia are the geographic areas with both the largest amount issued and the largest number of different issuers (until 2021). Finally, considering the types of issuers, Financial Corporates and Non-Financial Corporates are the most active in this field, both in terms of total amount and in terms of number of issuers, followed by Government-Backed Entities and Development Banks.

If the global Green Bonds market is constantly developing, the same can be said about the various regulations and standards that, especially in recent years, have been introduced to better define and regulate the market for these debt instruments. Among the various standards and guidelines, the most relevant are:

- *Sustainable Development Goals* (SDGs), a collection of 17 environmental and social objectives established by the United Nations. In particular, these objectives, applied to sustainable finance instruments, aim to mitigate climate change and ensure the protection of ecosystems, with a target date of 2030;
- *Green Bond Principles*, introduced by the International Capital Market Association

(ICMA), are best practice guidelines that encourage openness, disclosure and support integrity in the growth of the Green Bond market by outlining the procedure for the issuance of a Green Bond;

- *Climate Bonds Standards*, developed by the Climate Bonds Initiative, represents one of the market's most reliable and well-regarded enforcement mechanisms. This certification apply a "mark" on a Green Bonds, and this allows investors, governments and other stakeholders to identify and prioritize low-carbon and climate resilient investments and avoid greenwashing;
- *European Green Bond Standard*, introduced by the European Commission, introduces a rigorous standard to which all issuers can voluntarily adhere, certifying the alignment of projects to be financed with the EU Taxonomy and guaranteeing investors protection from greenwashing. The application to this standard can take place by both public and private entities, even outside the European Union.

## EU Taxonomy and Alignment Analysis (Mitigation)

In order to meet the EU's climate and energy targets for 2030 and reach the objectives of the European Green Deal, the Action Plan on Financing Sustainable Growth called for the development of the "EU Taxonomy", a unified classification scheme for sustainable economic activities. The EU Taxonomy is the cornerstone of the EU Action Plan on Sustainable Finance, which outlines areas of intervention to support the allocation of capital into more sustainable investments or economic activities. In particular, it represents a classification system that establish a list of economically environmentally sustainable activities. The other objective of the EU Taxonomy is to provide an appropriate definition of what economic activities qualify as environmentally sustainable, both for companies, investors and policymakers. Going more specific, the Taxonomy Regulation establishes six main environmental objectives, that businesses have to support but also not violate:

1. Climate change mitigation;
2. Climate change adaptation;
3. The sustainable use and protection of water and marine resources;
4. The transition to a circular economy;
5. Pollution prevention and control;
6. The protection and restoration of biodiversity and ecosystems.

Regarding these six environmental objectives, the Taxonomy Regulation introduces the Technical Screening Criteria (TSC), that define the specific requirements and thresholds for an activity to be considered as significantly contributing to a sustainability objective. In practice, for each type of activity or project financed by a bond, the TSCs define whether that activity or project is aligned with the European Taxonomy. At this stage, this level of alignment can also be "partial". This is the case when an activity or project meets certain technical requirements while not meeting others. Therefore, a bond may be 100% aligned or 0% aligned to the Taxonomy, but cases of intermediate percentages may also occur.

Taking advantage of the alignment calculation methodology, directly defined within the European Taxonomy, we decided to perform an alignment analysis, focusing on the first environmental objective (Climate change mitigation). This analysis was performed in collaboration with MainStreet Partners, a London-based ESG advisory company. In particular, the main objective of this study was to investigate how many bonds are already well advanced in terms of compliance with the Taxonomy Regulation. In addition, this type of analysis allowed us to determine the most virtuous geographical regions and issuer types in terms of Taxonomy-alignement. Leveraging a database of 462 Green and Sustainability Bonds provided to us by MainStreet Partners, a meticulous data collection phase kicked off the study. Specifically, for each individual bond, we analysed, through the available documentation, every single activity and then defined the degree of alignment of the bond with the EU Taxonomy, based on whether it met the technical requirements of the latter.

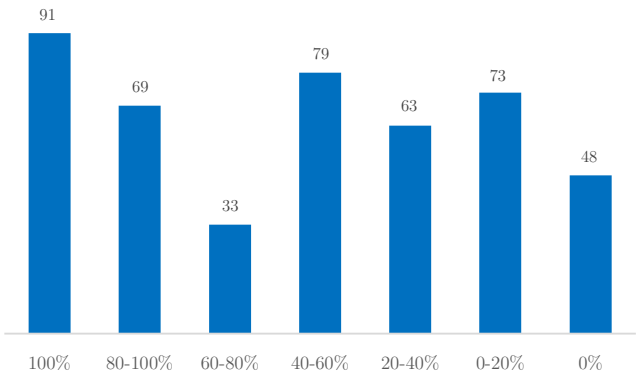



Figure 3: Number of bonds per alignment percentage obtained.

The final outcomes of this analysis, displayed in Figure 3, saw numerous bonds (20% of the database) achieving the highest degree of alignment, while 10.5% of the bonds were

found to be completely non-compliant. In general, however, the overall situation cannot be considered satisfactory, as the majority of bonds (57.7%) achieved an alignment below 60%, while only the remaining 42.3% exceeded this threshold. This is probably mainly due to businesses' or institutions' lack of readiness to make investments in light of the standards set by the European Commission.

Shifting the discussion to the most virtuous geographical regions in terms of taxonomy compliance, we ascertained that Europe and Asia are the best performers to date if we consider Green Bonds, followed by the North American continent. The outcome for Europe might have been expected, given the sizeable market share that this region contributes to for Green Bonds and that the EU Taxonomy is primarily focused on Eurozone issues. Extending the discussion by considering the types of issuers, we found that corporates are the best performers considering Green Bonds, while governmental issues dominate in terms of Sustainability Bonds. Going on to analyse the average bond alignment in the different years of issuance (Figure 4), we noticed that in the period 2016-2020 the alignment is almost stable around 63-64%, in the case of Green Bonds. The big shift observed in 2021, however, is not very reliable as it refers to a very small number of observations. Talking about Sustainability Bonds, besides confirming the fact that the average alignment level of these instruments is lower than their green counterparts, we noticed that there is a similar trend as in the previous case in the years 2017-2020, as the average alignment stands around 20%.

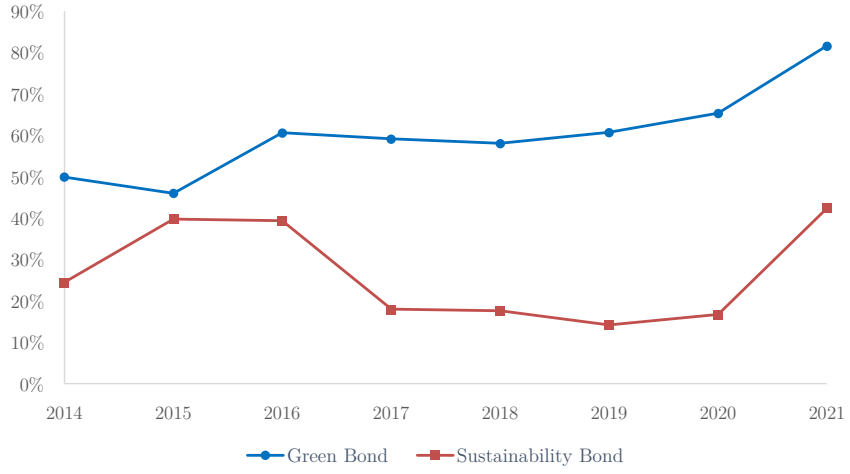



Figure 4: Average Taxonomy alignment progress per year.

## Impact Reporting Analysis

Impact reporting is one regulatory component that enables the enormous potential of Green Bonds to support society's transition to a low-carbon economy to be explicitly stated. As one of the four elements of the Green Bond Principles, along with the use of proceed statement, this document details the environmental impacts made possible by the projects and/or assets financed with proceeds from Green Bonds (ICMA, 2021). It has been possible to carry out an extensive impact analysis using this kind of information, whether disclosed or not, presenting a dual objective. By identifying the most advantageous geographic areas and issuer types in terms of impact reporting availability, this analysis on the one hand enabled the identification of the most pertinent trends in impact reporting. Exploiting this kind of information, it has been possible to perform an in-depth impact analysis that allowed us to identify the most relevant impact reporting trends, by determining the most virtuous geographical regions and issuer types in terms of impact reporting availability, and investigate the true impact that Green, Social and Sustainability Bonds have on society, highlighting the geographical areas and classes of players which contribute the most in fostering a true environmental impact.

Through the use of an ad-hoc dataset created in collaboration with Main Street Partners, a meticulous data collection was required to obtain the impact information voluntarily provided by the Green, Social and Sustainability Bonds' issuers taken into consideration. Once the available impact data were gathered, these were used in order to compute cumulative and average measures on the basis of a set of meaningful environmental and social metrics. In particular, as displayed in Figure 5, it was observed that almost all the bonds in the dataset reported on the volume of greenhouse gases avoided and/or reduced. The amount of energy produced from renewable energy added and the increase in renewable energy capacity are the two additional impact metrics that are the most frequently reported.

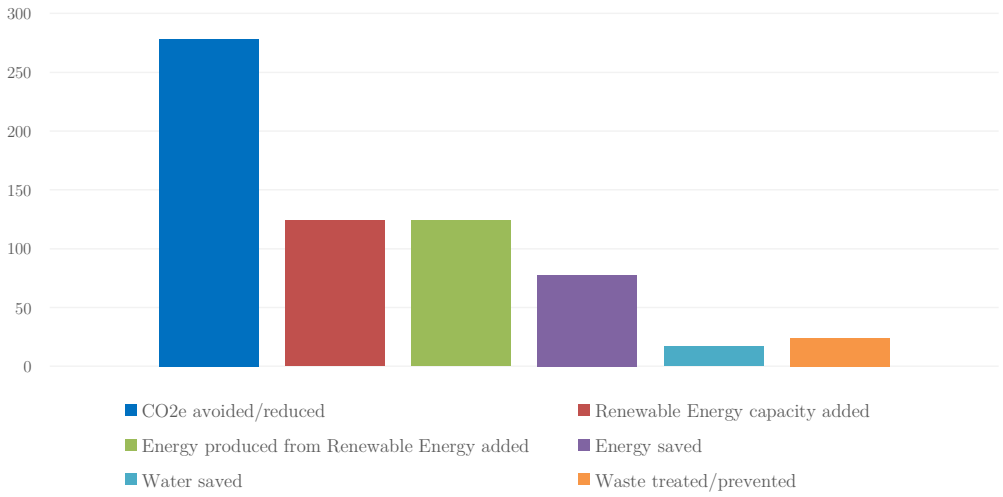



Figure 5: Number of bonds reporting on different environmental metrics.

Overall, taking into account the average results for these three environmental metrics, Green and Sustainability Bonds issued by European and Asian players ended up having the biggest environmental impacts, at least in terms of $CO_2$ avoided/reduced, MWh of renewable energy generated, and MW of renewable energy capacity added. In particular, this result demonstrated that, when compared to other geographical regions, the European Green Bond market represents the most mature and developed. With regard to the North America region, and the United States in particular, the results were disappointing as, despite being one of the largest issuers of Green and Sustainability Bonds, the US state has environmental impact values well below expectations, underperforming other geographical areas. Extending the discussion by considering the types of issuers, we found that financial and non-financial private players overcame Supranational, Governmental and Municipal entities both in terms of $CO_2$ avoided/reduced, renewable energy produced and renewable energy capacity installed. This seems to indicate that, on average, green debt instruments issued by private entities tend to have a greater environmental impact than green products of a similar nature issued by public entities.

## Empirical Research

Despite the extensive academic research that has already been done on the topic of Green Bonds, it is still possible to find new research areas. Indeed, none of the papers in the current literature takes into consideration a fundamental aspect: the bonds' alignment to the European Taxonomy. This dissertation, therefore, seeks to enrich the existing literature by attempting to include this parameter, which today, but especially in the

future, will be of fundamental importance and will be a determining factor in the choices of Green Bond issuers and, above all, investors. Indeed, with the implementation of the new regulations such as the European Taxonomy, corporates and institutions will be required to invest in more sustainable projects in the coming years, and investors will be more and more likely to allocate their capital to investments that adhere to standards and regulations. Moreover, investor interest in environmental and social issues is clearly rising, both for regulatory compliance and risk mitigation purposes as well as to take advantage of new financial market opportunities. In particular, this dissertation will investigate the relationship between the yield at issuance of a group of Green Bonds and their alignment to the EU Taxonomy, in order to determine whether this important factor has any influence on the price of these financial instruments at the time of issuance. More specifically, given that a correlation exists, we expect a negative correlation between the Green Bond's yield at issuance and its degree of alignment with the EU Taxonomy. This means that a Green Bond with a high alignment score to the European Taxonomy will have a lower yield at issuance than a Green Bond with a lower alignment. Indeed, it is reasonable to assume that an investor would be willing to "give up" a portion of his financial return in order to obtain a Green Bond with the highest degree of alignment to the EU Taxonomy, and thus a debt instrument that is as close to the regulatory criteria as possible. Overall, the initial research question was formulated as follows:

> **H1a**: The yield at issuance of a Green Bond is correlated to its level of alignment with the European Taxonomy.

On the other hand, it is also reasonable to assume that, to date, a correlation between these two parameters does not exist. This assertion derives from the fact that the EU Taxonomy is, nowadays, just a best practice and not a strict regulation. Therefore, it is possible that companies, institutions and governments are not yet fully taking into account all the standards and criteria introduced by this new regulation. As a result, the following additional research question was proposed:

> **H1b**: The yield at issuance of a Green Bond is not correlated to its level of alignment with the European Taxonomy.

After outlining the research questions, an accurate methodology was implemented to test them. Firstly, it was important to adjust the starting dataset in order to assure the consistency and quality of the results acquired from our analysis. Following an initial skimming of the data we already had, a data collection phase was required. Specifically, we perform a manual bond-by-bond examination and collect the data needed to continue with the research. To be more specific, the parameters we needed were the yield at issuance, the

coupon type, the bond's rating, the bond's "callability", the issue amount, the maturity and the issuer's type. Then, it has been decided to utilize a cross-sectional OLS (Ordinary Least Squares) regression model to test our hypothesis.

The regression analysis was performed on a final database of 271 Green Bonds, and the results are displayed in Figure 6

```
Model 4: OLS, using observations 1-271
Dependent variable: Yield
Omitted due to exact collinearity: DMaturity_Range_3 DCallability_2 DIssuer_Type_5

                     coefficient   std. error   t-ratio   p-value
  ---------------------------------------------------------------------
  const                 2.89424     0.652620     4.435    1.36e-05 ***
  Alignment            -0.198428    0.231960    -0.8554   0.3931
  Rating_Score         -0.0767206   0.0174903   -4.386    1.68e-05 ***
  Issue_Amount         -0.198580    0.0682298   -2.910    0.0039   ***
  DMaturity_Range_1     0.782684    0.397700     1.968    0.0501   *
  DMaturity_Range_2     1.19229     0.409988     2.908    0.0040   ***
  DCallability_1        0.638689    0.215336     2.966    0.0033   ***
  DIssuer_Type_1       -1.17032     0.474143    -2.468    0.0142   **
  DIssuer_Type_2       -0.292605    0.599213    -0.4883   0.6257
  DIssuer_Type_3       -1.13520     0.465868    -2.437    0.0155   **
  DIssuer_Type_4       -0.691703    0.489151    -1.414    0.1585
```

Figure 6: Results of the OLS regression model.

Results show that the alignment would be negatively correlated with yield as the coefficient turns out to be negative at -0.198428. This finding implies that yield declines as alignment rises. This outcome is consistent with H1a, but negates H1b, since not only the correlation coefficient is not null, but it is also negative; this result would suggest that investors should be willing to accept a lower return in exchange for a higher alignment to the taxonomy of the bond in question. However, the p-value is much above the threshold (0.3931) and the standard error is extremely high (0.231960). As a result, this number is not statistically significant and so unreliable. Consequently, we cannot attribute a correlation between alignment and yield, and so the first research question is rejected, while the second one is verified.

## Conclusions

This dissertation tried to contribute to the scientific literature about Green Bonds through the investigation of a possible correlation between the yield at issuance of a bond and its alignment to the European Taxonomy. In fact, after having constructed an entire database of Green Bonds by calculating the alignment to the Taxonomy for each of them, an econometric regression analysis was carried out with the aim of validating one of our research questions.

On the basis of the analysis' results, we can state that, to date, there is no evidence of a correlation between the yield at issuance of a bond and its alignment to the European Taxonomy. The feeling is that investors are not yet ready to take the next step toward entirely sustainable investments at the expense of a partial reduction in economic return. Despite the fact that there appears to be a rising interest in greener financial instruments, as we have seen, the rules set forth by the European Taxonomy do not appear to have a significant impact on practitioners' actions.

However, this study calls for further research in the future. The fact that Green Bonds have evolved over the past few years from being a niche financial instrument to a mainstream product shows how quickly changing the current situation is. Once the regulatory framework is, hopefully, more harmonized and once enforcement mechanisms are better defined, future research may provide more precise and reliable evidence of Green Bonds' dependence on their alignment with the EU Taxonomy. In particular, we recommend repeating this research once the Taxonomy's requirements are enforced to verify whether the pricing of Green Bonds can be correlated with the green quality of the investments financed with these instruments, as we firstly hypothesized in this thesis.

# Contents

# Introduction

Nowadays, the economy and financial system are at risk from the more frequent, severe, and damaging effects of climate change. The growing anxiety about these risks has increased the interest of people, institutions and governments in environmental problems like climate change, biodiversity loss, resource scarcity, population growth. Moreover, recent decades have seen accelerated environmental pressures and a depletion of natural resources, along with rapid economic growth and social advancement.

A fundamental shift in favour of an inclusive, sustainable development is more crucial than ever today, and this should be accomplished through actions that successfully mitigate desertification, water scarcity, and climate change. The climate issue has indeed become more urgent than ever in the wake of the COP21 climate agreement in Paris in December 2015. Actors are becoming more and more vocal with regard to the need for businesses to adopt a more responsible growth model, as well as their worries about the irreparable harm being done to the environment. In fact, implementing the Paris Agreement necessitates both economic and social transformation, which is why several attempts have been made to promote responsible investment also in the capital market.

On the global agenda, 2015 has been a year of important innovations as, three months before the adoption of the Paris Agreement, there was the entry into force of the Sustainable Development Goals. The Sustainable Development Goals (SDGs), which replaced the Millennium Development Goals (MDGs), were adopted by the United Nations, and they define seventeen development goals with the thirteenth goal focusing specifically on addressing climate change. This goal seeks to put the environment at the forefront of people's lives by incentivizing nations to take swift, coordinated action to combat climate change and its effects in accordance with the Intergovernmental Panel on Climate Change's (IPCC) recommendations (IPCC). According to the IPCC's 2014 report, human activities are the primary cause of global warming at 95% (IPCC, 2014). Additionally, the report demonstrated that a rise in the global temperature below 2 °C above pre-industrial levels is feasible. However, this would require a radical shift from the business as usual scenario.

In this global context, finance has played and continues to play a significant role. Although there are many resources and approaches available in the broad field of sustainable finance, Green Bonds unquestionably stand out as one of the most promising market-based approaches to raise awareness of environmental risks and direct funding to projects that benefit the environment. Private investors perceive these instruments as a bottom-up initiative and a way to obtain funding to tackle climate change. These fixed income securities appear to be the only way they differ from traditional debt instruments at first glance, aside from the fact that they are designed to fund environmental or climate-related projects. As a result, Green Bonds have been created as financial products to assist governments, businesses, and supranational institutions in pursuing environmental mitigation policies that are currently required to be implemented to mitigate the dangerous issue of climate change. On the other hand, Green Bonds give investors the opportunity to include an ethical standard in their investment decisions and thereby produce sustainable value in addition to financial value.

The aim of this dissertation is to analyse the global context of sustainable finance, focusing mainly on Green Bonds, their history, the market situation at this time and the different regulations concerning them. In particular, Chapter 1 of this thesis introduces the concept of sustainable finance, also focusing on the definition of Green Bonds as a financial instrument. Chapter 2, on the other hand, analyses the state-of-the-art literature on Green Bonds up to the present day, summarizing the main fields of research and the results obtained by academics and scholars. Chapter 3 will be dedicated not only to analysing the global Green Bonds market, but also to presenting the main regulatory frameworks governing sustainable finance. Chapter 4, on the other hand, aims to present the EU Taxonomy, starting with historical background and ending with the practical application of its directives. Chapters 5 and 6 will present two important analyses carried out on sustainable financial instruments in collaboration with a London-based company: MainStreet Partners. Finally, Chapter 7 aims to set out the empirical analysis we have carried out, with the aim of enriching the current literature and bringing to light new considerations that have not been adopted to date.

# 1 | Sustainable Finance and Sustainable Financial Instruments

So far, 2020 has shown to be a year of profound global unrest that has an impact on all facets of human life. Humanity is at a crossroads in terms of addressing and resolving past, present, and future risks to society and the planet, from the socio-economic Covid-19 disruptions and protests against racial inequality to the continuously worsening climate crisis. The international community has established ambitious yet crucial goals with the Paris Climate Agreement and the UN Sustainable Development Goals (SDGs) to protect and enhance the lives of both current and future generations. Numerous stakeholders, including legislators and policymakers, business and civil society representatives, and academics, have been developing and conceptualizing the proper tools and strategies to achieve these goals.

The financial industry as a whole as well as financial instruments have been recognized as major levers in the fight against global warming and sustainable development. Sustainability, climate change, and socio-environmental issues are becoming more and more relevant among industry professionals, as evidenced by the terms impact investing, sustainable investing, and sustainable finance entering the investor lexicon in recent years. Climate-related risks, environmental, social, and governance (ESG) factors, and non-financial performance metrics have moved from minor to significant investment considerations. Investors are now focusing on the various methods and tools at their disposal to incorporate ESG factors or manage risks associated with the environment and climate in their portfolios.

## 1.1. Introduction to sustainable finance

European Commission defines *sustainable finance* as the process of taking environmental, social and governance (ESG) considerations into account when making investment decisions in the financial sector, leading to more long-term investments in sustainable economic activities and projects.
*Environmental* considerations might include climate change mitigation and adaptation, as well as the environment more broadly, for instance the preservation of biodiversity, pollution prevention and the circular economy. *Social* considerations could refer to issues of inequality, inclusiveness, labour relations, investment in human capital and communities, as well as human rights issues. A key factor in ensuring the inclusion of social and environmental considerations in the decision-making process is the *governance* of public and private institutions, which includes management structures, employee relations, and executive compensation.

Sustainable finance is understood in the EU's policy context as financial support for economic growth while lowering environmental pressures and taking into account social and governance factors. Transparency regarding the risks associated with ESG factors that could have an impact on the financial system is a component of sustainable finance, as is the mitigation of such risks through sensible corporate and financial governance.

One of the first key steps in introducing the concept of sustainable finance was the Paris Agreement. The Paris Agreement is the first-ever universal, legally binding global climate change agreement, adopted at the Paris climate conference (COP21) in December 2015 (European Commission).
The Paris Agreement outlines an international framework for preventing dangerous climate change by keeping global warming to well below 2°C and pursuing efforts to keep it to 1.5°C. It also aims to support nations in their efforts and improve their capacity to deal with the effects of climate change. The Paris Agreement serves as a link between current policies and the goal of achieving climate neutrality by the end of the century.
In order to actively contribute and try to achieve these objectives, countries presented the National Climate Action Master Plans (NDCs). These plans, while clearly outlining the path forward, are not enough on their own to achieve the objectives set forth in the agreement. By establishing itself as a leader for this transformational process, the European Union has in this context played a crucial role in the mediation of this agreement. In particular, the COP21 member states agreed to submit updates every five years.

In order to fulfil the policy goals outlined in the European Green Deal[1] and the EU's international commitments on climate and sustainability goals, sustainable finance is essential. In addition to using public funds, it accomplishes this by directing private investment toward the transition to a resource-efficient, fair, climate-neutral, and climate-resilient economy. Sustainable finance will make sure that investments support a strong economy and a long-term recovery from the COVID-19 pandemic's effects.
The European Green Deal Investment Plan, which will mobilize at least €1 trillion in sustainable investments over the coming ten years, was presented by the Commission on January 14, 2020. It will establish the proper conditions (or "enabling framework") to encourage and support the public and private investments required for the shift to a climate-neutral, environmentally friendly, competitive, and inclusive economy.

Subsequently, with a higher emissions reduction target of 55% by 2030 compared to 1990, the Commission unveiled its 2030 climate target plan on September 17, 2020. In order to achieve these 2030 climate and energy targets, the EU intends to invest roughly 350 billion Euros more annually during the 2021–30 decade than it did during the prior decade. With the European Fund for Strategic Investments and other programs, the EU has already started to give momentum to aid in attracting the necessary investments. The size of the investment challenge, however, exceeds what the public sector can handle on its own. The financial sector represents a fundamental role in achieving these goals. Indeed, it can:

- invest in businesses and technologies with a greater focus on sustainability;
- provide long-term, sustainable financing for growth;
- help in establishing a low-carbon, climate-resistant, and circular economy.

In order to achieve this, the Commission has been working on a comprehensive policy agenda on sustainable finance since 2018. This agenda includes a plan for financing sustainable growth, a new sustainable finance strategy within the context of the European Green Deal, and a plan for financing the shift to a sustainable economy. Through its International platform on sustainable finance, the Commission is also coordinating efforts on a global scale.

Within the framework of the European Green Deal, a revised sustainable finance strategy was disclosed by the Commission: the "strategy for financing the transition to a sustain-

[1]The European Green Deal a package of legislative proposals put forth by the European Commission with the overall objective of achieving climate neutrality in Europe by 2050.

able economy", published on July 6, 2021.
The new strategy suggests taking action in several areas. Then, in order to recognize transition efforts, it will first take into account expanding the EU taxonomy framework and sustainable finance standards and labels. In order to support SMEs, people, and the real economy on the way to sustainability, it emphasizes the significance of inclusion. It achieves this by offering the appropriate resources and incentives for obtaining transitional financing, and by looking into how to take advantage of the opportunities presented by digital technologies for sustainable finance. It also emphasizes the need for, and steps toward, strengthening the financial system's resistance to the risks posed by environmental degradation and climate change. Finally, the strategy outlines the Commission's global strategy, including work on global standardization, including taxonomy and disclosures.

## Commission expert groups on sustainable finance

The Taxonomy Regulation's Article 20 establishes a "*Platform on Sustainable Finance*" The platform is an advisory group made up of professionals from both the public and private sectors. This panel of experts provides the Commission with advice on the technical standards for the EU Taxonomy, the taxonomy's future development, and sustainable finance in general.
These expert classes are grouped into different categories:

- *Technical expert group on sustainable finance (TEG)*: the group's task was to support the Commission in a variety of ways, including the creation of an EU green bond standard, a unified classification system for sustainable economic activities, methodologies for low-carbon indices, and metrics for climate-related disclosure. The TEG began work in July 2018 and its mandate was extended until 30 September 2020. Its 35 members from civil society, academia, business and the finance sector, as well as additional members and observers from EU and international public bodies, worked both through formal plenaries and subgroup meetings for each work stream;
- *High-level expert group on sustainable finance (HLEG)*: twenty senior experts from civil society, the financial industry, academia, and observers from European and international institutions made up the HLEG, which was established in December 2016. Its responsibility was to advise the Commission on how to:
  - direct public and private capital flows toward sustainable investment opportunities;
  - determine the actions that financial institutions and regulators should take to

safeguard the financial system's stability against environmental risk;

- implement these measures on a European level.

- *Member States expert group on sustainable finance (MSEG)*: the European Commission's action plan on financing sustainable growth included the creation of the Member States Expert Group (MSEG) on Sustainable Finance in April 2018. In order to facilitate efficient coordination of sustainable finance initiatives at the national and European levels, and to help the European Commission implement EU laws and policies pertaining to sustainable finance, the MSEG brings together financial market and environmental experts from Member States. In the context of the EU Taxonomy Regulation (Regulation (EU) 2020/852), the MSEG has been given a distinct advisory role with respect to the EU Taxonomy.

### 1.1.1. Climate-related risks

The global climate crisis we are currently experiencing is unlike any other time the planet has faced adversity. The crisis that climate change brings with it has never before existed, and it threatens to last indefinitely as it structurally affects every economy and society. This recession, therefore, is different from the crises we have faced in the past. The consequences that this may bring in the long term, if action is not taken promptly, would be devastating.
In this specific case, the dangers posed by climate change are significant and pertinent. Climate change has historically had very negative impacts, but never like what has been happening in recent years: devastating natural events are now on the increase in areas of the globe that have never, in the past, been considered at risk in this respect. Moreover, these events can also have great repercussions on the economies of the countries in which they occur.
Some of the most famous examples are the fires in Australia in the early 2020s that caused about $5 billion in damage. Also, it is worth to mention the Cyclone Idai, which hit parts of Southern Africa in 2019, especially Mozambique, which saw its GDP fall by 20%.
From a theoretical point of view, the risk associated with climate changes (*climate-related risks*) are divided in: physical risks and transition risks.

*Physical risks* are defined as dangers brought on by the physical consequences of environmental deterioration and climate change, which consequently can affect the economy. They can be classified as: (i) *acute* if they result from weather and climate-related incidents and immediate environmental destruction, or (ii) *chronic* if they result from

long-term changes in weather and climate patterns or a slow decline in ecosystem services (European Banking Authority).
Physical risks relate to the financial system depending on the physical risk itself as well as the exposure and vulnerability of the entities to the risk as well as the risk mitigation strategies in place, such as insurance coverage. For instance, there may be an increase in the credit and market risk for banks, and there may be an increase in the underwriting risk for (re)insurers, endangering asset values and possibly challenging business strategies. In a broader sense, it is presumable that physical risks are transmitted to the financial system through macroeconomic and microeconomic effects, including those on businesses, households, sovereigns, or other financial institutions. Corporates may be impacted by physical risks, for example, through the destruction of tangible assets, but also through the disruption of production and supply chains, costs associated with adaptation, or worsening macroeconomic conditions (European Central Bank).

On the other hand, *transition risk*, in the context of climate change, refers to the risk associated with altering strategies, policies, or investments as society and business strive to lessen their reliance on carbon and climate impact. These risks can be sparked by a variety of factors, including shifts in the public sector, shifts in investor and consumer sentiment, a growing preference for environmentally friendly environments, or even changes and innovations that make it easier to access existing green technologies (such as renewable energy) at more affordable prices. Transition risks might include:

- changed land-use policies or water conservation practices, impacting the agricultural sector;
- the expenses associated with developing low-carbon technologies for the energy sector;
- a decline in the value of investments in sectors with high carbon emissions;
- additional regulation and reporting requirements.

To hasten the shift to the use of renewable energy, a government might, for instance, decide to adopt abruptly stricter environmental and climate policies. This could have a negative impact on all those businesses that are not prepared financially and economically for the change, which would have a negative impact on their profitability. Additionally, a different type of transition risk is associated with corporate reputation. In fact, given how crucial it has become to adopt policies that support environmental sustainability, businesses that fail to uphold these unwritten rules frequently face an implicit risk, namely a hidden reputational risk.

### 1.1.2. Sustainable investments in last years

As stated previously, the term "sustainable finance" refers to the area of finance that includes investments that seek not only a financial return but also a favourable impact on society, the environment, and the government, or what are known as "ESG factors". Generally speaking, this category of investments is known as SRIs, or *Sustainable and Responsible Investments*. A socially responsible investment is one that is regarded as such due to the nature of the business that the company engages in. Avoiding investments in businesses that manufacture or market addictive substances (such as alcohol, gambling, and tobacco) and looking for businesses involved in social justice, environmental sustainability, and alternative energy/clean technology initiatives are common themes for socially responsible investments. Investments in socially conscious mutual funds or exchange-traded funds, as well as individual companies, can be made in socially responsible areas (ETF). Thus, these investments include all investment activities that, in addition to generating value for the investor through a financial profit, also produce well-being for the business itself, having an effect on all the players involved from an ESG perspective.

The term "socially responsible investment" has become overused and gained popularity in the 1980s and 1990s. According to the Journal of Impact and ESG Investing (2020), the modern SRI process has three main pillars that support the present situation:

1. Values-based avoidance screens;
2. Proactive sustainability-focused analytics, colloquially referred to as “ESG investing”;
3. Corporate engagement and impact investing.

Overall, this sustainable approach to finance has become more and more important in recent years. The global investment industry has seen an exponential rise in sustainable investments in recent years, according to the 2020 Global Sustainable Investment Alliance Report (2021). As can be inferred from Table 1.1, in 2020 global sustainable investment in the five key markets covered by the report hit $35.3 trillion, up 15% over the previous two years (2018–2020) and 55% over the previous four years (2016-2020).

Table 1.1: Snapshot of global sustainable investing assets, 2016-2018-2020 (USD billions).

| REGION | 2016 | 2018 | 2020 |
|---|---|---|---|
| Europe | 12,040 | 14,075 | 12,017 |
| United States | 8,723 | 11,995 | 17,081 |
| Canada | 1,086 | 1,699 | 2,423 |
| Australasia | 516 | 734 | 906 |
| Japan | 474 | 2,180 | 2,874 |
| **Total (USD billions)** | **22,839** | **30,683** | **35,301** |

Source: Global Sustainable Investment Review 2020.

According to Table 1.2, the total professionally managed assets under management during the reporting period increased to $98.4 trillion. A total of 35.9% of the total assets under management are reported to be in sustainable investments. This represents an increase of 2.5 percentage points from the previous reporting period.

Table 1.2: Snapshot of global assets under management 2016-2018-2020 (USD billions).

| REGIONS | 2016 | 2018 | 2020 |
|---|---|---|---|
| Total AUM of regions | 81,948 | 91,828 | 98,416 |
| Total sustainable investments only AUM | 22,872 | 30,683 | 35,301 |
| % Sustainable investments | 27.9% | 33.4% | 35.9% |
| **Increase of % sustainable investments** (compared to prior period) | | **5.5%** | **2.5%** |

Source: Global Sustainable Investment Review 2020.

The value of sustainable investment assets is rising globally, except for Europe, where there seems to be a decline. However, this is because EU legislation has significantly changed how sustainable investment is defined in this region[2].

[2]The data's inclusion of regulatory definitions may mean that not all products or strategies previously considered would adhere to the new regulatory definitions, which may account for the decline in Europe. It is still too early to draw firm conclusions about trends because the European market is undergoing rapid and continuous change.

Table 1.3: Growth of sustainable investing assets by region (2014-2020).

| | GROWTH 2014-2016 | GROWTH 2016-2018 | GROWTH 2018-2020 |
|---|---|---|---|
| Europe | 12% | 11% | -13% |
| United States | 33% | 38% | 42% |
| Canada | 49% | 42% | 48% |
| Australasia | 248% | 46% | 25% |
| Japan | 6,692% | 307% | 34% |

Source: Global Sustainable Investment Review 2020.

As shown in Table 1.3, sustainable managed assets grew by over 48% in Canada over the past two years, representing the largest increase in this period. From 2018 to 2020, the United States closely trailed Canada with a growth of 42%, followed by Japan at 34%. Sustainable asset growth in Australasia persisted, but at a slower rate than between 2016 and 2018, with an increase of 25% from 2018 to 2020 compared with 46% from 2016 to 2018. This slowdown is a result of an industry transition in which RIAA[3] defined and measured standards for sustainable investment have become more stringent.
Due to a modified measurement methodology from which European data for this year's report was derived, Europe reported a 13% decline in the growth of sustainable investment assets from 2018 to 2020. This reflects a period of change brought on by updated definitions of sustainable investment that have been incorporated into EU law as a result of the European Sustainable Finance Action Plan.

Table 1.4: Proportion of sustainable investing assets relative to total managed assets (2014-2020).

| REGION | 2014 | 2016 | 2018 | 2020 |
|---|---|---|---|---|
| Europe | 58.8% | 52.6% | 48.8% | 41.6% |
| United States | 17.9% | 21.6% | 25.7% | 33.2% |
| Canada | 31.3% | 37.8% | 50.6% | 61.8% |
| Australasia | 16.6% | 50.6% | 63.2% | 37.9% |
| Japan | | 3.4% | 18.3% | 24.3% |

Source: Global Sustainable Investment Review 2020.

[3]Responsible Investment Association Australasia

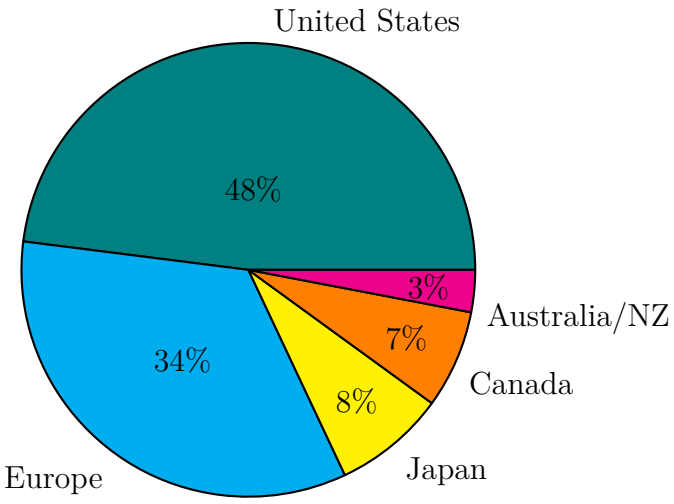



Figure 1.1: Proportion of global sustainable investing assets by region (2020)

Source: Global Sustainable Investment Review 2020.

Table 1.4 depicts how strongly sustainable investing continued to increase in Canada, the US, and Japan relative to total managed assets.
In contrast, between 2018 and 2020, a decline in the proportion of sustainable investment assets to the total amount under management was recorded in Europe and Australasia. Although it has declined by 13% in two years, Europe still ranks second in terms of sustainable investment assets as a proportion of total assets under management (41.6%), preceded only by Canada. However, with a drop in performance of about 40%, Australasia fared even worse than Europe.
With a 2-year increase of 22% from 2018 to 2020, Canada is the region that performed the best, and as a result, it has the highest share of sustainable investment assets relative to total assets under management (61.8%). Similarly, the United States also experienced rapid growth, with a 29% increase in this number between 2018 and 2020. The overall ratio, which is 33.2%, indicates that the overall proportion is still trailing. Last but not least, even though Japan's economy grew by 34% over these two years, it still has the lowest percentage of sustainable investment assets among the economies taken into consideration (24.3%).

Concluding, in Figure 1.1 can be seen that United States and Europe still represent more than 80% of global sustainable investing assets during 2018 to 2020. Over the past two years, the percentages of global sustainable investing assets in Canada (7%), Japan (8%) and Australasia (3%) have remained largely unchanged (Global Sustainable Investment Review 2020).

### 1.1.3. Sustainable investments strategies and instruments

As we said in previous sections, sustainable investment is a method of managing and selecting a portfolio that takes environmental, social, and governance (ESG) considerations into account. However, to date, there is no definition that does not present some sort of ambiguity in these terms.
To try to mitigate this problem, the GSIA (Global Sustainable Investment Alliance) gives a more precise definition of what sustainable investment strategies can be:

- *ESG integration*: this refers to the investment managers' explicit consideration of ESG opportunities and risks in traditional financial analysis and investment decisions, based on a well-thought-out process and reliable research sources. This type explicitly takes into account ESG factors in addition to financial factors in the standard investment analysis. The focus of the integration process is on the potential (both positive and negative) effects of ESG issues on the financial performance of the company, which could then influence the investment choice.
  The integration of these two disparate viewpoints, namely ESG and financial measures, is challenging to define, though. There have been numerous studies and efforts in this direction, and two main approaches have been identified:
  - a *quantitative* approach that attempts to predict the relationship between ESG factors and financial returns represents the first viable option. Actually, the goal of this methodology is to improve price predictions for the future by attempting to estimate the relationship between asset returns and pertinent ESG factors;
  - a *fundamental* approach in which analysts' financial or business evaluation models are directly impacted by the estimated effects of ESG variables. For instance, analysts may take the performance of ESG factors into account when assessing a company by appropriately modifying the firm's cost of capital in the valuation model.
- *Corporate engagement and shareholder action*: this approach involves making use of shareholder power to influence corporate behaviour, such as through direct corporate engagement (i.e., speaking with senior management and/or boards of directors), filing or co-filing shareholder proposals, and proxy voting that is guided by thorough ESG guidelines. Thus, here we have an active shareholder engagement with companies to influence their corporate behaviour on ESG issues. This is a long-term procedure, and it aims to change behaviour or improve disclosure;

- *Norms-based screening*: here investments are screened according to their compliance with international standards and norms. With this strategy, investments are screened using a combination of international norms that address ESG factors. Thus, we have the exclusion of companies and projects with a business practice not in line with international norms. International standards are defined by organizations such as the UN (United Nations), ILO (International Labour Organization), OECD (Organization for Economic Co-operation and Development) and NGOs (non-governmental organizations);

- *Negative/exclusionary screening*: a strategy that excludes certain investments or classes of investments, such as businesses, industries, or nations, from the investible universe. This strategy systematically eliminates businesses, industries, or nations from the universe of allowable investments if they engage in specific activities according to predetermined criteria. Weapons, pornography, tobacco, and animal testing are examples of typical criteria. Exclusions may be used across the entire product spectrum of assets, whether at the level of a specific fund or mandate or, increasingly, at the level of an asset manager or asset owner. Due to the fact that exclusion criteria are frequently based on the decisions made by asset managers or asset owners, this strategy is also known as ethical- or values-based exclusions;

- *Best-in-class/positive screening*: a strategy in which the top or best-performing investments within a category or class are chosen or weighted according to ESG factors. In this strategy, the best-performing or most improved companies or assets within a specified investment category are chosen or given more weight. Thus, here, as opposed to the previous strategy, investment in areas, businesses, or initiatives are chosen for their superior ESG performance in comparison to their competitors and that score above a predetermined threshold;

- *Sustainability themed/thematic investing*: this approach involves investment in themes or assets linked to the development of sustainability (such as Green Bonds). Thematic funds, for instance, have to concentrate on one or more ESG-related issues. Investments with a sustainability focus naturally help to address social and/or environmental problems like climate change, eco-efficiency, gender equity and health. To be included in this approach, funds must have an ESG analysis or investment screening;

- *Impact investing*: impact investments are investments made in businesses, nonprofits, and funds with the goal of producing both a financial return and positive social and environmental impact. Depending on the situation, impact investments

can be made in both emerging and developed markets and aim for a range of returns starting below market-to-market rates. In contrast to philanthropy, investments are frequently project-specific because the investor keeps ownership of the asset and anticipates a profit. Microfinance, community investing, and funds for social enterprises are all examples of impact investment;

- *Community investing*: in this approach capital is given to businesses with a clear social or environmental purpose, as well as funding that is specifically targeted to historically underserved people or communities. Although community investing is broader and takes other types of investing and targeted lending activities into account, some community investing is impact investing.

As we saw, it is necessary to understand which strategies can be put in place to make sustainable investments, but it is equally important to analyse the instruments with which these strategies can be implemented.
The great growth and development of sustainable finance in recent years has given rise to several sustainable finance instruments, including:

- *Green Equity*: these are investments in environmentally friendly projects, where the investor buys stock in the target business. Other frequently used instruments include venture capital and investment funds, in addition to direct participation through the purchase of company shares;
- *Green Bonds*: these bonds are similar to conventional ones, but they are issued with the purpose of funding projects that have a favourable impact on the environment, such as energy efficiency, the production of clean energy, the sustainable use of land, and others;
- *Green Loans*: any type of loan instrument that has funds allocated solely to green projects that address pressing environmental issues like climate change, the depletion of natural resources, the extinction of species, and air, water, and soil pollution. The borrower's regular reporting to the lender of the actual use of the loan proceeds, as well as the use of qualitative performance indicators and quantitative performance measures (such as electricity generation, greenhouse gas emissions reduced/avoided, etc.), is a crucial component of a green loan;
- *Social Bonds*: the International Capital Market Association (ICMA) defines social bonds as bonds whose proceeds are used exclusively to finance or re-finance social projects, i.e. projects with clear socio-economic benefits. Basic infrastructure, job creation/saving through financing and financing for SMEs, food safety and hygiene,

socio-economic progress and strengthening are a few examples of project categories funded by social bonds;

- *Sustainability Bonds*: are any kind of bond instruments dedicated to funding projects that are both green and social, with some green projects having social benefits and others having social benefits and environmental benefits. The majority of the time, the funds are invested in initiatives with a social or environmental impact that are in line with the UN sustainable development goals (SDGs). Corporate SDG bonds (non-financial), SDG bonds issued by banks and other financial institutions, project and asset-backed SDG bonds, sovereign SDG bonds, and municipal SDG bonds are examples of sustainability bonds;

- *Sustainability-Linked Bonds*: these securities, also known as "key performance indicator" bonds or KPI bonds, link the bond's interest rate to the issuer's achievement of a pre-established sustainability target within a predetermined timeframe. Thus, this creates incentives for the issuer to undertake sustainable investments that enable him to achieve the targeted performance. Indeed, a financial term or structural aspect of the bond will change to the benefit of investors if the issuer does not achieve a pre-defined environmental, social or sustainability-linked target. Most importantly, KPI bonds allow the issuer to use the proceeds for other purposes at its discretion and do not mandate that they be applied to any particular eligible projects or in a particular way.
  The majority of KPI bond issuers to date have employed a "*coupon step-up*", which stipulates that if the sustainability-linked target is not met by a specific cut-off date, the interest rate on the bonds will rise by a specific percentage. While not intended to be a punishment for the issuer, the coupon step-up or other monetary or structural change attaches a financial incentive for the issuer to meet the KPI target. As long as the KPI target is met, there are typically no covenants or events of default associated with it. Instead, the more important risk that issuers take into account in reality is damage to their credibility and reputation;

- *Sustainability-Linked Loans*: similarly to Sustainability-Linked Bonds, these are any type of loan instrument where the interest rate (that is paid by the borrower) is variable and linked to a few chosen sustainability performance indicators, like carbon emissions or an ESG target. If the sustainability goals are met, the borrower will receive favourable interest rates; if not, higher rates will apply. This mechanism functions as a financial inducement for achieving sustainability goals.

## 1.2. Green Bonds: an instrument to reach the environmental goals

Although there are many resources and approaches available in the broad field of sustainable finance, *Green Bonds* unquestionably stand out as one of the most promising market-based approaches to raise awareness of environmental risks and direct funding to projects that benefit the environment. There isn't a widely and unambiguously accepted definition of this phenomenon due to the relatively recent development of this type of instrument.

In general, Green Bonds are defined as debt securities whose proceeds will be used to fund sustainable investments that have a positive impact on the environment, such as energy efficiency, energy production from clean sources, sustainable land use, etc. Thus, a Green Bond is differentiated from a regular "*vanilla*[4]" bond by its label, which signifies a commitment to exclusively use the funds raised to finance or re-finance "green" projects, assets or business activities (ICMA, 2015).

Although the OECD does not define what a green investment or green bond is, it has discussed in its work what "green infrastructure" and "green investments" are (OECD, 2013; Inderst et al., 2012) and has provided a general quantitative basis for determining to what extent infrastructure systems can be considered "low-carbon and climate-resilient (LCR)" (Kennedy and Corfee-Morlot, 2012).

A Green Bond is a type of bond, like all other bonds, that is used to raise money from investors in the debt capital market. Typically, the bond issuer collects a predetermined sum of money from investors over a predetermined time period (the "maturity"), repaying the money (the "principal") when the bond matures and paying a predetermined sum of interest ("coupons") along the way.

As a result, Green Bonds are created as financial products to assist governments, businesses, and supranational institutions in pursuing environmental mitigation policies that are currently required to be implemented to combat the dangerous issue of climate change. On the other hand, green bonds enable investors to include an ethical standard in their investment decisions and as a result, produce sustainable value in addition to financial value (Paranque and Revelli 2019).

These fixed-income securities, that use their proceeds towards the financing of ESG-aligned projects, have proven particularly attractive among investors. The market for green bonds has also sparked the development of social bonds and sustainability bonds,

[4]The most basic or typical version of a financial instrument, typically options, bonds, futures, and swaps, is known as plain vanilla.

two similarly structured debt products that broaden the purview of green bonds to include all three components of sustainability.

Howerer, it is important to go into what defines the "*greenness*" of a green bond and what the repercussions are if a sustainability standard is not met. Indeed, in most jurisdictions, there is no direct public regulation of the green bond market. Instead, private governance regimes based on the market largely control the sustainability component of green bonds.

Green bonds, like many other business strategies built on social responsibility commitments, are susceptible to "*greenwashing*". Greenwashing, in ESG investing and sustainable finance industries, is defined as the practice of marketing or disseminating financial products or services that either overstate their favourable sustainability impacts, understate their material environmental risks, or generally misrepresent their perceived ESG-related benefits. Companies may, for instance, use selective disclosure, questionable eco-labels, deceptive visuals (such as the use of biodiversity symbols on products), and deceptive narratives.
The issue of greenwashing is made worse by the increasingly fragmented ownership of bonds, which makes it difficult for creditors to monitor and enforce their rights. This issue is being addressed by the private standards, certification programs, indices, and assurance practices that have appeared in the green bond market. But there is a pressing need for more legal innovation as the green bond market expands and diversifies.
There are many academic works that explore the role of integrating public regulation and private governance as a means of addressing the regulatory deficits of private governance in sustainable finance markets.
Two of the main reasons why companies engage in greenwashing are reputational and economic considerations. Indeed, a business may decide to mislead customers about its environmental policies in an effort to boost sales and gain the trust of both customers and potential investors, as well as institutions and shareholders.

Several products in the field of green bonds have been criticized as greenwashing efforts, most notably a sustainability-related bond issued by Italian energy conglomerate Enel. While in the aforementioned case the charges of greenwashing levelled by significant institutional investor Nuveen were not universally agreed upon, some researchers asserted that while undoubtedly improvable, Enel's bond in question offered more thorough target-setting and incentives to reach the latter than traditional green bonds up to that point.
In light of these persisting systemic risks, resulting from greenwashing and the general

definitional fluidity regarding the eligibility of projects to be considered green or ESG-aligned, several national financial market regulators made an effort to lay out precise guidelines regarding the kinds of activities that could profit from the proceeds of green bonds.
Considering the European Union, the EU Taxonomy[5] has the objective to create a classification system for sustainable economic activities that will establish a universal language for investors to use when investing in projects and business ventures that significantly improve the environment and the climate. In fact, for activities to be eligible under the EU Taxonomy, issuers must show how the funds raised will be used in practice. These activities, then, have to comply to several conditions, criteria and environmental objectives.

Another characteristic of Green Bonds, about which the literature is full of studies, is the so-called "*greenium*". Indeed, it would appear that the only difference between Green Bonds and conventional bonds is the different allocation of the proceeds raised through the issuance, while maintaining a functional similarity as a financial instrument. Instead, there are other differences between the two, and one is represented by the greenium. The greenium, or "green premium", refers to the higher price (i.e., premium) that investors accept to pay in order to purchase Green Bonds, compared with conventional bonds. A higher bond price translates in a lower yield to maturity that buyers receive, and so this will have an impact on the cost of financing of the issuer.
Thus, in general, a greenium is said to exist if a conventional bond's price is lower (or if its yield is higher) than a Green Bond with the same properties.
However, the issue of the true existence of this greenium is complicated, and not all authors reached the same consensus, as will be thoroughly discussed in Chapter 2.

### 1.2.1. Explaining Green Bonds

As we continue with this general discussion of green bonds, an important distinction made by ICMA allows us to identify four main instrument types that can be considered Green Bonds. These mainly differ in terms of the types of green projects funded and whether collaterals are used. Undoubtedly, more varieties of Green Bonds could appear in the coming years as the market continues to develop and take on new characteristics.
The current four types of Green Bonds (ICMA, 2021) are:

1. *Standard Green Use of Proceeds Bond*: an unsecured debt obligation with full recourse-to-the-issuer only and aligned with the GBP (Green Bond Principles);

[5]More detailed information about the EU Taxonomy is displayed in Chapter 4.

2. *Green Revenue Bond*: a non-recourse-to-the-issuer debt obligation aligned with the GBP in which the credit exposure in the bond is to the pledged cash flows of the revenue streams, fees, taxes, etc., and whose use of proceeds go to related or unrelated Green Project(s);
3. *Green Project Bond*:a project bond for a single or multiple Green Project(s) for which the investor has direct exposure to the risk of the project(s) with or without potential recourse to the issuer, and that is aligned with the GBP;
4. *Secured Green Bond*: secured bond where the net proceeds will be exclusively applied to finance or refinance either:
    i. the Green Project(s) securing the specific bond only (a "Secured Green Collateral Bond"); or
    ii. the Green Project(s) of the issuer, originator or sponsor, where such Green Projects may or may not be securing the specific bond in whole or in part (a "Secured Green Standard Bond"). A Secured Green Standard Bond may be a specific class or tranche of a larger transaction.

The category of "Secured Green Bonds" may include, but is not limited to, covered bonds, securitizations, asset-backed commercial paper, secured notes, and other secured structures, where generally the cash flows from the assets are available as a source of repayment or the assets serve as security for the bonds in preference to other claims.

According to prior research and market-based evidence, different benefits can be related to this type of financial instruments (independent of any specific Green Bond typology), from both the issuer's and the investor's perspectives.
In particular, the advantages for the issuers are:

- Lower costs: as we briefly discussed before, there is some evidence of a "greenium" in the market for Green Bonds that reduces the cost of financing of the issuer. Moreover, many governments started to offer companies issuing this kind of financial products some cost advantages, primarily in the form of tax reductions and incentives, in order to encourage the transition to a low-carbon economy;
- Reputation: by issuing Green Bonds, a company can credibly demonstrate its support for sustainable development initiatives as well as its awareness of environmental and social concerns. Nowadays, being recognized as an environmentally friendly company is more crucial than ever, especially in light of the accessibility of information;

- Investors' diversification: since Green Bonds are financial products whose proceeds are used to fund climate-related projects, their appeal extends beyond simple economic profit. Investors who have a tendency to care about environmental issues and who are willing to trade off a higher economic return for a better climatic-environmental return will therefore be more likely to buy these kinds of products;
- Engaging long-term investors: given the gradual tightening of regulations that will push more and more toward a zero-emission economy, green bonds are financial instruments that are likely to perform best over the long-term, thus attracting even more "patient" investors.

Talking about investors, the main benefits are:

- Diversification: the degree of correlation between the market for green bonds and other financial markets was examined in several studies. The outcome of these analyses demonstrates the opportunities for diversification that investors can take advantage of by purchasing Green Bonds, positioning these eco-friendly financial products as buffers against fluctuations in other financial markets;
- Environmental benefits: by purchasing Green Bonds, investors are able to balance risk-adjusted financial returns with environmental benefits;
- Requirements satisfaction: some issuer may be constrained to undergo some environmental restrictions. In this case, Green Bonds may be able to satisfy ESG requirements to be met by the buyer;
- Transparency: the great disclosure of information that characterize the market of Green Bonds allows investors to be more informed aware about the financial instrument that they are purchasing.

Despite the above-mentioned advantages of Green Bonds, the major drawbacks and risks are:

- Greenwashing: as we previously discussed, Green Bonds may be correlated to greenwashing activities. This threat can drive away potential investors that who are not sure whether the issuer will use the funds as promised;
- Reputational risk: the large amount of information to be disclosed by the issuer exposes it to reputational risk. In fact, the failure to meet some periodic ESG target may cause the image of the company in question to drop;
- Cost of certification: unlike conventional bonds, green bonds are more susceptible to

upfront costs, from labelling and associated administrative, certification, reporting, verification and monitoring requirements;

- Regulatory environment: currently, there multiple regulations that issuers can adhere to when issuing these instruments. However, in this regard, there are primarily two issues. First, the regulatory environment can become complex and contradictory due to the numerous options for paths to take. Additionally, potential issuers frequently are not aware of these protocols and standards. Again, inadequate information and, in this instance, the high cost associated with following such regulations, represent significant obstacles that should not be undervalued.

In spite of these benefits and drawbacks, Green Bond have quickly become a financial success. In fact, the market for green bonds has expanded significantly in recent years. Indeed, since the first green bond was issued in 2007, green bonds have dominated the market, though social bonds and later sustainability bonds have now helped to diversify the market.

The European Investment Bank issued the first green bond in 2007, followed the World Bank in 2008. Green bonds have been issued by municipal, regional, and federal governments as well as multinational corporations since 2013. The first $1bn green bond was issued by IFC in March 2013, and it sold within an hour of issue. In June 2013, the American state of Massachusetts issued the first municipal green bond, and in December 2016, Poland became the first sovereign state to issue a green bond with a label. Vasakronan, a Swedish real estate company, issued the first corporate green bond in November 2013. Since then, numerous multinational corporations across a variety of industries have issued green bonds, and investor demand has vastly outpaced supply.


Figure 1.2: Green Bonds milestones.

Source: Climate Bonds Initiative.

As displayed by Figure 1.3, the Green Bond market reached the $1 trillion cumulative issuance in 2020. Until that year, since the first issuance in 2007, the growth rate was approximately 95%.

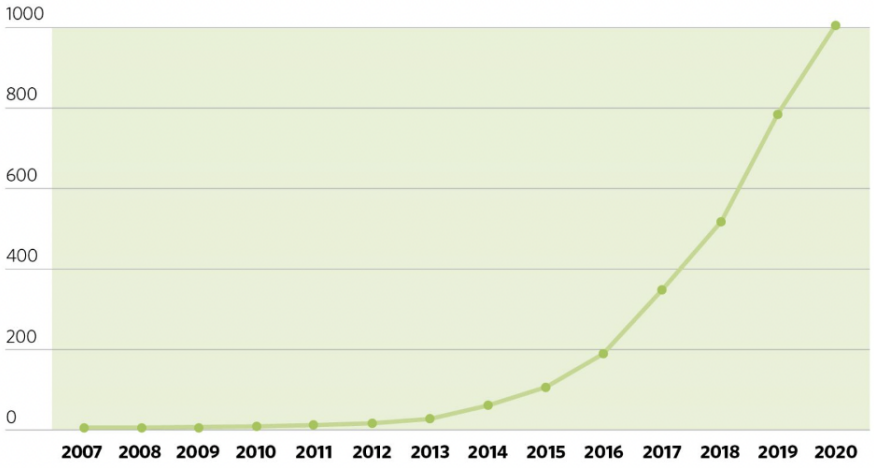



Figure 1.3: Green Bonds cumulative amount issued ($bn).

Source: Climate Bonds Initiative.

Speaking in broader terms, the GSS+ (Green, Social, Sustainability, Sustainability-Linked and Transition) debt increased to almost $1.1tn in 2021, a 57% increase over volumes in 2020, according to Climate Bonds Market Intelligence's most recent analysis. Indeed, at the end of 2021, Climate Bonds had recorded more than 16,000 GSS+ debt instruments with a cumulative volume of $2.8tn.

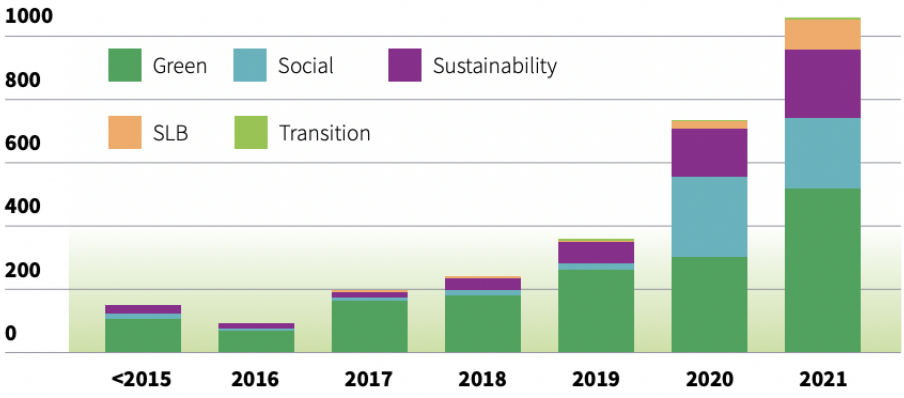



Figure 1.4: GSS+ debt volume per year ($bn).

Source: Climate Bonds Initiative.

The green theme continues to be the largest source of debt, accounting for 49% of the total ($523 billion), and SLBs showed the fastest growth, expanding by ten times year-over-year.

As we have seen, the Green Bonds market has grown a lot, especially in recent years. However, this trend does not seem to slow down.

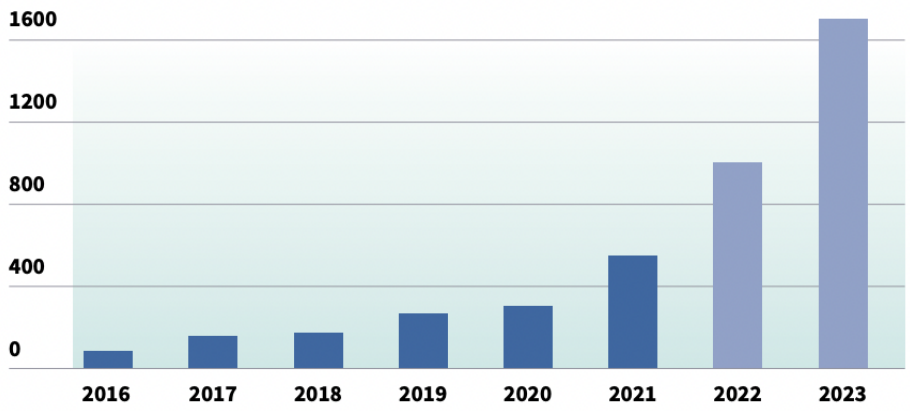



Figure 1.5: Green Bonds market expected growth ($bn).

Source: Climate Bonds Initiative.

In fact, even after the slight slow down of issuances in 2020 due Covid-19, 2022 is expected to close reaching $1 trillion of issuance, and then exceed $1.6 trillion in 2023 (Figure 1.5). Being able to reach these milestones so early in the decade would be a crucial sign that, as the world races against time, large amounts of capital are being directed toward climate solutions.

To achieve net-zero by 2050, according to a recent McKinsey analysis, a total of $9 trillion in green investments are required annually. Although this number is higher than other estimates, it serves as a baseline against which to measure current investment levels.

According to Climate Bonds CEO (Sean Kidney), the next global milestone that governments, policymakers, and investors need to reach in order to make the necessary contribution to achieving our climate goals is a $5 trillion annual green bond issuance by 2025. Considering this, the McKinsey figure might be achievable, when combined with equity flows and sovereign outlays.

# 2 | Literature review

In this section, the objective is to analyse the State of the Art of literature on the topic of Green Bonds, in order to gain an in-depth understanding of which studies and analyses on this topic have already been carried out. This initial study thus makes it clearer why it was decided to focus on the topic of this thesis, which had not yet been touched upon by any academic articles published to date.

Although a relatively new topic, several academic publications on Green Bonds have been published in recent years. Despite the topic's novelty, there is a thriving research environment, which can be attributed to the astonishing relevance that these financing instruments are assuming. In particular, the existing literature focuses on three dimensions of analysis:

- the presence of a green premium;
- the presence of a liquidity premium;
- the impact of the Green Bond on the issuer.

## 2.1. Green Premium

The Green Bond market offers the possibility for various investors to finance projects that make a positive contribution to the environment. However, whether this new type of investment is really worthwhile compared to conventional bonds, from the point of view of the risk-return profile, is currently being debated.

The majority of the literature currently in circulation focuses on whether there is a green premium, which is the yield difference between a Green Bond and a conventional bond (also called a brown bond). In other words, the green premium, also referred to as *greenium*, is the premium that investors are willing to pay to subscribe to a Green Bond over a corresponding brown bond.
Speaking of Green Bond premium, the first relevant study is "The Cost of Being Green" of

Preclaw and Bakshi's (2015), which opened the door for all related future studies on this topic. The key finding of this seminal study was that, in the end, investors were paying more to purchase Green Bonds, and so that a "greenium" exists.

Despite this, the debate over the greenium has become more widespread among researchers since the publication of the first crucial study by Preclaw and Bakshi. Although numerous studies have been conducted to determine whether this green premium exists, no clear consensus has been reached. Researchers, indeed, are divided into two macro-groups: those who claim that greenium exists and those who claim that it is to be considered null. This range of viewpoints among researchers can be largely attributed to the methodological heterogeneity with which the different studies were conducted. For instance, there are differences between the studies published in terms of the reference market where these bonds are traded, as well as the various issuer types that are taken into account (i.e., financial institutions, corporations, or supranational institutions), and the various rating classes assigned to the bonds.

In this first part, relevant studies belonging to the first group are presented, i.e., those in favour of the existence of a green premium.
A first important contribution is provided by the study by Fatica, Panzica and Rancan (2021), in which the presence of the premium is emphasized in particular for bonds issued by supranational institutions and corporates. As pointed out in the study, this makes it possible for these entities to have access to a lower cost of debt. In contrast, the study underline evidence of the presence of a premium for financial institutions. This absence would mainly be attributable to the difficulty for these types of issuers to directly correlate the bonds they issue with projects deemed green.

Another factor that is considered in several studies concerns the rating assigned to the different bonds. An example is the study by Hachenberg and Schiereck (2018), in which Green Bonds and comparable non-green bonds issued between late 2015 and early 2016 are compared. This research resulted in the discovery of the presence of a premium for Green Bonds, particularly A-rated bonds, for which "*pricing differentials show statistical significance, with green bonds trading 3.88 bps (4.87%) tighter than comparable non-green bonds*". An important insight provided by this study concerns a possible offsetting effect of the higher transaction costs incurred by issuers with the price difference between Green Bonds and non-green bonds. Indeed, issuing Green Bonds entails higher costs such as the need to receive a second party opinion or external certification regarding the transaction, as well as monitoring and reporting on the green use of proceeds. In particu-

lar, the study shows that this offsetting effect is relevant for bonds rated AA, A and BBB.

Other studies even emphasize how "*the magnitude of the savings for issuers (in terms of interests paid) exceeds the costs to get the green label or rating*" (Gianfrate and Peri, 2019). In the latter study, Gianfrate and Peri bring an interesting perspective on the motivation behind the financial savings achieved by issuers. Indeed, in their paper "The green advantage: Exploring the convenience of issuing Green Bonds", they assert that these financial savings are the natural consequence of an excess demand for Green Bonds. Nowadays, in fact, customers are increasingly sensitive to environmental issues and, as a result, institutional investors are increasingly skewed towards environmental friendly forms of investment.

As previously mentioned, the reference market for bonds (primary or secondary market) also turns out to be a discriminating factor in the analyses and studies carried out in the existing literature. In particular, several studies analyse the two markets separately, trying to identify the presence or absence of a green premium in each of them. As for the primary market, the focus is on the presence of a green premium when the bond is issued (Partridge and Medda, 2018; Baker et al., 2018; Gianfrate & Peri, 2019; Kapraun & Scheins, 2019; Fatica et al., 2020; MacAskill et al., 2021; Löffler, Petreski and Stephan, 2021). In contrast, in the secondary market, the focus is on the price development of bonds in post-issue trades (Preclaw and Bakshi, 2015; Karpf & Mandel, 2018; Partridge & Medda, 2018; Gianfrate & Peri, 2019; Kapraun & Scheins, 2019; Zerbib, 2019; MacAskill et al., 2021).
Löffler, Petreski and Stephan conducted a study that in a way synthesizes several previous researches. In their analysis, they found evidence of greenium in both the primary and secondary markets. In particular, Green Bond yields are 15-20 bps lower than those of comparable conventional bonds. The motivation given by the authors to explain these results is twofold: on the one hand, the lower underlying risk associated with Green Bonds could explain their lower yields; on the other hand, "*institutional investors are willing to pay a higher price for the bond's "green label" because they have a pro-environmental preference*".

In other studies, however, the presence of a green premium was found to be less pronounced in both markets. This was the case in the study conducted by Partridge and Medda, who compared Green municipal Bonds that were issued at the same time by the same issuers as conventional "vanilla" bonds. This type of comparison is very effective, in fact "*the true test of a Green Bond price difference would be to have two identical bonds*

*(i.e., same issuer, tenor, format) priced on the same day*" (Michaelsen, 2018). The results showed that signals of the presence of a greenium at the time of issuance start from 2017 onwards, and can be quantified as 4 bps. In the secondary market, on the other hand, signals of the presence of a greenium are less pronounced, and this is mainly due to the larger monthly and annual fluctuations.

An important contribution to the literature of those belonging to the macro-group of those in favour of greenium was made by MacAskill and colleagues (2020). Indeed, they reviewed several studies that had been conducted up to that point, taking into account the methodological differences in the various approaches used. The objective was to "*establishing a consensus on the existence, or non-existence, of a green premium in the Green Bond market*". As a result, this study examined the performance of various green and non-green bonds on the primary and secondary markets, while also attempting to assess the variables that influence the development of the green ones. In detail, their analysis considers studies published between 2007 and 2019. As shown in Figure 2.1, the results of this research confirmed the presence of a premium in 56% of the primary market studies and up to 70% of the secondary market studies.

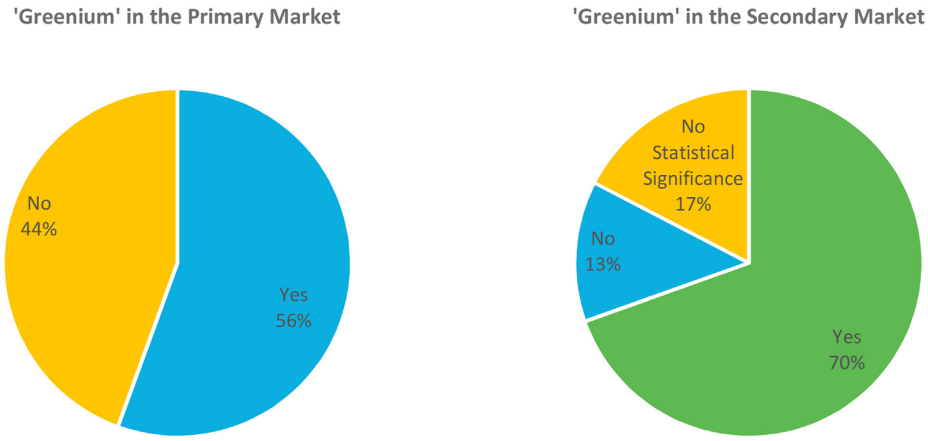



Figure 2.1: Literature consensus on the existence of a green premium in the primary and secondary market.

Source: MacAskill et al., 2020.

The study shows that, in terms of the spreads between Green Bonds and conventional bonds, these can range widely in the primary market. However, in the secondary market, a spread typically falling between -1 and -9 basis points can be found in most cases (Figure 2.2).

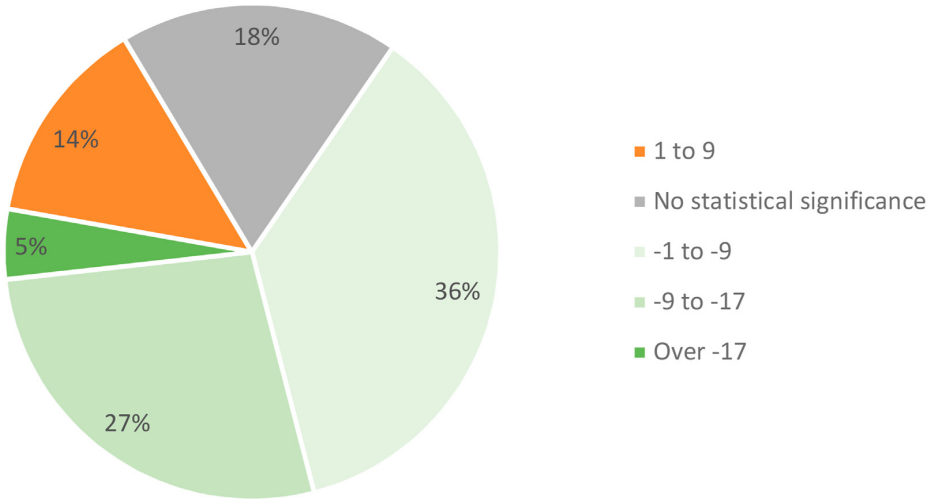



Figure 2.2: Average sample green premium (bps) in the secondary market.

Source: MacAskill et al., 2020.

One of the most relevant aspects of this study concerns the identification of a set of factors considered determinant in the development of a green premium. Indeed, the result of this paper is that the greenium is primarily found in Green Bonds that comply to certain peculiar characteristics, such as the fact that they are investment-grade, government-issued bonds, and that they follow specific Green Bond governance and reporting guidelines. In particular, these factors can be reduced to three categories: social, economic and environmental (Figure 2.3).

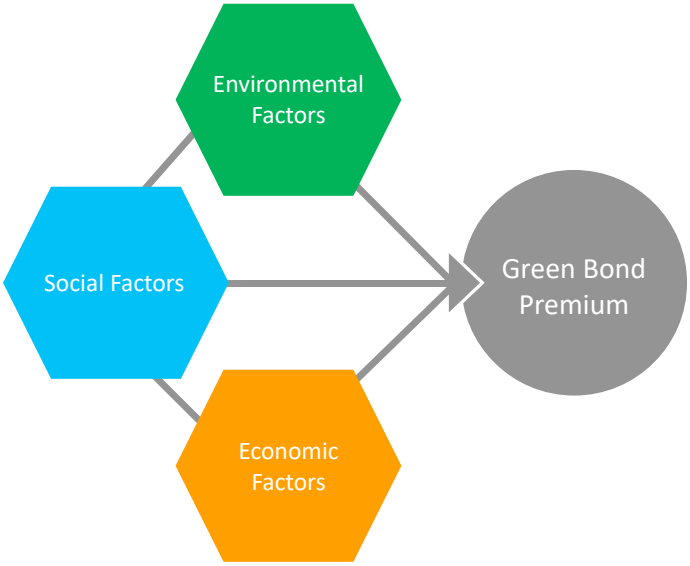



Figure 2.3: Drivers of the "green premium" for bond investors and issuers.

Source: MacAskill et al., 2020.

Having reviewed the various studies supporting the presence of a Green Bonds' premium, we now turn to analyse that part of the literature in favour of a zero premium. Among the most prominent studies are those of Hacıömeroğlu et al. (2021), Lau, Sze, Wan and Wong (2020) and Tang and Zhang (2018).
The existence of a green premium, according to a first significant line of researchers who have focused primarily on the study of corporate bonds, results primarily from failing to take various control factors into account. Hacıömeroğlu and colleagues (2021) compared the yield to maturities of green versus brown corporate bonds on the dates of issue, taking into account market, firm, bond, and currency characteristics in addition to the green status of the bond. Their insightful and compelling conclusion was that if these factors (i.e., market, firm, bond, and currency) are ignored, evidence for the existence of a "greenium" can be found at a magnitude of about 25 basis points.
Contrarily, the outcome of the process significantly changes when the research perspective is altered and all of these yield factors are taken into account in the evaluation model. In fact, the model shows that in such a scenario, issuing a Green Bond rather than a brown bond may not necessarily result in the issuers of these financial instruments enjoying a cost advantage. This leads to the conclusion that results on the existence of the green premium are biased if, mistakenly, all the control factors and the ensuing interactions between them are not taken into account. This is an important point in the discussion of greenium because it emphasizes the already mentioned methodological heterogeneity in carrying out this kind of research.

The second paper (Lau et al., 2020) analyses the largest possible sample of Green Bonds globally, when compared to all previous studies. One of the two central themes addressed in this paper concerns the factors on which greenium depends. In order to better understand the following reasoning, they start with the following question: "*why investors are willing to pay for, and issuers willing to sell, a bond at a price different from another with totally the same characteristics except that the use of the proceeds is confined to serving pro-environmental purposes?*". Since companies are profit-maximising entities, they would not be willing to issue Green Bonds instead of identical conventional bonds if this would not bring them some kind of benefit. The higher costs of issuing a Green Bond (compliance cost) must therefore be lower than the associated benefits. These benefits can be either pecuniary (i.e., government incentives or tax deductions) or non-monetary (i.e., improving corporate image through a green label associated with the company). To summarize, the greenium is thus dependent on two factors: on the one hand, there is the environmental benefit of the bond received by the investor; on the other hand, the additional costs of issuing a Green Bond are offset by the associated benefits.

The second main theme of the paper concerns the analysis of whether greenium actually exists. In detail, the research results show how the mean estimate of the greenium amounts to just slightly more than one basis point, highlighting the central premise that the yields on Green and brown bonds are the same. Considering the median estimate, which may be more representative of the central tendency, it even suggests that the greenium is practically non-existent. Figure 2.4 shows the probability distribution of total greeniums resulting from this research, highlighting the absence of a significative pricing differential between the two categories of debt instruments.

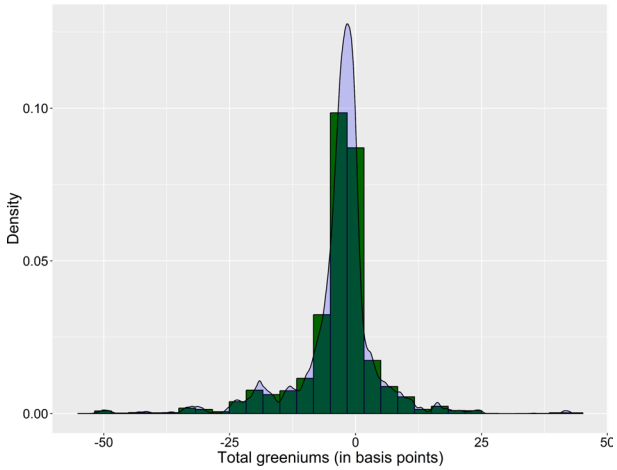



Figure 2.4: Distribution of the total greeniums.

Source: Lau et al., 2020.

As for the third major study taken into analysis (Tang and Zhang, 2018), a sample is taken that includes all the normal corporate bonds issued by the Green Bond issuers from 2007 to 2017. In this way, a within-firm comparison is conducted between Green Bonds and conventional bonds issued by the same firm. The results show that the yield spread is not significant, suggesting an absence of access to cheaper debt financing. However, it is important to note that the sample of Green Bonds issued by the same firms is particularly limited (in particular, only 41 firms issued both conventional corporate bonds and Green Bonds during the period of analysis).

Alessi and colleagues from the European Commission Joint Research Centre in Italy added another insightful article to the Green Bond literature in 2021. In their paper based on European individual stock returns, they determined a negative greenium, also highly statistically significant, and defined it as the risk premium associated with a firm's greenness. The study's peculiarity, which is also reflected in the novelty of the findings, is that the authors created an index of greenness and environmental transparency at the

level of each individual company that takes into account both the volume of a company's GHG emissions and the quality of its environmental disclosure in an effort to reduce the issue of "greenwashing". They were able to separate two samples of green and non-green companies using the index they created, which allowed them to identify the previously mentioned negative sign associated with the green premium. The greenium's lack of positivity seems to indicate that investors are willing to buy more green assets, thus accepting lower return, while also weighing it against the positive aspect of the coin, which is a hedging strategy against climate risk.

## 2.2. Liquidity Premium

The second dimension of analysis that was considered with regard to Green Bonds is the relationship between liquidity premium and Green Bond yield spread. This issue was addressed by Febi and colleagues (2018), who identified liquidity problems as characteristic of the Green Bond market due to its disproportional thinness and the unclear solvency profile of these instruments. First, the study separates the liquidity premium from credit risk and possible bond-specific and macroeconomic factors. In this way, the results are not influenced by these other types of factors that can be considered as exogenous in the study in question. By doing this, the authors understood how the presence of a liquidity premium is a pertinent characteristic that needs to be considered when dealing with this type of market.

This can be explained by the two main reasons stated above: (i) the disproportional thinness of the Green Bond market and (ii) the unclear solvency profile of these green debt instruments.

i. In the Green Bond market, demand and supply appear to be strongly imbalanced, with demand far outstripping supply. The growing demand is due to several factors, including:

   – Investors' need to comply with ESG (Environmental, Social, and Governance) and SRI (Socially Responsible Investment) targets;

   – The possibility of diversifying the investments' portfolio thanks to the low correlation of this type of investment with other fixed-income securities.

   However, this increase in demand does not appear to be accompanied by an adequate increase in supply, which is therefore insufficient. This is mainly due to the lack of fiscal incentives to entice investors towards this type of green investment and the lack of a classification system for Green Bonds that is universal and in line

with market-based frameworks (e.g., the Green Bonds Principle). This means that there is no effective and universally recognized definition of a green investment, and this leads issuers to incur further transaction costs (e.g., the costs to contract with external reviewers for pre- and post-issuance verifications). As a result, the issuance of Green Bonds is less attractive to issuers than the issuance of conventional bonds. Due to the imbalance between supply and demand, issuers have the opportunity to offer these debt instruments at a lower interest rate than that offered within the broader bond market (Preclaw and Bakshi, 2015; Zerbib, 2019). Despite this advantage for issuers, the shortage of supply is nonetheless persistent, and when analysed in parallel with an excess of demand, this inevitably causes the market to be thin and liquidity thus becomes relevant. Consequently, a liquidity premium should emerge.

ii. The second factor that explains the illiquidity of the Green Bond market is instead to be considered, at least partially, endogenous to the issuers: the lack of a credit risk profile of Green Bonds. There are two main reasons for this lack, according to Cochu et al. (2016):

    1. Reporting of green projects is not clear enough. Martin Lebelle and colleagues (2020) also demonstrated how the disclosure of Green Bond frameworks and annual reports (and their readability) increase bond liquidity;

    2. Bond's ratings that are mainly based on the balance sheets of the issuers, rather than on the actual green projects that should be financed with the proceeds from these issues.

    These investments are made in projects that frequently call for innovative, experimental activities that are frequently viewed as underdeveloped due to a general lack of success data for such green project implementation. Due to this lack of evidence, investors rate Green Bonds as riskier than traditional ones. Lack of standardization and control over the reporting mentioned above, which should attest to the project's performance, inevitably raises the costs of adverse selection and may increase illiquidity, causing the creation of a liquidity premium.

Therefore, in order to investigate how a potential liquidity shortfall might affect the bond yield spread, the authors chose to approach the issue from two perspectives and use two different estimates for liquidity: the LOT liquidity measure (Chen et al., 2007) and the bid-ask spread (Amihud and Mendelson, 1986; Brandt and Kavajecz, 2004). The study focused on a reference period from 2014 to 2016. The results showed that Green Bonds are more liquid than conventional bonds, contrary to expectations. The study also

demonstrated that both estimates used to represent liquidity are positively correlated with the yield spread of both Green and brown bonds. However, only using the LOT liquidity as guiding estimate was relevant for the analysis of Green Bonds. Indeed, the premise of the LOT model is that, even though the true value of the bond is influenced by numerous stochastic factors, measured prices will only take into account new information if the marginal trader's information value is greater than all the liquidity costs. This implies that each bond has a liquidity cost threshold that corresponds to the minimal information value for a trade. Thus, thanks to this approximation, they were able to ensure that they had a measure that could adequately capture a variety of additional information, including market impact costs, commission costs, and opportunity costs, as well as an estimate that had excellent explanatory power for the yield spreads of green bonds.

A further important finding of this study is that the impact of LOT liquidity has decreased over time. This suggests that the impact of liquidity risk on yield spreads has become negligible in recent years. The latter factor can be explained by an increasing maturity of the Green Bond market in recent years. Indeed, when issuers are aware of the impact of liquidity risk, they can prevent its effects by reducing the causes of adverse selection costs. For instance, this is possible through increased transparency regarding green projects. In this way, namely avoiding increased liquidity risk, the issuer would then be able to benefit from a more advantageous cost of debt when issuing a Green Bond.

## 2.3. Green Bond impact on the issuer

The last main dimension of analysis that is taken into account in most of the existing literature concerns the impact of a Green Bond issue on the issuers themselves. This impact is analysed from both a financial and an environmental perspective. Regarding the latter, the literature seems to be aligned in affirming the presence of a positive impact on the environmental performance of issuers, both in terms of actual physical emissions and the ESG score associated with the company itself. The issuance of Green Bonds is therefore favourable, at least from the environmental point of view. Turning instead to the financial side, the present studies are divided into two streams of thought, and there is therefore no single shared view. Although most of the literature is inclined to affirm the presence of a positive relationship between the issuance of Green Bonds and a company's financial performance, there is a small branch of literature that states that the issuance of a Green Bond has no effect on a company's financial results. Finally, in relation to the impact on issuers, another recurring theme in the literature is the signalling effect

that the issuance of a Green Bond produces. In fact, the issuance of such a green debt instrument sends a signal to the market and investors, showing them that the company is attentive to sustainability issues and makes commitments towards climate positive initiatives, supporting and encouraging demand for this type of financial instrument.

The first important study taken into consideration is the one by Tang and Zhang (2018), who sought to identify whether there would be a positive impact on issuers following the issuance of a Green Bond. Issuing a Green Bond for the first time is in fact a more expensive process than issuing conventional bonds, so it is necessary to understand whether existing shareholders will benefit or whether from a purely financial point of view this is not a beneficial process.

This study starts with the creation of a combined dataset of Green Bonds from Climate Bonds Initiative and Bloomberg, and arrives at interesting conclusions that are in line with previous literature. In particular, the authors noted that the share price is positively correlated to the issuance of a Green Bond, therefore issuing Green Bonds can increase the value of the company itself, at least in the short term. These results are shown in Figure 2.5, that illustrates the stock market reaction to the Green Bond announcement around a 20-day event window.

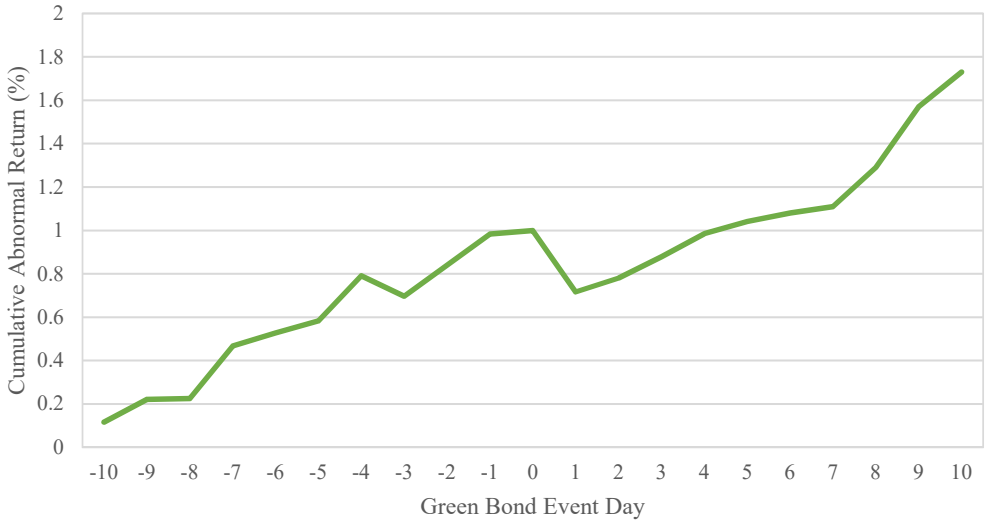


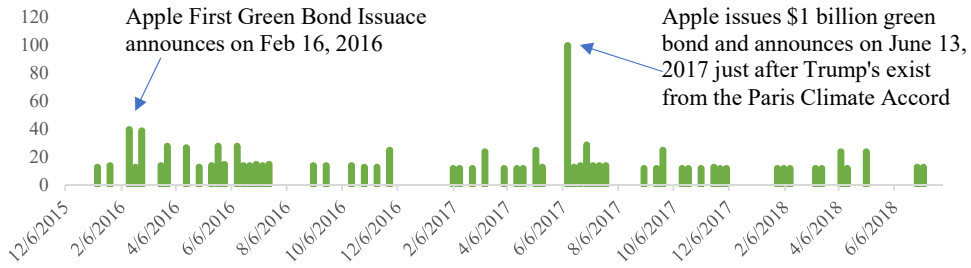

Figure 2.5: Stock market reaction to Green Bond issuance announcement.

Source: Tang and Zhang, 2018.

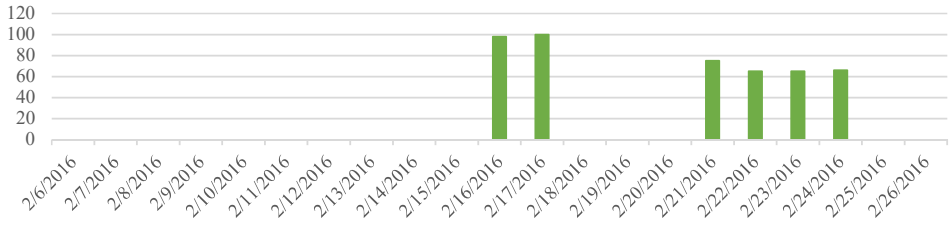
Going deeper, the authors noted that there are higher returns in the case of an initial Green Bond issue than in the case of a repeat issue. They then identified three potential sources behind this positive return:

1. *The financing cost channel*: given the growing commitment towards sustainability and being environmental friendly, investors have greatly increased the demand for Green Bonds. The natural consequence of this situation is an increase in the prices of these bonds, which translates into a reduction in the cost of debt for the issuers. This reduction may therefore be viewed favourably by the market, leading to a consequent increase in share value;

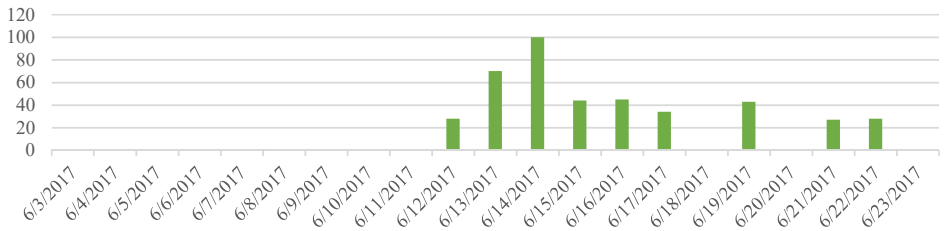
2. *The investor attention channel*: when an issuing company decides to label its bonds as green, this leads to increased media attention and increased visibility for investors. This can lead to an increase in demand for the company's shares, thus broadening its investor base. An example of this phenomenon is shown in Figure 2.6;




(a) "Apple Green Bond" Google search volume.




(b) Apple first green bond issuance Google search volume zoom in.




(c) Apple issues green bond after Trump's Paris Climate Accord exit zoom in.

Figure 2.6: Apple Green Bond Google search volume.

Source: Tang and Zhang, 2018.

3. *The firm fundamental channel*: the issuance of a Green Bond is directly linked to the company's willingness to invest in projects deemed green. This turns out to be valuable for the business, especially in the long term.

When comparing the yield spread of the same company in the same year, no significant price difference is noted. Therefore, the first source of the financing cost channel is not validated, as the positive market return following a Green Bond issue goes beyond the direct benefits of a decrease in the cost of debt, if this occurs at all. A further interesting result of this study concerns the composition of ownership after the issue of a Green Bond. In particular, the authors noted that there is an increase of around 8% in institutional ownership, while on the opposite, hedge funds reduce their exposure to these companies following an issue.

Another relevant paper that addresses this topic was published in 2022 by Yue Wu. In particular the study analysed if there is any cumulative abnormal return (CAR) around the announcement date of the Green Bond issuance, so an event study is performed using firstly an event window that goes from 10 days before to 10 days after the announcement; then also other event window with different time span was tested. If the results of this event study display any significant and positive CAR, it means that it is possible that a beneficial impact for the existing shareholders exist. The authors' conclusions diverge, at least in part, from those of the previously examined study. With regard to seasoned-offering Green Bond emissions, they have no impact on the performance of issuer-issued securities on the market, but when it comes to initial emission levels, they have a negative impact on the aforementioned securities market. In fact, contrary to what one might expect, the results illustrated in Figure 2.7 show that the CAPM CAR of the first-issued Green Bonds is below 0. This unexpected outcome may be explained by taking into account the investors' individual analyses and perceptions of publicly traded companies. In particular, the issuance of new bonds by a quoted company may be perceived negatively by investors in the market, as it could mean that the company needs liquidity to cope with a crisis.

| | First-time issue | | | Seasoned offerings | | |
|---|---|---|---|---|---|---|
| Event window | [−10,10] | [−5,10] | [−5,5] | [−10,10] | [−5,10] | [−5,5] |
| CAPM CAR | −0.0078 | −0.0063 | −0.0044 | −0.0036 | 0.0035 | 0.0006 |
| | | | | (−0.8976) | (−0.9998) | (−0.2049) |
| P (T-Test) | | | | 0.3705 | 0.3186 | 0.8379 |
| P (Wilcoxon Signed-Rank) | 0.0000 | 0.0000 | 0.0000 | | | |

Note: CAPM = capital asset pricing model, CAR = cumulative abnormal returns.

Figure 2.7: Statistical results of CAR using 250-day regressed beta.

Source: Wu, 2022.

The last relevant study to be analysed is the one published by Flammer in 2021. One of the main topics discussed in this study concerns the signalling effect generated by the issuance of a Green Bond. The signalling theory is based on sending a signal (which

must be costly) to reduce information asymmetry between companies and investors. This reduces the transaction costs for investors to go out and find companies that best reflect the characteristics they are looking for. In particular, by issuing Green Bonds, companies are able to send a signal to the market about their commitment to environmental friendly investments. This signal is credible mainly because these bonds are often certified by independent third parties, which guarantee the actual investment in green projects of the proceeds. The theory of signalling is closely linked to market reaction and environmental performance. With regard to the first link, the study concludes that the stock market responds positively to the announcement of a Green Bond issuance. More precisely, the positive response is more pronounced for Green Bonds that are externally certified or in the case of a first-time issuance. On the other hand, the author also notes that following a Green Bond issuance, companies improve their environmental performance from several points of view, such as lowering $CO_2$ emissions and raising environmental ratings.

Another relevant study, aiming at analysing the relationship between the emission of a Green Bond and both the environmental and corporate financial performances, is the one of Kim Ee Yeow and Sin-Huei Ng ("*The impact of green bonds on corporate environmental and financial performance*"). In particular, this study differs from the previous analysed, because it does not analyse the financial performances in terms of firm value, but instead in terms of operational efficiency. As a matter of fact, we know that through the emission of green bonds, firms tend to adopt greener practices, which in turn may cause better resource productivity over the long run (Lagas, 2015; Volz, 2018). In summary, Green Bonds can be seen as catalysts for green practices, which in turn are catalysts for the creation of wealth. Since there is a strong relationship between productivity and profitability, this could indicate that the issuance of new Green Bonds indirectly impacts profitability itself. Another relevant aspect discussed in this study regards the effects of external certification (also analysed in the study of Flammer); in particular, how these affects the Green Bonds' ability to impact a firm's performances.

The results of this study underlined that certified Green Bonds have GHG (Greenhouse Gases) emission levels that are, on average, 2.10% lower than non-certified conventional bond issuers' emissions. Thus, this outcome shows how issuing Green Bonds with an external certification, improves the company's environmental performance. This result is in line with that obtained by Flammer. External certifications therefore have a very important weight in differentiating those Green Bonds that are actually associated with green projects that lead to environmental benefits, from those Green Bonds that are merely instruments used by companies for practices such as greenwashing. In other words,

in today's Green Bond market, which is not yet fully developed, external certifications are crucial in distinguishing high-quality Green Bonds from low-quality ones. These results are again in line with Flammer's findings regarding the signalling theory argument. Since obtaining external certification is an expensive process, such certification is a costly signal showing the market a stronger commitment to the environment.

On the other hand, with regard to financial performances, the study did not find any evidence to conclude that issuing Green Bonds improves operational performance and leads to better corporate efficiency. Therefore, the premium found in the Green Bond yield does not appear to be justified, as Green Bonds and conventional bonds appear to be identical in terms of financial performance. Investors should therefore take this into account, and be aware that they should not expect better performance by diversifying their portfolio through Green Bonds, especially in the short term. The important results arrived at by the authors can be summarized as follows:

- Non-certified Green Bonds do not have an impact on the environmental performance of the firm;
- Certified Green Bonds have a positive impact on the environmental performance of the company;
- Green bonds do not have an impact on the operating performance neither on the efficiency of the firm;
- The importance of external certification for Green Bonds is not due to the ineffectiveness of the instrument itself, but to the embryonic stage of the Green Bond market. This is why third-party certification plays an essential governance role at this stage;
- The environmental and financial benefits of the emission of Green Bonds will only be seen over the long term. Therefore, a firm should aim to issue longer term Green Bonds;
- Unobservable factors in the real world play an incredible role on environmental and financial performance, so a firm must not depend totally on Green Bonds to improve those performances.

The last relevant study analysed with regard to this topic is the one published by Fatica and Panzica (2021). The authors particularly focused on the relationship between Green Bond issuance and companies' environmental performance. The authors initially divided the pool of bonds at their disposal between bonds issued for refinancing purposes and non-

refinancing Green Bonds. The most relevant results were then noted for non-refinancing Green Bonds, as comparing the latter with conventional bonds with similar financial characteristics and environmental ratings, the authors noted that there is a decrease in issuance, up to 2 years after the bond issuance. This outcome appears to be consistent with an increase in eco-friendly activities financed through the issuance of such bonds. It is important to underline that the study focuses not only on direct emissions (Scope 1) but also on total emissions, decreasing the possibility of obtaining misleading results coming from measurement errors due to having considered a range of emissions too broad. Finally, as already mentioned in the previously analysed papers, Fatica and Panzica also noted in their study that a greater emission reduction is present in the case of certified Green Bonds from external entities. What these two authors add to the previous studies is that this greater emission reduction is also present for those bonds issued after the Paris Agreement. This underlines the importance of the public sector in addressing climate challenges.

# 3 | Green Bonds: Market Analysis and Regulatory Framework

In Chapter 1 we introduced the concept of Sustainable Finance, giving more emphasis to the concept of Green Bonds. In that part we took care to define what Green Bonds are, define what types exist, list advantages and disadvantages, and so on.
In Chapter 2 we analysed Green Bonds from an academic point of view, focusing on the major studies that have been carried out in recent years on these financial instruments, also showing the results obtained to date.

In this chapter, the emphasis has shifted to trying to analyse the characteristics of the current Green Bonds market, which, as mentioned earlier, has undergone a significant boost especially in recent years. Thus, the goal of this part is to examine how this innovation became a common financial instrument in a just over ten years. The various turning points this recent phenomenon has experienced will therefore be examined, beginning with the 2007 issuance of the first Green Bond and ending with the most recent market developments.
To do this, the Green Bonds market will be analysed in depth, and this was possible by doing our own processing on the data provided by the Climate Bond Initiative. The data referred to are up to 31 December 2021, unless there are special cases that will be promptly mentioned.
The discussion will begin with a geographical analysis of the phenomenon, then move on to focus on the main types of issuers, the destinations of proceeds, the main currencies in which they are issued, and finally the size of the deals.

The second part of this chapter is more focused on the regulatory part. Indeed, the current regulatory framework will be discussed, analysing the main standards that characterize Green Bonds.

## 3.1. The Green Bond Market

Over the past few years, the global market for Green Bonds has grown incredibly. The European Investment Bank (EIB), the bank of the European Union, issued the first Green Bond in 2007. The proceeds from this first issuance, a EUR 600 million "Climate Awareness Bond," a zero-coupon AAA-rated security with a 5-year maturity, were allocated to projects promoting renewable energy and energy efficiency. The World Bank also released its first Green Bond the following year, a SEK 2.3 billion bond with six-year maturity.

However, early emissions were sporadic, and until 2012, Green Bonds were only issued by Multilateral Development Banks, which are international financial institutions chartered by two or more countries to promote economic development. The first corporate Green Bond was released in November 2013 by Swedish real estate firm Vasakronan. Since then, the Green Bond market has exploded, finishing every year at record-breaking highs.
The first sovereign Green issuance occurred in 2016, by Poland, while the milestone of USD100bn in annual issuance came to pass in November 2017 during COP23 in Bonn, the 23rd United Nations Conference on Climate Change, testifying how Green Bonds were becoming a mainstream product.

Despite a justified slowdown in 2020 due to the crisis caused by Covid-19, this promising path has enabled to reach the milestone of $1.6 trillion of cumulative issuance in 2021 (Figure 3.1).

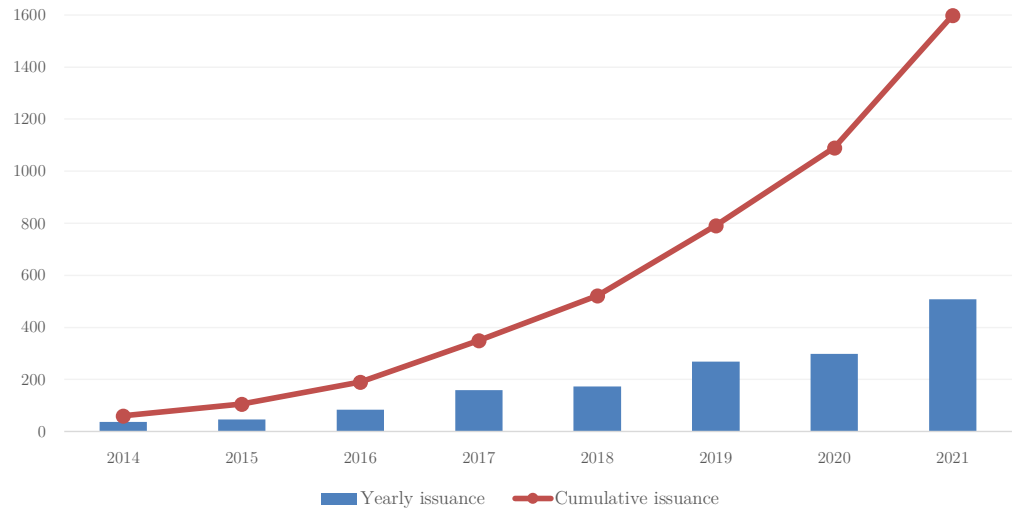



Figure 3.1: Green Bonds annual and cumulative issuance (2014-2021).

Source: Climate Bonds Initiative, own elaboration.

Therefore, there is no doubt about the success these financial instruments have had, especially in the last six years. As summarized in Table 3.1, the Green Bond market is characterized by more than 2000 different issuers, almost 10,000 number of instruments, with 80 issuing nations in 47 different currencies.

Table 3.1: Total size of Green Bond markets as of 31/12/2021.

| | |
|---|---|
| **Total size of market** | $1.6tn |
| **Number of issuers** | 2,045 |
| **Number of instruments** | 9,886 |
| **Number of countries** | 80 |
| **Number of currencies** | 47 |

Source: Climate Bonds Initiative.

What's important to highlight is that the Green Bond market continued to expand well also after 2020, despite all the uncertainty that Covid-19 brought with it.
Indeed, in 2021, annual Green Bond issuance surpassed $500 billion for the first time, a 75% increase over volumes in the previous year, especially due to the great performance in March, June and September, which turned out to be the most prolific month in the history of the Green Bond market ($86bn).

Table 3.2: Green Bond market scorecard.

| | 2020 | 2021 | Percent change YOY |
|---|---|---|---|
| **Size of market** | $298.1bn | $522.7bn | +75% |
| **Number of issuers** | 636 | 839 | +32% |
| **Number of instruments** | 1,749 | 2,089 | +19% |
| **Average size of instrument** | $165m | $250m | +51% |
| **Number of countries** | 56 | 58 | +3.5% |
| **Number of currencies** | 34 | 33 | -3% |

Source: Climate Bonds Initiative.

The rapid growth of the green debt market can also be inferred by data in Table 3.2. In addition to the 75% increase over the previous year, the green theme continued to draw in new issuers throughout the year, totalling 839 issuers (+32%). Individual green bond sizes increased by more than 50% to reach $250m on average. Without a doubt, that expansion was aided by the addition of developed market (DM) sovereign bonds from

both new and established issuers.
The number of issuing countries also increased slightly (+3.5%), with the number of currencies remaining more or less the same as in 2020.

Talking about the current situation, the beginning of 2022 was characterized by turbulence due to the Russian invasion of Ukraine in February and subsequent European energy crisis, exacerbated post Covid-19 inflation.
This consequently had a great impact on the financial markets and thus also on the bond market. Rising interest rates and high volatility resulted in decreased bond issuance in the first half of 2022, in respect to the same figures of the previous year.

Compared to the record H1 volumes of $277.5bn in 2021, new green debt instruments totalled $218.1bn in the first half of 2022, recording a decline of 21%. This result was quite predictable. given the inflation concerns following COVID-19 and the general market volatility that followed Russia's invasion of Ukraine.
While green issuance in Q1 saw its lowest volumes since Q4 2020, it picked up in Q2 with $121.3 billion, a 25% increase over the quarter. With a first-half total of nearly $47 billion, or 22% of the H1 green-themed volume, June was the busiest month of the year. This brings the total amount of green-labelled issuance closer to the USD2tn milestone, at just under $1.9tn.
In particular, the volumes recorded were mainly due to the private sector (financial and non-financial), while, for the second consecutive quarter, China was the most prolific country in terms of volume ($48.2 billion, or 22% of the total), issuance (190 transactions) and number of issuers (116).

### 3.1.1. Green Bond Market: geographical analysis

#### Country-level

As we mentioned earlier, the Green Bond phenomenon has had a global success and growth, especially in recent years. However, from a geographical analysis of historical data, it can be understood which nations are historically more inclined to issue Green Bonds. As can be seen from Figure 3.2, countries exceeding $10bn issuances are:

- Canada and United States in North America;
- Brazil and Chile in Latin America;
- China, India and Australia in the Asia-Pacific region;

- South Africa in Africa;
- Scandinavian regions, United Kingdom and Wester European countries (with France and Germany above all) for the Eurozone.

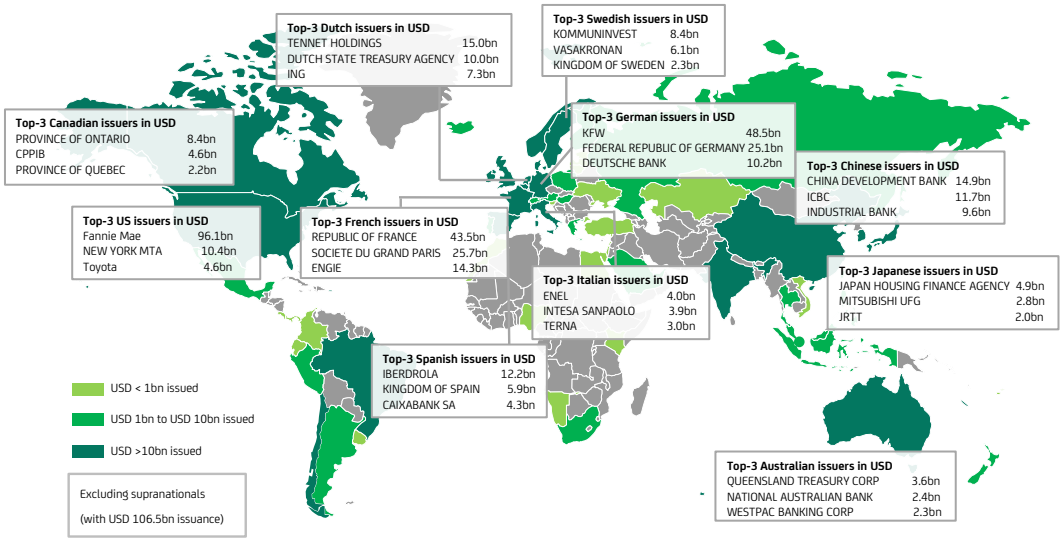



Figure 3.2: Green Bond issuance map (updated to January 2022).

Source: Climate Bonds Initiative, UniCredit Research.

The same outcomes can be seen more precisely from the Figure 3.3, which represents the ranking of Green Bond emissions by nations up to 2021.

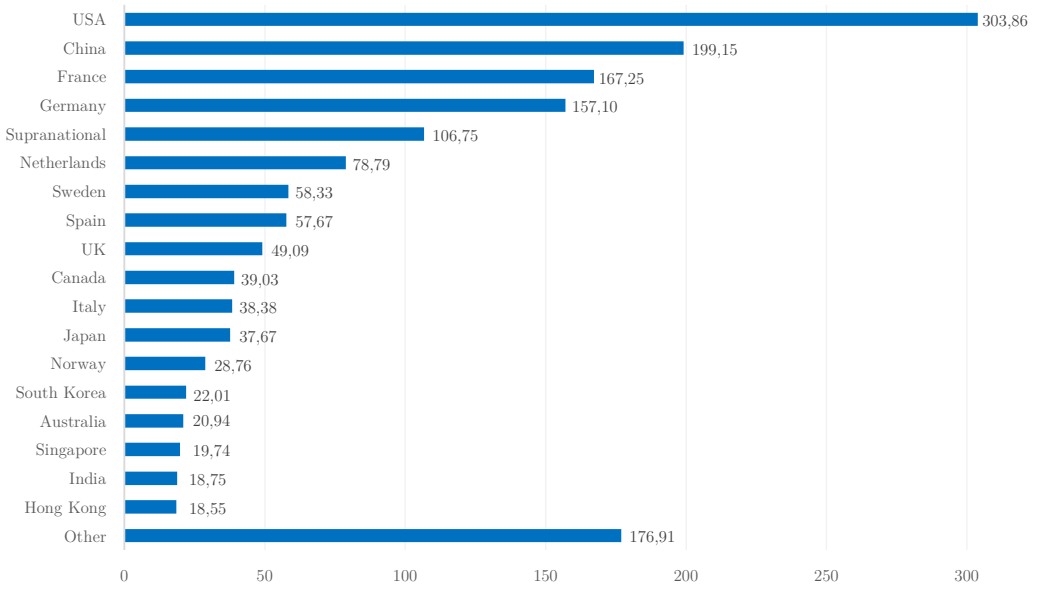



Figure 3.3: Green Bonds: cumulative amount issued per country, until 2021 ($bn).

Source: Climate Bonds Initiative, own elaboration.

The United States largely leads, with more than $300 billion worth of Green Bonds issued since the market's inception, followed by China ($199bn), France ($167bn) and Germany ($157bn).
Supranational issuances are next ($107bn), then other European nations, among which Netherlands, Sweden and Spain. Italy ranks 11$^{th}$ in the global ranking (7$^{th}$ at European level) with a cumulative amount issued of $38.4bn.

The United States also dominates the ranking for the total number of Green Bonds issuers (469), from the establishment of the market (Figure 3.4). Next we find China (334), Japan (146) and Sweden (99). Italy is not in the top 10 here either, with a total number of issuers of 30.

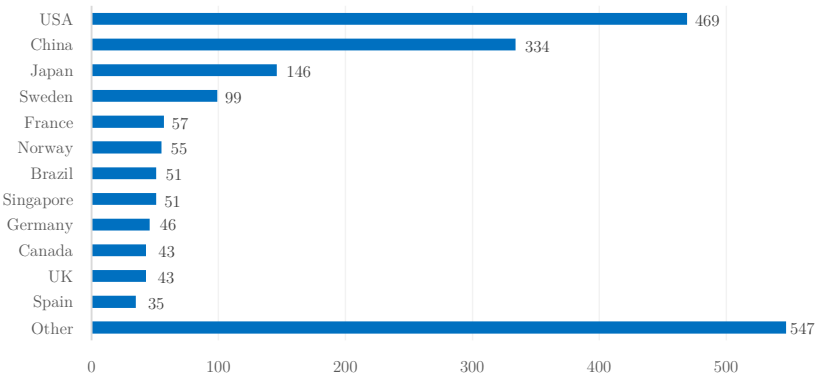



Figure 3.4: Green Bonds: cumulative amount of issuers per country, until 2021.

Source: Climate Bonds Initiative, own elaboration.

The results just shown are more or less confirmed when looking at the figures for 2021 (Figure 3.5).
The United States continued to be the world's major supplier of Green Bonds. Volumes increased by 63%, from $50.3bn in 2020 to $81.9bn. The total cumulatively is $304 billion, which is 50% more than China, the next-largest country source ($199bn). The strongest period for US was the first quarter, when issuers printed 338 deals totalling $23.2 billion. This represented a 208% year-over-year increase, which is not surprising given that the debt market collapsed during the same time last year. Throughout the year, issuance remained higher than in 2020, but issuers kept an eye on the Fed in anticipation of the inevitable signalling of rate increases.
The US Green Bond market has been distinguished by a disproportionately large number of issuers bringing smaller deals. 204 issuers entered the market in 2021, and the average deal size increased from $70 million in 2020 to $100 million.

From 15 in 2020 to 36 in 2021, the number of Green Bonds issued in the non-financial corporate space more than doubled, and the total amount increased from $7 billion to $27 billion. From $475m in 2020, the average bond size increased to $750m in 2021. Just seven non-financial corporate Green Bonds were benchmarked size in 2020, compared to 23 in 2021.
The amount issued by government-backed entities, the majority of which are US municipalities (muni) issuers, nearly tripled to $15.6 billion in 2021 from $5.5 billion in 2020. Covid-19 diverted attention away from the issuance of muni Green Bonds in 2020 as many people were dealing with the socioeconomic effects of the pandemic.

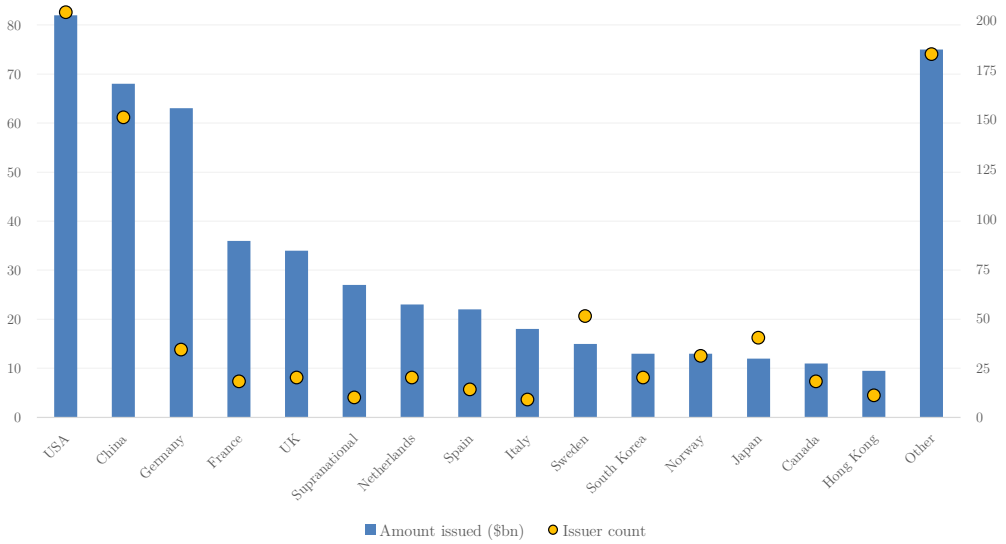



Figure 3.5: Green Bonds: amount issued (left axis, $bn) and number of issuers (right axis) per country, in 2021.

Source: Climate Bonds Initiative, own elaboration.

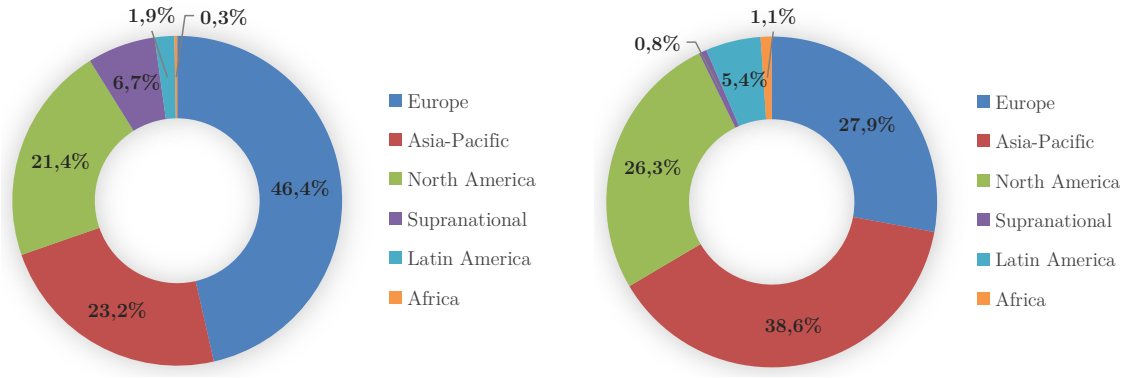
With an almost threefold increase in volumes ($68.1bn) and nearly 2.5 times the number of securities (268 in 2021, 109 in 2020), China recovered from a shaky 2020 ($23.8bn). The non-financial corporate sector saw the most aggressive growth, with volumes tripling to $31.2bn. After 17 deals in 2020, Chinese ABS vanished to become a single bond in 2021.

Germany's annual Green Bond volumes increased by 49% year over year to $63.2 billion, aided by rapid expansion in the financial sector. A total of 48 Green Bonds totalling $10.6 billion were priced by Deutsche Bank. With the issuance of two new bonds totalling nearly $11.5 billion, the German government strengthened its position in the Green Bond market.

With the issuance of its second sovereign Green Bond, France, whose total value by year's end was $13 billion, consolidated its position as a global leader in policy. France accounted for $36 billion of the total issuance for the year, which is down from the $37 billion in 2020.

## Regional-level

Looking at regional level, as displayed in Figure 3.6a, Europe ranks first as the portion of Green Bonds issued until 2021 (46.4%). This is followed by the Asia-Pacific region, which accounts for 23.2% of issuances, and North America, which rounds off the podium with 21.4%. At the bottom of the ranking there are the Supranational issuances which, together with the Latin America and Africa regions, make up the remaining 8.9%.




(a) Cumulative amount issued.

(b) Cumulative number of issuers.

Figure 3.6: Green Bonds: proportion of amount issued and number of issuers per region, until 2021.

Source: Climate Bonds Initiative, own elaboration.

Taking into account the number of distinct issuers results in a slight change in the situation. As we can see from Figure 3.6b, the Asia-Pacific region has the largest number of issuers (752) representing almost the 40% of the total number. From this data, we can guess that the Green Bonds market in this region is mainly domestic in nature. Indeed, since it is the region with the most issuers, but the amount issued is just under a quarter of the total, one can understand how the average deal size is low.
The opposite is true for the European region, which comes second in terms of number of issuers (27.9%). Instead, North America maintains a consistent raking, with a 26.3% of number of issuers.

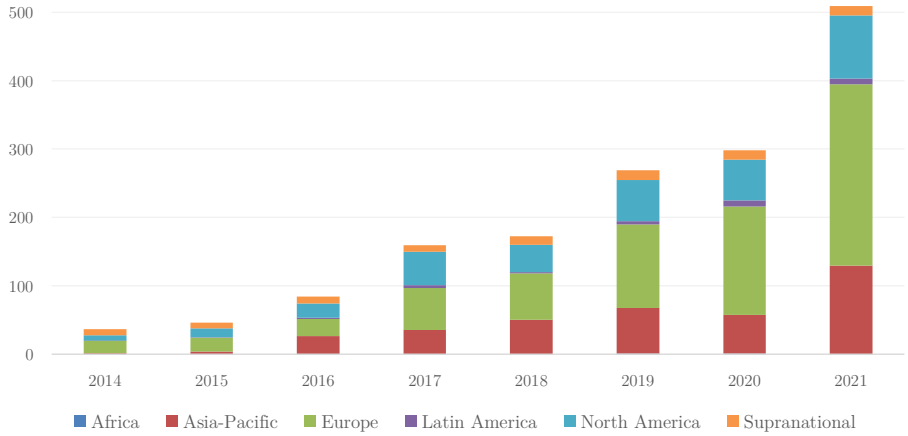



Figure 3.7: Green Bonds: amount issued ($bn) per region.

Source: Climate Bonds Initiative, own elaboration.

Focusing on year-by-year data, we can remark the great growth that the phenomenon of Green Bonds has had over the years.
From the Figure 3.7, Europe's leading role can be seen. In particular, Europe strengthened its position as a leader over time and now outpaces the other regions in terms of total volume issued, thanks to a Green Bond market supported by numerous large issuers from both the private and public sectors.
In 2021, half of the Green Bond volumes were originated in Europe, which contributed $265bn (50%) to the total. The financial corporate (136%) and sovereign (103%) issuer types experienced the region's most ferocious year-on-year growth. In 2021, six European nations added sovereign volumes, including four first-time issuers and taps from three nations.

If Europe was the most prolific issuance region, Asia-Pacific experienced the strongest annual growth (129%). By year's end, Asia-Pacific had risen to be the second most active market for Green Bonds, with a cumulative value of $371.7 billion. A third of the cumulative Asia-Pacific Green Bond issuance was added in 2021 ($129.5bn). Non-financial corporate issuers, which saw YOY growth of 309%, were in charge of $52 billion. Financial corporates saw a massive 268% YOY increase in volume, adding $36 billion. The top three country sources in the region by volume were China, Japan, and Singapore, which together accounted for 70% of the volume.

With a cumulative Green Bond issuance of $343 billion, North America dropped one position to third. Stronger policy messaging and the current low interest rate environ-

ment contributed to the 2021 annual figure of $92 billion being 55% higher than the $60 billion recorded in the previous year. Non-financial corporate entities made the largest absolute contributions ($28.3 billion), followed by ABS ($23bn).

The cumulative total of the Green Bonds issued by Supranational issuers, which totalled $120.7 billion at the end of 2021, made up the fourth-largest source. From 2020 onward, annual volumes doubled to $27.3 billion, and the rise can be attributed to the green debut of the European Union (EU), with a $13.9 billion bond.
The amount of deals issued by 36 issuers in the Latin America and Caribbean (LAC) region decreased year over year, totalling $8.2 billion. Chile provided all the LAC sovereign Green Bond volume in 2021, which fell by 68% to $1.2bn from $3.8bn in 2020. Only three African issuers entered the market in 2021, bringing the region's total issuance to $4.4 billion. No sovereign Green Bonds from Africa were issued in that year.

## Market-level

Moving towards a market vision, Figure 3.8 displays the total amount of Green Bonds issued in last years. Over time, developed markets strengthened their dominance, with emerging markets and supranational issuances playing a relatively minor role.
In 2021, 73% of the Green Bond volume came from developed markets (DM), while only 21% of it came from emerging markets (EM), and only 4% came from supranational issuers. The EM contribution increased from 17% in 2020, with extraordinary growth from issuers such as development banks (378%), financial institutions (324%), and non-financial corporate (278%). While volumes shrank in the other two regions, they increased YOY in four of them, as we previously saw.

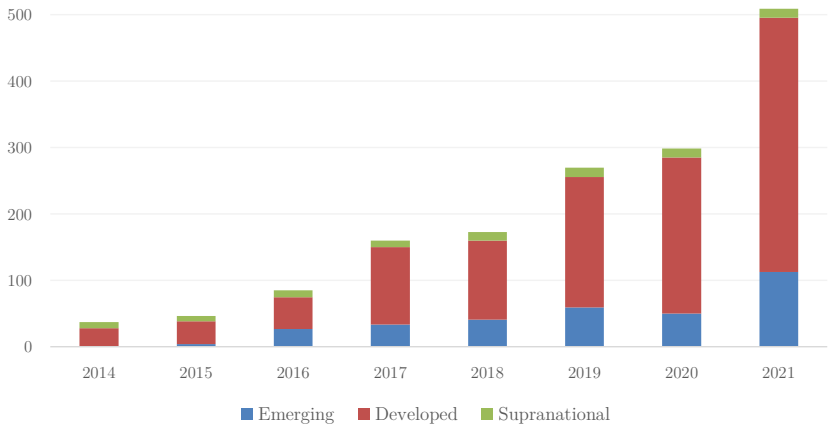



Figure 3.8: Green Bonds: amount issued ($bn) per market type.

Source: Climate Bonds Initiative, own elaboration.

The same results are confirmed when analysing the historical total number of issuers. Indeed, as shown in Figure 3.9, the vast majority of individual issuers come from the developed markets (64.6%).
However, it is necessary to mention the growing importance of emerging markets. In fact, in 2021 they accounted for 34.4% of the total, against the 26% recorded in 2020. As a result, the proposition of supranational issuers decreased from 4% (2020) to 1% (2021).

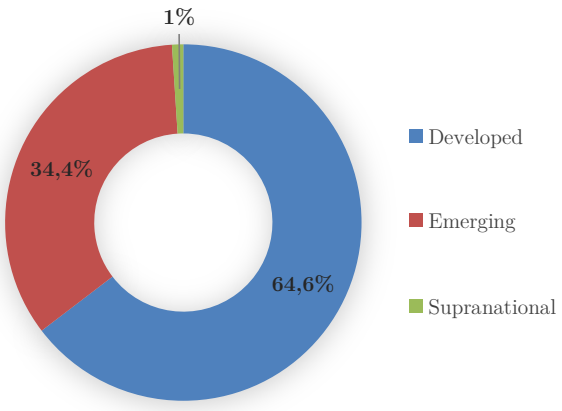


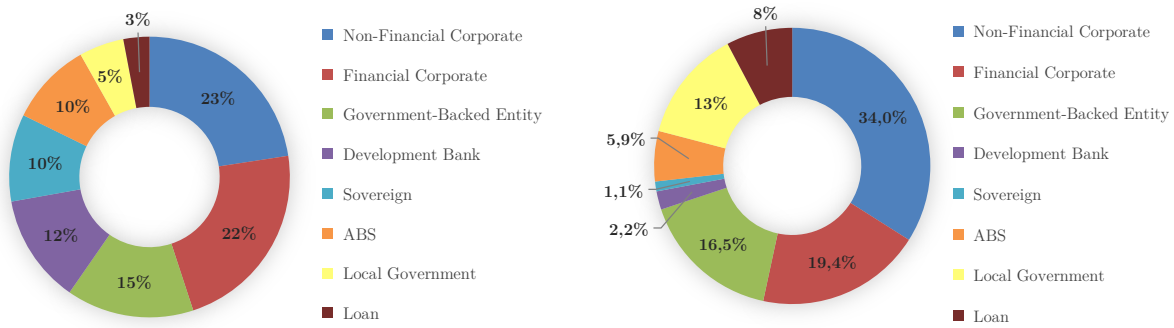

Figure 3.9: Green Bonds: proportion of number of issuers per market type.

Source: Climate Bonds Initiative, own elaboration.

### 3.1.2. Green Bond Market: issuer analysis

After examining the major geographic trends affecting the market for Green Bonds, another intriguing analysis considers the various categories of issuers. Different parties, both public and private, take part in the issuance of green debt. The primary groups of green issuers, as categorized by the Climate Bonds Initiative, are:

- Financial Corporate;
- Non-Financial Corporate;
- Development Bank;
- Sovereign;
- Government-Backed Entity;
- Local Government;
- ABS (Asset-Backed securities);
- Loan.




(a) Cumulative amount issued.

(b) Cumulative number of issuers.

Figure 3.10: Green Bonds: proportion of amount issued and number of issuers per issuer type, until 2021.

Source: Climate Bonds Initiative, own elaboration.

As we can see from Figure 3.10, in terms of the amount issued, these players are not equally relevant, and the average deal size varies greatly depending on the type of issuer. As shown in the Figure 3.10a, the main Green Bond issuers are represented by corporations: Non-Financial corporations (23%) and Financial corporations (22%). These are then followed by Government-Backed Entity[6] and Development Banks[7], that together account for 27%. At the bottom of the ranking, we find Sovereign (10%), ABS (10%), Local Governments (5%) and Loans (3%).

Taking a look at the Figure, 3.10b, we can see that, even in terms of the number of issuers, corporations remain in first place. In particular, Non-Financial corporations represent the 34% of the issuers, while Financial corporations represent the 19.4%. Comparing these percentages with those for the amount emitted, we can see that the average amount issued by these categories is relatively low.
With a percentage in line with the previous outcome (16.5%), Government-Backed Entities also finished third in this classification. Regarding Development Banks, Sovereign and ABS, we can notice that they do not even represent 10% of the total issuers, while they count for more than 30% talking about the issued amount. This denotes that the average deal size in this case is well above average.

In 2021, as shown in Figure 3.11, the dominance of the corporate sector remains.
In 2021, the private sector experienced a rebound in issuance, driven largely by financial corporate (143%) and non-financial corporate (111%) issuers. Together, these two issuer

[6]Businesses and other entities that receive funding or assistance from a Government.
[7]Financial organization that offers non-commercial risk capital for economic development projects.

categories accounted for 44% of total Green Bond volumes at the end of 2021. Additionally, sovereigns saw triple-digit growth of 111% over the period, and they now make up 10% of total volumes.

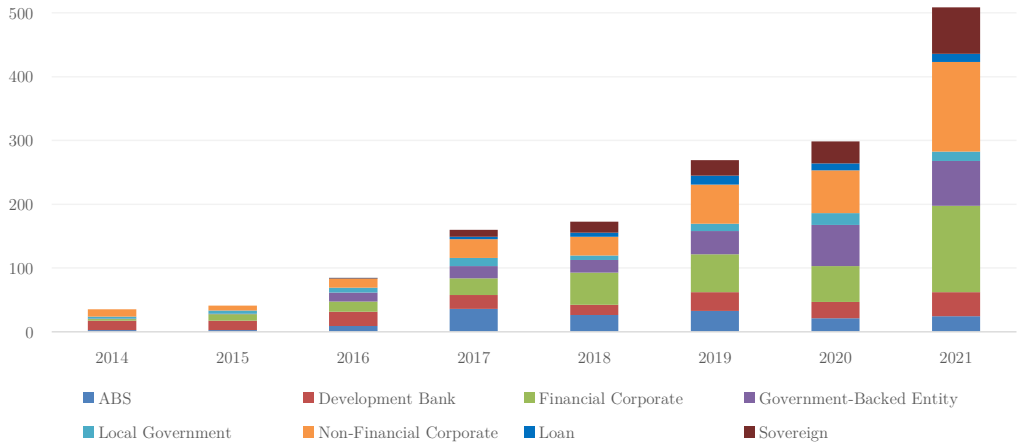



Figure 3.11: Green Bonds: amount issued ($bn) per issuer type.

Source: Climate Bonds Initiative, own elaboration.

Financial corporations overcame a supply contraction in 2020 ($55 billion) to regain a market for Green Bonds in 2021 that reached $135 billion. A combined 17% of the total came from China and 16% from Germany. The two Chinese financial issuers that issued the most Green Bonds in 2021 were China Development Bank ($6.5 billion) and ICBC ($4.5 billion). Approximately the same as the 53% figure from 2020, just over half of the financial corporate paper (55%) was issued in the Euro. In 2020, the USD share decreased slightly from 24% to 20%, while the RMB share significantly increased from 5% to 12%. Given the region's robust recovery following Covid-19, this is largely in line with expectations.

Based on cumulative volumes that exceeded $361 billion, non-financial corporates ended 2021 as the largest issuer type. 328 issuers issued 540 Green Bonds in 2021 for a total of $140.6 billion. The largest issuer was China Three Gorges Corporation, a state-owned enterprise in China, which priced 18 Green Bonds totalling $7.2 billion.
Two of the top ten non-financial corporate issuers stand out for bringing the market for Green Bonds much-needed diversity. While high yield issuer Ford Motor Company finally entered the market with its first green bond worth $2.5bn, American multinational Mondelez made its debut with a trio of Green Bonds, totalling $2.4bn (Table 3.3).

Table 3.3: Top Green Bond corporate issuers in 2021.

| Issuer Name | Amount ($bn) | Number of Green Bonds |
|---|---|---|
| **China Three Gorges Corp** | 7.2 | 18 |
| **Iberdrola** | 3.3 | 3 |
| **CTP Group** | 3.0 | 3 |
| **Ardagh Group** | 2.8 | 4 |
| **Engie SA** | 2.6 | 3 |
| **Ford Motor Co.** | 2.5 | 1 |
| **EDP** | 2.4 | 3 |
| **State Grid Corporation of China** | 2.4 | 3 |
| **Mondelez International** | 2.4 | 3 |
| **Liberty Global** | 2.3 | 3 |

Source: Climate Bonds Initiative, own elaboration.

The total amount of sovereign Green Bond issuance reached $161 billion, of which $72.8 billion was added in 2021. With two green bonds totalling $21 billion, the UK supported its hosting of COP-26 and contributed 30% of the supply.
Spain, Italy, Serbia, and South Korea, four additional issuers, joined the Sovereign Green Bond Club in 2021 with respective contributions of $5.9 billion, $10 billion, $500 million, and $812 million. At the end of 2021, France was the largest individual sovereign issuer, with two green bonds totalling $44 billion outstanding.

In 2021, Development Banks increased their market share of Green Bonds by 45%, reaching $38 billion for the year. The biggest individual issuer was KfW (in 2021 green bonds constituted 20% of KfW's funding mix). Government-Backed Entities expanded by 30% in 2021. Despite the fact that this growth rate was significantly lower than the 80% growth anticipated in 2020, this issuer type was still responsible for the third-largest outright volume at $84 billion. This issuer type typically consists of smaller bonds from a variety of issuers, with 137 of the 184 issuers bringing in under $500 million each. The European Union was the biggest issuer, contributing $13.8 billion in green bonds, nearly twice as much as the second-placed Société du Grand Paris, which contributed $7.5 billion.

ABS issuers accounted for $24.2 billion (one-tenth of the issuance). Of the 19 issuers, Fannie Mae was the most prolific, providing $13.4bn across 542 securities (close to 80% of

ABS volume). Local governments made up 5% of the total volumes in 2021 and were the only issuer type to see a decrease, from $18.5 billion in 2020 to $14.6 billion in 2021. The number of issuers decreased to 79 from 94 in 2020, and the amount of local government issuance from the USA decreased from $9.5 billion to $4.7 billion. In 2021, Green Loans made up 3% of the market, with Asia-Pacific accounting for 60% of the total volume. Due to the bilateral nature of loans of all types, only the largest ones are recorded in the public domain, despite the fact that this issuer type's contribution increased by 18% in 2021.

### 3.1.3. Green Bond Market: use of proceeds analysis

Another pertinent area of investigation, besides the geographic scope and issuer typology analysis, is the use of proceeds. The objective is to comprehend the purpose of the funds raised through the issuance of Green Bonds.
The use of proceeds categories are broken down in accordance with the Climate Bonds Initiative classification as follows:

- Energy;
- Buildings;
- Transport;
- Water;
- Waste;
- Land Use;
- Industry;
- ICT (Information and Communication Technology);
- Unspecified A&R.

Figure 3.12 shows the overall percentage of green financing allocated to each of these categories. As is clearly visible, there are three categories of use of proceeds that account for most Green Bonds issued: Energy, Building and Transport, which together amount to more than 80% of the total issue.
Next we find the categories Water, Waste and Land in use, but together they amount to only 16%. At the bottom of the ranking are the categories Industry, ICT and Unspecified A&R, which play a marginal role, amounting to only 2.3% of the total.

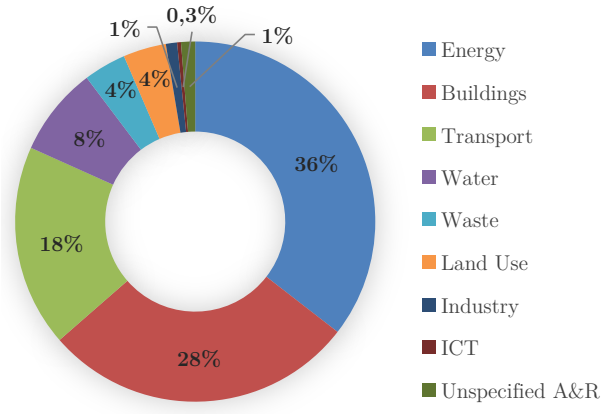



Figure 3.12: Green Bonds: proportion of amount issued per type of use of proceeds, until 2021.

Source: Climate Bonds Initiative, own elaboration.

Furthermore, it is interesting to analyse how these categories have evolved in use in recent years. As can be clearly seen from the Figure 3.13, the Energy category has always had a greater impact than all other categories, even in previous years. This is probably due to the fact that the topic of energy transition towards renewable energy systems has been very popular over the years, and therefore the first uses of Green Bonds were also aimed in that direction.
Besides the energy sector, the categories Buildings and Transport are the most relevant. These, in fact, have had a progressively increasing use in recent periods, especially since 2017. Additionally, Water, Waste, and Land Use projects have recently begun to receive more funding, but these still represent rather marginal categories in terms of the use of proceeds.

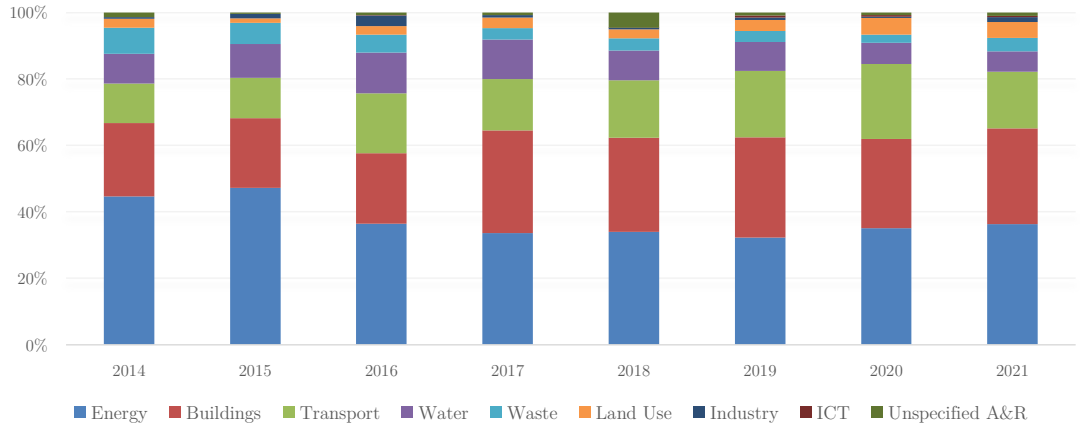



Figure 3.13: Green Bonds: percentage composition of yearly use of proceeds.

Source: Climate Bonds Initiative, own elaboration.

As we already said, in 2021, the three largest UoP (Use of Proceeds) categories, Energy, Buildings, and Transport, made up 81% of the total. Nevertheless, this represents a decrease from the record 85% in 2020. However, in 2021, all UoP categories showed growth year over year, with Industry showing the highest growth (824%) and Transport showing the lowest growth (31%).
Buildings received the most support from financial corporate issuers (37.5%), while Energy and Transport received the most support from non-financial corporate issuers, providing 40% and 27% of the total capital, respectively. Industry UoP allocations increased from just $1 billion in 2020 to $9.1 billion in 2021. Industry was earmarked as a UoP category in 32 transactions, including sovereign deals from the UK, Serbia, Hong Kong, and the EU Green Bond.

### 3.1.4. Green Bond Market: currency analysis

Investigating the type of money used to issue Green Bonds is another intriguing topic. Despite being a global financing tool, most issuances are conducted in a small number of currencies, specifically those that provide the quickest access to capital markets. However, there are also Green Bonds that are offered in a number of different currencies, particularly if they are intended only for domestic markets.

As we can see from Figure 3.14, the three main currencies of issuance are EUR, USD and CNY (Chinese Yuan Renminbi).
As for the first two, these are the most widely used currencies worldwide, amounting to 73% of total issuances. It's noteworthy that the Euro, not the US Dollar, is at the top of this ranking, indicating that Europe dominates the market for green debt.

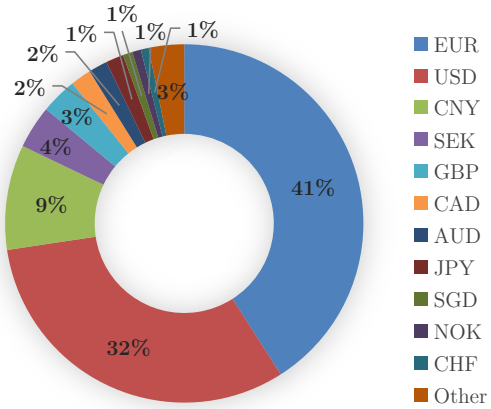



Figure 3.14: Green Bonds: proportion of amount issued per currency, until 2021.

Source: Climate Bonds Initiative, own elaboration.

CNY is the third most popular currency for issuing Green Bonds (9%), far behind EUR and USD. However, unlike the top two, this currency is still largely domestic. As a result, it is typically used by local players who have no interest in entering international markets. SEK (Swedish crown) and GBP rounded out the podium, with a combined amount of 7%, thus still playing an almost marginal role. The remaining currencies account for just over a tenth of the total (11%) and consist mainly of currencies destined for the various domestic markets.

Looking at how the situation has evolved over time (Figure 3.15), we can see that the EUR has only recently become the most widely used currency in the Green Bond market. Indeed, until 2018, it was the USD that dominated the issuances of Green Bonds, and this is as a result of this phenomenon's recent massive explosion in Europe.
It is also interesting to note the recent relevance of the Chinese market. In fact, the CNY has only started to be relevant since 2016. This was due to regulatory developments in China in late 2015, that marked the official launch of China's domestic Green Bond market.

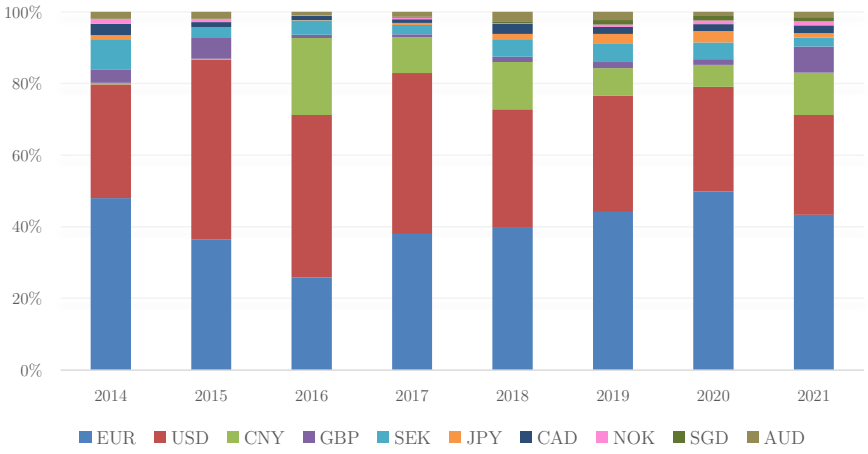



Figure 3.15: Green Bonds: percentage composition of yearly currencies.

Source: Climate Bonds Initiative, own elaboration.

In 2021, 82% of Green Bonds were issued using *hard currencies*, a 3% decrease from the previous year. Due in large part to the rebound in RMB issuance, which increased to $58.7 billion from $17.4 billion in 2020, issuance in *soft currencies* increased by 102%.
A "hard currency" is defined as any internationally traded currency that is a reliable and stable store of value. A currency's *hard* status may depend on a variety of variables, such as the legal and administrative systems of the issuing state, the level of corruption, the stability of the purchasing power over time, the political and fiscal situation and outlook

of the associated nation, and the Central Bank's stance on monetary policy. Conversely, a "soft currency" is a currency that is extremely sensitive and changes value frequently. Such currencies respond very sharply to a country's political or economic situation.

In 2021, there were 33 different currencies in circulation. The share of the top three currencies EUR (43%), USD (26%), and RMB ($58.7bn) remained similar to the prior year (81%). The amount of EUR issued in 2021 ($226.7 billion) was greater than the sum of EUR and USD issued in 2020 ($225.6bn).
Last year, EUR was the preferred currency, both in terms of volume and number of international issuers (36). However, the number of EUR issuers (408) was under half of those issuing in USD. While 81% of bonds issued in EUR originated from issuers using Euro as their official currency, the majority (96%) of bonds issued in USD were domestically issued. The European Green Bond market has confirmed itself as the most developed in the entire world, with the largest number of specialized investment mandates and the most advanced regulatory frameworks. Indeed, where possible, issuers prefer to issue in EUR to ensure the greatest possible investor diversity.

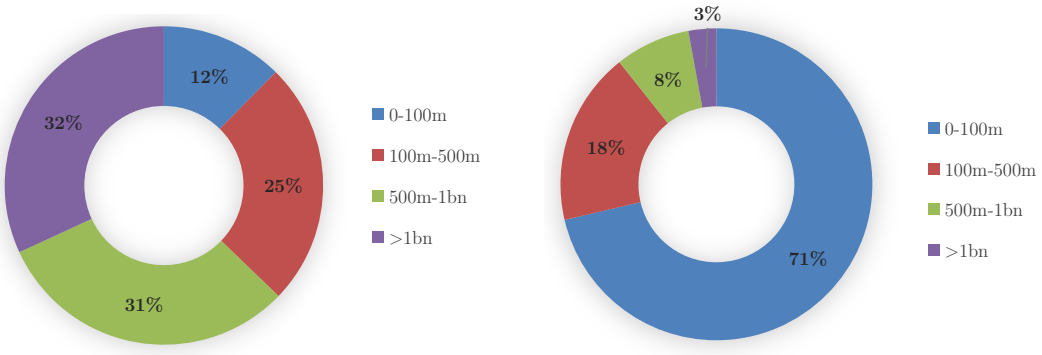
With 97% of the market share compared to 96% the year before, the top ten currencies were slightly more concentrated in 2021. The top ten's composition only underwent one change: CHF (Swiss franc) was replaced by NOK (Norwegian crown), which provided 45 bonds totalling $6 billion. Due in part to the issuance of Green Government Bonds worth $21 billion, GBP increased its footprint by 686% to $35 billion, moving up from seventh to fourth place.

### 3.1.5. Green Bond Market: deal-size analysis

This in-depth analysis of the Green Bond market context comes to an end with some considerations on the deal size of green debt issuance. Here, the objective is to determine the typical deal size in the market for green securities and to identify any historical trends.

As shown in Figure 3.16a, more than 60% of the total market volume is made up of benchmark-sized transactions (issuances with a size larger than $500 million), with 32% of Green Bonds having a size greater than $1 billion. The remaining market share (37%) is split between small ($0-100 million) and medium-sized ($100-500 million) deals.
However, taking into account the quantity of deals for each size range (Figure 3.16b), the situation is entirely different. In this case, small-sized bonds make up the 71% of Green Bonds, while benchmarked-sized bonds only make up 11% of the market as a whole.

The implication is that a sizable portion of the volume is made up of a small number of large Green Bonds. These bonds are typically those that are issued by specific types of issuers, such as Sovereigns and Development Banks, who aim to raise capital to fund significant, long-term projects and satisfy the interest of international investors. At the same time, the majority of Green Bonds are issued by modestly sized companies with a strong domestic focus.




(a) Cumulative amount issued. (b) Cumulative number of deals.

Figure 3.16: Green Bonds: proportion of amount issued and number of deals per deal size, until 2021.

Source: Climate Bonds Initiative, own elaboration.

In terms of how the circumstance has changed recently, we can see how, in previous years, the market was characterized by few issuances from big players (Figure 3.17). Subsequently, as the Green Bond phenomenon gained popularity, also small issuers entered into play, reducing the market share attributable to significant deals. However, over the past few years, a significant rise in the proportion of larger, benchmark-sized deals trend has emerged.

In 2021, benchmark size deals made up 70% of the volumes, an increase from the 62% in 2020.
The two biggest sources of bonds falling into the $1bn+ category were $68 billion in sovereign Green Bonds and $40 billion in financial corporate bonds. This category had fewer bonds than the others, with 93 bonds, up from 54 a year earlier. As opposed to this, the smallest bonds, up to $100 million, increased by $43.5 billion spread over 1261 bonds.
Moreover, Green Bond sizes on average increased from $170 million (2020) to $250 million (2021).

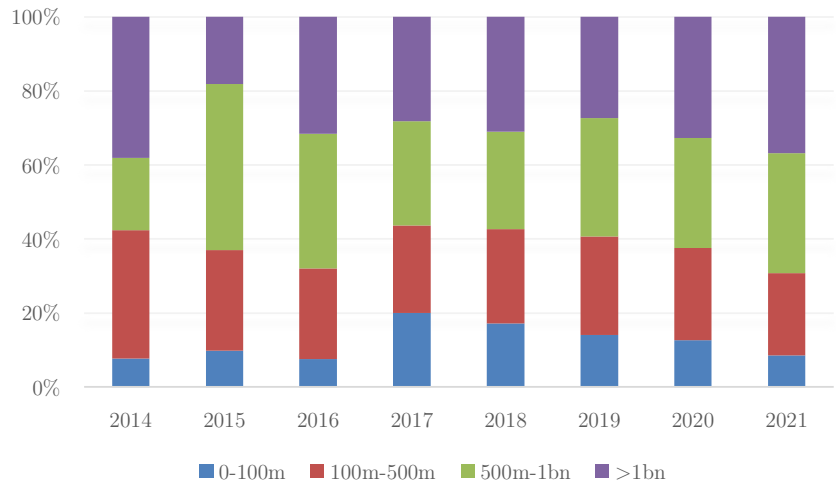



Figure 3.17: Green Bonds: percentage composition of yearly deal sizes.

Source: Climate Bonds Initiative, own elaboration.

Table 3.4 shows the largest deals occurred in 2021, filtered for each issuer type. As can be seen, the two biggest deals were those of the European Union ($13.9 billion) and Great Britain ($13.6 billion).
The third-largest deal was made by China Development Bank, a financial corporation, with a recorded amount of $6 billion.
The remaining deals are relatively smaller than those just mentioned, with values ranging from $2.2 billion (Province of Ontario) to $4.8 billion (KfW).

Table 3.4: Largest deal in each issuer type, 2021.

| Issuer Type | Issuer | Amount ($bn) |
|---|---|---|
| **ABS** | SLG Office Trust 2021-OVA | 2.8 |
| **Development Bank** | KfW | 4.8 |
| **Financial corporate** | China Development Bank | 6 |
| **Government backed** | European Union | 13.9 |
| **Loan** | Vineyard Wind | 2.3 |
| **Local Government** | Province of Ontario | 2.2 |
| **Non-financial corporate** | Ford Motor | 2.5 |
| **Sovereign** | United Kingdom | 13.6 |

Source: Climate Bonds Initiative.

## 3.2. Green Bond Standards & Regulation

Today, the regulatory market for Green Bonds is continuously developing, and is also highly diversified according to the different geographical areas of the globe.
In fact, with a few notable exceptions in some nations, the market for Green Bonds is primarily self-regulated by a diverse group of players, including non-governmental organizations, credit rating agencies, and second opinion providers that create voluntary standards.

The purpose of this section is, therefore, to review some of the most widely used guidelines that work to regulate and uphold the integrity of the Green Bond market. Firstly, the Sustainable Development Goals (SDGs), adopted by the European Union in 2015, will be introduced, which aim to address global challenges by 2030, including poverty, inequality, climate change, environmental degradation, peace and justice.
Next, we will discuss the Green Bond Principles, introduced in January 2014 by the International Capital Market Association (ICMA), which represented a key catalyst for subsequent market developments and are the basis for many of the existing green labels.
We will then look at the standards for Climate Bonds, introduced by the Climate Bonds Initiative. These voluntary standards have been very successful in the Green Bond market and therefore need to be addressed.
Lastly, we will discuss the European Green Bond Standard (EU GBS), presented by the European Commission on 6 July 2021, with the aim of stimulating the financing of sustainable investments and the transition to a zero-emission economy.

One European classification of sustainable investments that plays a key role is the EU Taxonomy, which came into force on 12 July 2020. However, this will not be dealt with in this section, but will be analysed in more detail in Chapter 4.

### 3.2.1. Introduction to the Sustainable Development Goals

As a strategy to "achieve a better and more sustainable future for all", the *Sustainable Development Goals* (SDGs) are a collection of 17 interconnected objectives established by the United Nations. They are also known as *2030 Agenda*, a name derived from the title of the document "Transforming our world: The 2030 Agenda for Sustainable Development" that acknowledges the close connection between environmental sustainability, global challenges, and human well-being.
The Sustainable Development Goals aim to address a wide range of economic and social

development issues, including poverty, hunger, the right to health and education, access to water and energy, jobs, inclusive and sustainable economic growth, climate change and environmental protection, urbanization, production and consumption patterns, social and gender equality, justice and peace.
The goals, enumerated in United Nations Resolution A/RES/70/1 passed by the UN General Assembly on 25 September 2015, are overall 169, to be achieved by 2030. They were agreed upon from the principles included in Resolution A/RES/66/288, entitled "The Future We Want", a non-binding document drafted after the 2012 UN Conference on Sustainable Development, to replace the Millennium Development Goals, which had 2015 as their time horizon. While the latter addressed developed and developing countries in different ways, the Sustainable Development Goals are universal in nature and are based on the integration of the three dimensions of sustainable development (environmental, social and economic) as a prerequisite for eradicating poverty in all its forms.
All 193 Member States of the United Nations have ratified the 2030 Agenda and have thus committed themselves to translating the envisaged Sustainable Development Goals into their policies. Each year, states can present the status of implementation of the seventeen SDGs in their country through Voluntary National Reviews. The 2030 Agenda identifies the High Level Political Forum as the global forum for monitoring, evaluating and guiding the implementation of the Sustainable Development Goals. To support this activity and ensure the comparability of assessments, the United Nations Statistical Commission established the Inter Agency Expert Group on SDGs (IAEG-SDGs), with the task of defining a set of indicators for monitoring the implementation of the 2030 Agenda at the global level.


Figure 3.18: The 17 Sustainable Development Goals.

Source: United Nations.

The Sustainable Developments Goals, as stated in the document "Transforming our world: the 2030 Agenda for Sustainable Development" (United Nations, 2015), are:

- *Goal 1*: end poverty in all its forms everywhere;
- *Goal 2*: end hunger, achieve food security and improved nutrition and promote sustainable agriculture;
- *Goal 3*: ensure healthy lives and promote well-being for all at all ages;
- *Goal 4*: ensure inclusive and equitable quality education and promote lifelong learning opportunities for all;
- *Goal 5*: achieve gender equality and empower all women and girls;
- *Goal 6*: ensure availability and sustainable management of water and sanitation for all;
- *Goal 7*: ensure access to affordable, reliable, sustainable and modern energy for all;
- *Goal 8*: promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all;
- *Goal 9*: build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation;
- *Goal 10*: reduce inequality within and among countries;
- *Goal 11*: make cities and human settlements inclusive, safe, resilient and sustainable;
- *Goal 12*: ensure sustainable consumption and production patterns;
- *Goal 13*: take urgent action to combat climate change and its impacts;
- *Goal 14*: conserve and sustainably use the oceans, seas and marine resources for sustainable development;
- *Goal 15*: protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss;
- *Goal 16*: promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels;
- *Goal 17*: strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development.

However, it is necessary to mention that the 17 SDGs are interconnected. For instance, while SDG2 (food production) is an individual goal, it is also related to SDG15 (life on land), SDG14 (life in the sea), SDG6 (water), and SDG13 (climate action). The same is true for climate mitigation and adaptation, which is both a stand-alone goal (SDG 13) and a cross-cutting action.
It is essential to approach the other SDGs with a climate lens in order to achieve the climate goals, especially Clean Water & Sanitation (SDG6), Affordable and Clean Energy (SDG7), Industry Innovation & Infrastructure (SDG9), Sustainable Cities (SDG11), and Life on Land (SDG15). In turn, all SDGs depend on the degree of climate action achieved. The overarching goal of ending poverty (SDG1), for instance, includes a sub-goal of reducing exposure to and vulnerability to climate-related extreme events. Climate change is predicted to make food security (SDG2) worse. Another area where it is believed that climate change will have a significant negative impact is health (SDG3). Investment in climate resilience will be necessary in addition to mitigation to achieve the goals.

Our ongoing analysis leads us to focus on six of the seventeen SDGs to which Green Bonds bring direct benefits, especially for emerging economies. In particular, these goals are (United Nations, 2015)[8]:

- Clean water and sanitation (SDG6);
- Clean energy (SDG7);
- Sustainable industry, innovation and infrastructure (SDG9);
- Sustainable cities and communities (SDG11);
- Climate Action (SDG13);
- Life on land (SDG15).

Clean water and sanitation (SDG6) accounted for 11% of Green Bond issuance in 2018. There is growing evidence of the intricate connections between water security and climate change. The same goes for the requirement to address waste water, reuse, and water efficiency practices in a carbon-constrained manner.
Although the market for green bonds has diversified over the past few years, clean energy (SDG7) still accounts for 40% of the market. Accelerating investment in energy efficiency programs, renewable energy systems, and related infrastructure benefits both the climate and SDGs.
Low carbon buildings are currently the second-largest market segment for green bonds

[8]Further information about these six goals are displayed in Appendix B.

(24%) after low carbon transportation (15%). Infrastructure for low-carbon construction and transportation supports sustainable business, innovation, and infrastructure (SDG9). The goal of sustainable cities and communities (SDG11) is addressed by many of the assets financed by green bonds, which are largely located in urban areas. A significant issuer of green bonds are cities and entities with a close connection to them, like utilities and transportation firms. This and other SDGs are strengthened when more cities issue green bonds as a key component of their climate strategies.
The rapidly expanding green finance sector is already financing investments that advance action on climate change (SDG13) and many other SDGs. The vast majority of proceeds from green bond issuance to date have been used to fund climate mitigation, adaptation, and resilience, with only a small portion going to other green assets.
Lastly, 3% of green bonds are also used to finance sustainable forestry and agriculture, improving the quality of life on land (SDG15).

### 3.2.2. Green Bond Principles

The ICMA's Green Bond Principles (GBP), which were released for the first time in 2014, are described as "*voluntary process guidelines that recommend transparency and disclosure and promote integrity in the development of the Green Bond market by clarifying the approach for issuance of a Green Bond*" (ICMA, 2021). These guidelines are typically revised once a year to reflect the expansion and development of the global Green Bond market; the most recent revision was released in June 2021.
These voluntary best practice guidelines were established in 2014 by a consortium of investment banks: Bank of America Merrill Lynch, Citi, Crédit Agricole Corporate and Investment Bank, JPMorgan Chase, BNP Paribas, Daiwa, Deutsche Bank, Goldman Sachs, HSBC, Mizuho Securities, Morgan Stanley, Rabobank and SEB. Since then, ongoing guidelines development and monitoring have been transferred to a separate secretariat run by the International Capital Market Association (ICMA).

GBP are voluntary process guidelines that encourage openness, disclosure and support integrity in the growth of the Green Bond market by outlining the procedure for the issuance of a Green Bond. They have been updated as of March 2015, and they are designed to be widely adopted by the market. They offer issuers direction on the crucial elements involved in launching a credible Green Bond, they help investors by ensuring that the data they need to assess the environmental impact of their Green Bond investments is readily available, and they help underwriters by guiding the market toward uniform disclosures that will speed up transactions.

Thus, investors, banks, underwriters, arrangers, placement agents, and others can use the GBP's recommended process and disclosure for issuers to understand the features of any specific Green Bond. Through core elements and important recommendations, the GBP emphasizes the necessary transparency, accuracy, and integrity of the information that will be disclosed and reported by issuers to stakeholders.
The GBP provides high level categories for eligible green projects in recognition of the variety of current viewpoints and the ongoing improvement in our understanding of environmental issues and consequences. When necessary, however, the GBP refers to other parties who provide complementary definitions, standards, and taxonomies for assessing the environmental sustainability of projects. The GBP encourage all market participants to build on this foundation in order to create their own sound procedures, citing a wide range of complementary standards as necessary.

Green Bond Principles define Green Bonds as "*any type of bond instruments where the proceeds will be exclusively applied to finance or re-finance in part or in full new and/or existing eligible Green Projects and which follows the four components of Green Bond Principles*" (ICMA, 2021). These four core components are:

1. Use of Proceeds;
2. Process for Project Evaluation and Selection;
3. Management of Proceeds ;
4. Reporting.

## Use of Proceeds

The use of bond proceeds for eligible green projects, which must be adequately described in the security's legal documentation, is the cornerstone of a Green Bond. All designated eligible Green Projects must offer obvious environmental benefits, which the issuer will evaluate and, where possible, quantify. It is advised that issuers provide an estimate of the share of financing vs. re-financing and, where appropriate, clarify which investments or project portfolios may be refinanced. Issuers should also, if applicable, provide information about the anticipated look-back period for refinanced eligible Green Projects.

The GBP recognizes several broad categories of eligibility for green projects that support environmental goals like climate change mitigation, climate change adaptation, natural resource conservation, biodiversity conservation, and pollution prevention and control.
While being only a guide, the list of project categories defined by the GBP includes the

most typical types of initiatives that the Green Bond market has supported or is anticipated to support. Assets, investments, and other related and supporting costs, like R&D, that may relate to more than one category and/or environmental objective are included in "green projects." The list also includes project categories for the three environmental goals: climate change adaptation, biodiversity conservation, and pollution prevention and control. As a result, they refer to the projects that are more specifically designed to meet these environmental objectives.

The eligible Green Projects categories (as defined by 2021 ICMA's GBP), include, but are not limited to:

- *Renewable energy*, including production, transmission, appliances and products;
- *Energy efficiency*, such as in new and refurbished buildings, energy storage, district heating, smart grids, appliances and products;
- *Pollution prevention and control*, including reduction of air emissions, greenhouse gas control, soil remediation, waste prevention, waste reduction, waste recycling and energy/emission-efficient waste to energy;
- *Environmentally sustainable management of living natural resources and land use*, including environmentally sustainable agriculture, environmentally sustainable animal husbandry, climate smart farm inputs such as biological crop protection or drip-irrigation, environmentally sustainable fishery and aquaculture, environmentally sustainable forestry, including afforestation or reforestation, and preservation or restoration of natural landscapes;
- *Terrestrial and aquatic biodiversity* conservation, including the protection of coastal, marine and watershed environments;
- *Clean transportation*, such as electric, hybrid, public, rail, non-motorised, multimodal transportation, infrastructure for clean energy vehicles and reduction of harmful emissions;
- *Sustainable water and wastewater management*, including sustainable infrastructure for clean and/or drinking water, wastewater treatment, sustainable urban drainage systems and river training and other forms of flooding mitigation;
- *Climate change adaptation*, including efforts to make infrastructure more resilient to impacts of climate change, as well as information support systems, such as climate observation and early warning systems;

- *Circular economy adapted products, production technologies and processes*, such as the design and introduction of reusable, recyclable and refurbished materials, components and products, circular tools and services, and/or *certified eco-efficient products*;
- *Green buildings* that meet regional, national or internationally recognized standards or certifications for environmental performance.

Given that there are numerous ongoing international and national initiatives to produce taxonomies and nomenclatures that aren't always in agreement, these categories are obviously not set in stone. Additionally, industry and region may have different definitions of what is "green" and what are "green projects".

## Process for Project Evaluation and Selection

Following this component, the issuer of a Green Bond should outline the decision-making process it follows to determine the eligibility of projects using Green Bond proceeds. In particular, investors should receive the following information from the Green Bond issuer:

- the environmental sustainability objectives of the eligible Green Projects;
- the process by which the issuer determines how the projects fit within the eligible Green Projects categories;
- complementary information on processes by which the issuer identifies and manages perceived social and environmental risks associated with the relevant project(s).

Moreover, issuers are encouraged to:

- position the information communicated above within the context of the issuer's overarching objectives, strategy, policy and/or processes relating to environmental sustainability;
- provide information, if relevant, on the alignment of projects with official or market-based taxonomies, related eligibility criteria, including if applicable, exclusion criteria; and also disclose any green standards or certifications referenced in project selection;
- have a process in place to identify mitigants to known material risks of negative social and/or environmental impacts from the relevant project(s). Such mitigants may include clear and relevant trade-off analysis undertaken and monitoring required where the issuer assesses the potential risks to be meaningful.

## Management of Proceeds

According to this component of the GBP, the net proceeds of the Green Bond, or an amount equal to these net proceeds, should be credited to a sub-account, moved to a sub-portfolio or otherwise tracked by the issuer appropriately, and attested to by the issuer in a formal internal process linked to the issuer's lending and investment operations for eligible Green Projects.
Thus, long as the Green Bond is outstanding, the balance of the tracked net proceeds should be periodically adjusted to match allocations to eligible Green Projects made during that period. The issuer should make known to investors the intended types of temporary placement for the balance of unallocated net proceeds.
These proceeds can be managed in two approaches: per bond (*bond-by-bond* approach) or on an aggregated basis for multiple Green Bonds (*portfolio approach*).
The GBP encourage a high degree of transparency and suggest that an issuer supplement its management of proceeds by using an external auditor or other third party to confirm the internal tracking procedure and the allocation of funds from the proceeds of the Green Bonds.

## Reporting

This last core component says that, in addition to reporting on the use of proceeds and the temporary investment of unallocated proceeds, issuers should make, and keep, readily available up to date information on the use of proceeds to be renewed annually until full allocation, and on a timely basis in case of material developments. The annual report should include a list of the projects to which Green Bond proceeds have been allocated, as well as a brief description of the projects, the amounts allocated, and their expected impact. Where confidentiality agreements, competitive considerations, or numerous underlying projects limit the amount of detail that can be made available, the GBP recommend that information is presented in generic terms or on an aggregated portfolio basis (e.g. percentage allocated to certain project categories).
The GBP recommend the use of qualitative performance indicators and, where feasible, quantitative performance measures of the expected environmental sustainability impact of the specific investments (e.g., reductions in greenhouse gas emissions, number of people provided with access to clean power, reduction in number of cars required, ...). The GBP recognize that there are currently no established standards for impact reporting on green projects, and they welcome and encourage initiatives, including those from notable Green Bond issuers, that will contribute to the creation of an impact reporting model that others can use and/or modify to suit their needs. Until more harmonization is achieved, trans-

parency is of particular value, including disclosure of methodologies and key underlying assumptions.

Along with the four essential elements of the GBP, the 2021 edition of the GBP identifies important recommendations for (i) Green Bond Frameworks and (ii) External Reviews. It urges information on the extent of project alignment with official or market-based taxonomies, and calls for increased transparency for issuer-level sustainability strategies and commitments. It also offers advice on how issuers should go about identifying mitigating factors for known material risks of damaging social and/or environmental effects. It also includes updated information and further clarifications regarding recommended market practices.

## Green Bond Frameworks

According to this recommendation, issuers should explain the alignment of their Green Bond or Green Bond programme with the four core components of the GBP (i.e., Use of Proceeds, Process for Project Evaluation and Selection, Management of Proceeds and Reporting) in a Green Bond Framework or in their legal documentation. Such Green Bond Framework and/or legal documentation should be available in a readily accessible format to investors.
Moreover, it is recommended that issuers summarize in their Green Bond Framework relevant information within the context of the issuer's overarching sustainability strategy. This may include reference to the five high level environmental objectives of the GBP (climate change mitigation, climate change adaptation, natural resource conservation, biodiversity conservation, and pollution prevention and control). Issuers are also encouraged to disclose any taxonomies, green standards or certifications referenced in project selection.

## External Reviews

With External Reviews, it is recommended that issuers appoint (an) external review provider(s) to assess through a pre-issuance external review the alignment of their Green Bond or Green Bond programme and/ or Framework with the four core components of the GBP (i.e., Use of Proceeds, Process for Project Evaluation and Selection, Management of Proceeds and Reporting) as defined previously.
Post issuance, it is recommended that an issuer's management of proceeds be supplemented by the use of an external auditor, or other third party, to verify the internal

tracking and the allocation of funds from the Green Bond proceeds to eligible Green Projects.

Issuers can get external opinions on their Green Bond process in a variety of ways, and there are various types of reviews that can be provided to the market. Indeed, the scope of independent external reviewers can vary, and they can be broadly categorized into the following types, in accordance with ICMA's "Guidelines for Green, Social, Sustainability and Sustainability-Linked Bonds External Reviews" (2022):

- *Second Party Opinion (SPO)*: An institution with environmental expertise that is independent from the issuer may provide a Second Party Opinion (either required or recommended pre-issuance as described in the respective Principles). The institution should be independent from the issuer's adviser for its Green Bond framework or climate transition strategy, or appropriate procedures such as information barriers will have been implemented within the institution to ensure the independence of the Second Party Opinion. Any concerns on the institution's independence should be disclosed to investors. Some of the most famous SPO providers are CICERO, Sustainalytics and Vigeo Eiris.
  Thus, a Second Party Opinion can include an assessment of the issuer's overarching objectives, strategy, policy, and/or processes relating to environmental sustainability. For Green Bonds, external reviewers should also assess:

  1. the environmental and/or social features of the type of Projects intended for the Use of Proceeds;
  2. the environmental benefits and impact targeted by the eligible green projects financed by the Green Bond;
  3. the potentially material environmental risks associated with the projects (where relevant).

- *Verification*: an issuer may obtain independent verification with respect to a certain set of criteria, usually related to business processes and/or environmental criteria. The verification may focus on the alignment of the project with internal or external standards or requests made by the issuer. In addition, the assessment of the environmental sustainable characteristics of the underlying assets may qualify as verification and may refer to external criteria. The assurance or attestation of the issuer's internal tracking method for the Use of Proceeds, the allocation of funds from the proceeds of Green Bonds, the environmental or social impact statement or the alignment of reporting with the Principles may also qualify as verification;

- *Certification*: an issuer can have its Green Bond or associated Green Bond Framework or Use of Proceeds certified against a recognized external green standard or label. A standard or label defines specific criteria, and alignment with such criteria is normally tested by qualified, accredited third parties, which may verify consistency with the certification criteria;
- *Green Bond Scoring/Rating*: an issuer can have its Green Bond associated framework or a key feature such as Use of Proceeds, evaluated or assessed by third parties, such as specialized research providers or rating agencies, according to an established scoring/rating methodology. The output may include a focus on environmental performance data, processes related to the Principles or another benchmark data, such as a 2 degree climate change scenario. This score/rating is distinct from credit ratings, which may, however, reflect material environmental risks.

The Principles accept that an external review may be partial, covering only certain aspects of the issuer's Green Bond or related structure, or it may be comprehensive in its assessment of alignment with the four main components of the Principles. The Principles take into account that the timing of an external audit may depend on the nature of the audit and that the publication of the results may be limited by confidentiality requirements.
Further information on External Reviews can be found in the Appendix C.

### 3.2.3. Climate Bonds Standards

As stated before, CBI's Climate Bonds Standards and Certification Scheme unquestionably represents one of the market's most reliable and well-regarded enforcement mechanisms. The Climate Bonds Initiative launched the Climate Bond Standard and Certification Scheme in December 2010, to help both the investment community and governments preference fixed-income investments for climate change solutions.
Due to its operation of self-labelled debt instruments screening, which allows for the identification of bonds and other comparable debt instruments as eligible for inclusion in the CBI Green Bond Database, CBI over time emerged as one of the most significant players in the Green Bond sector.
Apart from this, a key component of the Initiative is the Climate Bonds Standards & Certification Scheme, that allows investors, governments and other stakeholders to identify and prioritize low-carbon and climate resilient investments and avoid greenwashing.
The certification proved to be a real success over time, with more than $200bn in Certified Climate Bonds, even though adhering to the standards is voluntary (Figure 3.19).

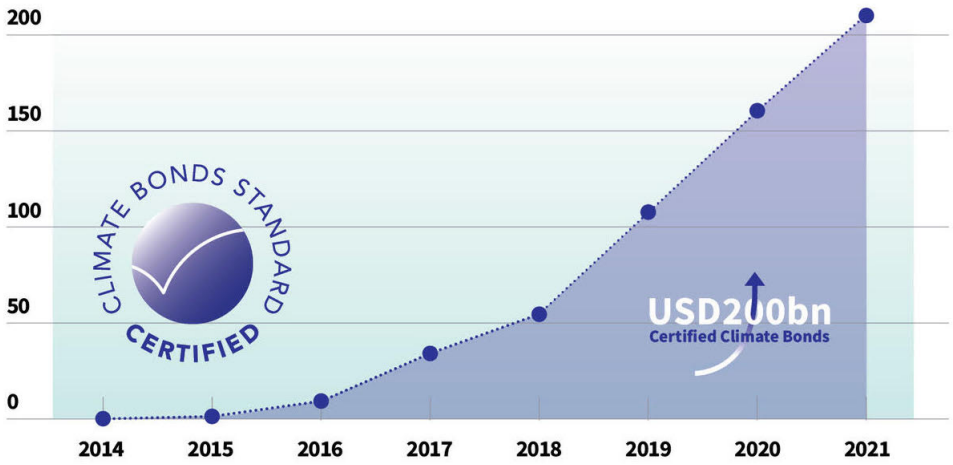



Figure 3.19: Cumulative amount of Certified Bonds ($bn).

Source: Climate Bonds Initiative.

The success of these standards also stems from the great heterogeneity of the countries in which this certification is adopted. As can be seen in Figure 3.20, the Climate Bond Certification embraced by countries like the United States, Canada, Brazil, Russia, China, Australia and the majority of the European nations.


Figure 3.20: Map of the global Climate Bond Certifications (updated to 2021).

Source: Climate Bonds Initiative.

The "Certification mark" under the Climate Bonds Standard confirms that the bond, loan or other debt instrument is:

- fully aligned with the Green Bond Principles and/or the Green Loan Principles;
- using best practice for internal controls, tracking, reporting and verification;
- financing assets consistent with achieving the goals of the Paris Climate Agreement.

The Climate Bonds Standard & Certification Scheme seeks to give the Green Bond market the confidence and assurance necessary for it to grow. To finance and refinance projects and assets that are in line with global climate goals, the mainstream debt capital markets must be activated. A crucial prerequisite for this mainstream participation is robust labelling of Green Bonds. The green label is underpinned by trust and confidence that the use of funds will be directed to projects and assets that are in line with the Paris Climate Agreement. Investor capacity to assess green credentials is, however, limited, especially in the fast-paced bond market.

The Climate Bonds Standard & Certification Scheme builds on the broad integrity principles contained in the Green Bond Principles to create a robust, flexible and effective certification system. Key features include:

- full alignment with the Green Bond Principles, Green Loan Principles, the proposed EU Green Bond Standard, ASEAN Green Bond Standards, Japan's Green Bond Guidelines and India's Disclosure & Listing Requirements for Green Bonds;
- clear mandatory requirements for use of proceeds, selection of projects & assets, management of proceeds and reporting;
- sector criteria for determining the low-carbon and climate resilient credentials of projects and assets;
- an assurance framework with independent verifiers and consistent procedures;
- certification awarded by the Climate Bonds Standard Board;
- certification is confirmed after issuance of the bond or loan with mandatory independent verification and annual reporting for the term of the investment.

This certification allows investors and issuers to enjoy some benefits. In particular, investors can use the Climate Bonds Standard as a screening tool to assure the low-carbon nature and integrity of their fixed-income investments. Despite the fact that certification as meeting the Climate Bonds Standard does not provide any assurance regarding credit

risks or returns, it does enable investors to save time and money when examining the low-carbon credentials of investments across sectors and asset classes. Because the Certification ensures greater transparency and consistency, investors can do less independent research to examine the bonds. A liquid market of Certified Climate Bonds also allows investors to actively participate in the delivery of the Low-Carbon Economy in three key ways:

1. proactively hedge against future climate risks by financing a low-carbon transition;
2. signal to the market their appetite for suitably risk-adjusted green deal-flow;
3. signal to governments their willingness to invest in the low-carbon transition subject to stable policy frameworks and risk-adjusted returns.

For issuers, on the other hand, the voluntary certification allows to clearly demonstrate to the market that their bond or loan meets science-based standards for climate integrity, and best practice standards for management of proceeds and transparency. Therefore, the possible benefits for issuers may be:

1. demonstrate to the market, through the robust label Certification, that their bond meets best practice standards for climate integrity, management of proceeds and transparency;
2. a wider investor base interested in their bond. These investors will be more "sticky", as they hold their debt for longer. There may sometimes be pricing advantages, depending on the circumstances, because of this increased investor demand for their bond;
3. visibility, that allows potential investors to quickly find a credible green/climate bond on providers of market information;
4. enhanced reputation, as the Certification allows an issuer to associate its organization with efforts to scale up financial flows for delivering the low-carbon economy and securing prosperity for future generations.

The standard is innovative as it permits corporate bonds to be linked with low-carbon activities while maintaining the issuer's normal credit ratings, in addition to the more obvious Green Bonds portfolio that can be branded as "Climate Bonds". Since the certification focuses on the low carbon portfolio or projects & assets being financed by the Green Bond, rather than the entity which is issuing it, Certified Climate Bonds can be issued by a variety of different organizations, such as project developers, utilities, banks, Local Governments, National Governments and so on.

From an operational viewpoint, as defined in "Climate Bonds Standard - Version 3.0" published by the Climate Bonds Initiative in December 2019, according to the Standards there are two different sets of requirements, one for each stage of issuing a Green Bond:

i. *Pre-Issuance Requirements*, which need to be met for issuers seeking certification ahead of issuance. These requirements are designed to ensure that:
   - the issuer has established appropriate internal processes and controls prior to issuance or closing of the bond or other debt instrument;
   - these internal processes and controls are sufficient to enable conformance with the Climate Bonds Standard after the bond has been issued or has closed, and allocation of the proceeds is underway;
   - the issuer has provided a Green Bond Framework document which confirms its conformance with the Pre-Issuance Requirements of the Climate Bonds Standard.

ii. *Post-Issuance Requirements*, which need to be met by issuers seeking ongoing certification following the issuance.

It is also possible to obtain the Certification for bonds or other debt instruments that have already been issued or closed. Issuers only need to adhere to the Standard's Post-Issuance Requirements in this case.

Regarding the Post-Issuance Requirements, issuers are required to report annually to maintain the Certification of the bond or other debt instrument. The exact nature of the reporting is dependent on the range of underlying projects and assets, and on the issuer's choices. Reporting is split into three types:

- *Allocation reporting*, for confirming the allocation of bond proceeds to eligible projects and assets, and this is mandatory for all Certified debt instruments;
- *Eligibility reporting*, for confirming the characteristics or performance of projects and assets to demonstrate their eligibility under the Taxonomy and relevant Sector Eligibility Criteria. This is also mandatory for all Certified debt instruments;
- *Impact reporting*, that refers to the disclosure of metrics or indicators which reflect the expected or actual impact of eligible projects and assets. This report is encouraged for all Certified debt instruments, but is not mandatory.

These three different types of reporting can be included in a single "Update Report" which must be provided annually while the bond or other debt instrument remains outstanding.

### 3.2.4. European Green Bond Standard

As we have just seen, the Green Bond Principles and the Climate Bond Standards represent the two main reference regulatory frameworks for the international Green Bond market. These private voluntary enforcement mechanisms are effective tools that have helped this phenomenon grow significantly over the past few years, but they do not appear to be enough to guarantee the integrity and credibility of the market in the near future.

In this direction, after the European green deal of December 2019, the European green deal investment plan of 14$^{th}$ January 2020 announced that the Commission would establish an EU Green Bond Standard (EU GBS), designed by the Commission's High-Level Expert Group on sustainable finance. This was done because the European Union recognized the fundamental role played by Green Bonds in financing assets needed for the low-carbon transition, but until then, there was no uniform Green Bond standard within the EU.

Technically, the European Green Bonds Regulation, known as the European Green Bond Standard or EU GBS, introduces a rigorous standard to which all issuers can voluntarily adhere, certifying the alignment of projects to be financed with the EU Taxonomy and guaranteeing investors protection from greenwashing. Any issuer of Green Bonds, both public and private, will be able to adhere to the standard, including those based outside the EU.
Unlike ICMA's standards, which focus on the issuance process, EU GBS look primarily at the projects to which the proceeds of the issuance are allocated, with the aim of supporting investors in identifying the most worthy projects, increasing the quality of the instruments and setting standards for external review activities. Once it is adopted by co-legislators, this proposed Regulation will set a gold standard for how companies and public authorities can use Green Bonds to raise funds on capital markets to finance such ambitious large-scale investments, while meeting tough sustainability requirements and protecting investors.

Therefore, the three main objectives of this standard are:

i. improve the ability of investors to identify and trust high-quality Green Bonds;

ii. clarify the definitions of green economic activities to make it easier to issue these high-quality Green Bonds, and minimize potential reputational risks in sectors that are in transition;

iii. establishing a voluntary registration and supervision regime will standardize the external review process and increase public confidence in external reviewers.

Moreover, The European Union defines these four key requirements under the proposed framework:

- *Taxonomy-alignment*: the funds raised by the bond should be allocated fully to projects that are aligned with the EU Taxonomy;
- *Transparency*: full transparency on how the bond proceeds are allocated through detailed reporting requirements;
- *External review*: all European Green Bonds must be checked by an external reviewer to ensure compliance with the Regulation and Taxonomy alignment of the funded projects;
- *Supervision by the European Securities Markets Authority (ESMA) of reviewers*: external reviewers providing services to issuers of European Green Bonds must be registered with and supervised by the ESMA. This will ensure the quality of their services and the reliability of their reviews to protect investors and ensure market integrity.

The main objective, therefore, is to create a new reference standard for Green Bonds to which other market standards can be compared and aligned. The new standards will make an effort to clarify some of the uncertain aspects that characterize the state of the market today, such as the ambiguity surrounding the "green" definition of projects, the lack of information regarding the environmental impact, the calibre of some external auditors, and verification checks.
Overall, while the guidelines issued by ICMA constitute for the issuer a series of non-binding recommendations, following the requirements imposed by European standards becomes mandatory for the purpose of issuing a Green Bond. The ultimate goal is to create a more stringent system that all issuers must adhere to in order to prevent market uncertainty and discontinuity.

## 3.3. In-depth discussion on Reporting

As we could see through the discussion on the Green Bond Principles, Climate Bond Standards and EU Green Bond Standard, standards give much weight and relevance to the subject of *reporting*.

The methodologies of reporting can be divided into two macro-areas:

- *Use of Proceeds Reporting*: a report detailing the eligible assets and projects financed with the Green Bond proceeds. According to the Green Bond Principles, this report should be published before the issuance (ex-ante), and updated yearly (ex-post), until full allocation;
- *Impact Reporting*: a report detailing the environmental results achieved from the projects or assets financed with the Green Bond proceeds. Depending on when the assessment is done, the impact can be further classified into expected (ex-ante) and actual (ex-post). Ex-ante impacts must be estimated because they are anticipatory. Ex-post impact, on the other hand, is evaluated after the impact actually occurs. It can either be measured if it can be determined through direct measurement, like for installed power capacity, or estimated if it needs to be estimated, as in the case of some metrics that are challenging to determine through direct measurement, as for $CO_2$ emissions avoided.

Because of its high level of non-standardization, Impact Reporting is particularly less common and more complicated than Use of Proceeds Reporting. Due to this, this section will pay more attention to this type of reporting, laying the groundwork for the next chapters.

As we previously said, in order to understand the relationship between Green Bonds and the issuer's climate targets, the issuer must report on how proceeds are used and the environmental impact. However, post-issuance reporting has so far been given little attention, both by investors (Maltais and Nykvist, 2020) and in the academic literature (Sartzetakis, 2020).
How issuers report the use and impact of Green Bonds matters not only to assess how Green Bonds are linked to issuers' climate targets, but also for reducing information asymmetries and the risk of greenwashing. Investors, regulators, and other financial sector stakeholders can evaluate whether funds have been allocated to green projects that are eligible and have a positive environmental impact thanks to reporting (Maltais and Nykvist, 2020).
However, despite GBP's efforts to increase financial market participants' understanding of the significance of environmental and social impact in order to raise more capital for sustainable development, impact reporting is only advised by the Principles. The same is true for Climate Bond Standards, as this type of reporting is still not required to obtain the CBI's Certification, despite being encouraged. The position of EU GBS, which mandates that issuers of European Green Bonds shall prepare a European Green Bond

report on the environmental impact of the use of the bond proceeds after full allocation of the proceeds and at least once during the lifetime of the bond, is a little stricter.
The fact that there are no legally binding standards for disclosing how proceeds are used or for reporting on the environmental impact of Green Bond projects has meant that many issuers have overlooked the importance of this kind of information.

Overall, this lack of transparent and comparable post-issuance reporting impedes the growth of the Green Bond market and does little to reduce the risk of greenwashing. Harmonized impact methodologies, according to Tuhkanen and Vulturies (2020), are essential for making post-issuance reports of Green Bonds more reliable and comparable. Indeed, a set of impact indicators that are used consistently would eventually help to increase market legitimacy and trust, show issuers and investors to be accountable, and allow market stakeholders to be benchmarked.

Climate Bonds Initiative recently released its third study on post-issuance reporting in the Green Bond market with the goal of shedding light on reporting practices and understanding the availability and characteristics of disclosure on the use of proceeds and environmental impacts of projects and assets financed by Green Bonds, thus identifying areas for improvement. This report includes the analysis of 694 bonds (from 408 issuers), issued from November 2017 to March 2019, for a total amount of issuance of $212bn. The results of this study are displayed in Table 3.5.

Table 3.5: Use of Proceeds and Impact reporting scope (2021).

| | Use of Proceeds | Impact | Both | At least one |
|---|---|---|---|---|
| Number of issuers reporting | 77% | 59% | 57% | 79% |
| Number of bonds reporting | 77% | 63% | 62% | 78% |
| Amount issued ($bn) reporting | 88% | 74% | 73% | 88% |

Source: Climate Bonds Initiative.

As we can see, availability of post-issuance reporting is widespread, but UoP is still more commonly reported than impacts. Indeed, only 59% of issuers (representing 74% in volumes) reported the impacts, compared to 77% of issuers who provided UoP reporting, accounting for 88% of the amount issued. By reporting on both UoP and impacts, 57% of issuers and 73% of the issued amount showed best practices. These findings are an improvement over the earlier study's findings, which found that only 47% of issuers and 66% of the total amount issued reported on both metrics.

The amount issued share is generally higher, as larger issuers are more likely to report. The reporting share has increased versus the early market (especially on impacts). However, as stated in the CBI report, several issuers are still not reporting within one year of issuance.

### 3.3.1. Impact Reporting

Focusing on Impact Reporting, we can see how the disclosure of impacts has become more common in the green bond market over the last few years, and there is now more guidance and resources covering this aspect of reporting. To some extent, the increase may also have been compounded by the increasing requirements for investors to disclose the impacts of their portfolios (especially in the EU), putting further pressure on issuers to report impacts and bringing "impact" to the forefront of many discussions in finance. However, impact reporting is still more difficult to perform than use of proceeds reporting, and it is also significantly less standardized. Indeed, almost all issuers that report impacts also report allocations (97%), but this drops in the opposite case: 74% of issuers that report UoP also report impacts.

Other findings of the CBI papers report that nearly half of issuers report a combination of measured and estimated impacts, while three quarters of issuers report actual (ex-post) impacts. Furthermore, a variety of metrics are employed, even in the case of related project types. It is, therefore, extremely difficult to compare and aggregate impacts due to the lack of uniformity in the impact data. The frequent use of relative metrics, like the amount of GHG emissions saved, which inevitably depend on the comparison baseline, is one of the main causes of this.
GHG saved/avoided/reduced is the most common metric. Most issuers report it, and together with $CO_2$ saved/avoided/reduced, it is the only metric to appear in eight out of nine project categories[9], being least used in "Water" (12% of issuers) due to the sector's reduced focus on climate mitigation. Among other widely used general metrics are area/length protected/conserved/managed/built etc., and number of units built/installed/renovated etc., which are not related to a particular substance and so are even more general than the rest.

Therefore, the fragmentation of reporting modalities has highlighted the fundamental role that can be played by more defined methodologies. Indeed, the expansion of reporting since the market's inception is positive and has given rise to a breadth of approaches, but it also raises some concerns, particularly around lack of standards and consistency.

[9]These refer to the project categories defined by the Climate Bond Initiative, listed in Section 3.1.3.

Post-issuance reporting is currently fragmented, meaning that issuers practice it on their own, but there are indications that this will change, at least in some regions of the world. While UoP reporting is relatively straightforward, the absence of a common framework to report impacts means that issuers must decide which metrics/KPIs to report along with how to monitor, measure/calculate and report them. The recommendations made under the GBP are limited in terms of metrics to the use of both qualitative performance indicators and, when practical, quantitative performance measures, along with the disclosure of the main underlying assumptions and/or methodology. Impact reporting commitments have been cited by some stakeholders as one of the main obstacles to additional Green Bond issuance. The perceived cost and difficulty are related to an initially steep learning curve, which is anticipated to flatten out as issuers gain reporting experience over time. Additionally, assurance and verification of impacts are frequently absent, and even when they are, they frequently take the form of a brief, ambiguous statement. Therefore, there is also significant room for improvement in terms of the accuracy and reliability of impact measurement and monitoring.

Given the context above, attempts to provide clarity and consistency to impact reporting have been underway for a few years. These provide guidance on different aspects of impact reporting, but it is debatable whether they can all be considered impact reporting methodologies/frameworks. The reporting landscape has been made more interesting by the expanding market and some growing guidance in reporting practices. The harmonization of disclosure is still fundamental, though. Indeed, it appears that there is still a long way to go before reporting, especially impact reporting, is made consistently available throughout the market, creating issues for impact comparison and aggregation. On the other hand, given the fragmented nature of reporting to date, with issuers that, in the absence of a common framework, must typically produce and publish their Green Bond reports independently, this is not surprising.

Currently, the two most comprehensive and widely adopted impact reporting methodologies are:

- *ICMA Harmonized Framework for Impact Reporting*;
- *Nordic Public Sector Issuers Position Paper on Green Bond Impact Reporting.*

Among all the methodologies identified, these stand out as the:

i. most relevant and specific to green bonds;

ii. most comprehensive, covering various aspects of impact reporting and a range of

sectors, and able to be applied globally;

iii. most widely adopted (by issuer count), although still only covering a minority of the market.

## ICMA Harmonized Framework for Impact Reporting

The ICMA Harmonized Framework is the result of a merger between the "Proposal for a harmonized framework for impact reporting", published by eleven international financial institutions (IFIs) in December 2015, and subsequent sector-specific guidance developed through ICMA's Impact Reporting Working Group under the GBP, which focuses on providing suggested metrics. This guide outlines general core principles and recommendations for reporting in order to provide issuers with a reference as they develop their own reporting. It also offers impact reporting metrics and sector specific guidance for the GBP project categories. Moreover, this handbook includes reporting templates for issuers to use and adapt to their own circumstances, making reference to the most commonly used indicators.
First published in 2019, the latest update of the ICMA Harmonized Framework (June 2022) features suggested metrics for the last GBP eligible Green Project category not yet covered (Environmentally sustainable management of living natural resources and land use) and complements the nine existing GBP project categories.

## Nordic Public Sector Issuers Position Paper on Green Bond Impact Reporting

The NPSI Position Paper was originally launched in October 2017 by a group of ten Nordic public sector issuers, with the aim of being a comprehensive guidance document for impact reporting complementary to the work of the IFIs.
The latest update (February 2020) features new recommendations regarding the reporting of climate-related physical risks and the SDGs. Despite being initially designed for public sector issuance, many issuers, including commercial banks and various corporate issuers, have adopted the framework outlined in the NPSI Position Paper (also outside the Nordics).

This concise discussion of the function and key principles of impact reporting represents the conclusion of the Green Bond market and its regulation.
The next chapter, however, will be devoted entirely to the EU Taxonomy, which will prove to be a fundamental pillar for the subsequent discussions of this dissertation.

# 4 | EU Taxonomy

The EU Taxonomy represents the cornerstone of the EU Action Plan on Sustainable Finance, which describes fields of actions to support the orientation of capital into more sustainable investments or economic activities. The aim of this chapter is to discuss the EU Taxonomy in depth and to analyse its implications for the Green Bond market.
To do this, the concept of taxonomy will first be introduced, with historical references and looking at the global situation today.

## 4.1. Taxonomies: a bit of history and context

The term "*taxonomy*" is generally used in scientific fields to describe a system for the identification and classification of information. In green finance, a green or sustainable taxonomy has gained increasing market acceptance and use over the past few years and describes a classification system that identifies activities, assets or revenue segments that deliver on key environmental objectives. The goal of a taxonomy is to make it clear to participants in the financial market which actions or assets qualify for sustainable investments.

Since decades, it has been possible to identify assets that are suitable for inclusion in ESG and other sustainable investment products using green/sustainable definitions, principles, and classification systems. These were historically primarily private sector driven, typically built in-house, and frequently based on methodologies, ratings, and scoring tools created by specialized service providers. While many of these were fit for purpose, the number of different approaches and their sometimes-opaque criteria led to concerns around greenwashing.
In order to help the Green Bond market expand, public actors entered the fray and proposed more top-down approaches to determining green/sustainable activities. Green Bond guidance that was generally voluntary and in accordance with the Green Bond Principles was established at the national and regional levels to start this process. These guidelines proved useful in promoting transparency and disclosure, but as they generally

did not have specific eligibility criteria (e.g., performance thresholds) with regard to what is green, concerns around greenwashing persisted.

Public authorities have increasingly shifted to a more comprehensive and necessary set of eligibility requirements in the form of a taxonomy to address these concerns. The more thorough and obligatory paradigm for evaluating and approving the issuance of green bonds was first proposed by China (the official name is the *Green Bond Endorsed Project Catalogue*, but it is usually referred to as the China Taxonomy). The European Commission accepted a group of experts' advice in 2016 to create a European Taxonomy, which resulted in a regulation that was approved by the EU co-legislators. In Figure 4.1 are displayed the regions of the world where a taxonomy has already been implemented, in draft, under development or still under discussion.

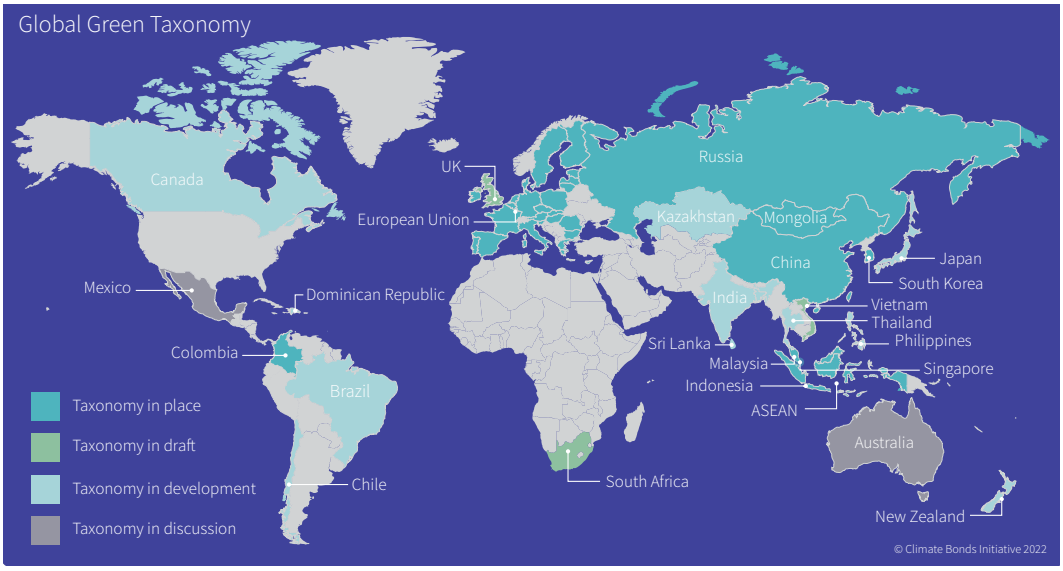



Figure 4.1: Map of the global green taxonomies (updated to 2021).

Source: Climate Bonds Initiative.

The main difference between taxonomies and ESG guidance is that the former are generally:

- *Granular*: taxonomies provide specific information (often binary or numerical) on what qualifies as green or sustainable. As a result, there will be less need for interpretation and, therefore, less risk of greenwashing;
- *Publicly available*: taxonomies are available publicly and are not based on proprietary methodologies. They can therefore be used by a variety of actors and become widely understood and accepted. A combination of public, private, and

non-governmental actors may be involved in the taxonomy development process;

- *Science-based*: to the greatest extent possible, taxonomies are based on scientific principles as opposed to national priorities or opinions.

These differences represent the added value that taxonomies have brought to the green and sustainable investment landscape, providing clarity on what can be considered green and reducing the need for interpretation or in-depth due diligence.

Although many other nations have taxonomies in draft or in discussion, the EU and China are arguably the two main jurisdictions referred in taxonomy discussions. Indeed, most other country taxonomies are based at least in part on the EU and China taxonomies.
Since January 2015, the Chinese domestic Green Bond market has been required to follow the Green Bond Endorsed Project Catalogue (China taxonomy), which was later updated in 2021 to more closely follow international definitions. This taxonomy addresses climate change, environmental improvement, circular economy, waste recycling and pollution prevention.
The development of the EU Taxonomy is occurring in stages. The Climate Delegated Act (which specifies thresholds related to climate change) and the overarching Taxonomy Regulation were both approved in 2021. Climate change adaptation and mitigation measures, which make up two of the six proposed project categories, are the primary focus of this phase of the taxonomy criteria. Beyond green bonds, the EU Taxonomy will support the requirement that investors, banks, and businesses in the EU disclose their sustainable investments and assets. However, the EU Taxonomy will be discussed more in detail in the next Section.
As of early 2022, the most well-developed taxonomies are green taxonomies, covering environmental issues. Climate change is the environmental objective with the most coverage across different taxonomies. Globally, social taxonomies are not as well-developed, but there is a desire, especially in Emerging Markets, to eventually include social goals.

As previously mentioned, taxonomies can help investors by offering precise, unambiguous guidance. Taxonomies' scientific foundation can reduce the amount of due diligence required of them, and investors can be somewhat certain that they will align with their investment goals. When disclosure rules are included with a taxonomy (as in the EU), investors may benefit from having access to the information and data they need to make investment decisions.
As far as issuers are concerned, taxonomies help them in establishing certainty regarding

the assets that can be included in green finance instruments. It reduces interpretation and allows them to clearly show which assets are aligned with, for example, the aims of the Paris Agreement. This implies that issuers, especially in the more challenging sectors, are required to give much less justification as to why an investment is green. Before the EU Taxonomy, for instance, there was limited guidance available about what green cement production looked like, so a company might have needed to defend its position to the market by arguing that green cement production is equivalent to a certain amount of tonnes of $CO_2$ emissions per tonne of cement. Now, the only requirement is to demonstrate compliance with the threshold in the EU Taxonomy.

The biggest challenge for future developments of taxonomies is certainly implementation. Although taxonomy creation has been the main topic of discussion up to this point, this will probably change to shift the discussion around use and implementation. Reporting under the EU Taxonomy is now mandatory for large companies and encouraged for SME's, so we expect to see evidence of reporting and, along with it, challenges, and solutions for other taxonomies to reference for their own implementation.

## 4.2. EU Taxonomy for Sustainable Activities

As we said in previous discussions, in order to meet the EU's climate and energy targets for 2030 and reach the objectives of the European Green Deal, it is vital that we direct investments towards sustainable projects and activities. The current COVID-19 pandemic has reinforced the need to redirect money towards sustainable projects in order to make our economies, businesses and societies more resilient against climate and environmental shocks. To do this, there needs to be agreement on terminology and a definition of what is meant by "sustainable." For this reason, the Action Plan on Financing Sustainable Growth called for the development of the "EU Taxonomy", a unified classification scheme for sustainable economic activities.

The EU Taxonomy is a classification scheme that establish a list of economically environmentally sustainable activities. It might have a significant impact on how the EU scales up sustainable investment and puts the European Green Deal into practice. Companies, investors, and policymakers would have access to appropriate definitions of what economic activities qualify as environmentally sustainable thanks to the EU Taxonomy. This should provide security for investors, safeguard private investors from greenwashing, assist businesses in becoming more environmentally friendly, lessen market fragmentation, and assist in directing investments to areas where they are most needed.

The Taxonomy Regulation was published in the Official Journal of the European Union on 22 June 2020 and entered into force on 12 July 2020. It establishes the basis for the EU Taxonomy by setting out four overarching conditions that an economic activity has to meet in order to qualify as environmentally sustainable. A precise definition of when a business or enterprise is operating sustainably or environmentally friendly is provided by the EU Taxonomy regulation, which establishes a clear framework for the concept of sustainability. Compared to their competitors, these companies stand out positively and thus should benefit from higher investments. Thereby, the legislation aims to reward and promote environmentally friendly business practices and technologies. In particular, the Taxonomy Regulation, in Article 9, establishes six environmental objectives:

1. Climate change mitigation;
2. Climate change adaptation;
3. The sustainable use and protection of water and marine resources;
4. The transition to a circular economy;
5. Pollution prevention and control;
6. The protection and restoration of biodiversity and ecosystems.

According to the EU Taxonomy regulation, a business must not only support at least one environmental goal but also must not violate the remaining ones in order to be classified as a sustainable economic activity. An activity aiming to mitigate the climate but at the same time also negatively affecting biodiversity cannot be classified as sustainable. The classification of an economic activity in terms of sustainability is based on the following four criteria (defined in Article 3 of the Regulation), which base on the previously mentioned environmental objectives:

1. the economic activity contributes to one of the six environmental objectives;
2. the economic activity does "no significant harm" (DNSH) to any of the six environmental objectives;
3. the economic activity meets "minimum safeguards" defined by the OECD Guidelines for Multinational Enterprises and the UN Guiding Principles on Business and Human Rights;
4. the economic activity complies with the Technical Screening Criteria developed by the EU Technical Expert Group (TEG).

Technical Screening Criteria (TSC) define the specific requirements and thresholds for an activity to be considered as significantly contributing to a sustainability objective. These Technical Screening Criteria are being elaborated in secondary legislation called Delegated Acts by the Technical Expert Group.
On December 9, 2021, the Official Journal published the first Delegated Act on sustainable activities for the goals of climate change adaptation and mitigation, and is applicable since January 2022. A Delegated Act supplementing Article 8 of the Taxonomy Regulation was published in the Official Journal on 10 December 2021 and is applicable since January 2022. This Delegated Act specifies the content, methodology and presentation of information to be disclosed by financial and non-financial undertakings concerning the proportion of environmentally sustainable economic activities in their business, investments or lending activities. Specific nuclear and gas energy activities have been added to the list of economic activities covered by the EU Taxonomy, subject to strict conditions, according to a Complementary Climate Delegated Act that the Commission adopted on March 9, 2022. It will be effective as of January 2023 after being published in the Official Journal on July 15, 2022. The requirements for the particular nuclear and gas activities are in line with EU environmental and climate goals, and they will hasten the transition away from solid or liquid fossil fuels like coal and toward a climate-neutral future.

As we said, the TEG uses the EU Taxonomy as the framework to ensure a unified classification system for determining when economic activities can be considered environmentally sustainable, using these environmental objectives as the rational target. Based on the NACE[10] classification, the official industry classification used in the European Union, the TEG selected a list of macroeconomic sectors considered relevant in terms of GHG emissions in the EU (roughly 93.5% of Europe's emissions), and covering a significant proportion of GDP and total employment at the EU 28 level. These macroeconomic sectors can be divided in nine macro areas:

1. Forestry;
2. Environmental protection and restoration activities;
3. Manufacturing;
4. Energy;
5. Water supply, sewerage, waste management and remediation;
6. Transport;

[10]Nomenclature statistique des Activités économiques dans la Communauté Européenne

7. Construction and real estate activities;
8. Information and communication;
9. Professional, scientific and technical activities.

Then, for each macro sector, the TEG defined a list of eligible activities and determined the "detailed technical screening criteria" required to assess whether economic activities meet the relevant substantial contribution to the environmental objectives. It should be noted that that eligibility under the EU Taxonomy is assessed on an activity basis rather than by entity (i.e., company).

At this point, we need to clarify the nature of these activities. Indeed, within the activities that substantially contribute to one or more environmental objectives, the Taxonomy defines two classification categories: *enabling* activities and *transitional* activities. These were included to enable activities that might not have previously been thought of as sustainable to support the overarching goal of promoting sustainability.
Enabling activities allow other activities to make a substantial contribution to one or more of the Taxonomy's six objectives. However, enabling activities cannot lead to a "lock-in" of assets, which would undermine long-term environmental goals. They must also have a substantial positive environmental impact over the activity's lifecycle.
Transitional activities must contribute to climate change mitigation and a pathway to keeping global warming in line with Paris Agreement commitments. Transitional activities only qualify where the following criteria are met:

- there are no technologically or economically feasible low-carbon alternatives;
- Green House Gas (GHG) emission levels correspond to the best performance in the sector or industry;
- the activity does not lead to carbon lock-in or hamper the development and deployment of low-carbon alternatives.

However, as we said previously, an economic activity is qualified as environmentally sustainable when (i) it contributes substantially to at least one of the six environmental objectives; (ii) it follows the principle of "Do No Significant Harm" to any other environmental objectives; and, (iii) it complies with minimal social safeguards. Indeed, when an economic activity meets the EU Taxonomy performance thresholds, it is then certified as "*EU Taxonomy-aligned*". At this point, it is crucial to understand the difference between *eligibility* and *alignment*.
Eligibility of activities implies that an activity is included in the Delegated Acts on cli-

mate change mitigation or climate change adaptation (or the other four environmental objectives). Whether an activity is Taxonomy-eligible or not says nothing about the level of sustainability of that activity. Being Taxonomy-eligible is merely an indication that a certain activity makes a substantial contribution to one of the six environmental objectives of the Taxonomy.
On the contrary, Taxonomy-alignment implies that an activity complies with the requirements enumerated specifically for this activity in the Taxonomy, thus when the activity when an activity is compliant with the technical screening criteria, the "Do No Significant Harm" criteria and the minimal safeguards linked to this activity in the Taxonomy.
Let's make an example: let's suppose that a company has two business activities: manufacturing solar panels and extracting oil via fracking. Both activities reprensent exactly 50% of the total revenues of the company. Solar panels manufacturing is included in the EU Taxonomy, while fracking is clearly not included. This means that 50% of revenues of the total operations of the company are Taxonomy-eligible. If the solar panels operations of the company comply with the technical screening criteria (TSC) listed in the EU Taxonomy, do no significant harm (DNSH) to any of the other environmental objectives and meet the minimum safeguards, then all the turnover resulting from this activity can be counted as Taxonomy-aligned.

In practice, a business that engages fully or partially in eligible economic activities and satisfies the technical requirements of EU Taxonomy is permitted to designate a corresponding portion of its performance (turnover, capital expenditures, or operational expenditures) as environmentally sustainable. A financial intermediary investing in that business can therefore determine its proportionate share of Taxonomy-aligned investment. The intermediary (such as investment and mutual funds, private and occupational pensions) will disclose the kind and level of EU Taxonomy alignment of its financial products in this way. This represents a powerful edge for investment firms, as companies will have to disclose their EU Taxonomy-aligned turnover and capital expenditure in their annual reports, as required in the Non-Financial Reporting Directive. Otherwise, the financial intermediary will have to declare that a product does not align.

### 4.2.1. EU Taxonomy: how does it work in practice

As with all other regulations, nothing comes easy. For this, the TEG developed a 5-steps approach in order to help entities to apply the criteria of the EU Taxonomy.

## Step 0 - Identify eligible activities under the EU Taxonomy

The starting step of the process is to determine which economic activities are "eligible", and so covered by the EU Taxonomy. To do this, the different activities carried out by a company must be mapped, classified and then divided according to different NACE codes.

## Step 1 - Eligibility screening

The objective of this step is to assess the proportion of turnover/expenditures derived from economic each activity eligible under the EU Taxonomy.
At this stage, it is also recommended to group eligible activities in two clusters: enabling activities, which "enable" other activities to make a substantial contribution to one or more environmental objectives, and transitional activities, for which there is no technologically and economically feasible low-carbon alternative.

## Step 2 - Substantial contribution screening

The goal of this step is to assess if the eligible activities meet the technical screening criteria (TSC). This is one of the most difficult parts. While some economic activities (e.g., electricity generation from wind) do not have technical thresholds to comply with, most of them have. For instance, electricity generation from geothermal is Taxonomy-eligible, but it should meet the technical criteria of no more than 100g $CO_2$-e emissions per kWh over the life-cycle of the installation, as calculated using specific methodologies (e.g., ISO 14067:2018) and verified by a third party.
The Taxonomy Regulation acknowledges that this step can be particularly onerous when there are no reported data. This justifies allowing complementary assessments and estimates, so long as financial market participants can justify their assumptions and rationale for their estimates. For example, if an investor, who is assessing the level of alignment of a bond with respect to the Taxonomy, does not find the data concerning TSCs, he must consider that instrument as non-aligned to the EU Taxonomy.

## Step 3 - Do Not Significant Harm (DNSH) screening

At this point, we want to validate if the eligible economic activities do not significantly harm other environmental objectives. This step demands that investors perform due diligence to confirm that the company's activities, not only during the production stage but also throughout the life-cycle of the activity itself, meet some qualitative, quantitative, and process-based requirements for each other environmental objectives.

Also here, the lack of data can be quite challenging to deal with. The TEG recommends the reliance on existing credible information sources, such as reports from international organizations, civil society, and media, as well as established market data providers.

## Step 4 - Social minimum safeguards screening

The goal here is to assess if companies meet minimum human and labour rights standards. The Taxonomy mandates that for economic activity to be environmentally sustainable, it should also be aligned with the OECD Guidelines for Multinational Enterprises, the UN Guiding Principles on Business and Human Rights, the International Labour Organisation's (ILO) Core Conventions, and the International Bill of Human Rights. As for step 3, the TEG recommends relying on internal due diligence processes as well as on external credible information sources.

## Step 5 - Calculate the alignment with the EU Taxonomy

Economic activity is to be considered Taxonomy-aligned only if it complies with steps 1-4. For instance, let's imagine that the proceeds of a Green Bond are equally allocated in two eligible activities: one activity complies with all previous steps, while the other do not. At this point, we can say that the Green Bond is 50% Taxonomy-aligned.

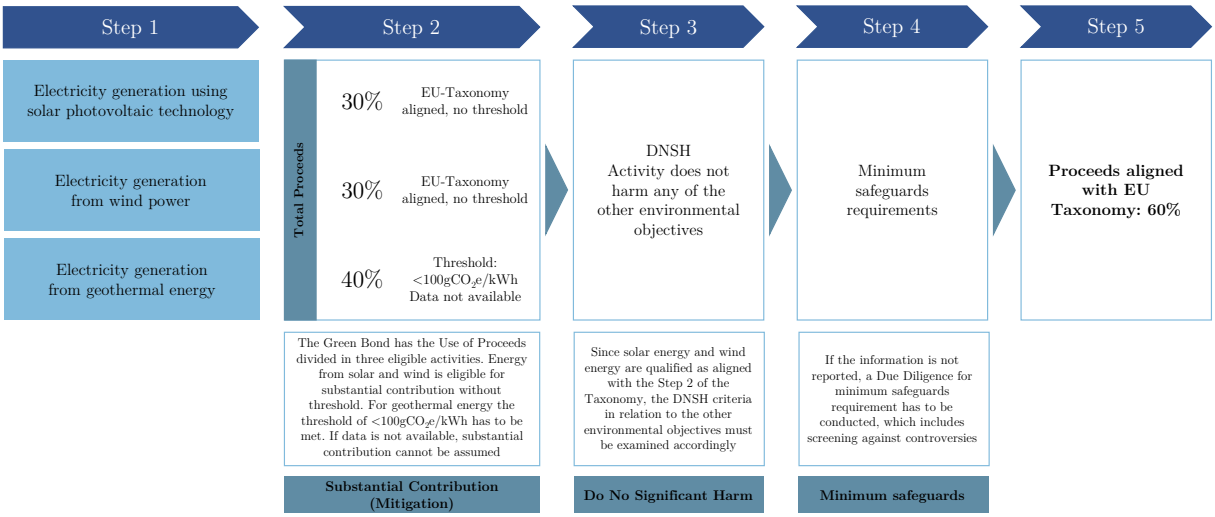



Figure 4.2: Application example of the alignment process for a Green Bond.

### 4.2.2. EU Taxonomy: to whom it is addressed

According to the Article 1 of the Regulation, the EU Taxonomy applies to three groups of players:

- financial market participants that make available financial products (like asset managers, life insurance, banks that offer portfolio management, ...);
- large companies who are already required to provide a non-financial statement under the Non-Financial Reporting Directive (NFRD);
- measures adopted by Member States or by the Union that set out requirements for financial market participants or issuers in respect of financial products or corporate bonds that are made available as environmentally sustainable.

The Non-Financial Reporting Directive (NFRD) is a disclosure tool that aims to provide a thorough framework for corporate reporting that includes both qualitative and quantitative data to make it easier to evaluate how companies' sustainability impacts and risks. Large public-interest organizations are required by NFRD to include information about environmental, societal, and governmental (ESG) issues in their non-financial statements. According to the EU Taxonomy, companies falling within the scope of the existing NFRD are expected to report on the extent to which their activities are sustainable. In accordance with the requirements of the SFDR and the current EU Taxonomy, the indicators for this requirement will be laid out in a separate Commission Delegated Act.
Following a review of the NFRD consultation that closed in June 2020, the European Commission has issued a Corporate Sustainability Reporting Directive (CSRD) proposal on April 21$^{st}$, 2021. The proposal from the European Commission broadens the application of NFRD requirements to cover all large businesses, whether they are publicly traded or not, and does away with the pre-existing 500-employee threshold. All large corporations will now be held publicly accountable for their effects on people and the environment, expanding the scope of entities from 11,600 to 49,000. Additionally, the Commission is recommending that the scope be expanded to encompass listed microenterprises as well as small and medium-sized businesses (SME) that have securities listed on regulated markets.
Then, there is also the Sustainable Finance Disclosure Regulation (SFDR). This law, which takes effect from March 10, 2021, creates a thorough reporting framework for financial products and financial entities, adding to corporate disclosures. Investments in economic activities with varying levels of environmental performance may be part of various investment strategies. For this reason, the SFDR distinguishes disclosure requirements for:

- financial products that claim to have "sustainable investment" as their objective (in environmental objectives are often referred to as "dark green" financial products);
- financial products that claim to be promoting social or environmental characteristics (often referred to as "light green" financial products).

The SFDR requirements are linked with those under the EU Taxonomy by including environmentally sustainable economic activities' as defined by the Taxonomy Regulation in the definition of "sustainable investments" in the SFDR.

Financial market participants, that offer the above-mentioned financial products or services, need to disclose amongst other whether ESG products or sustainable investments that they offer to their customers are Taxonomy-aligned. This applied from the 1st January 2022 for what concerns o climate change mitigation and climate change adaptation, and then from the 1st January 2023 for the other four environmental objectives (Figure 4.3.
For each relevant product, the financial market participant will be required to state:

- how and to what extent they have used the Taxonomy in determining the sustainability of the underlying investments;
- to what environmental objective(s) the investments contribute;
- the proportion of underlying investments that are Taxonomy-aligned, expressed as a percentage of the investment, fund or portfolio. This disclosure should include details on the respective proportions of enabling and transition activities, as defined under the Regulation.

The disclosures must be made as part of existing pre-contractual and periodic reporting requirements. These products also carry sustainability disclosure obligations under the regulation on Sustainability-Related Disclosures in the Financial Sector.

Then we have the non-financial corporates that fall under the requirements to publish in non-financial reports. These corporates need to incorporate certain KPIs in their reports. Article 8 of the Taxonomy regulation requires corporates to report how and to what extent the activities are associated with Taxonomy-aligned activities in connection with the in connection with the Non-Financial Reporting Directive. Thus, non-financial firms are expected to report their alignment with the EU Taxonomy both in terms of:

a. the proportion of their turnover derived from products or services associated with economic activities that qualify as environmentally sustainable, and so Taxonomy-

aligned;

b. the proportion of their capital expenditure (CapEx) and the proportion of their operating expenditure (OpEx) related to assets or processes associated with economic activities that qualify as environmentally sustainable, and so Taxonomy-aligned.

This disclosure should be made as part of the non-financial statement, which may be located in annual reporting or in a dedicated sustainability report. Also in this case, these requirements apply from the 1st January 2022 for what concerns o climate change mitigation and climate change adaptation, and then from the 1st January 2023 for the other four environmental objectives.

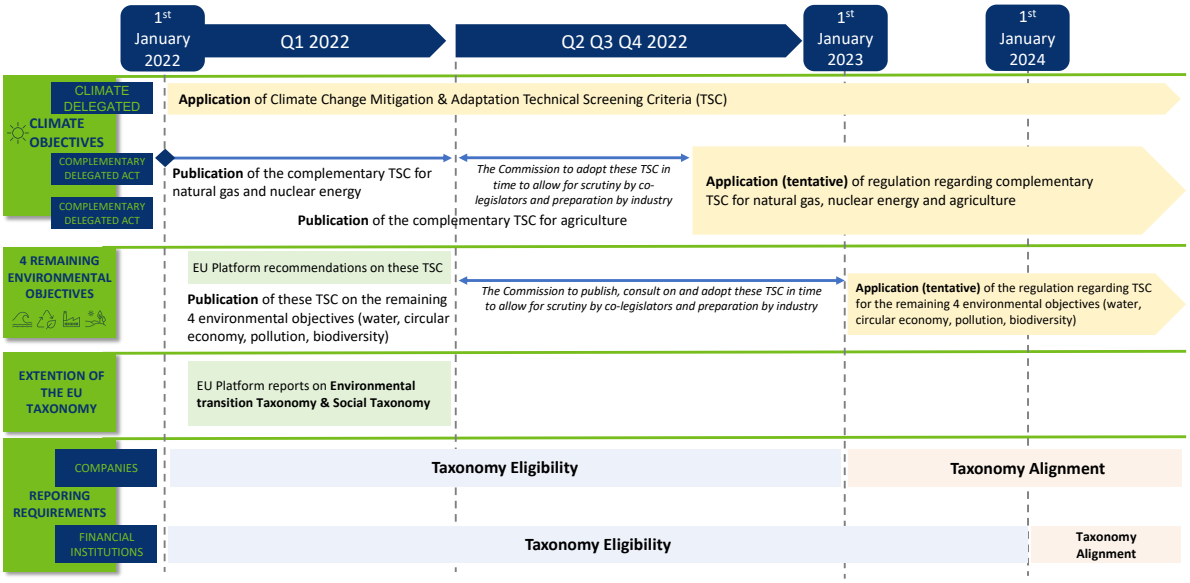



Figure 4.3: Milestones of the EU Taxonomy (January 2022).

Source: Eurosif.

However, under the EU Taxonomy even the so-called small and medium-sized enterprises (SMEs) can be impacted (indirectly), not only big corporation. In fact, for example, banks are asked to disclose some KPIs, such as the Green Asset Ratio (GAR), for the loan portfolio. The GAR is a key performance indicator under the Taxonomy Regulation that shows the proportion of exposures related to Taxonomy-aligned activities compared to the total assets of those credit institutions. The GAR should relate to the credit institutions' main lending and investment business, including loans, advances and debt securities, and to their equity holdings to reflect the extent to which those institutions finance Taxonomy-aligned activities.

The loan portfolio of a bank obviously includes also loans to SMEs, and banks need to gather the required information from them. Thus, if there are corporates that are not

obliged to disclose information under the Taxonomy Regulation, the bank and the corporates have to agree on bilateral agreements to exchange information, so that the bank is able to calculate that Green Asset Ratio as required.

In addition to the various entities for which the EU Taxonomy Regulation sets mandatory requirements on disclosure, there are many possible voluntary uses of the EU Taxonomy by market participants, which are not defined in policy instruments. For example, companies can use the criteria of the EU Taxonomy as an input to their environmental and sustainability transition strategies and plans. Companies and project promoters can choose to meet the criteria of the EU Taxonomy with the aim of attracting investors interested in green opportunities. Investors can choose to use the EU Taxonomy criteria in their due diligence for screening and identifying sustainable investment opportunities aiming to achieve a positive environmental impact.
In fact, companies can achieve multiple benefits by having Taxonomy-aligned activities:

- *Companies* that are subject to the Corporate Sustainability Reporting Directive (CSRD) must inform the financial markets if their operations are Taxonomy-aligned or not. Investors will have access to this information and can use it to inform their decisions. Companies engaged in Taxonomy-aligned activities will profit from institutional investors, individual investors, and banks interested in green investments as they seek to finance Taxonomy-aligned economic activities;
- *Investors* who are looking to have a positive impact on the environment will be attracted to Taxonomy-aligned economic activities because they will be confident that the given activity meets the established gold standard (i.e., has high environmental performance and significantly contributes);
- *Institutional investors* may include funding for some Taxonomy-aligned activities in the design of their financial products. In order to comply with the SFDR's mandatory disclosure requirements, those who fall under its scope must also disclose the extent, if any, of any underlying Taxonomy-aligned investments in the financial products they provide;
- *Large banks* may also be motivated to support Taxonomy-aligned economic activities by, for instance, lending. This means that a business seeking a bank loan might be able to negotiate a lower interest rate if the loan's goal is to fund or achieve Taxonomy alignment for a specific activity;
- *Retail investors* are increasingly interested in green financial products. The forthcoming changes to the standards for portfolio management and investment advice

require that those offering investment services take the client's sustainability preferences as well as risk tolerance into account. In order to be presented with financial products that suit their preferences, this creates a channel for retail investors to express their preference for investing in financial products that have a positive environmental impact or to steer clear of those that do not. Companies with Taxonomy-aligned activities have better opportunities to reach retail investors when financial advice is given while taking into account the sustainability preferences of retail investors.

All companies and organizations that are in some way connected to the EU Taxonomy will be increasingly influenced, from a strategic point of view, by a shift or change in the business model and strategies. Foremost, it is important to underline that the Taxonomy does not prevent financial market participants to finance or invest in activities that are not eligible to the Taxonomy; also, not all economic activities that might contribute to mitigate climate change or support transition are covered today by the Regulation.
However, the Taxonomy, in combination with the Non-Financial Reporting Directive (NFRD) and the Sustainable Finance Disclosure Regulation (SFRD), will lead to a massive shift into more sustainable within the next decade. Besides large institutional investors such as Allianz, BlackRock and so on, many big players have already announced to shift their capital into green assets or companies that substantially contribute to the net-zero economy within the next 20 to 30 years. Moreover, at least for European companies and non-EU companies that want to invest in Europe, the EU Taxonomy will be a guiding principle to label economic activities and investments as green or sustainable. Maybe, the EU Taxonomy will be aligned to other taxonomies from other economic regions or into global taxonomies, but the guiding principles behind will remain the same. Regardless, if this perspective will lead to a shift in a company's business, it will lead to a shift in thinking and controlling activities. Companies need to be able to differentiate and economically control their businesses along the economic activities in the Taxonomy. It is important that controllers, treasurer, and accountants understand the Taxonomy, the technical criteria, and so on, otherwise they will not be able to manage stakeholder dialogue with investors in the future. Moreover, being Taxonomy-aligned, or at least being supportive to the environmental transition, will be a matter of reputation. That is not only because of climate change or other environmental objectives, but also because of the social safeguards and with that because of the environmental and social responsibility of a company. Thus, we can infer that the Taxonomy and the accompanying regulations will lead to a change in strategy and business model. To put it in a simpler way, companies that do not change their business model towards a model that contributes with its

activities to the environmental objectives, or at least enable others to do so, will most probably not stay relevant in the market.

### 4.2.3. EU Taxonomy: further developments

As we saw in previous sections, the EU Taxonomy defines which economic activities are environmentally sustainable. However, the European Commission made very clear that the Taxonomy is not fixed, but it will evolve over time. This stems from the fact that in the future there will be technical improvements, the environmental objectives may change and other activities that today are not covered by the Regulation will be added (thus adding new technical screening criteria). To review the criteria, the Commission has set up the so-called Platform on Sustainable Finance.

#### The Platform on Sustainable Finance

The Platform on Sustainable Finance is a permanent expert group of the European Commission that has been established under Article 20 of the Taxonomy Regulation, will assist the Commission in developing its sustainable finance policies, notably the further development of the EU Taxonomy. The Platform consists of world-leading sustainability and industry experts representing a wide range of stakeholders, including financial market participants, industry, civil society and academia. According to the Taxonomy Regulation, the Commission has to consult the Platform on Sustainable Finance, before adopting the Delegated Act on technical screening criteria. The Platform is crucial in the development of the technical screening criteria because it gives the Commission essential technical and scientific input and enables thoughtful debate among experts that takes into account the opinions of all relevant stakeholders. The Platform is giving the Commission advice regarding the technical screening standards and any potential updates that may be required. Additionally, the Platform is advising the Commission on the technical screening criteria's applicability and evaluating their impact in terms of the potential benefits and costs of their use. As was already mentioned, the Platform will help the Commission analyse stakeholder requests for the development or revision of technical screening criteria for a specific economic activity. Moreover, the Platform advises the Commission on the review of the Taxonomy Regulation and on covering other sustainability objectives, including social objectives and activities that significantly harm the environment.
In addition to providing advice to the Commission on the development of the technical screening criteria, the Platform is also to advise the Commission on:

i. the further development of the EU Taxonomy framework;

ii. the monitoring of capital flows towards sustainable finance;

iii. sustainable finance policy development.

The Platform has, in principle, an unlimited duration, taking into account the different tasks provided for in the Taxonomy Regulation and the need to amend the technical screening criteria of the EU taxonomy over time, in order to reflect, for instance, changing EU environmental legislation or technological developments. It functions via a plenary with the full complement of 57 members and 11 observers, assisted by subgroups where the technical work on its opinions, reports, or recommendations is carried out. The plenary is a venue for ensuring that appropriate connections are made between the pertinent subgroups and for formally endorsing recommendations and reports from the Platform. The Platform is chaired by a Chairperson, Mr Nathan Fabian, Chief Responsible Investment Officer, from Principles for Responsible Investment (PRI). For an overview of the organizational set-up of the Platform, look at Figure 4.4.

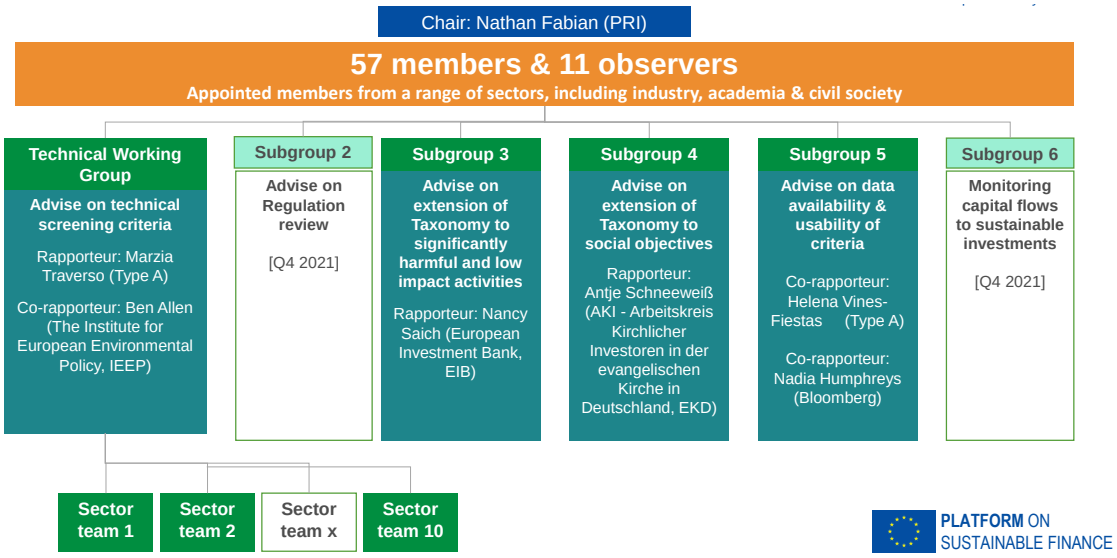



Figure 4.4: Platform structure (last update: 6 May 2021).

Source: European Commission.

As we said, in total, the Platform can draw on the expertise of 57 members and 11 observers:

- 50 members selected from more than 500 highly-qualified applications after a public call for applications on the basis of their environmental, sustainable finance and, where relevant, social/human rights expertise, also aiming at a geographical, gender, cross-sectoral, type of organization and other balance in the Platform's membership;
- 7 representatives, defined in Article 20, from:

  - the European Environment Agency;
  - the three European Supervisory Agencies;
  - the European Investment Bank;
  - the European Investment Fund;
  - the European Union Agency for Fundamental Rights.
- 11 invited observers.

The 50 selected members of the Platform have a mandate limited to two years. After the two years, the Commission will have the possibility to extend the mandate or to appoint new members.

As far as we have been able to understand so far, the EU Taxonomy nowadays covers only environmental objectives, but in the near future a Social Taxonomy will be introduced. Indeed, on February 28, 2022, the Platform presented its final report on the Social Taxonomy, a document that will now be evaluated by the EU Commission. The proposed regulation will be crucial in helping the financial sector to make investment decisions, not only looking at environmental, but also at social values.

In conclusion, we can say that the EU Taxonomy represents and will continue to represent a turning point in sustainable finance. This, in fact, can be used as a tool for many purposes, such as assess whether financial products offered by financial market participants, like asset managers, pension funds, life insurers, are linked to sustainable investment. Going forward, the Taxonomy will also be used in prudential capital requirements for banks. In fact, the assets related to environmental objectives will get a lower risk rate. Furthermore, the Taxonomy can also be used by companies willing to progress on their sustainable journey. Indeed, it is a valuable tool to set strategic targets to shift towards sustainable activities and track the progress. Also, the Taxonomy can be used and most probably will be used by the EU itself and national states as screening criteria for public procurement public aid and recovery plans. In addition, it is very likely that in future, banks will use Taxonomy or technical selection criteria when deciding whether to grant a loan or on what terms to grant it. Finally, it can be used or will be used by risk managers to assess the transition risk of a financial services firm's portfolio.
As a consequence of the above, it can happen that in the future, companies that have their house in order from a sustainability point of view can have higher valuations than those that have not started the transition. For instance, a company that has not started

the transition yet is characterized by a huge transition risk, and, therefore, investors will tend to avoid it. Thus, there can be risk-based reason for why that company would have a lower valuation than another similar company that has already made investments towards sustainability. Then, on the other hand, there is also regulation that is driving investments, because it is making consumers aware giving them the information to choose investment products they want to choose from a sustainability point of view.
This will certainly also impact the financial market, since, specially for those activities that are fully Taxonomy-aligned, a lot of money is going to run after those stocks and bonds, therefore making them more expensive.

It is also important to mention that the EU Taxonomy will have an impact on businesses located outside Europe. Indeed, the EU Taxonomy will impact non-EU companies, given the global nature of financial markets and trade flows. For example, a non EU-investor or financial advisor offering products in Europe is subject to the SFDR, which requires alignment with the EU Taxonomy of investment products. In addition, a non-EU company with EU-based investors will likely be required by these investors to provide information about the company's alignment with the EU Taxonomy.
Non-EU companies that don't want to provide information required by the EU Taxonomy are basically going to make themselves out of scope for investment by European investors, and this will motivate a lot of foreign companies to adopt reporting of this kind. Thus, even if it's only a European legal requirement, it is effectively going to become a global standard because such a big part of the investment industry is in Europe, and it is very hard for companies to rely only on US or Asian investors.

# 5 | Taxonomy Alignment Analysis (Mitigation)

As we saw in the previous chapter, the alignment calculation process is a key step for companies and institutions to assess their level of alignment with the EU Taxonomy. This step is crucial in view of the future since, as we have already seen, as of 1st January 2023 for the reporting period 2022, the Delegated Act will apply fully to non-financial undertakings and as 1st January 2024 for the reporting period 2023 to financial undertakings. This means that, starting from the next year, companies are required to disclose *full* reporting, concerning the publication of the proportion of the three indicators (turnover, CapEx and OpEx) that are associated with economic activities aligned and non-aligned with the European Taxonomy. This same process, however, will be required of financial institutions from 2024 onwards.
These requirements will increasingly lead companies and financial institutions to undertake investments in line with green and sustainable goals, in order to get as close as possible to the European aim of climate-neutral by 2050.

This chapter will be entirely dedicated to this type of analysis, and aims to analyse the alignment to the European Taxonomy of a GSS+ bonds dataset. The objective is to investigate how many of these bonds are already well advanced in terms of compliance with the Regulation. In addition, this type of analysis allows us to determine the most virtuous geographical regions and issuer types in terms of Taxonomy-alignement.
To achieve this, the chapter is divided into three parts. In the first part, there will be a presentation and a review of the database used for the analysis. Next, the methodology of data collection will be discussed. Lastly, the third part will be devoted to the actual analysis with the presentation of the final results. In fact, the application methodology will be explained in detail in order to fully understand how the results were derived from the source data.

## 5.1. Dataset composition

The database used to perform the analysis reported in this chapter was developed in collaboration with by MainStreet Partners. Founded in 2008 and based in London, MainStreet Partners (MSP) provides access to companies and investment funds that combine consistent financial returns with environmental and social well-being. MSP is an ESG partner to asset managers, private and investment banks, insurance companies and institutional investors to whom it provides a platform for portfolio-level sustainability needs. It consists of an Investment Advisory division dedicated to tailor-made investment solutions (multi-asset and multi-manager ESG portfolios with mutual funds, equities and bonds using traditional or absolute return benchmarks), developing products aligned to the United Nations' SDGs and thematic investments. Furthermore, it has a Portfolio Analytics division with a holistic approach to ESG analysis for evaluating funds with quantitative models, measuring extra-financial results in line with green regulations and improving ESG profile.

The starting dataset used to perform the analysis consisted of 462 bonds. For each of them, the following basic information were already included into the dataset:

- ISIN Code of the bond;
- Issuer's name;
- Bond's label (i.e., Green Bond, Social Bond, Sustainability Bond, ...);
- Issue Date;
- Maturity Date;
- Currency;
- Amount issued.

For the purpose of this dissertation, other features of the analysed bonds were added, such as:

- Issuer's type (Corporate, Supranational, Government, Municipality);
- Issuer's region (Europe, North America, ...);
- Issuer's country.

The initial dataset is mainly composed by Green Bonds (Figure 5.1). Indeed, among the 462 bonds, 365 (79%) were classified as Green, while 91 (19.7%) were Sustainability Bonds. The remaining 1.3% is represented by six other bonds, in particular Transition Bonds (5) and Thematic Bond (1).

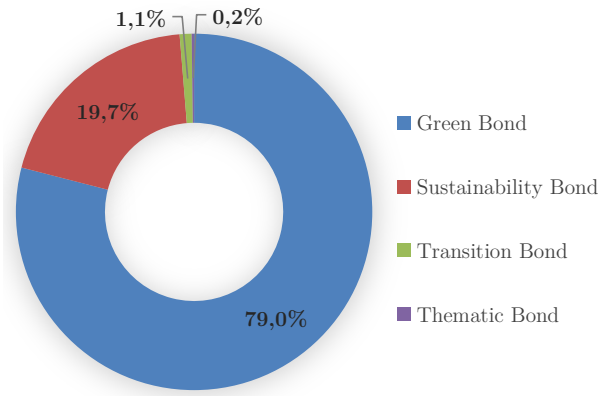



Figure 5.1: Composition of the starting dataset.

*Transition bonds* are a new class of bonds, the proceeds of which are used to fund a firm's transition towards a reduced environmental impact or to reduce its carbon emissions. The proceeds can be used exclusively to finance new and/or existing eligible transition projects. These bonds require the issuer to commit to shifting to more sustainable business practices. While neither the project nor the issuer are required to be "green", the proceeds from these bonds must be used for activities that support the climate transition. For instance, a coal mining company might issue a transition bond to finance for carbon capture and storage initiatives. Transition bond advocates say that it is preferable for businesses looking to go "greener" to finance their assets using transition bonds, as opposed to being shut out of the Green Bond market and left without a funding alternative for transition projects.
On the other hand, *Thematic bonds* are traditional fixed income instruments which allow investors to finance specific investment themes such as climate change, health, food, education, access to financial services and target specific Sustainable Development Goals (SDGs) through investing. For instance, the only Thematic bond of the dataset was issued by International Finance Facility for Immunisation Co (IFFIM), with the goal to provide Gavi, the Vaccine Alliance, "*flexible funding for its core immunisation programmes and efforts to develop and distribute eventual COVID-19 vaccines to countries around the world, particularly the poorest*".

The latter two types of bonds are outside the scope of this analysis. In fact, it is im-

possible to compare Transition bonds to their Green or Sustainable counterparts, as the objectives of these fixed income instruments are completely different. Furthermore, the Thematic bond has the use of proceeds completely dedicated to the healthcare sector, and therefore it is not in scope of the EU Taxonomy with regard to the six environmental objectives. Given these reasons, we decided to remove these six bonds from our analysis, given also the fact that they represent only 1.3% of the entire initial sample.

Therefore, the final database consists of 456 bonds, of which 365 (80%) are Green Bonds and 91 (20%) Sustainability Bonds.

Table 5.1: Summary statistics of the final database

| | |
|---|---|
| **Number of bonds** | 456 |
| **Number of issuers** | 211 |
| **Total amount (€bn)** | 390.48 |
| **Average bond size (€mln)** | 856.32 |
| **Oldest bond** | 13/11/12 |
| **Most recent bond** | 14/09/21 |

As we can see from Table 5.1, these 456 bonds have been issued by 211 individual issuers, over a period of time ranging from November 2012 to September 2021. These bonds account for a total of €390.48 billion[11], with an average bond size of €856.32 million. This large average bond size value is mainly due to the fact that MainStreet Partners, for the purpose of their activities, only covers and screens bonds whose size is generally larger than €200 million. This can also be understood by looking at the distribution of deal-sizes.

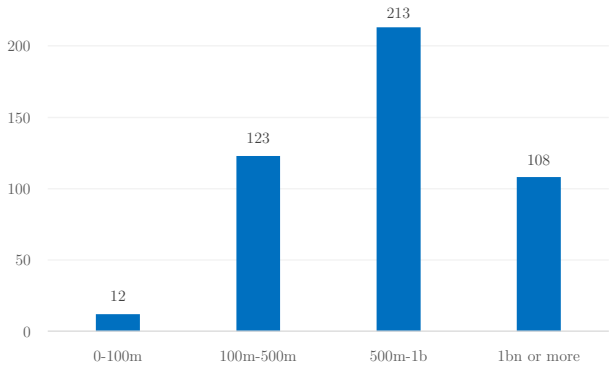



Figure 5.2: Deal-size distribution of the bonds in the dataset (€).

[11]The amounts of various currencies are converted in Euros with the appropriate conversion rate updated to 30/09/2021.

In fact, as can be seen from Figure 5.2, the majority of emissions (46.7%) are in the 500 million-1 billion range. Next, the second most "populous" category is the 100m-500m range, representing the 27% of the sample, while the last place on the podium is represented by issuances reaching (or exceeding) €1 billion. Finally, only 2.6% of the emissions in the database are below €100 million.

As mentioned above and as illustrated in Table 5.2, Sustainability Bonds represent a minority of the reference sample.

Table 5.2: Summary statistics per instrument's type

| | Amount (€bn) | Number of deals | Number of issuers |
|---|---|---|---|
| **Green Bond** | 313.22 | 365 | 176 |
| **Sustainability Bond** | 77.26 | 91 | 44 |

Out of 456 bonds, just 91 (20%) are represented by Sustainability Bonds, and they account for the 20.6% (€77.26 billion) of the total volume issued. The majority share of the sample (80%) is represented by Green Bonds, which account for the remaining 74.9% of the total volume issued. The amount issued and the number of deals do not differ significantly, indicating that the average deal size for these various bond types is similar. The obvious dominance of Green Bonds over its "peers" is the other key finding that comes from these data. This may be explained given that Green Bonds, despite being a relatively new instrument (the first official Green Bond was only issued in 2007), have evolved over time into a commonplace financial security. On the other hand, Sustainability Bonds are even more recent financial products that have only recently begun to represent sizeable market volumes. This outcome can be seen most clearly from the Figure 5.3, that represents the yearly distribution of the bonds in our dataset.

These findings are consistent with the Green Bond trends analysed in Chapter 3. Our reference sample actually shows the explosive growth of the Green Bond market in recent years. Alternatively, the market for Sustainability Bonds is still in its early life. Indeed, most of the securities of these types reported in the sample were issued starting from 2017. Overall, the reference sample seems to be a reliable indicator of the current market environment, with Green Bonds still dominating the scene but new bond typologies beginning to gain ground.
Another piece of information that can be gleaned from this graph concerns the time period on which this dataset is most focused. In fact, we can notice that the majority of the

bonds in our database have been issued in the time interval 2017-2020. The issuances in those years represent more than 94% of the total issuances in our sample.

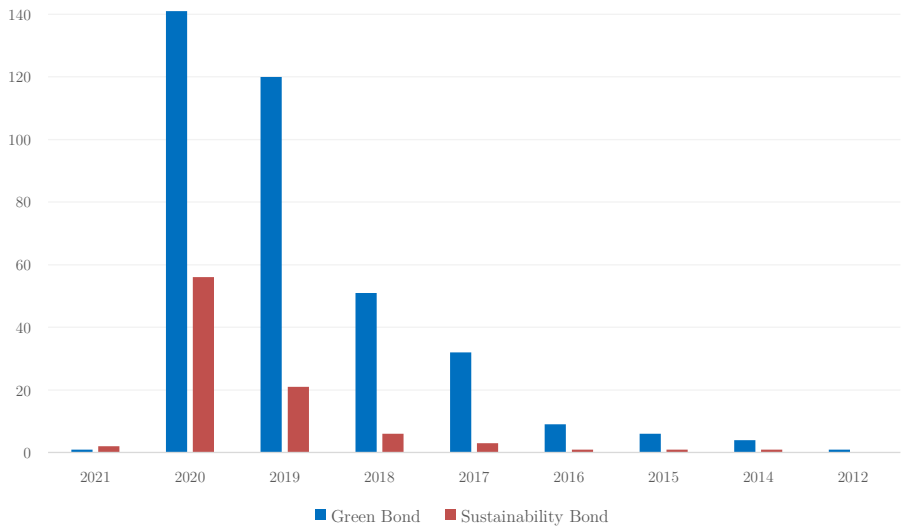



Figure 5.3: Yearly distribution of the bonds' issuances in the dataset.

After providing these introductory descriptions, we also consider it important to analyse the geographical scope of our dataset as well as the different types of issuers that characterize it.
Starting with the first, Figure 5.4 displays the total amount issued for each type of bond across the various geographic regions. Europe clearly dominates the Green Bond issuances, followed by Supranational entities and the North America region. These in fact constitute 91.3% of the total amount issued recorded in our database.

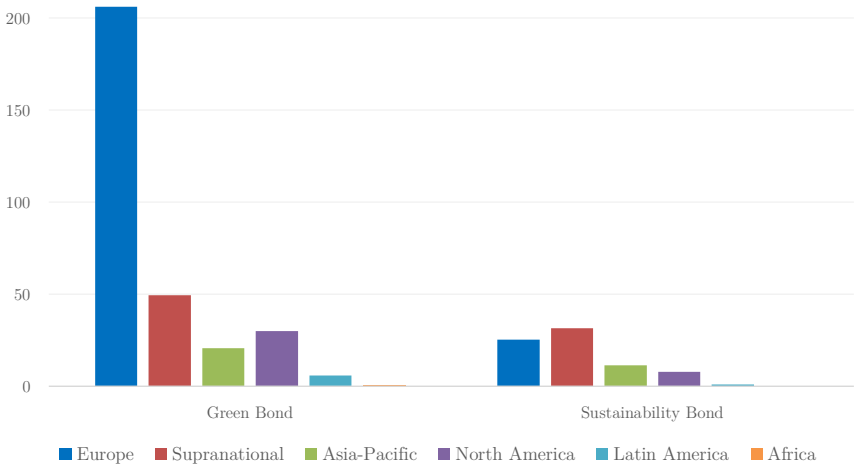



Figure 5.4: Amount issued per geographical region (€bn).

The last three regions (Asia-Pacific, Latin America and Africa) play a marginal role, representing only the 8.7% of the Green Bond issuances.
In terms of Sustainability Bonds, we can observe that Supranational issuances appear to be greater than all others. This can be justified by the fact that Supranational entities are the ones that are increasingly aware to social (and not only environmental) issues, especially with regard to developing countries. This is a fundamental step, which is also confirmed by looking at the results of the Asia-Pacific and North America areas. Indeed, in our dataset, the amounts issued from Asia-Pacific exceed those from North America. This confirms the fact that companies and institutions in undeveloped countries are increasingly involved in social projects, especially concerning health, education and poverty support for the population.
These results are certainly influenced by MainStreet Partners' focus on European countries. However, these outcomes are in line with the results released by the Climate Bonds Initiative, which see Europe as the world leader in the issuance of Green Bonds and the Supranational entities having the lead in the issuance of Sustainability Bonds.

Talking about issuers, Figure 5.5 displays the total amount of issuances per issuer types. Corporates are the most interested in issuing Green Bonds, accounting for 61.7% of the total issuance amount for instruments in this category. In our sample, we then find Governments and Supranational organizations that, however, fall well below the level of issuances of corporations. Municipalities, finally, just represent a marginal share.
Turning to Sustainability Bonds, we can see that the European domain fades, ceding primacy, albeit slightly, to the Supranational organizations. This result is in line with what was discussed earlier. Here, third place is occupied by municipal issuances, while the role represented by Governments becomes almost marginal.

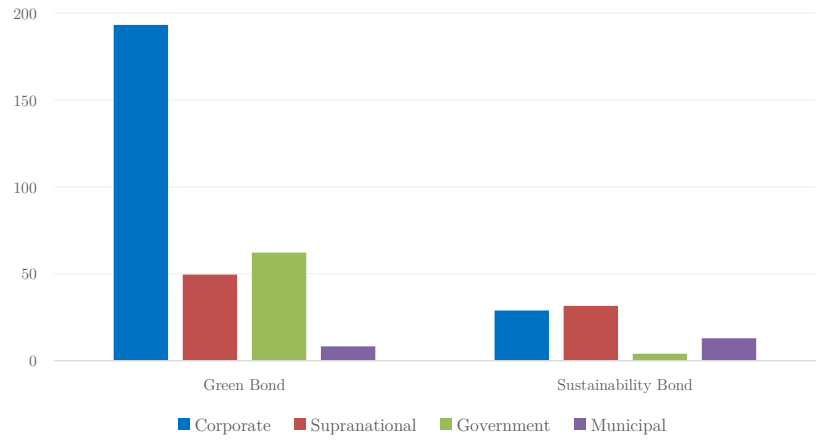



Figure 5.5: Amount issued per issuer's type (€bn).

As before, we would like to emphasize that these are the results of an analysis carried out on our sample of bonds. However, also in this case, the results are confirmed by the latest Climate Bonds Initiative reports, which see corporations dominating the Green Bonds issuance market, while Supranational organizations play a more prominent role towards social and sustainable issues.

Lastly, this brief examination of bond typologies of our dataset comes to a close by examining the typical deal size of these debt instruments. As can be seen from the Figure 5.6, the bond size in our sample is on average above the benchmark value of €500 million. These results are consistent with the outcomes already presented in Figure 5.2. The majority of bonds, both Green and Sustainability, fall within the range 500m-1bn, with percentages of respectively 47.9% and 41.8%. As for Green Bonds, the range 100m-500m account for 28.8%, while the portion of bonds reaching (or exceeding) €1 billion is 22.5%. Very similar results are found for Sustainable Bonds, which have a higher proportion of "1bn or more" bonds (28.6%), while the ones included in the span 100m-500m represent the 27.5% of the total. Smaller bonds account, for both categories, for only a marginal portion of the sample, at 2.7% for Green Bonds and 2.2% for Sustainability Bonds.

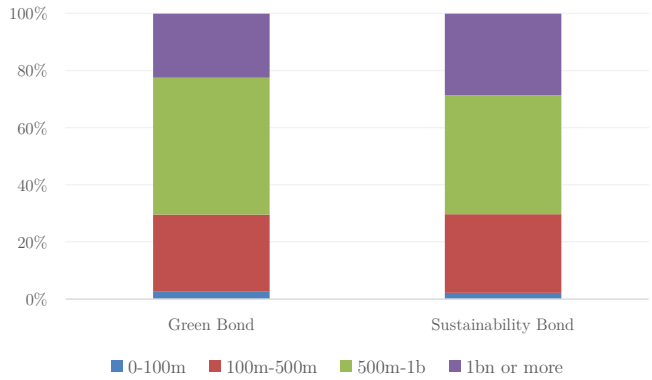



Figure 5.6: Proportion of deal-sizes per bond typology.

After this introductory analysis, which highlighted the characteristics of our dataset, differentiating them according to the type of debt instrument under consideration, we proceed with a deeper analysis of the database, no longer differentiating between Green and Sustainability Bonds.

Starting from a geographical analysis, the map shown in Figure 5.7 represents the most representative nations in our sample in terms of number of issuances. Of course, in this part of the analysis, Supranational issuers are not considered.

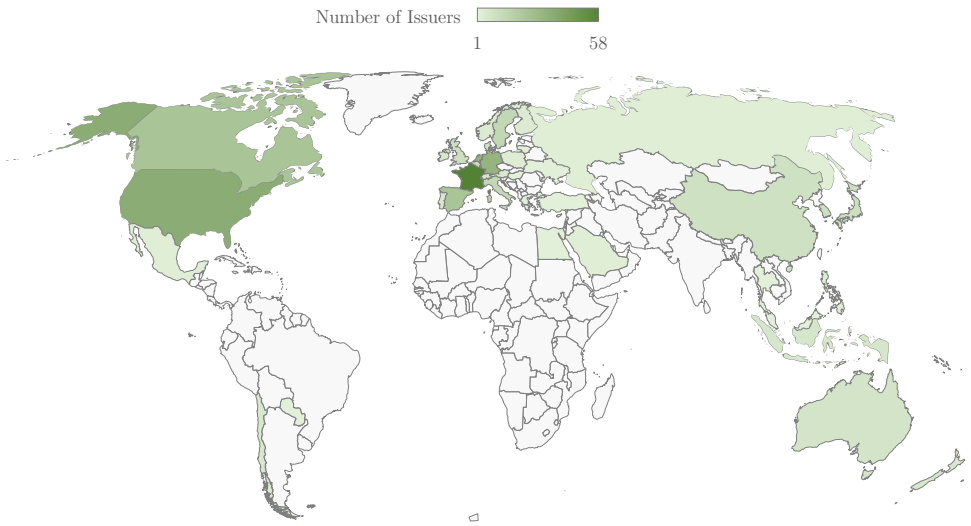



Figure 5.7: Worldwide geographical distribution of bonds'issuances.

The results depicted confirm what has already been seen, namely that most of the issuances come from Europe, North America and Asia. In particular, the largest number of issuances can be found in France (58), in the United States (36), in the Netherlands (33) and in Germany (32). Within this ranking, Italy ranks 7$^{th}$, with 14 issuances. On the Asian continent we find mainly Japan, South Korea and China with 10, 10, and 9 issuances respectively. In the Latin American region, we find a total of 8 issuances from Chile (5), Mexico (2) and Paraguay (1). Finally, we find only one bond from the African continent, issued by the Egyptian government.

These results are more or less confirmed when considering the total amount issued per country, although there are some small differences. As shown in Figure 5.8, France confirms the first place, with a total amount issued of €55.45 billion, followed by Germany (€51.95bn), the Netherlands (€33.83bn) and the United States (€27.03bn). Definitely worth mentioning is the positioning of Belgium (€16.28bn) and Ireland (€9.79bn), which are placed 6$^{th}$ and 8$^{th}$ respectively in this ranking. As these two nations only registered 10 (Belgium) and 5 (Ireland) issuances, it means that the average value of the bonds issued are very high. Italy is in 9$^{th}$ place, with a total amount issued of €9.75bn. Honourable mention also for Chile, whose five bonds reached a total issuance of €5.33bn, thus with an average bond value of over €1 billion.
These results are different from those presented in Chapter 3. Indeed, according to the amount of Green Bonds issued, the United States are the leading issuer globally, followed by China and France, which is ahead of the aforementioned European nations in third place. As a result, the sample used for this analysis overestimates Green Bonds issued

in Europe, while top nations like the United States and China are underrepresented relative to the current state of the market. As previously stated, this may be explained by taking into account MainStreet Partner's geographic focus, as they, being based in London, primarily serve European players, who may be more willing to invest in European instruments.

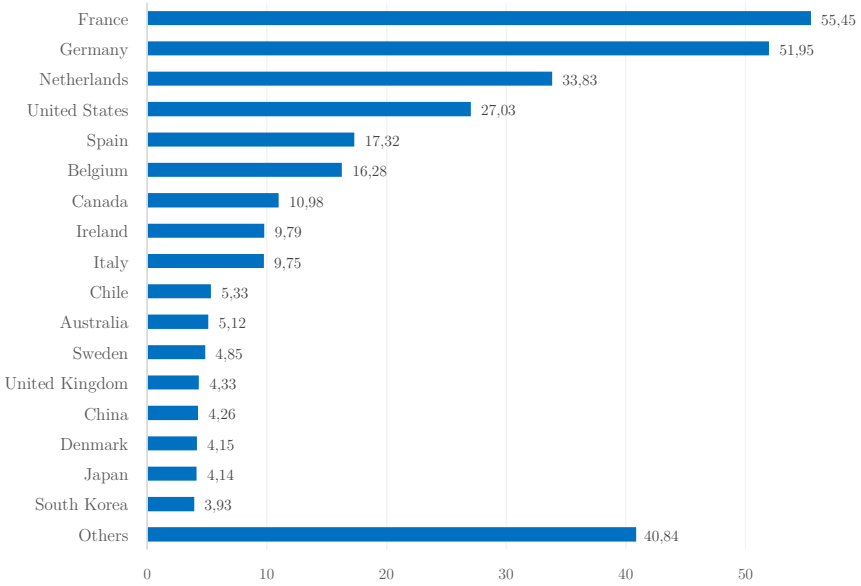
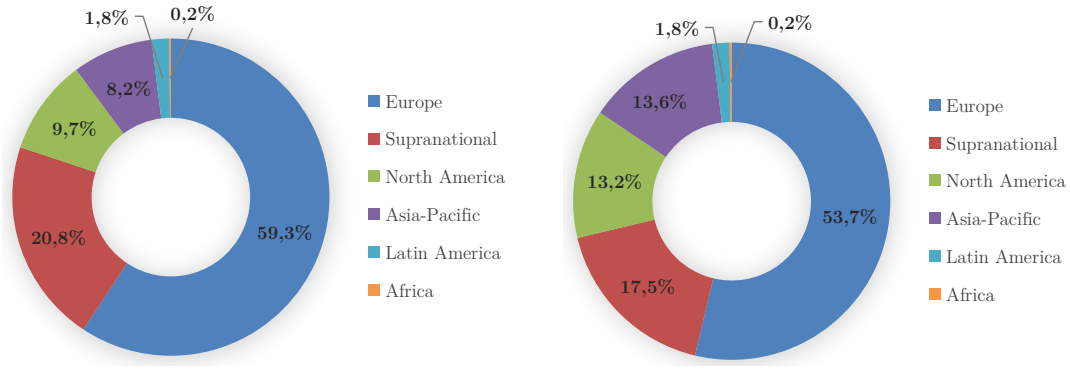



Figure 5.8: Bonds' total amount issued per country (€bn).

The results just described are also confirmed by shifting the discussion to broader terms. Taking a look at Figure 5.9, we can see that Europe is the most represented region, accounting for almost 60% of bond volumes included in the dataset and almost 54% in terms of number of deals. Subsequently, there are Supranational issuances, followed by North America and Asia-Pacific regions.




(a) Amount issued. (b) Number of deals.

Figure 5.9: Regional distribution of the bonds in the dataset.

Here we confirm the marginal role played by Africa and Latin America, which combined account for only 2% of the entire sample, both in terms of amount issued and number of deals. These outcomes provide additional evidence for MainStreet Partners' emphasis on European bonds.

Finally, taking into account the analysis per currency, the outcomes follow from what has been said thus far. Starting with the currencies that are most frequently used for bond issuance, the over-representation of Europe, as previously explained, translates into a clear dominance of the EUR, especially when compared to the USD. Indeed, as shown in Figure 5.10, EUR issuances account for 53.1% of the total, while bonds issued in USD represent only 24.1%.

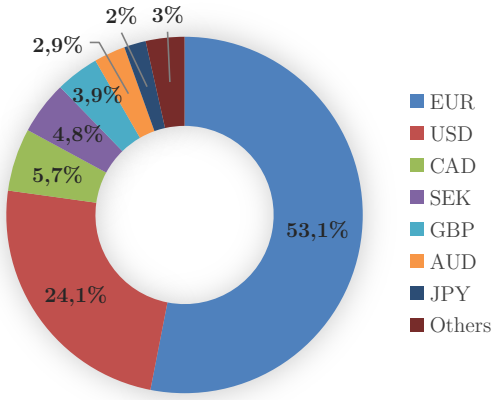



Figure 5.10: Proportion of currencies in the sample per number of deals.

These two top currencies together make up 77.2% of the sample, with the remaining portion being split among other minor currencies, such as the Canadian Dollar (5.7%), the Swedish Krone (4.8%), the British Pound (3.9%), the Australian Dollar (2.9%) and the Japanese Yen (2%). As we already specified in Chapter 3, these currencies are mostly used for domestic issues.

Before concluding this section, it is important to restate that all these considerations apply to the sample of bonds provided within Main Street Partners' database. However, the majority of the findings are consistent with market-wide trends, which confirms the findings shown in Chapter 3 and adds new and valuable insights to them, despite a few pertinent differences that have been highlighted during the discussion.

## 5.2. Data collection

After introducing the statistics and features of our bonds' database, we will now give a brief explanation of how the data were first gathered and then processed. But before doing so, it is necessary to make a few preliminary clarifications.

The alignment analysis against the EU Taxonomy of our bond dataset was carried out, under the direction of MainStreet Partners, only with reference to the first environmental objective, that of *climate change mitigation*. In particular, our work was to individually analyse each bond to verify that the use of proceeds met the Technical Screening Criteria (TSC) for climate change mitigation, as defined by the European Commission[12]. As for the evaluation of the Do Not Significant Harm (DNSH) Principle, this was not in the scope of our analysis. Indeed, this type of information has been momentarily neglected, at the direction of MainStreet Partners, as it requires a totally different analysis process. Finally, the Minimum Social Safeguards were not considered in this analysis either. This was done because the Platform on Sustainable Finance only published the first draft report on Minimum Social Safeguards on the 11$^{th}$ July 2022, while the planned release of the final report is scheduled for September 2022. As a result, these data and criteria were not yet available at the time of the analysis.

The analysis was carried out on the entire dataset of 462 bonds, although the results will only be presented for Green and Sustainable Bonds. Indeed, as was mentioned in the section before, six bonds were disregarded because they belong to groups that were unrelated to the subject of our study. The analysis in question is carried out *per bond* and not *per issuer*. This means that the assessment of alignment against the EU Taxonomy is carried out per issue, and is therefore not referred to the issuer in general terms. Therefore, it is possible that the same issuer may obtain different rating percentages for its Green/Sustainability Bonds, as the outcome depends solely on the fulfilment of the Technical Screening Criteria of the individual assets financed by the individual bonds, which may be different.

The initial step in this process was to consult all available documentation concerning bonds in our sample. This was done by searching the various sections of the different issuers' web pages for the most recent documents in which the bonds issued and their use of proceeds were presented.

[12]More information can be found in Chapter 4.

The types of documents useful to our cause can be categorized into three macro-groups:

- Green/Sustainability Bond Frameworks and Second Party Opinions (SPOs);
- Green/Sustainability Bond Allocation Reports.

A Green/Sustainability Bond Framework is a document created by the issuer that articulates the company's proposed use of proceeds from the bond. The framework should include information on the eligible categories (as per the GBP) under which the projects being financed or re-financed fit. The Framework typically comes with a Second Party Opinion attesting to its compliance with the four components of the Green Bond Principles. The Allocation Report, on the other hand, is a less standardized document that is published, usually annually, by the bond issuer with the aim of presenting all projects financed through its bond issues in previous years.
The major difference between these two documents is that the Framework does not specify how the use of proceeds will be allocated to individual projects. In fact, it is very common for this type of document to present only the types of sustainable projects that will be carried out with the funds from the bond (e.g., the construction of a solar panel plant, the refurbishment of a building, the construction of a railway line, ...). An example is shown in Figure 5.11.

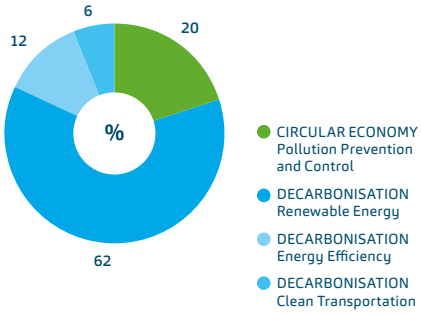
| Green Categories | Definition | Eligibility criteria | UN Sustainable Development Goals |
|---|---|---|---|
| **Renewable Energy** | The financing or refinancing of renewable energy in the EU and UK | • Wind energy<br>• Solar Energy |  |
| **Green Buildings** | The financing or refinancing of energy efficient commercial or residential real estate in the Netherlands | • Buildings with the construction year 2021 or later:<br>Energy performance is at least 10% lower than NZEB[1] requirements<br>• Buildings constructed prior to 2021:<br>The better of<br>1. EPC Label A or higher registered after 1/1/2013 or the construction date after 1/1/2013 (residential real estate only), or<br>2. Top 15% low-carbon residential or commercial buildings in the Netherlands |  |

Figure 5.11: Green Eligible Activities in a Green Bond Framework.

Source: NIBC Green Bond Framework, June 2021.

On the other hand, the Allocation Report often provides more precise information regarding the allocation of funds to individual projects. Indeed, it is common to find tables where the issuer breaks down how proceeds were used (or expresses the percentage value)

for each funded activity separately. An example is displayed in Figure 5.12. Very often in this type of documentation, the allocation of funds of all bonds issued by the issuer is presented, and therefore the identification of the precise bond we are interested in is done via the ISIN code, which uniquely identifies these financial instruments.




| TYPOLOGY OF PROJECT | ALLOCATION (mln €) |
|---|---|
| PV Plants Acquisitions | 156 |
| Bioenergy Plants | 103 |
| WTEs Repowering and Energy Efficiency | 50 |
| Low impact vehicle - waste collection | 27 |
| New Waste to Energy Plant | 70 |
| New Recovery Plants - Plastic | 13 |
| TOTAL ALLOCATION AMOUNT | 419 |

Figure 5.12: Allocation of Proceeds in a Green Bond Allocation Report.

Source: A2A Green Bond Report, July 2020.

Once we have defined the assets financed by the proceeds of a bond, found in the documents explained above, we need to distinguish those that are *eligible* from those that are *non-eligible* according to the environmental objective of the EU Taxonomy we are analysing. The detailed description of these two categories of activities is explained in Chapter 4. In particular, we are analysing the EU Taxonomy alignment related to the first environmental objective (Climate Change Mitigation), thus all funds allocated to activities supporting the other five objectives are to be considered non-eligible, and therefore non-aligned. However, there are other activities that fall into this category. Indeed, as clearly stated, our dataset includes both Green Bonds and Sustainability Bonds. Sustainability Bonds, as described in Chapter 1, are financial instruments that aim to finance projects on both environmental and social issues. The latter category of projects/activities does not fall within the scope of the six environmental objectives of the EU Taxonomy, and are therefore also to be defined as non-eligible. These activities, in fact, mainly relate to social initiatives aimed at helping vulnerable population groups, social housing, healthcare, economic and socially inclusive development, employment generation and so on.

After identifying the assets financed by the bond that are deemed eligible, the next process can be broken down into two different steps:

1. Identification of the alignment percentage of each activity;
2. Identification of the allocation percentage of proceeds for each activity.

### 5.2.1. Identification of the alignment percentage of each activity

In this first step, the objective is to assess the alignment with the EU Taxonomy of all the different activities/projects financed by each individual bond. As we have already specified, the definition of the activities is carried out by researching on the documentation (Frameworks and Allocation Reports) the use of proceeds of the bond under analysis, for each individual issuer.
These activities are defined and codified by the European Commission, and are divided into nine macro-areas:

1. Forestry;
2. Environmental protection and restoration activities;
3. Manufacturing;
4. Energy;
5. Water supply, sewerage, waste management and remediation;
6. Transport;
7. Construction and real estate activities;
8. Information and communication;
9. Professional, scientific and technical activities.

Within each macro-area, then, individual activities are specifically defined. For example, in the Energy (4) area, we find:

4.1. Electricity generation using solar photovoltaic technology;

4.2. Electricity generation using concentrated solar power (CSP) technology;

4.3. Electricity generation from wind power;

...

4.25. Production of heat/cool using waste heat.

As we already know, for each individual activity, the European Commission defines one or more Technical Screening Criteria that must be met in order for the activity to be considered as aligned with the EU Taxonomy. Regarding the environmental objective of Climate Change Mitigation, the criteria were published by the European Commission, on the 6$^{th}$ June 2021, in the Annex 1 of the Delegated Act concerning Taxonomy Regulation. Therefore, through the use of this document, it was possible to evaluate each activity

financed by each individual bond in our dataset, in order to assess whether the Technical Screening Criteria were met. The information required to make this type of assessment is directly disclosed by the issuers of the bonds. Indeed, within the various documentation made available by the issuers themselves, it was possible to carry out this type of analysis.

Based on the available information, the alignment to the EU Taxonomy of each individual activity was calculated using the following formula:

$$Alignement\ (\%) = \frac{\sum_{i=1}^{n} S_i}{2n} \quad \text{, with } S_i = \begin{cases} 0, & \text{if } i\text{-th criteria is not satified} \\ 1, & \text{if } i\text{-th criteria is partially satified} \\ 2, & \text{if } i\text{-th criteria is fully satified} \end{cases} \tag{5.1}$$

In this formula, $S_i$ refers to the "score" (0, 1 or 2) obtained by the activity in relation to the $i$-th Technical Screening Criterion, while $n$ represents the number of criteria defined for that specific activity.

Through this methodology, it was possible to take into account the partial fulfilment of the Technical Screening Criteria by each activity. Indeed, the Taxonomy Regulation at this stage allows a certain degree of flexibility, and so even partial alignment with Taxonomy requirement is acceptable and can be taken into account as a parameter deemed relevant.
Therefore, if an activity completely fulfils all the criteria it is considered to be 100% aligned, whereas if an activity only partially fulfils the criteria it will receive 50% alignment. If, on the other hand, an activity does not meet any of the criteria, it will be considered 0% aligned. In the event that it was not possible to find information regarding the fulfilment of one or more of the Technical Screening Criteria in the documents disclosed by the issuer, it had to be assumed that the criterion(s) was/were not fulfilled, and therefore a "score" of 0 was assigned in these cases.
We should also mention that for some, few, activities the EU Taxonomy does not define any criteria. In fact, according to the Regulation, these activities do not require criteria to be fulfilled as these are always to be considered aligned with the EU Taxonomy. Such activities are for example "*Electricity generation using solar photovoltaic technology*" (4.1.), "*Electricity generation using concentrated solar power (CSP) technology*" (4.2.), and "*Electricity generation from wind power*" (4.3.).
Finally, the activities that are categorized as non-eligible are automatically considered not compliant with the EU Taxonomy, as explained before, and therefore they are assigned an alignment of 0%.

### 5.2.2. Identification of the allocation percentage of proceeds for each activity

After defining the alignment percentage of each individual activity financed by the bond under analysis, the second step entails calculating the proportion of proceeds allocated to each individual activity. As previously illustrated, this information is gathered directly from the disclosures made by the bond's issuers within Frameworks and Reports. However, to date there is not much standardization with regard to this type of disclosure, so there is great heterogeneity in the way companies and institutions describe and present this kind of data. This kind of discordance necessitated a different approach to computing the allocation percentages of each asset based on the information made available by the issuers.

In particular, based on the documentation provided, there are three distinct cases:

1. *Project allocation*: the amount of proceeds (or the relative percentage) allocated to each individual activity financed by the bond under analysis is directly available. This type of information is usually contained in the Allocation Reports. An example is illustrated in Figure 5.12;
2. *Portfolio allocation*: the amount of proceeds (or the relative percentage) allocated to each individual activity related to a bonds' portfolio is available. This type of information is usually contained in the Allocation Reports. An example is illustrated in Figure 5.13;

| ISP GREEN LOAN PORTFOLIO | | | | | ISP GREEN FUNDING | |
|---|---|---|---|---|---|---|
| Eligible categories | # of loans | Signed Amount(€)[5] | Average tenor (years) | % out of Italy[6] | ISIN | Allocated Amount(€) |
| **Renewable Energy** | **885** | **1,965 mln** | **7.4** | **10.5%** | | |
| - Photovoltaic | 730 | 1,543 mln | 7.1 | 8.0% | **XS1636000561** | **500 mln** |
| - Eolic | 52 | 242 mln | 8.3 | 34.1% | | |
| - Hydroelectric | 57 | 122 mln | 9.2 | - | | |
| - Bioenergy | 46 | 57 mln | 6.4 | - | **XS1979446843** | **500 mln** |
| **Energy efficiency** | **34** | **120 mln** | **5.6** | **61.8%** | | |
| **Green Buildings[7]** | **16,701** | **2,625 mln** | **25.9** | **-** | | |
| - EPC label A | 11,302 | 1,919 mln | 25.9 | - | | |
| - EPC label B[8] | 4,036 | 569 mln | 26.2 | - | **XS2317069685** | **1,250 mln** |
| - Building refurbishment | 1,363 | 137 mln | 25.6 | - | | |
| **Circular Economy** | **149** | **1,418 mln** | **3.9** | **32.1%** | **XS2089368596** | **750 mln** |
| | **Total** | **6,128 mln** | | | | **3,000 mln** |

Figure 5.13: Portfolio allocation in a Green Bond Allocation Report.

Source: Intesa Sanpaolo Green Bond Report, December 2021.

3. *No specific allocation*: the amount of proceeds (or the relative percentage) allocated to each individual activity financed by the bond under analysis in not available. This is usually the case when only the Green/Sustainability Bond Framework is available. An example is illustrated in Figure 5.11.

Given these different disclosure methodologies, the operational process had to be modified according to the case we were facing and, in certain cases, assumptions had to be made. This complex process was not devised by the authors of this dissertation, but was developed directly by MainStreet Partners. Indeed, this is the standardized process that the London-based company's analysts actually use to carry out projects and analyses of this type.

With a "project allocation", the process is quite simple and obvious. In this case, in fact, it is possible to directly derive from the documentation the percentage allocation of the proceeds of all activities financed by the bond under analysis. Therefore, for each activity, a percentage of allocation of the bond'funds was associated, in addition to a percentage of alignment to the EU Taxonomy.
It is possible, however, that the use of proceeds of the bond was not fully allocated at the time of the analysis. Indeed, it is possible for a company or institution to issue a Green/Sustainability Bond whose proceeds will be used in part to finance sustainable projects in the future, and therefore the allocation of this portion of funds is not immediately specified. In this specific case, we would end up with a total allocation of bond proceeds below 100% and this would cause errors when compared to other similar instruments. The solution was to disregard the fact that the funds were not fully allocated, and thus calculate the different percentages as if the bond proceeds were assigned in full. Thanks to this simple modification, our dataset has 100% allocation for all bonds, thus allowing us to perform cross-analysis and comparisons.

In case of "portfolio allocation" the procedure is a bit different. As we have said, in this case we have the allocation of proceeds in the different activities for a portfolio of bonds and not per individual bond. In this case, the process involves calculating the allocation percentage (or using the percentage directly if provided) of the bond portfolio and then applying it directly to the activities of our bond under analysis. For example, if 60% of the proceeds of the bond portfolio is allocated to the activity "*Infrastructure enabling low-carbon road transport and public transport*" (6.15.), then the same percentage is applied to the same asset for the bond we are analysing. This assumption was deemed necessary in order to include in our database also the bonds for which only a "portfolio

allocation" was available. This procedure involves errors that are considered acceptable, as the allocation percentage of a bond portfolio gives an idea of the focus the company or institution in question has on one sustainable project rather than another. Indeed, if, for example, 90% of the proceeds of a group of bonds is allocated to wind energy projects, we can imagine that, for a bond of the same issuer financing the same activity, the allocation percentage would be very high, very close to that 90%.

The last scenario involves the case where the issuer only provides the activities/projects it intends to finance with the bond in question, but not in what proportion. Even in this case, it was necessary to make some assumptions, since we have no information regarding the division of proceeds. The simplification in this case is to consider the distribution of the bond's funds as equally divided for each financed activity. For example, if a bond aims to finance four sustainable activities/projects, a 25% portion of the proceeds will be allocated to each of them. This assumption is much stronger than in the previous case, but it is the only option MainStreet Partners has to consider bonds for which an Allocation Report has not yet been published.

Once all the alignment and proceeds allocation percentages have been mapped for each activity financed by the bond under analysis, the final step involves calculating the final percentage alignment of the bond to the EU Taxonomy. Specifically, the final alignment value is obtained by performing a weighted average of the alignment percentages of each activity, where the weights are represented by the proceeds' allocation percentages. Obviously, in this latter process, the allocation of proceeds to non-eligible activities/projects is also taken into account, which, as we have already mentioned, will achieve a 0% alignment.

This procedure was carried out for all 462 bonds present in the initial dataset, and the results obtained will be presented in the following section.

## 5.3. Results of the Alignment Analysis

As we have already specified previously, the alignment analysis was carried out on all 462 bonds that make up our initial dataset. However, the presence of financial instruments with very different purposes to Green and Sustainability Bonds, such as Transitional and Thematic Bonds, prompted us to remove them from the presentation of results, in order to maintain consistency of outcomes. Therefore, the data presented below only refer to Green and Sustainable instruments, represented by 456 bonds in the initial database.

The general results of the alignment analysis are presented in Figure 5.14. As we can see, the percentage of alignment assigned the most was 100%, with 91 bonds out of 456, thus representing 20.0% of the sample. The second most "populous" category is that of bonds in the 40-60% range, comprising 79 bonds that make up 17.3% of the total. Next we find the range 0-20% with 73 bonds (16.0%), the range 80-100% with 69 bonds (15.1%) and the range 20-40% with 63 bonds (13.8%). Finally, we find 48 bonds (10.5%) that achieved 0% alignment to the EU Taxonomy and only 33 bonds (7.2%) that fell within the 60-80% range. Overall, the average percentage of alignment to the EU Taxonomy of our dataset is 52.9%.

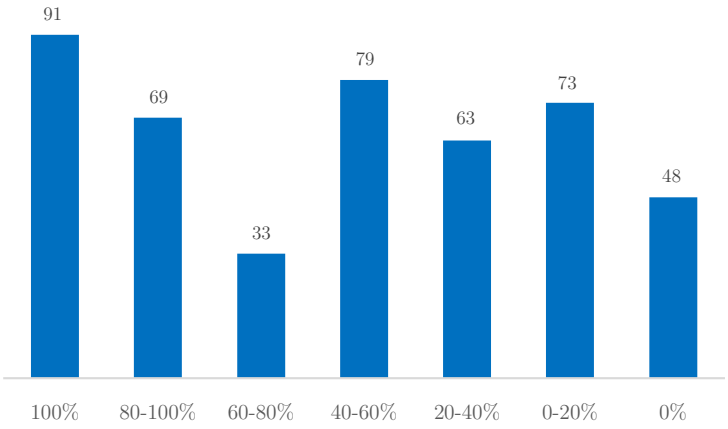



Figure 5.14: Number of bonds per alignment percentage obtained.

In this type of analysis, we wanted to emphasize the presence of bonds that achieved 0% and 100% alignment percentages. This is because these instruments represent the extreme cases, namely bonds that are totally not compliant with the EU Taxonomy and bonds that are perfectly in line with the Regulation.

These findings point to a less than ideal situation. In fact, as many as 57.7% of the bonds achieved an alignment below 60%, while only the remaining 42.3% exceeded this threshold. This highlights a not extremely positive situation, which may be primarily attributed to some businesses' or institutions' lack of readiness to make investments in light of the standards set by the European Commission. However, it must be emphasized once more that many of the bonds in our dataset are from outside the EU, so it is to be expected that some of the companies and/or institutions that issue these bonds do not currently adhere to the standards and guidelines established by the European Taxonomy. The analysis of these bonds is crucial, though, as many European investors will become more and more interested in making investments, including foreign ones, that are compli-

ant with the EU Taxonomy, as was already mentioned in Chapter 4.

After providing a general description of the results, we will now move on to a more in-depth analysis, taking into account multiple factors that differentiate the debt instruments that compose our dataset.
To do this, we start by highlighting how the outcomes vary when Green and Sustainability Bonds are taken into account separately. As can be seen in Figure 5.15, the Green Bonds achieved an average alignment of 61.8%, which being a mean value can be considered very high. Conversely, Sustainability Bonds generally achieved a very low alignment, with an average of 17.4%. Therefore, we can assert that the average alignment of the dataset (52.9%) is strongly influenced by the poor performance of the Sustainability Bonds. The latter, in fact, did not record alignment rates above 80%, with most of them (86.8%) not exceeding the 40% alignment threshold. This is primarily due to the fact that Sustainability Bonds fund social responsible projects in addition to environmentally sustainable ones. These projects, as outlined in the previous sections, do not fall within the scope of the EU Taxonomy and are therefore to be considered non-eligible (and consequently non-aligned).

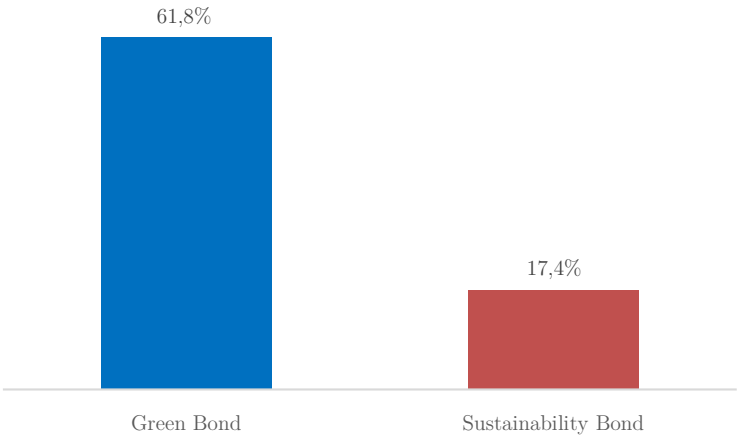



Figure 5.15: Average Taxonomy alignment per bond label.

This disparity between Green and Sustainable Bonds can also be seen by comparing the number of instruments that are fully aligned with the EU Taxonomy with the number of instruments that are not compliant with it. As shown in Figure 5.16, all 91 bonds that are fully aligned to the EU Taxonomy have a Green label, while no Sustainability Bond achieved this result. This group of Green Bonds accounts for a sizable portion of the total, namely almost a quarter (24.9%). Regarding the bonds that were found to be completely out of line with the European Taxonomy, we can see that there are 24 Green

Bonds and 24 Sustainability Bonds. However, since Green Bonds make up the majority of our dataset (80%), this result occurs in two totally different proportions. In fact, the Green Bonds with a 0% alignment are only 6.6% of the total, while the 24 Sustainable Bonds completely non-aligned account for 26.4% of the total. Clearly, these results are a symptom of what has already been described above, since in many cases, Sustainable Bonds only provided financing to projects with a social purpose, and these are therefore to be considered non-eligible.

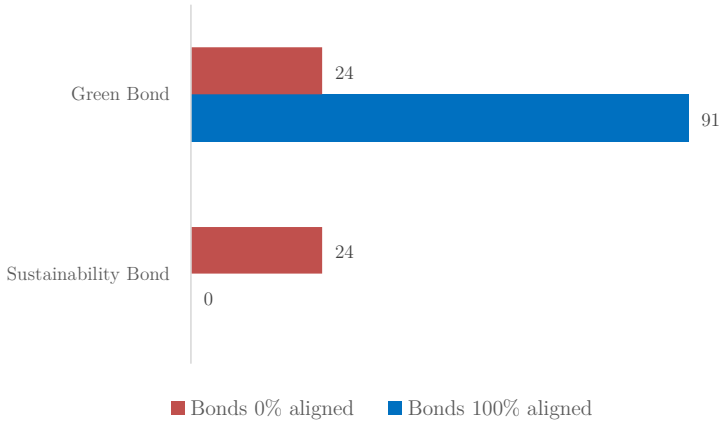



Figure 5.16: Number of instruments 0% and 100% aligned per bond label.

After analysing the differences between differently labelled bonds, it is also important to carry out a geographical analysis. The objective here is to determine whether there are any relevant alignment results or trends that vary from region to region.
As displayed in Figure 5.17, Europe dominates in terms of alignment of Green Bonds to the EU Taxonomy, with an average alignment value of 67.2%. Rounding out the podium in this ranking is the Asia-Pacific region, with an average alignment very similar to Europe (64.4%), and the North America region, with an average alignment of 54.7%. The last positions are composed by Supranational issuances, the Africa region and the Latin America region, with average Green Bonds alignment values of 49.2%, 46.0% and 41.6% respectively. The outcome for Europe could have been predictable, as we have repeatedly mentioned the significant role this region represents in terms of the Green Bond market, adding the fact that the EU Taxonomy is mainly aimed at Eurozone issues. However, the Asia-Pacific issuances also performed very well, pulling almost 10 percentage points away from the North America region, which, to date, is certainly more relevant in the global context and is the most favoured in terms of foreign investment by European investors.

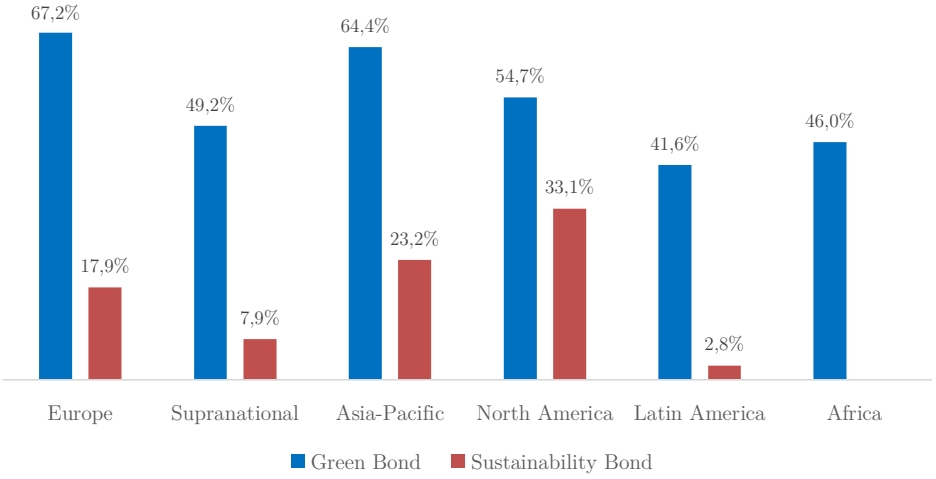



Figure 5.17: Average Taxonomy alignment per geographical region.

In terms of Sustainability Bonds, we can observe alignment values that are noticeably lower than the levels attained by Green Bonds, and this is consistent with what was stated in the preceding paragraph. North America recorded the highest average alignment value (33.1%), followed by Asia-Pacific (23.2%) and Europe (17.9%). The lowest values, instead, were obtained from the Supranational issuances (7.9%) and the Latin American region (2.8%), while there are no Sustainability Bonds issued in Africa in our dataset. This result could denote how there is a tendency in regions such as North America and Asia-Pacific for many Sustainability Bonds funds to focus on activities with environmental sustainability goals. Conversely, Sustainability Bonds issued in regions such as Latin America or Supranational issuances may be more focused on social projects and initiatives.

After analysing the bonds' results from the various regions, we can now examine the various countries to delve even further into the geographical study. To do this, we not only divided the categories of Green and Sustainability Bonds, but also considered only some of the available countries. In fact, for both bond labels, we will only present the top 12 countries in terms of number of bonds issued in our dataset. This is because we tried to calculate the average alignment where more data were available, in order to obtain the most consistent results possible.
In regard to Green Bonds, the results are shown in Figure 5.18. The country with the highest value of Taxonomy alignment is Denmark (88.4%), with more than 15 percentage points ahead of Italy (73.1%), which is in second place, and the Netherlands (72.7%), which placed third. In Asia, the best results are achieved by China (68.4%), Indonesia (59.3%) and Japan (49.3%), while on the American continent we find Canada and the

United States, with 57.3% and 52.8% respectively.

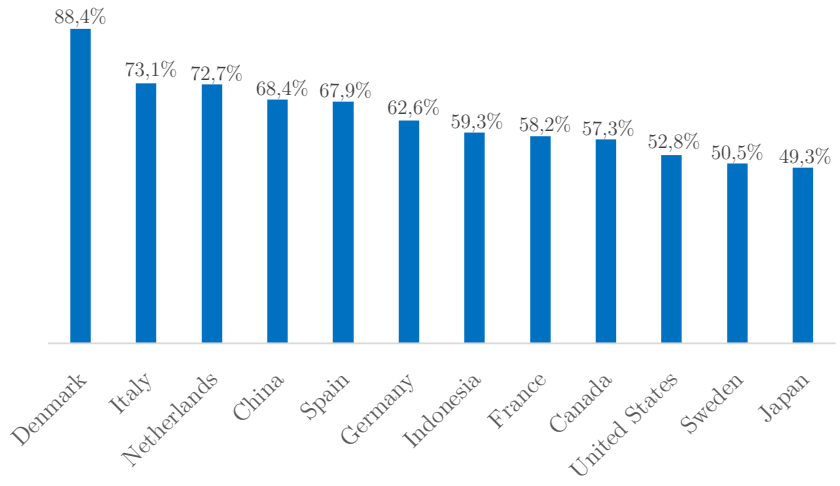



Figure 5.18: Green Bonds: average Taxonomy alignment per country.

Regarding Sustainability Bonds, instead, the results shown in Figure 5.19 show that the Netherlands had the highest percentage (33%), followed by Canada (34.0%), the United States (32.8%), South Korea (28.1%), Japan (27.3%) and France (23.8%). At the bottom of this classification there are Germany and New Zealand which achieved the lowest alignment percentages (0.2% and 0% respectively), despite being among the 12 countries with the most Sustainability Bonds issued in our sample. This means that the sustainable debt emissions of these two nations were directed entirely towards activities in social spheres, and therefore non-eligible under the EU Taxonomy.

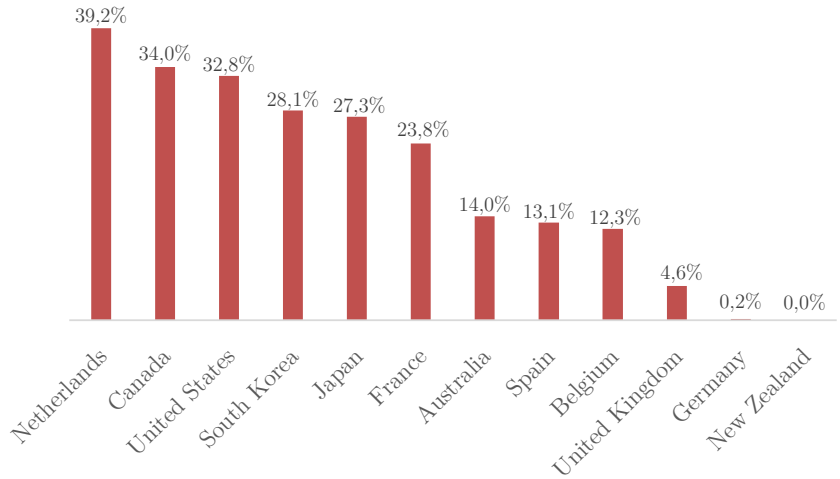



Figure 5.19: Sustainability Bonds: average Taxonomy alignment per country.

After discussing the findings of our analysis from a geographical standpoint, it's crucial to take into account the nature of the bond issuers. Figure 5.20 shows the average value of alignment to the EU Taxonomy, differentiated by issuer type. As can be seen, for Green Bonds, corporates emissions recorded the highest average alignment, reaching 65.4%. This was related to the fact that many corporate-issued bonds had a 100% alignment. In fact, 88 Green Bonds (the total number of 100% aligned bonds in the dataset is 91) issued by this type of entities recorded the highest alignment score to the European Taxonomy, representing 27.5% of the instruments in this category. Green Bonds issued by corporates that achieved a 0% alignment to the Taxonomy, on the other hand, represent only 6.9% of the total. Still considering green emissions, next we find Governments with an average alignment of 43.3%. Finally, with very similar values, we find Supranational institutions and Municipalities with average values of 37.3% and 37.0% respectively.
Turning instead to Sustainability Bonds, we can see that the best result was achieved by government issues, with an average EU Taxonomy alignment of 48.1%, which is very good considering the debt instrument in question. However, the other types of issuers achieved very low values, but we can say that the results were predictable. Corporate-issued Sustainability Bonds achieved an average alignment of 20.8%, while Municipalities achieved 14.4%. The Supranational institutions performed the worst (7.9%), which was also a result of the fact that up to 15% of these instruments achieved a 0% alignment.

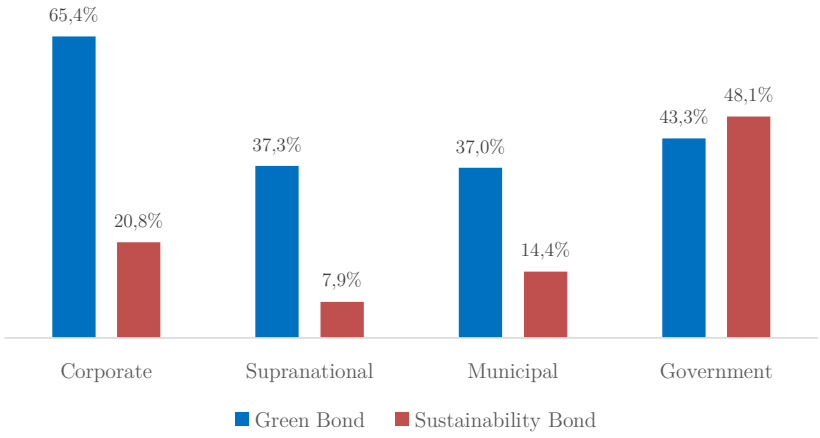



Figure 5.20: Average Taxonomy alignment per type of issuer.

Another interesting discussion can be made by considering the currencies in which the Green and Sustainability Bonds in our database are issued. In particular, Figure 5.21 shows the results of the alignment analysis considering the seven most relevant currencies, in terms of number of issuances, in the sample. In these terms, the two top-performing currencies, EUR and GBP, coincide also with the two most relevant and important cur-

rencies within the Eurozone, and Green Bonds issued in these currencies achieved average alignments of 67.4% and 60.7% respectively. This is also due to the fact that as many as 24.0% of the Green Bonds issued in Euro achieved a 100% alignment, while the same alignment value was attained by 22.2% of the Green Bonds issued in GB pounds. Other currencies, such as US Dollar, Canadian Dollar, Swedish Krona and Australian Dollar, achieved more or less acceptable results, with values ranging from 51.0% to 57.9%. Among the top currencies, the Japanese Yen had the worst performance, since Green Bonds issued in this currency obtained a very low average alignment (36.8%).
When Sustainability Bonds are taken into account, the outcomes significantly change. Indeed, two domestic currencies, SEK and JPY, had the best performances (34.1% and 25.0% respectively). In this case, debt instruments issued in EUR had an average alignment of only 19.3%. The worst performers were issues in Canadian Dollars (2.0%), British Pounds (3.0%) and Australian Dollars (3.5%). This is due to the fact that many of these bonds were completely misaligned with the European Taxonomy. In particular, the worst case is that of sterling, for which as many as 27.8% of sustainability issues were rated 0% in terms of alignment.

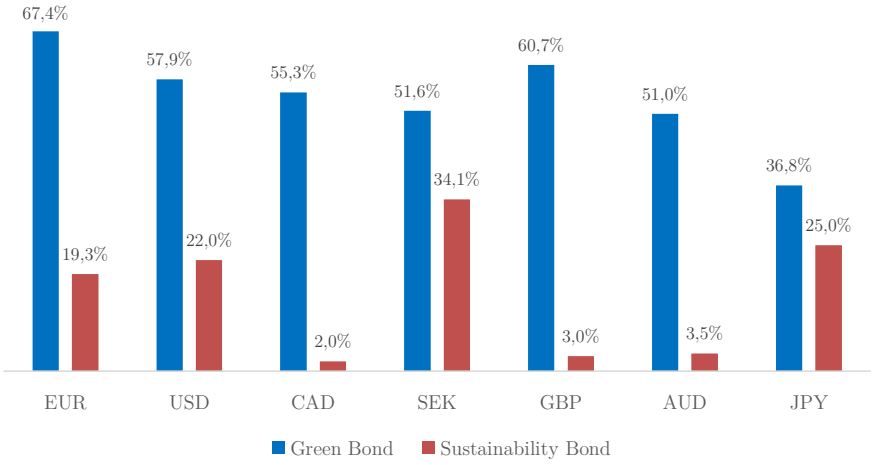



Figure 5.21: Average Taxonomy alignment per currency.

Yet another interesting field of analysis is the one referred to the size of the deals. One might think that larger issues imply more care and meticulousness in the disclosure of information, hence more compliance with the Regulation, but this is not the case. In fact, as we can see from Figure 5.22, there is no direct correlation between deal-size and alignment percentage. The bonds in our dataset that recorded the highest average alignment (67.1% for Green Bonds and 21.9% for Sustainability Bonds) were those issued in the range 500 million-1 billion. Next, the second-best result is for bonds with ten-digit

issues, with average alignment values to the EU Taxonomy of 59.7% for Green Bonds and 15.5% for Sustainability Bonds. Very similar results are found when considering the 100m-500m range, with average alignments of Green and Sustainability Bonds of 57.1% and 13.9% respectively. The worst result is the one related to small-scale issues, and thus intended to finance small projects and initiatives. These, in particular, recorded an average alignment of Green Bonds of only 29.8%, while, as far as Sustainability Bonds are concerned, all issues of this size scale were completely non-aligned with the European Taxonomy.

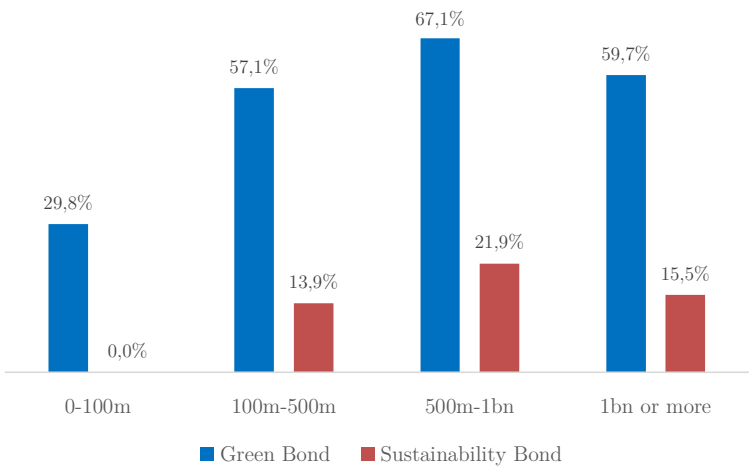



Figure 5.22: Average Taxonomy alignment per deal-size.

Finally, we conclude this brief discussion by analysing how average Taxonomy alignment percentages vary when considering emissions in different years. As we can see from Figure 5.23, we can notice a slightly upward trend regarding the alignment percentages of Green Bonds. The Green Bonds issued in 2014 recorded an average alignment of 50.0%, slightly reduced in the following year to 46.0%. Starting in 2016 and for the following four years, the situation is more or less stable at around 60%, with a minimum value of 58.0% (2018) and a maximum value of 65.3% (2020) in this period. In 2021, there was a significant increase in the average alignment of green instruments (81.6%). However, this result is not very consistent as it refers to a small number of observations, and therefore is an outcome to be considered not very reliable.

Speaking of Sustainability Bonds, however, in addition to confirming the fact that the percentage of alignment obtained by these debt instruments are clearly lower than those recorded by Green Bonds, we can observe that there is not a clear trend as in the previous case. Issuances in 2014 averaged 24.5% alignment, and then increased by roughly 15 percentage points over the next two years (39.7% in 2015 and 39.4% in 2016). In the

four-year period 2017-2020 the situation is almost stable, as in the case of Green Bonds. This is mainly due to the fact that most of the bonds present in our dataset have been issued in these recent years, and therefore the average of the alignments tends to be more or less the same. In particular, in these years the average alignment percentage is around 16%, with a maximum value in 2017 (18.0%) and a minimum value in 2019 (14.2%). Again, as in the previous case, a surge in results can be observed in 2021, with an average alignment of 42.4%. However, as already accomplished, this is due to the low presence in the dataset of observations in this year and, therefore, the results should be interpreted as not being particularly reliable.

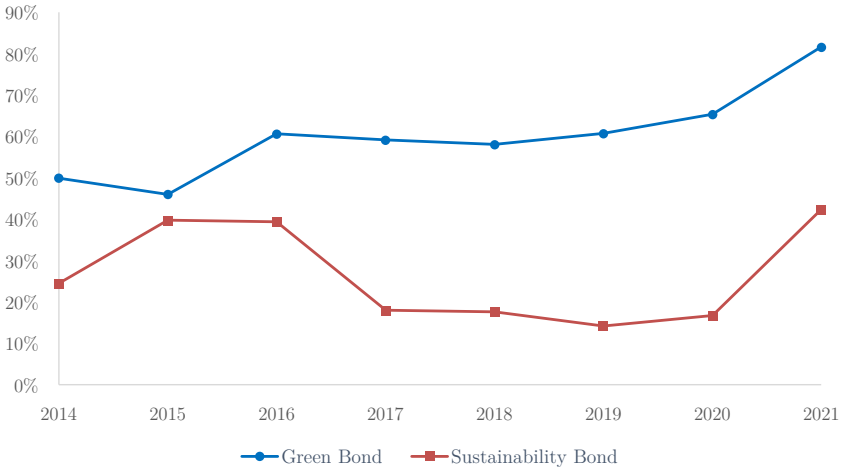



Figure 5.23: Average Taxonomy alignment progress per year.

After discussing the results related to the alignment percentages obtained by our Taxonomy Analysis, it is interesting to focus on the activities that have been financed by the bonds in our database. In fact, as we have seen, not all the activities that are regulated by the European Taxonomy are financed by sustainable instruments, but there are some projects that are definitely more prevalent than others. However, before proceeding with the discussion, a brief clarification is necessary. The results presented below refer to activities that have met, even partially, at least one of the Technical Screening Criteria assigned to them. As a result, the data displayed below will only apply to activities that recorded an alignment greater than 0%, while all activities that were considered completely non-aligned with the EU Taxonomy will be excluded from the count. This decision was taken because it is considered much more relevant to consider only those activities that have been financed following the European Commission's directives, with a view to a future in which the technical criteria defined by the Taxonomy will be mandatory to comply with. Indeed, it is not considered relevant to consider all those activities covered by the

Taxonomy, but that have not been financed and documented appropriately, also with a view to the soundness and consistency of the results.

Having said that, the results are shown in Figure 5.24[13]. As can be clearly seen, the two most prevalent activities are "*Electricity generation using solar photovoltaic technology*" and "*Electricity generation from wind power*", which are present in more than half of the bonds in our dataset. In particular, power generation projects using solar photovoltaic technologies are present in 241 bonds, representing 52.9% of the total, while power generation projects using wind power plants are present in 236 bonds, representing 51.8% of the total. The supremacy of these two activities is mainly due to the fact that they are the two world most popular renewable energy technologies. Furthermore, as explained in the previous sections, these activities are characterized by the absence of Technical Screening Criteria, and are therefore always to be considered aligned with the European Taxonomy.
Next, we find the activity "*Renovation of existing buildings*", which is present in no less than 110 bonds, accounting for 24.1% of the total dataset. Projects in this category relate to the redevelopment, reconstruction and refurbishment of existing buildings. In most cases, activities belonging to this category are attributed a partial alignment of 50% related to the presence of certain certifications, among which *BREEAM* (Building Research Establishment Environmental Assessment Method) and *LEED* (Leadership in Energy and Environmental Design). In particular, the EU Taxonomy requires for building renovation a certification of at least "Outstanding" for the BREEAM protocol or "Gold" for the LEED protocol.

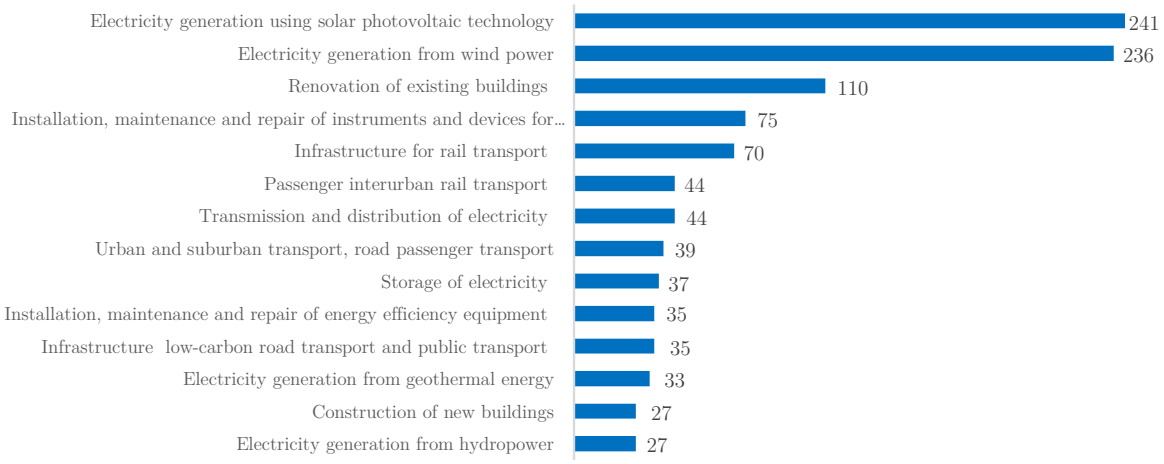



Figure 5.24: Main bond-funded activities in the dataset, by number of occurrences.

[13]The complete list of activities recorded within our dataset can be found in Appendix D.

The remaining activities shown in the figure represent the minority, and are mainly related to the Transports, Green Buildings and Energy Transmission sectors.

This chapter explained and presented the results of the alignment analysis to the EU Taxonomy carried out on our dataset in collaboration with MainStreet Partners. In the next chapter, the discussion will be taken to a totally different level, although still closely related to Regulation and disclosure topics. Indeed, an analysis will be presented regarding the Impact Reporting, already explained in Chapter 3, always carried out in collaboration with the London-based company. The outcome of this study will not be related to the percentage of alignment of the various activities to the Taxonomy, but will be related to the impact metrics results that are presented by issuers within the documents they disclose.

# 6 | Impact Reporting Analysis

As we saw in the previous sections, impact reporting is the regulatory aspect that, more than others, allows making explicit the enormous potential of sustainable debt instruments in fostering the transition to a low-carbon economy. The impact reporting, along with the use of funds statement, is one of the four elements of the Green Bond Principles and details the environmental impacts enabled by the projects and/or assets financed with proceeds from Green, Sustainable and Social Bonds.
This chapter will be completely dedicated to this type of reporting by conducting an in-depth impact analysis. This chapter, in particular, has two main objectives. On the one hand, this analysis will enable the identification of the most pertinent impact reporting practices, by identifying the most virtuous geographic areas and issuer types in terms of impact reporting availability. On the other hand, this chapter will enable a close examination of the true impact that Green, Sustainable and Social Bonds have on society, based on a set of predetermined environmental metrics. By doing this, it will be possible to draw attention to the regions and player groups that are most responsible for fostering a real environmental impact.

In order to achieve these goals, the chapter is divided in three main parts. In the first section, the database used to conduct the analysis will be presented, highlighting all its main features. Then, the data gathering process will be discussed. The results of this activity will make it possible to spot interesting and relevant market trends for impact reporting availability, one of the primary objectives indicated before. Lastly, the third part will be devoted to the actual analysis with the presentation of the final results. Indeed, gathered impact data will be used to compute cumulative and average measures based on some significant environmental parameters, enabling an objective assessment of the real impact of the analysed sustainable debt instruments on society.

## 6.1. Dataset composition

Even in this instance, the bond database used to perform the analysis was developed in collaboration with MainStreet Partners. In particular, Main Street Partners developed an ad-hoc dataset in which the selected bonds are grouped according to some of the most important impact measures, according to the main market guidelines.

The procedure for constructing this dataset consists in retrieving the Green Bond post-issuance reports that companies and institutions (should) disclose according to the Green Bonds Principles, finding the most relevant impact information reported and using them to compute the following environmental metrics:

- $CO_2$ avoided and/or reduced (tonnes);
- Renewable energy capacity added (MW);
- Energy produced from renewable energy added (MWh);
- Energy saved (MWh);
- Water saved (litres);
- Waste treated and/or prevented (tonnes).

In addition to these metrics, Main Street Partners' database also has several others that characterize the social aspect of a bond. These social metrics are:

- Jobs created;
- Jobs saved;
- SMEs/entities financed;
- People financed;
- Social housing units financed;
- Student supported.

These metrics, as already mentioned, only relate to Social and Sustainability Bonds, which fund projects and initiatives addressing social issues.

All these measures are computed both in absolute terms and on a €1 million basis. This was done in such a way in order to enable the comparison among bonds of different size.

All in all, the original sample used to perform the analysis consists of 355 bonds. For each of them, the following basic information were already included into the dataset:

- ISIN Code of the bond;
- Issuer's name;
- Bond's label (i.e., Green Bond, Social Bond, Sustainability Bond, ...);
- Issue Date;
- Maturity Date;
- Currency;
- Amount issued.

This basilar information is necessary in order to research the bonds' impact reports and to facilitate the matching of each bond in the dataset with its own impact metrics. In fact, the majority of issuers, particularly those with several bond issuances, tend to report at the portfolio level (i.e., an impact report for each bond issued) or at the program level (i.e., impact information is provided per project, whether they are financed through one or multiple bonds or not). Instead, a bond-basis was used to complete the current analysis. On the one hand, this enables a greater level of granularity and detail. On the other side, there was the need to adjust the general and sometimes confusing information reported by the issuers. In addition to the fundamental data mentioned above, additional bond information was included for the purpose of this thesis in order to improve contextualization with the goal of finding the most pertinent market and impact trends. In particular, these additional characteristics are:

- Issuer's type (Corporate, Supranational, Government, Municipality);
- Issuer's region (Europe, North America, ...);
- Issuer's country.

The initial dataset is mainly composed by Green Bonds (Figure 6.1). Indeed, among the 355 bonds, 250 (70.4%) were classified as Green, 63 (17.7%) are Sustainability Bonds, and 37 (10.4%) are Social Bonds. The remaining 1.4% is represented by 5 Transition Bonds.

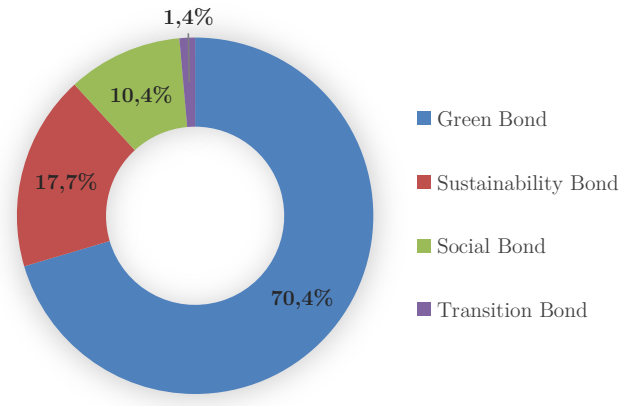



Figure 6.1: Composition of the starting dataset.

As we specified in the previous chapter, Transition Bonds are outside the scope of this analysis and will therefore be removed from the database. Therefore, the final database consists of 350 bonds, of which 250 are Green Bonds (71.4%), 63 are Sustainability Bonds (18.0%), and 37 are Social Bonds (10.6%).

Table 6.1: Summary statistics of the final database

| | |
|---|---|
| **Number of bonds** | 350 |
| **Number of issuers** | 193 |
| **Total amount (€bn)** | 282.54 |
| **Average bond size (€mln)** | 807.25 |
| **Oldest bond** | 04/02/14 |
| **Most recent bond** | 12/02/21 |

As we can see from Table 6.1, these 350 bonds have been issued by 193 individual issuers, over a period of time ranging from February 2014 to February 2021. These bonds account for a total of €282.54 billion[14], with an average bond size of €807.25 million. As we also specified in the last chapter, this large average bond size value is mainly due to the fact that MainStreet Partners, for the purpose of their activities, only covers and screens bonds whose size is generally larger than €200 million.

This fact is also confirmed by looking at the distribution of deal-sizes. As can be seen from Figure 6.2, in fact, the majority of emissions (48.9%) are in the 500 million-1 billion range. Next, the second most "populous" category is the 100m-500m range, representing the 28.0% of the sample, while the last place on the podium is represented by issuances

[14]The amounts of various currencies are converted in Euros with the appropriate conversion rate updated to 30/09/2021.

reaching (or exceeding) €1 billion (20.0%). Finally, only 3.1% of the emissions in the database are below €100 million.

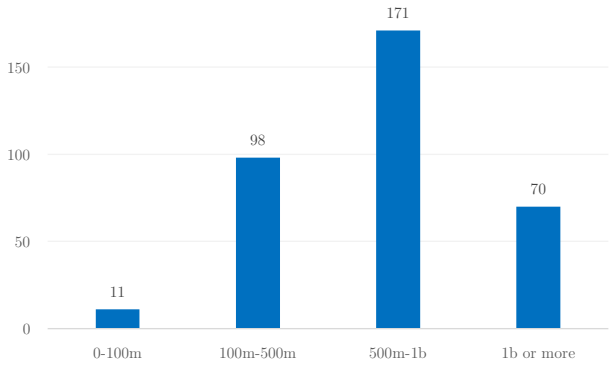



Figure 6.2: Deal-size distribution of the bonds in the dataset (€).

As previously stated, in addition to Green Bonds, Main Street Partners also examines Social and Sustainability Bonds, which are unique sorts of debt securities intended to promote sustainability on a wider scope than just from an environmental point of view. However, as mentioned above and as illustrated in Table 6.2, Social and Sustainability Bonds represent a minority of the reference sample.

Table 6.2: Summary statistics per instrument's type

| | Amount (€bn) | Number of deals | Number of issuers |
|---|---|---|---|
| **Green Bond** | 171.90 | 250 | 140 |
| **Social Bond** | 56.42 | 37 | 14 |
| **Sustainability Bond** | 54.22 | 63 | 39 |

Out of 350 bonds, just 63 (18.0%) are represented by Sustainability Bonds, and they account for the 19.2% (€54.22 billion) of the total volume issued, and just 37 (10.6%) are represented by Social Bonds, that account for the 20.0% (€56.42 billion) of the total volume issued. As can be seen from these results, Social Bonds are characterized on average by a significantly higher deal-size than Sustainability Bonds. In fact, we can see that the amount issued by Social Bonds is almost equal to that of Sustainability Bonds, despite being almost half of them.

The majority share of the sample (71.4%) is represented by Green Bonds, which account for the remaining 60.8% of the total volume issued (€171.90 billion). Also in this case, the dominance of Green Bonds over Social and Sustainability Bonds may be explained given that Green Bonds, have evolved over time into a commonplace financial security.

On the other hand, Social and Sustainability Bonds are newer financial products that have begun to represent sizeable market volumes only in recent years. This is also evident from a glance at Figure 6.3, which displays the total amount of bonds issued (covered by the dataset), taking into account the three different bond typologies present in the reference starting sample.

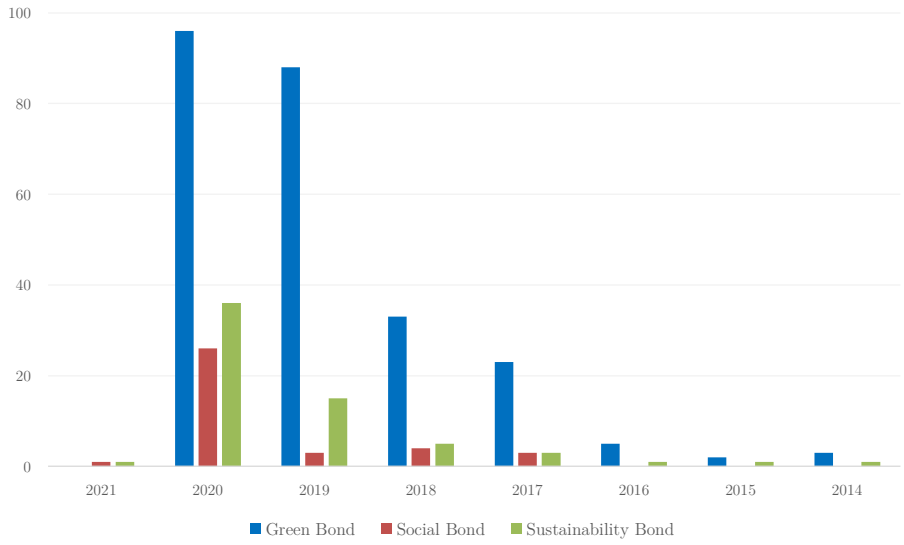



Figure 6.3: Yearly distribution of the bonds' issuances in the dataset.

Also in this case, the trend of Green Bonds is consisted with the findings reported in Chapter 3. Indeed, our reference database illustrates the recent exponential growth of the Green Bond market. On the other hand, the market for Social and Sustainability Bonds is just getting started. In fact, the majority of these types of securities reported in the sample were issued from the 2017. Overall, the reference dataset appears to be an accurate reflection of the current state of the market, with Green Bonds continuing to rule the roost but other bond typologies starting to gain traction.

Having said that, it is also interesting to investigate whether, when taking into account our sample, there are appreciable variations in terms of geographic scope and issuer typologies. Starting with the first point, Figure 6.4 shows the number of issuances per bond type across different geographical regions. In terms of the total amount issued for all three bond types, Europe is without a first region, followed by Supranational entities, Asia-Pacific and North America regions. In particular, these four regions represent 96.8% of the total amount issued recorded in our database. Thus, it is clear that Latin America and Africa regions only have a minor relevance.

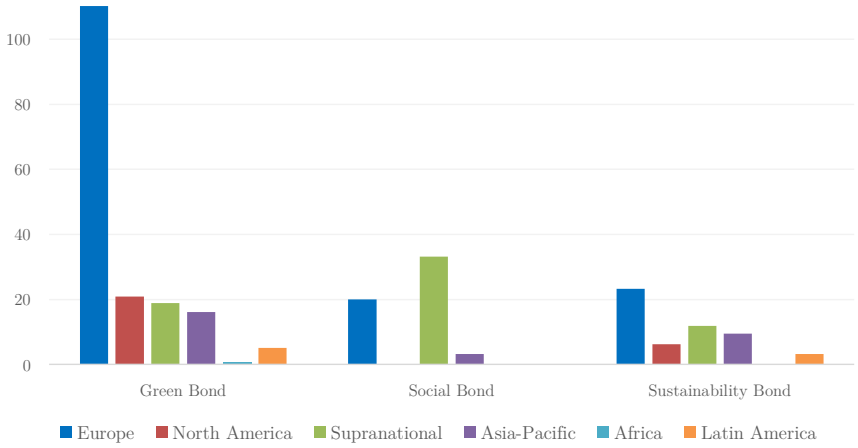



Figure 6.4: Amount issued per geographical region (€bn).

Apart from the European dominance, it is noteworthy that Supranational and Asia-Pacific issuances extend, albeit on a smaller scale, to Social and Sustainability Bonds. On the contrary, North America, which the second major player in terms of Green Bonds, has no volumes issued in Social Bonds, while it has only a small amount issued in Sustainability Bonds. Clearly, this is what is seen in the dataset under analysis, which represents just a small portion of the total market volumes, so it is impossible to reach a definitive conclusion. Particularly, it is possible that European dominance is somewhat inflated, considering the geographical scope of MainStreet Partners, as already pointed out in the previous chapter. These findings, however, appear to be consistent with the most recent market updates provided by the Climate Bonds Initiative. According to the Initiative, indeed, Asia-Pacific is the leading issuer in the social sector, followed by Supranational issuances, which instead represent the leader in the sustainability theme. Europe, on the other hand, generally dominates in the green sector due to a more developed market.

Looking at the typologies of issuers, Figure 6.5 shows the total amount of issuances per issuer types. As can be seen, corporates appear to be, in proportion, more interested in green issuances rather than in social and sustainable ones. The same can be applied to Government issuances, which are mainly directed towards green debt instruments. Indeed, in our sample, 94.4% of Government issuances are represented by Green Bonds, while only the remaining 5.6% is dedicated to Social and Sustainability issuances. The situation is different for the other types of issuers. Supranational entities (the third issuer of Green Bonds) are the leader in the social theme. As for Sustainability Bonds, on the other hand, in addition to corporations, which are numerically in the majority, we find municipal issuances that represent the 26.8% of the sustainable securities. Also in this

case, Municipalities play a marginal role in green and social issuances. This result is quite in line with what has been documented by the Climate Bonds Initiative, which sees public issuers playing a significant role in the social and sustainability theme, whereas private issuers (corporates) are the leader in the green context.

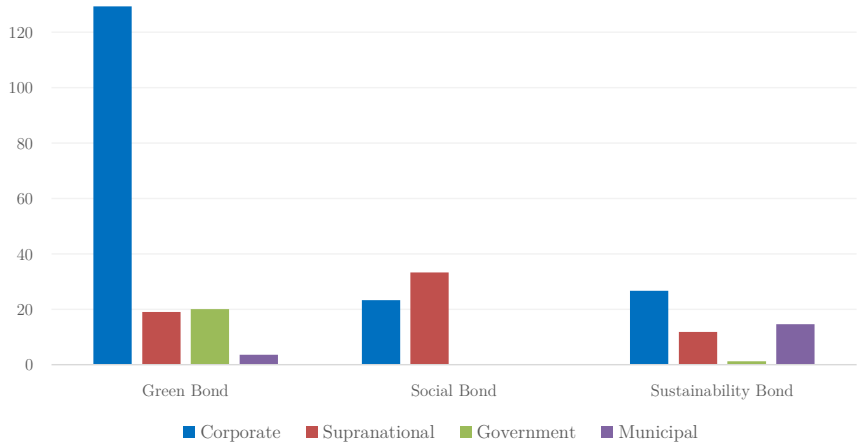



Figure 6.5: Amount issued per issuer's type (€bn).

Lastly, let us conclude this brief analysis on bond typologies by looking at the average deal size of these debt instruments. As we can see from Figure 6.6, the bond size in our sample is on average above the benchmark value of €500 million. These findings are somewhat skewed as a result of MainStreet Partner's focus on large sized bonds, as stated several times. Indeed, only 11 out of 350 bonds (3.1%) are in the range 0-100 million. Sustainability Bonds appear to be, on average, a bit larger than the other peers as 74.6% of these instruments are issued in a size larger than €500 million, with however the other bond typologies mainly in the 500m-1bn range.

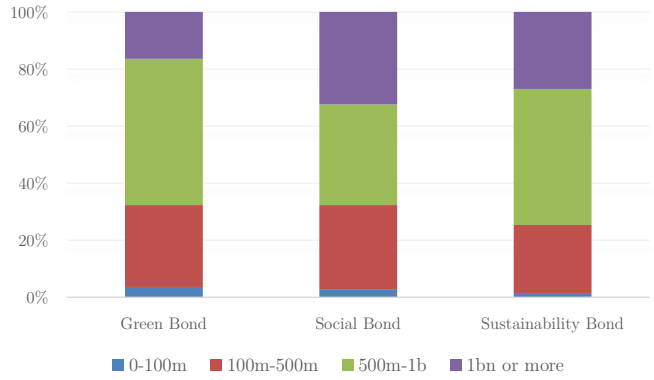



Figure 6.6: Proportion of deal-sizes per bond typology.

Following this initial analysis, which distinguished the traits of our dataset based on the type of debt instrument being considered, we continue with a more in-depth analysis of the database, no longer distinguishing between Green, Social and Sustainability Bonds.

Starting with a geographical analysis, the following map (Figure 6.7) depicts the countries with the highest number of issuances in our sample. Of course, Supranational issuers are not taken into account in this part of the analysis.

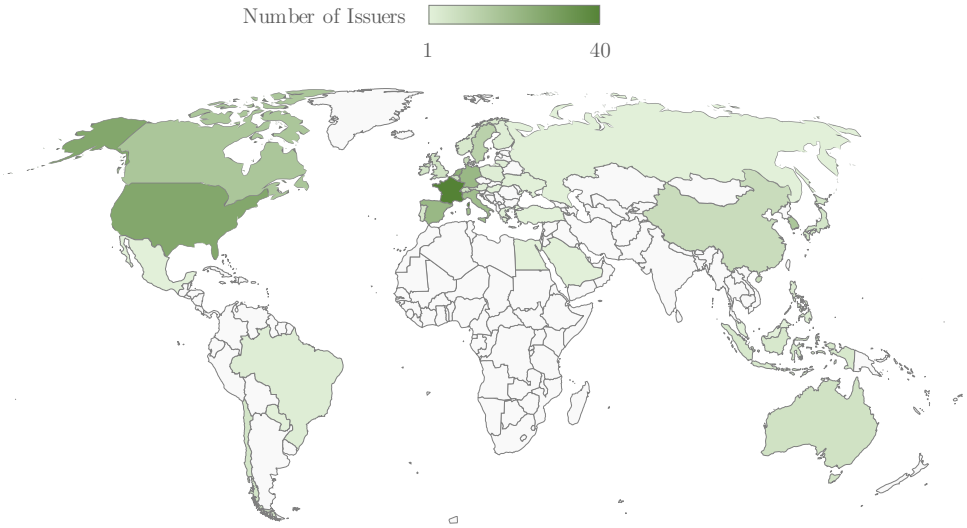



Figure 6.7: Worldwide geographical distribution of bonds'issuances.

The results shown support what has been observed, namely that the majority of the issuances originate in Europe, North America, and Asia. Particularly, France (40), the United States (27), the Netherlands (24) and Germany (21) are the countries with the most issuances. Italy holds the $6^{th}$ position in this ranking with 19 issuances. With 16, 8, and 6 issuances, respectively, South Korea, China and Australia represent the top countries in the Asia-Pacific region. In the Latin American region, we find a total of 8 issuances from Chile (5), Brazil (2), Paraguay (1) and Mexico (1). Finally, an Egyptian government's bond is the only one we can find from the African continent.

When taking into account the total amount issued by country, these results are largely supported, though there are a few slight variations. Indeed, Figure 6.8 shows that France confirms its supremacy with a total amount issued of €47.70 billion, followed by Germany (€22.09bn), the United States (€20.60bn) and other European nations (aside from Supranational issuances), such as the Netherlands (€18.92bn), Spain (€25.07bn) and Italy (€13.70bn). Also worth mentioning is the result recorded by Ireland and Indonesia. Indeed, these two nations ranked $9^{th}$ and $10^{th}$ respectively in this ranking, despite having

issued only five and four bonds respectively. This is clearly indicative of an average issuance well in excess of €1 billion. Again, as also specified in the previous chapter, these results differ from those presented in Chapter 3. This once again confirms MainStreet Partners' tendency to focus on European bonds, thus under-representing US Americans and Chinese issuances.

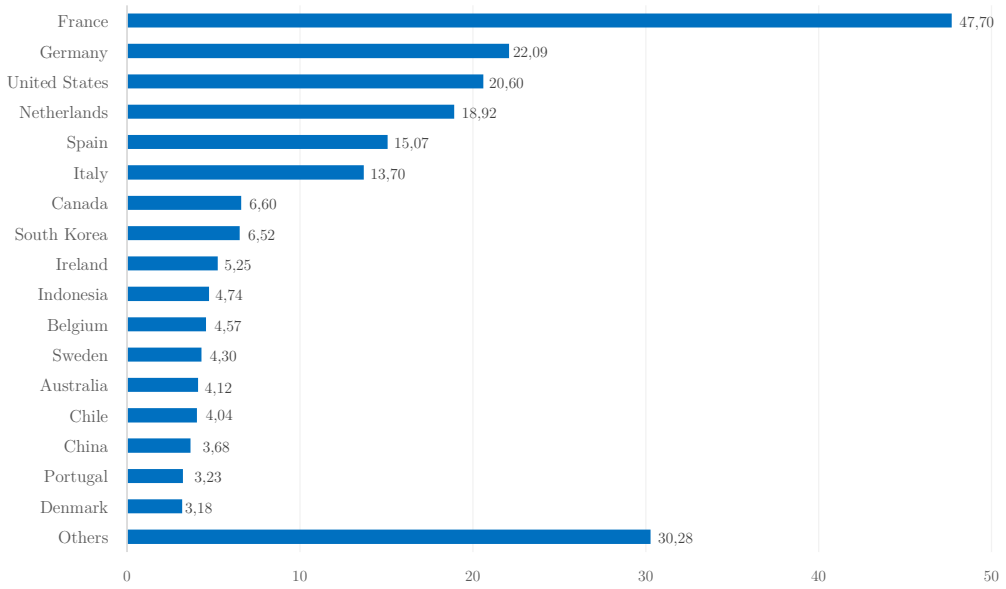
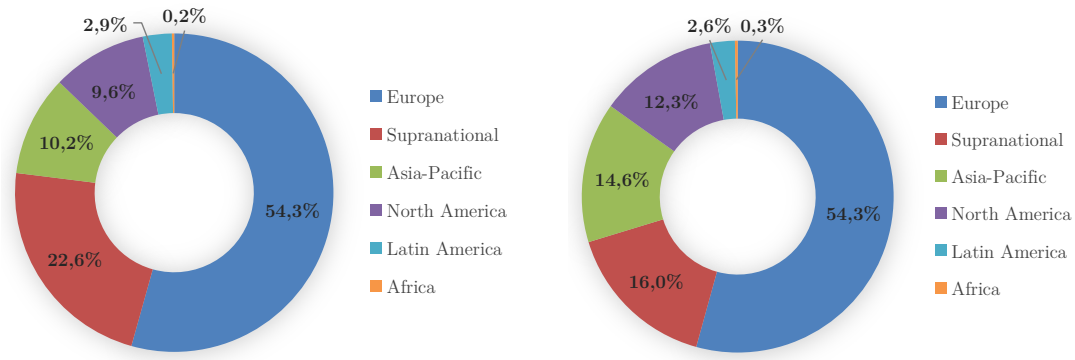



Figure 6.8: Bonds' total amount issued per country (€bn).

By examining the geographical distribution by regions, the same inferences can be made (Figure 6.9). Europe is clearly the most represented region, accounting for 54.3% both for bond volumes included in the dataset and in terms of number of deals. Subsequently, there are Supranational issuances, followed by Asia-Pacific and North America regions.

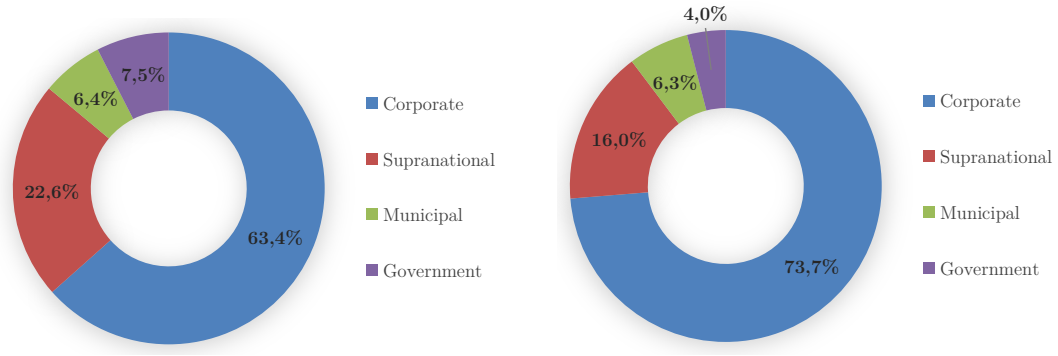



(a) Amount issued. (b) Number of deals.

Figure 6.9: Regional distribution of the bonds in the dataset.

Finally, we can confirm one more time the marginal role played by Latin America and Africa, which combined account for more or less 3% of the entire sample, both in terms of amount issued and number of deals. These outcomes, once again, provide additional evidence for MainStreet Partners' emphasis on European bonds.

Considering instead the issuer types, Figure 6.10 clearly shows that the corporate sector is definitely the most popular in terms of issuances of Green, Social and Sustainability Bonds. In particular, 63.4% of the amount issued in our dataset comes from corporation issuances, while they represent almost three quarters of the number of deals in the sample under analysis. These are followed by Supranational institutions, which account for 22.6% in terms of amount issued and 16.0% in terms of number of deals. Lastly, we find Municipal and Government issuances, that represent the minority part of our dataset. Indeed, these bonds constitute only the 13.9% in terms of amount issued, and only the 10.3% in terms of numerosity.




(a) Amount issued. (b) Number of deals.

Figure 6.10: Bonds' typologies distribution in the dataset.

Lastly, taking into account the analysis per currency, the results are a consequence of what has been said thus far. Starting with the most common currencies for bond issuance, Europe's over-representation, as previously established, translates into a clear domination of the EUR, especially when compared to the USD. Indeed, in our dataset, the difference between EUR and USD is way more pronounced compared to the situation in today's market. In particular, sustainable bonds issued in EUR account for 57.1% of the total, while those issued in USD account only for 23.1%.

These two top currencies together make up 80.3% of the database, with the remaining portion being split among other minor currencies, such as the Swedish Krone (5.4%), the Canadian Dollar (4.0%), the British Pound (2.6%), the Australian Dollar (2.6%) and the

Japanese Yen (1.7%). The latter percentages are in line with what was already expressed in Chapter 3, as these currencies are mainly used for domestic issuances

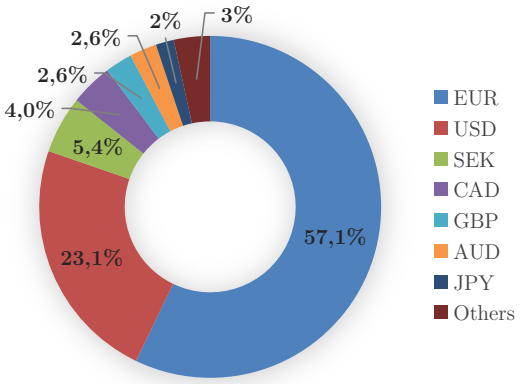



Figure 6.11: Proportion of currencies in the sample per number of deals.

In conclusion, it is crucial to reiterate before wrapping up this section that all of these considerations apply to the sample of bonds offered within Main Street Partners' database. Despite a few significant differences that have been brought up during the discussion, the majority of the findings are consistent with market-wide trends, which confirms the findings presented in Chapter 3, adding to them new and valuable insights.

## 6.2. Data collection

While the first section focused on a preliminary analysis of the initial sample as a whole, now we will give a brief explanation of how the data were first gathered and then processed. Also in this case, however, some preliminary clarifications are necessary before starting the discussion.

The Impact Reporting analysis was carried out on a bond database provided to us directly by MainStreet Partners. In particular, it is important to note that the 355 bonds in this dataset were all found to have impact metrics disclosed by the issuers themselves. This situation, however, does not always happen. In fact, it is important to say that Impact Reports are not strictly compulsory to date, but these are only a practice strictly encouraged by Regulation. This *modus operandi* is used by most issuers globally. In fact, for the largest issuers, an impact report for each bond (or portfolio of bonds) is provided on an annual basis. In particular, these annual documents are updated from time to time in order to provide all investors and stakeholders with up-to-date information regarding the use of funds supported by Green, Social or Sustainable Bond issuances.

Also in this case, as in the previous chapter, the analysis was carried out on the entire dataset of 355 bonds, although the results will only be presented for Green, Social and Sustainable Bonds. Indeed, as was mentioned in the previous section, five bonds were disregarded because they belong to groups that were unrelated to the subject of our study (Transition Bonds). Moreover, again as in the previous chapter, the analysis in question is carried out per bond and not per issuer. This means that the assessment of environmental and/or social impact is carried out per issue, and is therefore not referred to the issuer in general terms. Therefore, it is possible that the same issuer may obtain different impact results for its Green, Social and/or Sustainability Bonds, as the outcome depends solely on the impact data of each project/activity financed by the individual bonds, which may be different.

This process began with a review of all accessible documents (mainly Impact Reports) related to the bonds in our sample. This was done by looking through the various areas of the websites of the various issuers for the most recent documentation that presented the bonds issued and their results in terms of environmental and/or social impacts.

This type of document has already been discussed comprehensively in Section 3.3.1. In this regard, it should be remembered that the main feature of this type of documentation is, the great fragmentation of reporting modalities. It was explained that this is mainly due to the fact that to date there are no regulatory schemes and structures in place for drafting Impact Reports. Indeed, although there are more commonly used frameworks (such as the *ICMA Harmonized Framework for Impact Reporting* and the *Nordic Public Sector Issuers Position Paper on Green Bond Impact Reporting*), this step is left entirely to the discretion of the issuer who has full powers in terms of structuring the report, as well as on the decision to publish such documentation. This translates in a set of documents, relating to all the bonds in our sample, each one different from the other and with always conflicting methods of presenting data. Indeed, the objective here is to present a schematic methodology with which the impact data of each bond issued can be presented, also allowing us to make cross-comparisons between bonds with totally different characteristics.

As mentioned in the previous section, the framework proposed by MainStreet Partners, used for data analysis, divides impact metrics into two macro-areas: environmental metrics and social metrics.

In particular, for the environmental category, that refers only to Green and Sustainability

Bonds[15], the impact metrics (and related units of measurement) defined are:

- $CO_2$ avoided and/or reduced (tonnes);
- Renewable energy capacity added (MW);
- Energy produced from renewable energy added (MWh);
- Energy saved (MWh);
- Water saved (litres);
- Waste treated and/or prevented (tonnes).

As for the social category, instead, that refers only to Social and Sustainability Bonds[16], the impact metrics (and related units of measurement) defined are:

- Jobs created (number of jobs created);
- Jobs saved (number of jobs saved);
- SMEs/entities financed (number of entities financed);
- People financed (number of people financed);
- Social housing units financed (number of units financed);
- Student supported (number of people supported).

Before proceeding with the discussion, it is necessary to make an important distinction. In fact, as specified in the previous chapter, today's lack of standardization for this type of disclosure leads issuers to present data according to different methodologies.

In particular, with regard to impact reporting, there are two methodologies for the disclosure of impact metrics:

- *Project-level*: in this case, environmental and/or social impact results are provided on a bond basis. An example is shown in Figure 6.12;

[15]Environmental impact data (such as $CO_2$ avoided, renewable energy generates, ...) refers only to bonds' typologies that can invest in activities/projects with an environmental scope.

[16]Social impact data (such as jobs created, jobs saved, people supported, ...) refers only to bonds' typologies that can invest in activities/projects with a social scope.

| Overview of the KBC Green Bond assets and annual impact | | |
|---|---|---|
| **Green Bond 1** | | |
| | **Renewable Energy** | **Green Buildings** |
| **Allocated amount** | EUR Ⓐ 187.5 mio | EUR Ⓐ 300 mio |
| **Electricity produced/energy saved (MWh)** | 320,100 | 26,752 |
| **Avoided $CO_2$ emissions (tonnes)** | 60,073 | 5,011 |
| **Green Bond 2** | | |
| **Allocated amount** | EUR Ⓐ 255,5 mio | EUR Ⓐ 200 mio |
| **Electricity produced/energy saved (MWh)** | 455,062 | 17,816 |
| **Avoided $CO_2$ emissions (tonnes)** | 124,194 | 3,341 |

Figure 6.12: Example of a project-level Impact Reporting.

Source: KBC Green Bond Impact Report, March 2021.

- *Portfolio-level*: in this case, on the other hand, the environmental and/or social impact results are provided for a portfolio of bonds, and therefore refer to the sum of impact data of all the bonds in the portfolio. An example is shown in Figure 6.13.

**Portfolio date: December 2020**

| Eligible Project Category | Signed Amount (in USD mln) | Share of Total Portfolio Financing | Direct Jobs Supported | Indirect Jobs Supported | GHG emissions avoided in $tCO_2e$ |
|---|---|---|---|---|---|
| a/ | b/ | c/ | d/ | e/ | f/ |
| **Green investments** | **1,437** | **74%** | | | |
| Renewable Energy | 882 | 45% | 25,320 | 1,446,648 | 367,434 |
| Mixed | 412 | 21% | 9,469 | 143,526 | 108,162 |
| Agriculture, forestry and landuse | 73 | 4% | 10,176 | 102,144 | |
| Energy efficiency | 53 | 3% | 74 | 18,308 | 18,636 |
| Conservation of natural ressources | 17 | 1% | 11,598 | 23,997 | |
| **Social projects** | **387** | **20%** | | | |
| Gender: Women-owned SME | 84 | 4% | 26,557 | 310,768 | |
| Microfinance | 72 | 4% | 29,611 | 233,033 | |
| Least Developed Countries | 154 | 8% | 13,609 | 277,885 | |
| Mixed | 68 | 3% | 4,537 | 26,322 | |
| Youth finance | 9 | 0% | 1,352 | 7,612 | |
| **FMO's Treasury sub-portfolio (Green bonds)** | **128** | **7%** | | | |
| **Total** | **1,952** | **93%** | **132,304** | **2,590,243** | **494,232** |

Figure 6.13: Example of a portfolio-level Impact Reporting.

Source: FMO Sustainability Bonds Newsletter, April 2021.

Also in this case, the operational process had to be adjusted based on the case we were dealing with and, in some situations, assumptions had to be made because of these various disclosure methodologies. This procedure was directly developed by MainStreet Partners,

not the dissertation's authors. In fact, the London-based company's analysts actually follow this standardized procedure when working on projects and analyses of this nature.

Therefore, after identifying the various impact report documentation made available by the different issuers and the methodology of disclosure (project-level or portfolio-level), the next step was to map each individual bond and define which of these impact metrics it affects, as well as the amount of the metrics themselves. This process is carried out for each impact metric result obtained by the bond issuance. In particular, there are basically two pieces of information required:

1. The impact metric amount;
2. The monetary base.

The *impact metric amount* simply refers to the numerical value to be assigned to each impact metric affected by each individual bond. For example, a Green Bond that financed the construction of a solar park was able to achieve an annual $CO_2$ reduction of 500 tonnes. However, not in all cases were the units of measurement found in the documentation consistent with what was previously defined. In this case, it was simply a matter of applying a corrective multiplier to the "raw" value of the metric to translate this result into the desired unit of measurement. This applies mainly to environmental metrics, as the units of measurement for social metrics are unambiguous in each case.

The operational procedure for dealing with this type of information is distinct according to the methodology of disclosure:

- *Project-level*: in this case, the "raw" value simply refers to the impact result achieved by the bond in question;
- *Portfolio-level*: in this case, instead, the "raw" value simply refers to the impact result achieved by the entire bond portfolio.

The *monetary base*, instead, refers to the quantity expressed in monetary terms attributable to the achievement of the environmental and/or social impact results identified by the impact metric amount. This value is expressed in millions of euros. Since clearly not all bonds in our database are issued in euros, the monetary bases are also expressed in different currencies. In this case, monetary bases with a different currency to the euro are adjusted by applying the respective exchange rate[17].

[17]Currency conversion rates are updated to 31/12/2021.

Also in this case, the operational procedure for dealing with this type of information is distinct according to the methodology of disclosure:

- *Project-level*: in this case, the monetary base is simply the issued amount of the bond under analysis. For example, if a Green Bond of €500mln resulted in a reduction of 1,000 tonnes of $CO_2$, the monetary base is €500mln;
- *Portfolio-level*: in this case, instead, the monetary base is relative to the sum of the issued amount of all the bonds that compose the portfolio. The assumption here is that the amounts of environmental and/or social impact are proportional and thus evenly distributed to all bonds in the portfolio. This simplification is necessary since in this case it is not possible to trace the precise impact dates of each bond considered individually. For example, if a portfolio composed by three Green Bonds of €500mln each resulted in a reduction of 5,000 tonnes of $CO_2$, the monetary base in this case is €1.5bn, while the impact metric amount is 5,000 tonnes.

Once the impact metric "raw" amount and the monetary base have been calculated for all the bonds in our dataset, two further measures are computed.

First, we have a measure that we can call "normalized value", that is simply computed by dividing the "raw" impact measure and the monetary base. In this way, it is possible to obtain the results of environmental and/or social impact per million euro (e.g., 500 tonnes of $CO_2$/€mln). This measure makes it possible to compare bonds of different sizes. Indeed, through the normalized value, it is possible to identify which bonds performed best, given the same amount of funds invested.

Finally, we have the "overall value", that is computed by multiplying the normalized value (e.g., 500 tonnes of $CO_2$/€mln) by the total issued about of the bond under analysis (in millions of euros). In this way, it is possible to obtain the overall results of environmental and/or social impact for every bond in the starting sample. In the case of a project-level approach bond, this value is equivalent to the impact metric "raw" amount, while in the case of a portfolio-level approach bond, the "overall value" represents the environmental and/or social impact result proportional to the size of the bond relative to the size of the entire portfolio.

All these measures are calculated for all the 355 bonds in our dataset, and the results achieved will be presented in the following section.

## 6.3. Results of the Impact Reporting Analysis

As we have already stated, the Impact Reporting Analysis was conducted on each of the 355 bonds that make up our initial dataset. However, the presence of financial instruments, like Transition Bonds, which have very different scopes from Green, Social and Sustainability Bonds, forced us to omit them from the presentation of results in order to preserve consistency of results. Therefore, the data presented below only refer to Green, Social and Sustainable instruments, represented by 350 bonds in our database.

As a result, the impact metrics reported in Section 6.1 and Section 6.2 for these 350 bonds were calculated using the data provided in the relevant post-issuance documents. The reasoning is that these bonds are thought to raise monetary funds which are then used to finance environmentally and socially sustainable projects, which therefore have a measurable impact on society. Thus, both in absolute terms and on a EURmn basis, these impacts can be used to evaluate the environmental performance of the underlying bond. Clearly, not all bonds provide information based on the same metrics, depending on the project that was funded with the proceeds. Figure 6.14 displays the number of bonds for each of the six environmental metrics in the dataset that have impact data. As can easily be seen, the amount of greenhouse gases (GHG) avoided and/or reduced as a result of the funded projects was found to be reported in almost all bonds. This measure is then converted into a synthetic indicator representing the amount of $CO_2$ avoided and/or reduced in accordance with the Impact Reporting guidelines examined in Section 3.3.1.

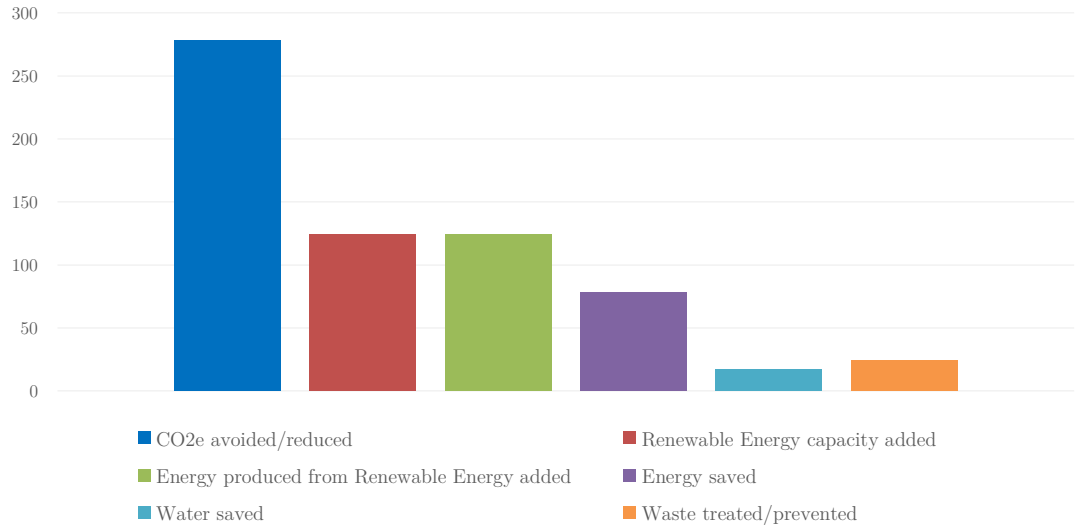



Figure 6.14: Number of bonds reporting on different environmental metrics.

This is the impact indicator reported in almost all impact reports, as 278 of the 313 bonds (sum of Green and Sustainability Bonds of the sample)[18] that were examined use this metric to describe their impact results, thus representing the 88.8%. The other environmental impact metrics most frequently reported are "*Renewable energy capacity added*" and "*Energy produced from renewable energy added*", both of which were reported in 124 bonds (39.6%), and "*Energy saved*" which was reported in 78 bonds (24.9%). The remaining measures, such as the amount of water saved and the amount of waste handled and/or avoided, were less prevalent, probably because they were tied to very specific initiatives. Indeed, these metrics were reported in only 17 (5.4%) and 24 (7.7%) bonds, respectively.

On the other hand, Figure 6.15 displays the number of bonds for each of the six social metrics in the dataset that have impact data. Clearly, in absolute terms, these results are much lower than those presented for environmental metrics. This is due to the fact that there are only 100 Social and Sustainability Bonds within the dataset. The "*SME/Entities financed*" indicator achieved the best results, being present in 36 bonds out of 100 (36.0%). Next up we find "*Jobs created*" (31.0%), "*Social Housing units financed*" (30.0%), and "*Students supported*" (26.0%). Finally, the least common social impact metrics in our database were found to be "*People financed*" and "*Jobs saved*", being reported in 18 (18.0%) and 17 (17.0%) bonds respectively.


Figure 6.15: Number of bonds reporting on different social metrics.

[18]The environmental metrics are related only to Green and Sustainability Bonds, while the social metrics are related to Social and Sustainability Bonds.

After this brief introduction, the analysis of the aforementioned impact metrics is covered in the following paragraphs. The goal is to identify important trends, particularly in relation to the regions, countries, issuer types and deal-sizes that have the greatest influence on fostering an environmental impact on society. The metric for the amount of $CO_2$ avoided and/or reduced will serve as the starting point for the analysis. In this instance, the extensive reporting of bonds in the dataset makes it possible to further the analysis across various variables. Next, also the indicators which refers to the amount of renewable capacity added and renewable energy produced are considered, while for the last nine metrics, given the low number of data available, it was not possible to perform meaningful analyses.

### 6.3.1. Impact Reporting: $CO_2$ avoided and/or reduced

Starting with the first metric, we can see from Figure 6.16 that the majority of the $CO_2$ avoided and/or reduced in our dataset is due to Green Bonds. In particular, of the 164,449 kilo tonnes of avoided $CO_2$ recorded by our sample, 148,716 kilo tonnes (90.4%) came from Green Bonds, while only 17,733 kilo tonnes (9.6%) came from Sustainability Bonds. This result is clearly biased, as has been pointed out several times previously, by the fact that green instruments overwhelmingly outnumber sustainable ones.

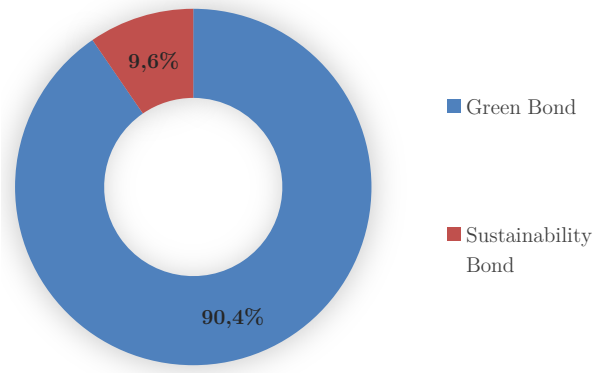



Figure 6.16: Proportion of instrument's types per tonnes of $CO_2$ avoided and/or reduced.

In order to remedy this situation, it is possible to view the same results averaged on the basis of the million euro (Figure 6.17). Also in this case Green Bonds prevailed, registering an average of 949.6 tonnes of avoided $CO_2$ per €1mln, compared to 412.5 tonnes per €1mln achieved by Sustainability Bonds. This confirms that Green Bonds are the best performing instruments in terms of greenhouse gas emissions avoidance and/or reduction.

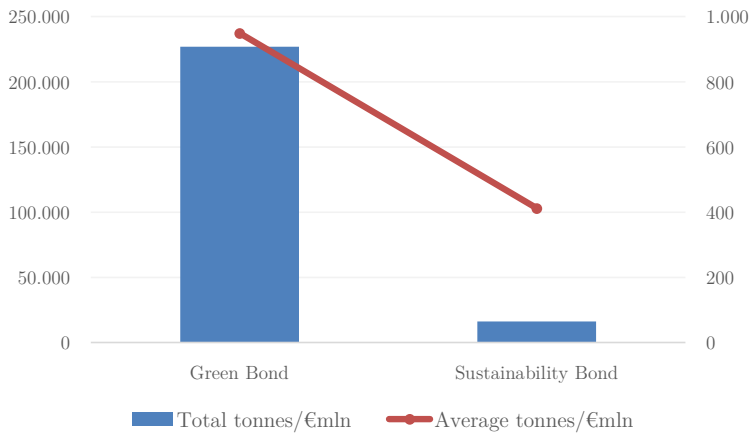



Figure 6.17: Total and average $CO_2$ avoided and/or reduced (per million Euro) per instrument's type.

Turning to a geographical analysis, Figure 6.18 shows which nations are most responsible for lowering and/or preventing the emission of $CO_2$ as a result of initiatives supported by the issuance of Green and Sustainability Bonds. Three major regions can once again be distinguished: Europe, Asia-Pacific and North America. Since the logic is still based on absolute numbers, countries who issue the most bonds are likely to have the greatest impact. Indeed, these nations are able to finance more and larger projects thanks to the vast amount of funds received, which has a significant impact on the reduction of GHG emissions.

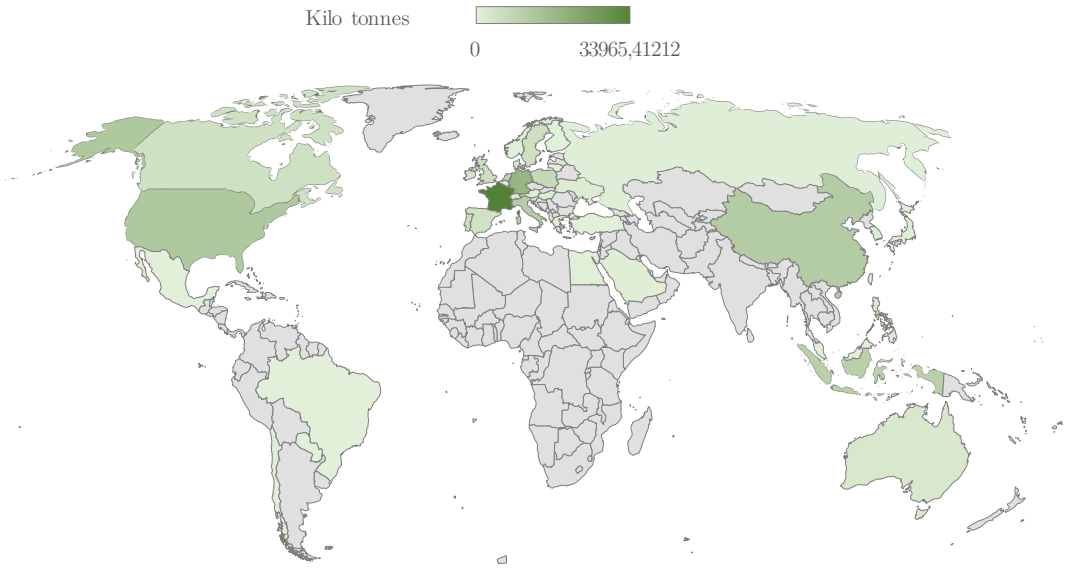



Figure 6.18: Worldwide geographical distribution of $CO_2$ avoided and/or reduced.

More specifically, Figure 6.19 lists the top nations in terms of $CO_2$ avoided and/or reduced in absolute volumes. It is not surprising that France and Germany, two of the largest issuers of Green Bonds, are in the top two spots. The United States of America comes in third place, while the Asia-Pacific region is represented by China, which ranks just behind. Italy ranks fifth, with a total $CO_2$ mitigation of about 10,585 kilo tonnes.

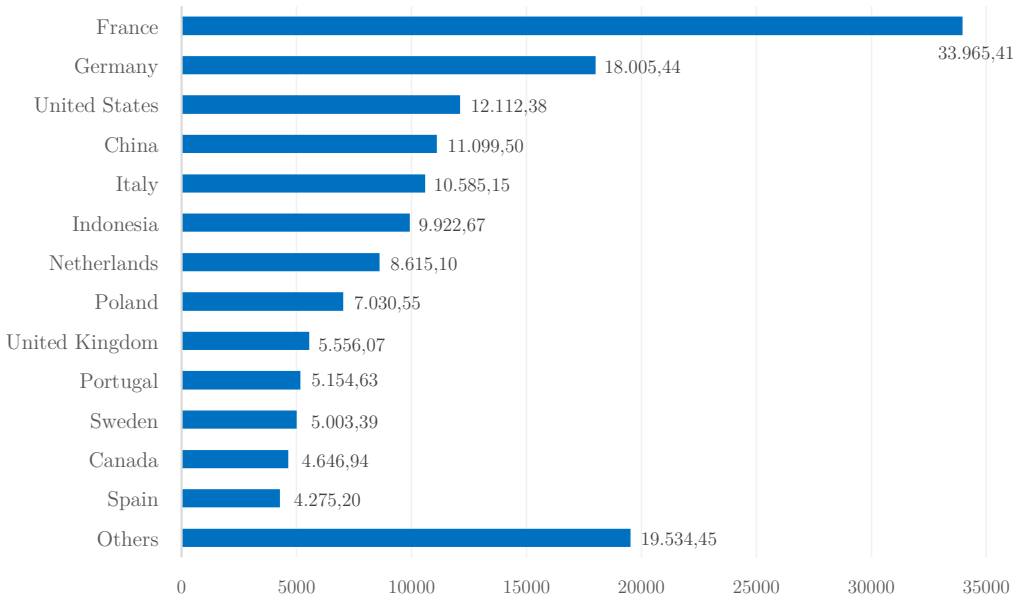



Figure 6.19: $CO_2$ avoided and/or reduced per country (kilo tonnes).

These findings contribute to our understanding of the enormous impact that the issuance of Green and Sustainability Bonds can have, but because they are presented as absolute numbers, they do not help us identify any significant trends. Deepening the analysis, Figure 6.20 highlights two essential information. On the left-hand axis (blue bars), it is reported the sum of $CO_2$ avoided and/or reduced per €1mln of bonds issued. To arrive at this result, the total impact of each bond is divided by its size, and the results are then combined while taking the country of issuance into account. These results, however, continue to favour those nations that have numerous deals, and therefore France, Germany and China continue to be at the top of the list. On the right-hand axis (red line), instead, it is reported the previous mentioned value but divided by the number of issuances per country, thus representing the average amount of $CO_2$ avoided and/or reduced (in tonnes) per €1mln issued in each nation. As a result, this final measurement is unrelated to the volume and number of bonds issued by individual nations, making it the ideal indicator for use in cross-national comparisons. Extreme results, such as those for Ukraine and Poland are not statistically significant because they pertain to a

small number of very large Green and/or Sustainability Bonds, which have impact data significantly higher than market averages. When comparing the most relevant nations previously taken into account, China and Indonesia result to be the best performing of the countries with a comparable amount of bonds issued. Indeed, for every €1 million issued, Indonesian bonds enable an average $CO_2$ reduction of about 3,275 tonnes, while Chinese debt instruments enable an average $CO_2$ reduction of about 2,788 tonnes. Talking about the European context, among nations with statistically significant data, we find indicative values between 430 tonnes (Netherlands) and 2,778 (United Kingdom), while the United States issuances appear to not have as much of an impact, as they typically only allow to avoid/reduce 648 tonnes per each €1mln issued. The overall conclusion from this analysis is that, at least for the sample used in the current study, Asian bonds have the most consistent impact in terms of $CO_2$ avoided. European nations and the United States come in second and third place, respectively, while for other nations, additional data would need to be gathered in order to draw meaningful conclusions.

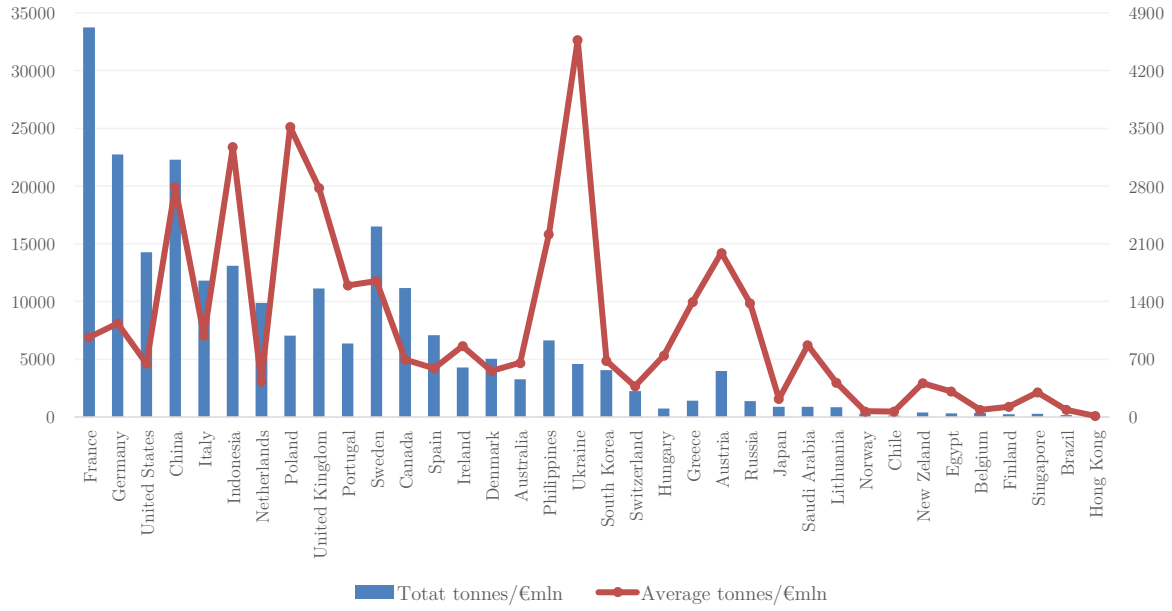



Figure 6.20: Total and average $CO_2$ avoided and/or reduced (per million Euro) per country.

Shifting the discussion to regional level, the results are confirmed. Figure 6.21 illustrates that Europe, with 67.0% of the total, is the region that contributes the most in absolute terms to lowering GHG emissions through the issuance of Green and Sustainability Bonds. Asia-Pacific (17.1%) is next (mainly thanks to China and Indonesia), overtaking North America (10.2%) and Supranational issuances (5.4%) in this ranking. Due to the small

number of bonds issued, the results for Africa and Latin America are, as usual, not significant.

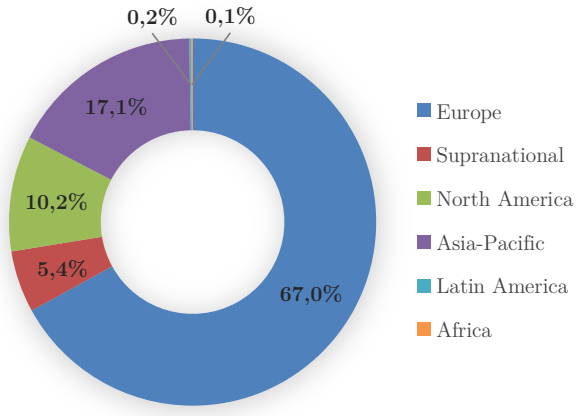



Figure 6.21: Proportion of regions per tonnes of $CO_2$ avoided and/or reduced.

Instead, if average values are considered (Figure 6.22), the previously described procedure places Asia-Pacific in first place, with an average of 1,526 tonnes of $CO_2$ avoided for every million euro issued. This result is primarily attributable to Chinese and Indonesian instruments, which, as previously mentioned, appear to have the greatest impact in terms of reducing GHG emissions. As was to be expected, Europe is in second place, followed by North America and Supranational issuances. Results for Africa and Latin America, as stated, are not noteworthy.

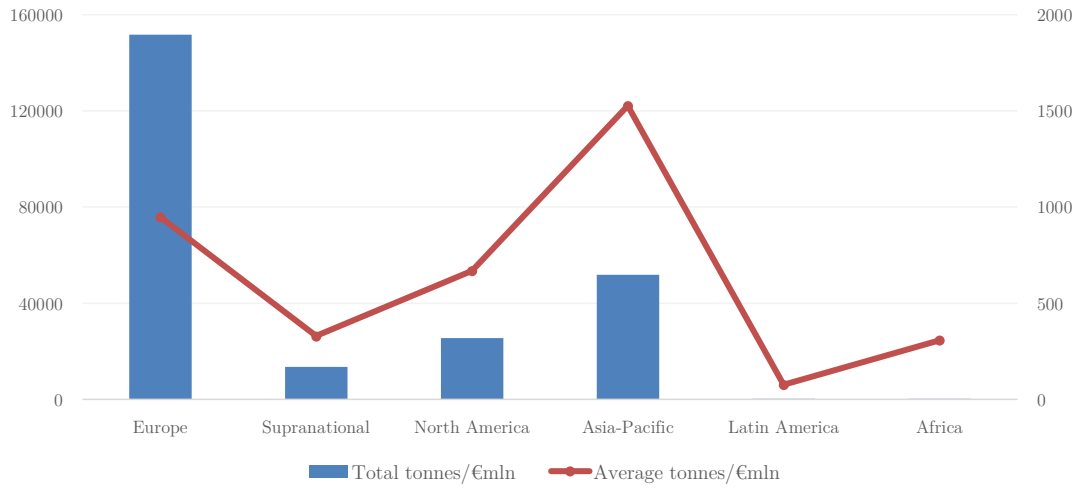



Figure 6.22: Total and average $CO_2$ avoided and/or reduced (per million Euro) per region.

Changing the focus of the analysis, the next graphs display the main findings regarding the issuer typologies. Figure 6.23 clearly shows that the majority of the GHG emission re-

duction (82.3%), in absolute terms, in our dataset is due to corporate issuances. Next, we find Government (12.2%) and Supranational (5.4%) issuances, with Municipal issuances virtually zero. The result is quite expected, as Municipal and Governmental bonds tend to be more focused on financing social issues.

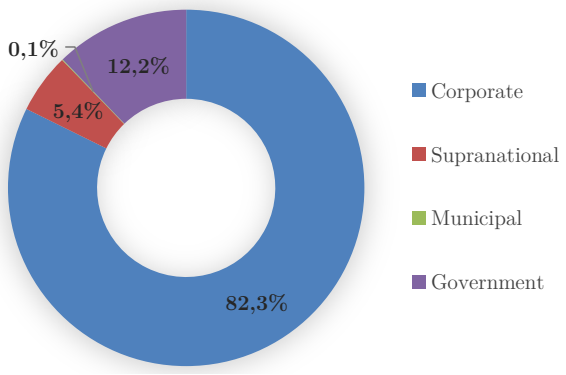



Figure 6.23: Proportion of issuer's type per tonnes of $CO_2$ avoided and/or reduced.

When comparing average results, Governmental bonds stand out as the instruments with the greatest impact, as illustrated in Figure 6.24. Indeed, these players frequently issue very sizable deals meant to finance lengthy, sizable projects with important implications for $CO_2$ avoidance and/or reduction. Looking at the others players, the debt instruments of corporations appear to have a greater impact than those of Supranational and Municipal issuers. In fact, for every €1 million issued, bonds from financial and non-financial corporates help to reduce $CO_2$ emissions by an average of 998 tonnes. As opposed to this, Supranational and Municipal issuers account for an average reduction of 329 and 22 tonnes $CO_2$ per €1mln issued, respectively.

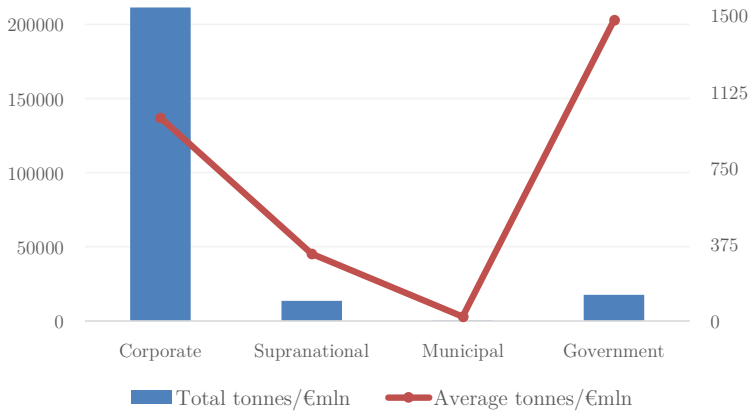



Figure 6.24: Total and average $CO_2$ avoided and/or reduced (per million Euro) per issuer's type.

Instead, analysing these metrics according to deal-sizes, from Figure 6.25 that large bonds (above €500 million) are more likely to mitigate more $CO_2$ emissions. This, as we are still speaking in absolute terms, is due to the fact that large issuances allow for larger projects to be financed, or in general finance numerous projects, thus allowing for better results in these terms. In addition to this, the result is also due to MainStreet Partners' focus on large issuances, as specified numerous times.

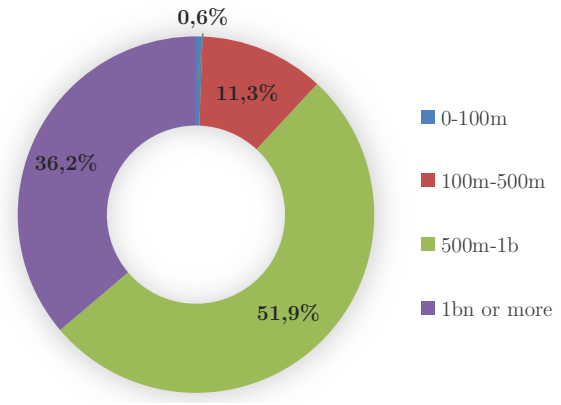



Figure 6.25: Proportion of deal-sizes per tonnes of $CO_2$ avoided and/or reduced.

These outcomes change slightly if we consider averaged values. In fact, as we can see from Figure 6.26, the smallest bond size (less than €100 million) performs best, with approximately 1,309 tonnes of GHG emissions avoided and/or reduced per million euro. However, this result is clearly distorted by the fact that these types of instruments are of too low a numerosity in our dataset, and therefore the result is not significant. Leaving this aspect aside, the other values are in line with the above.

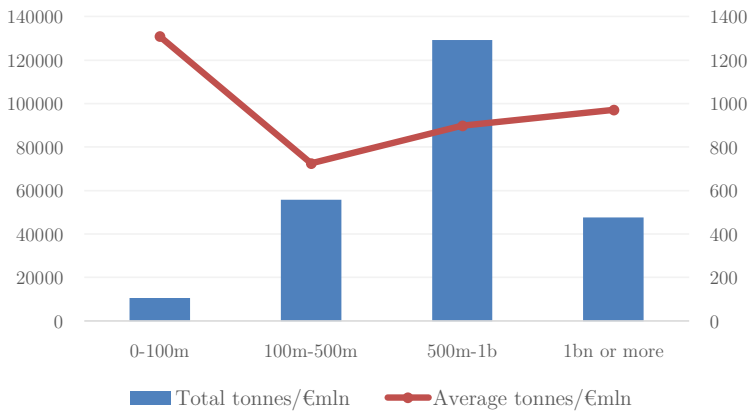



Figure 6.26: Total and average $CO_2$ avoided and/or reduced (per million Euro) per deal-size.

### 6.3.2. Impact Reporting: Renewable energy capacity added

Turning now to the second metric under analysis (i.e., "*renewable energy capacity added*"), we can see from Figure 6.27 that, also in this case, Green Bonds are the protagonists. Indeed, of the 58,788 MW of renewable energy capacity added by bonds in our dataset, 51,120 MW (87.0%) came from Green Bonds, while only 7,668 MW (13.0%) came from Sustainability Bonds. Also in this case we can say that this result is obviously biased because there are far more green instruments than sustainable ones, as has been noted previously on numerous occasions.

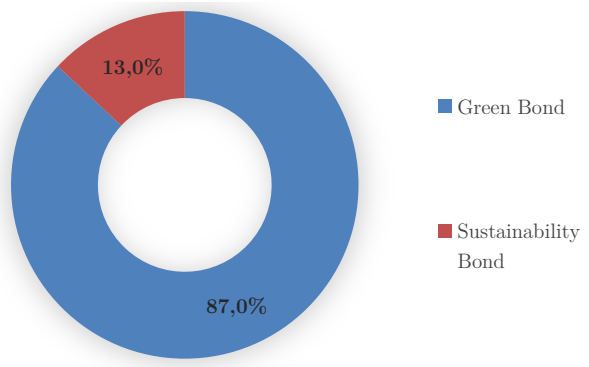



Figure 6.27: Proportion of instrument's types per MW of renewable energy capacity added.

However, the situation is different when looking at average values on a €1mln basis. Indeed, as we can see from Figure 6.28, Sustainability Bonds perform better, allowing the addition of a capacity of 0.84 MW/€mln, against the 0.76 MW/€mln of the green counterparts.

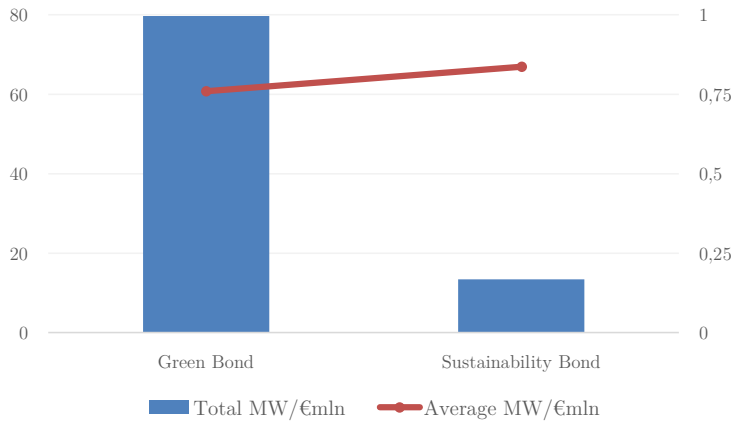



Figure 6.28: Total and average renewable energy capacity added (per million Euro) per instrument's type.

With regard to a geographical analysis, Figure 6.29 identifies the countries that have made the greatest contributions to the addition of renewable energy capacity as a result of programs backed by the issuance of Green and Sustainability Bonds. Again in this case, the three main regions are Europe, North America and Asia-Pacific. The logic still relies on absolute numbers, so the impact will probably be greatest for the nations that issue the most bonds. Therefore, Due to the enormous amount of funding they have received, countries in these regions are able to fund more and bigger projects, which has a big impact on the renewable energy capacity added.

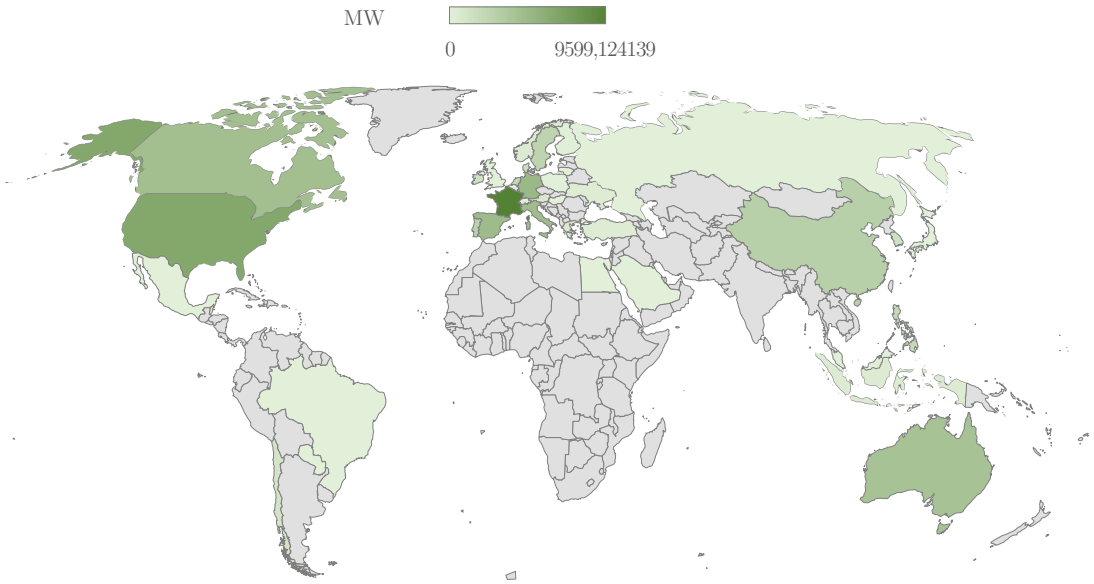



Figure 6.29: Worldwide geographical distribution of renewable energy capacity added.

Figure 6.30, in particular, lists the top countries in terms of the absolute volumes of energy capacity added. The fact that France and the United States are in the top two positions and are two of the biggest Green Bond issuers is not surprising. Besides France, Europe is represented by other major nations such as Germany, Spain and Italy. The Asia-Pacific region is represented mainly by Australia and China, while the first Latin America country is Chile at the 16$^{th}$ place.

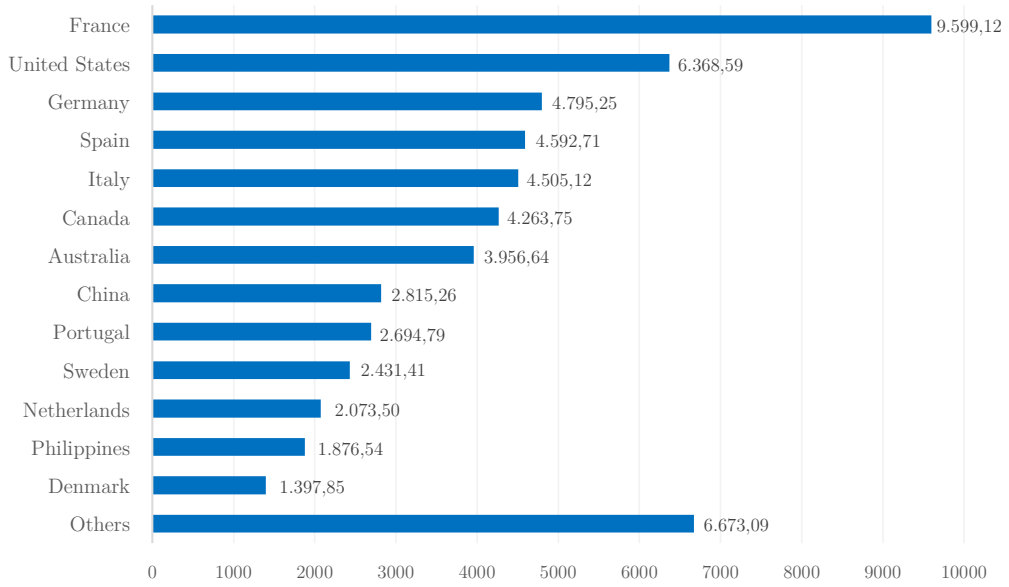



Figure 6.30: Renewable energy capacity added per country (MW).

Talking about averaged values, Figure 6.31 shows that Austria and Chile have the best performances, but their absolute amounts are too low to be considered statistically reliable. Therefore, the first relevant country turns out to be Australia, with an impressive 2.58 MW/€mln of additional renewable capacity. The other best results are from Sweden (2.43 MW/€mln), Philippines (2.18 MW/€mln) and Canada (1.52 MW/€mln).

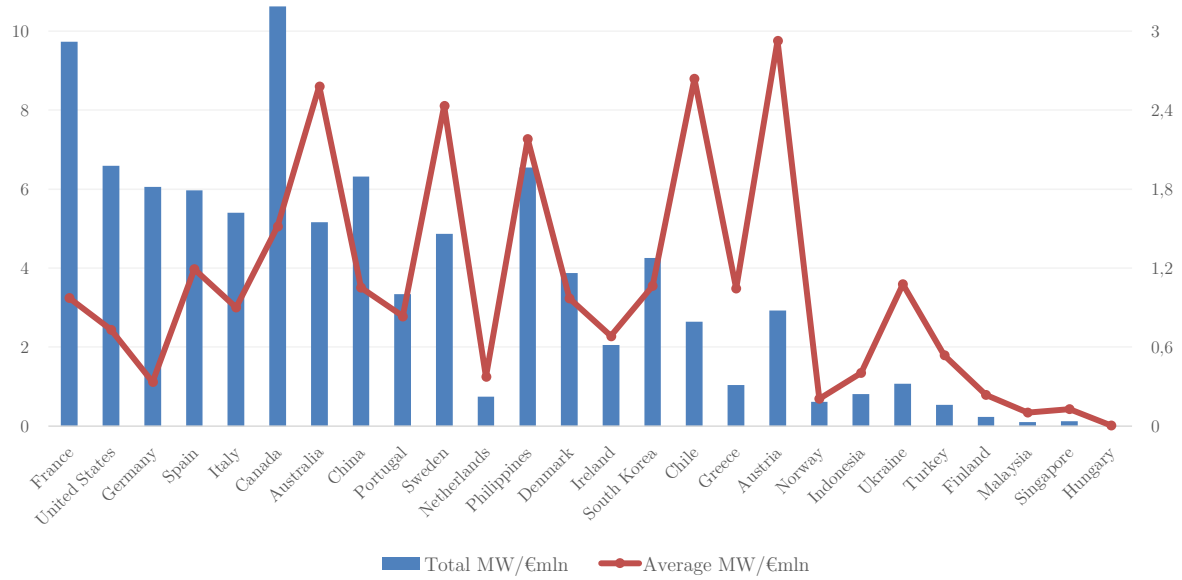



Figure 6.31: Total and average renewable energy capacity added (per million Euro) per country.

Turning to the geographical analysis per region, Europe is clearly the first area in terms of impact, contributing to the instalment of 60.5% of total renewable energy capacity added in absolute terms (Figure 6.32). Asia-Pacific and North America come next, with a percentage of 18.4% and 18.1% respectively. The minority is represented by Latin America and Supranational issuances, with a combined value of 3.0%.

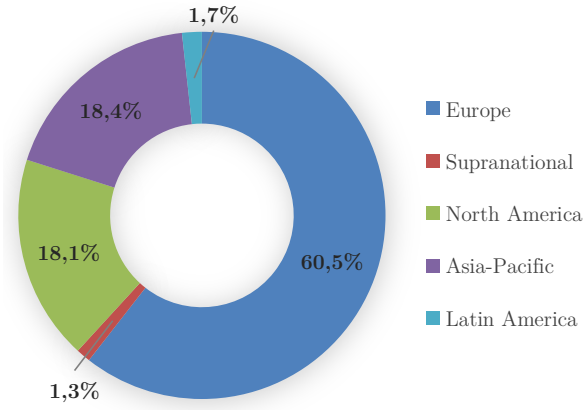



Figure 6.32: Proportion of regions per MW of renewable energy capacity added.

However, the results are different when considering averaged values. As can be seen from Figure 6.33, the most significant values see the Asia-Pacific region excel, contributing to add on average 1.19 MW of renewable energy capacity for each €1mln issued. This is then followed by North America (1.08 MW/€mln) and Europe (0.75 MW/€mln), with the results of the last two regions considered (i.e., Latin America and Supranational) not being significant.

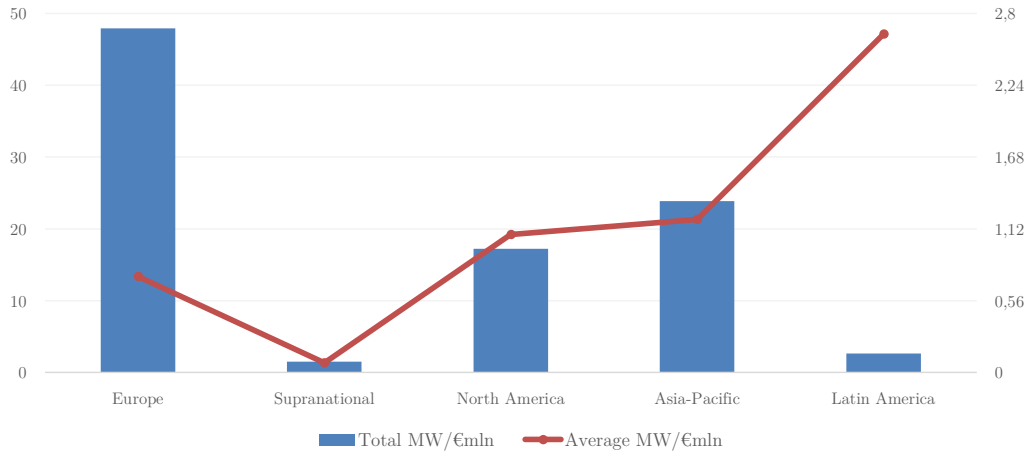



Figure 6.33: Total and average renewable energy capacity added (per million Euro) per region.

Looking instead at the situation regarding the type of issuers, we can see from Figure 6.34 how the results are in line with what was presented with the previous metric. Indeed, almost the entirety of the renewable energy capacity added through bonds in our dataset comes from corporate issuances (95.8%). The remaining part (4.2%) is split among the remaining categories, with the proportion of Municipal bonds being almost zero.

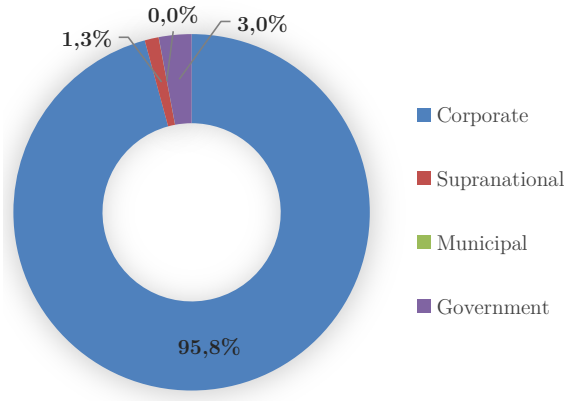



Figure 6.34: Proportion of issuer's type per MW of renewable energy capacity added.

Considering average results (Figure 6.35), findings are rather in line with the ones obtained from the previous graph. Also here, corporations result to perform better, allowing the addition of an average of about 0.93 MW/€mln. The other values are not highlighted as they are statistically insignificant.

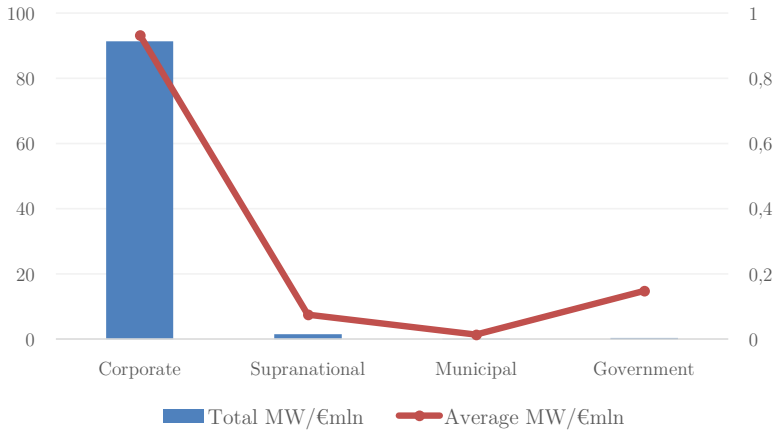



Figure 6.35: Total and average renewable energy capacity added (per million Euro) per issuer's type.

We conclude the discussion regarding this impact metric by analysing any correlations with the deal-size of the bonds within our dataset. As illustrated by Figure 6.36, larger bonds emerge, also in this case, as best performers in terms of adding capacity from renewable energy sources. In particular, 81.7% of the installed capacity recorded in our sample comes from emissions over €500 million. The remainder is allocated to bonds in the range 100m-500m, while smaller bonds recorded aggregate values of essentially zero.

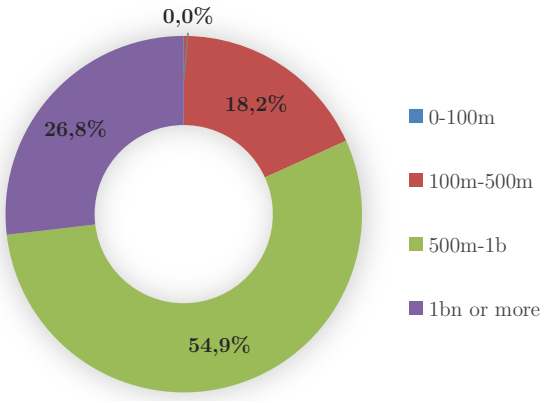



Figure 6.36: Proportion of deal-sizes per MW of renewable energy capacity added.

If we consider averaged values, these results slightly alter. As shown in Figure 6.37, bonds in the 100m-500m actually perform the best, allowing the installation of 0.89 MW of renewable energy capacity per million euro. For the 500m-1bn range the results are very similar (0.83 MW/€mln), while for the ten-digit bonds the results are below expectations, with only 0.51 MW/€mln of renewable capacity added. Once again, the smallest bonds performed the least well, also due to their low numerosity within our dataset.

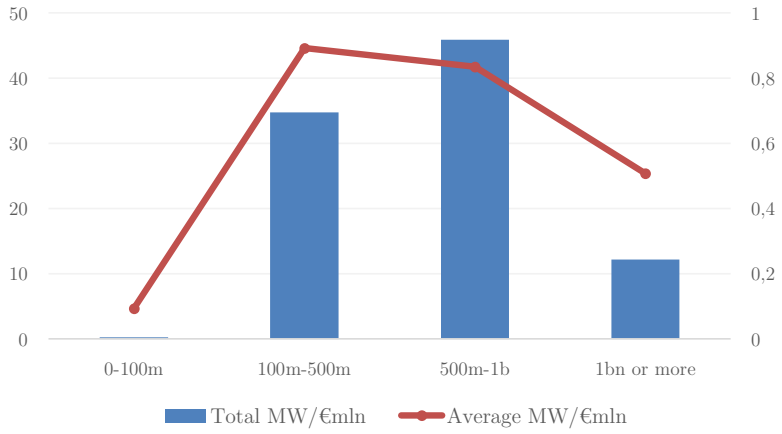



Figure 6.37: Total and average renewable energy capacity added (per million Euro) per deal-size.

### 6.3.3. Impact Reporting: Energy produced from renewable energy added

We now conclude the chapter with an analysis of the third impact metric (i.e., "*energy produced from renewable energy added*"). As can be seen in Figure 6.38, Green Bonds again appear to be the largest contributor of impact data in our dataset, albeit in a smaller percentage than the two measures previously analysed. In particular, 77.9% of the energy produced from renewable energy from bonds in our sample comes from green debt instruments, while the remaining 22.1% comes from the sustainable counterparts.

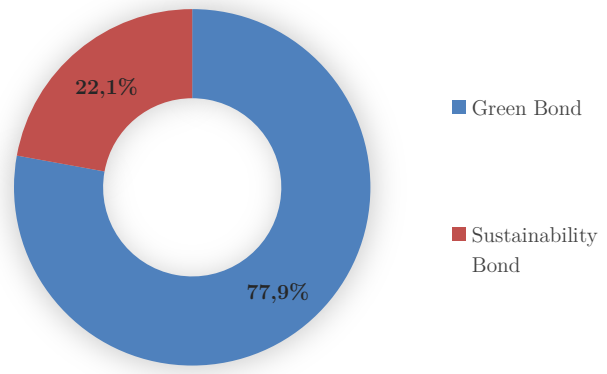



Figure 6.38: Proportion of instrument's types per MWh of energy produced from renewable energy added.

However, as in the case of the previous metric, the results differ when considering averaged values. In fact, as can be seen from Figure 6.39, Sustainability Bonds generate on average about 3,228 MWh/€mln, while Green Bonds generate on average only 1,583 MWh/€mln.

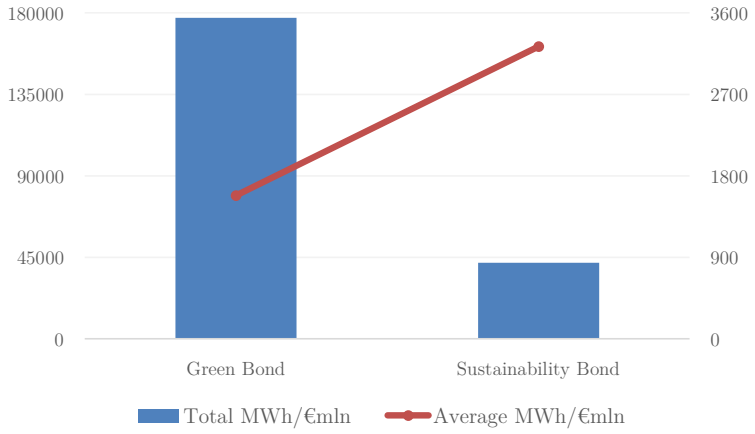



Figure 6.39: Total and average energy produced from renewable energy added (per million Euro) per instrument's type.

Regarding the geographical scope, Figure 6.40 shows, as always, the countries that have made the greatest contributions to the generation of renewable energy as a result of programs backed by the issuance of Green and Sustainability Bonds. As usual, we can see the three main areas: Europe, North America and Asia-Pacific.

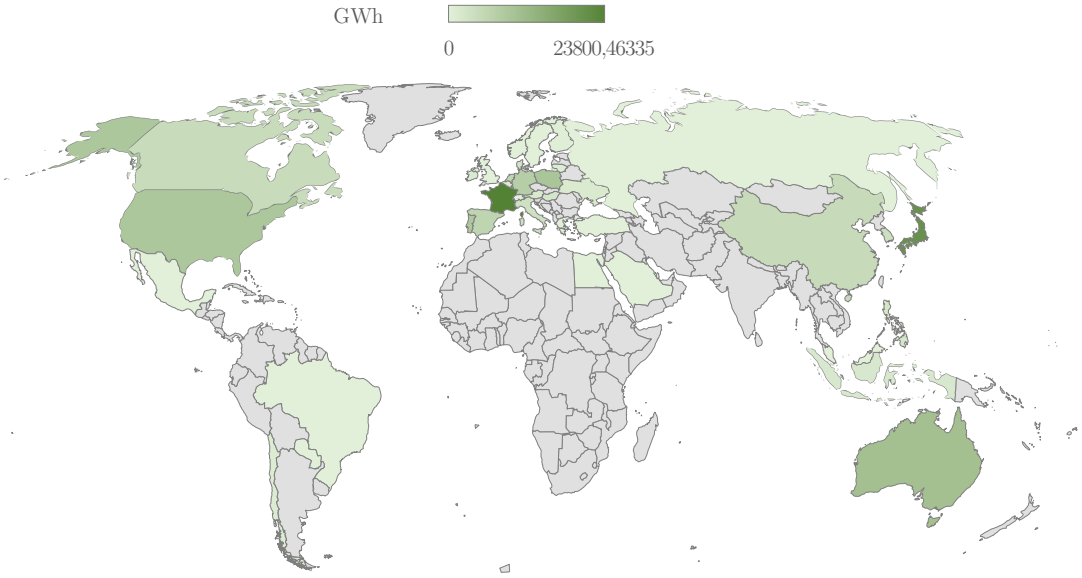



Figure 6.40: Worldwide geographical distribution of energy produced from renewable energy added.

Going into more detail, Figure 6.41 displays that France is the best performer also in this ranking, with more than 23,800 GWh of renewable energy generation. In the following positions we find players that we have not yet highlighted, including Japan (20,468 GWh), Australia (10,407 GWh) and Poland (9,207 GWh). The United States, which as we recall is one of the largest issuers of Green Bonds, ranks only fifth, with about 8,894 GWh of renewable energy generated. Apart from France, Europe does not perform well in this impact metric. In particular, we find Portugal, Germany, Spain and the Netherlands only in sixth, seventh, eighth and ninth place respectively. Italy, which usually placed consistently in the top ten, is here in thirteenth place, with about 3,140 GWh of renewable energy produced.

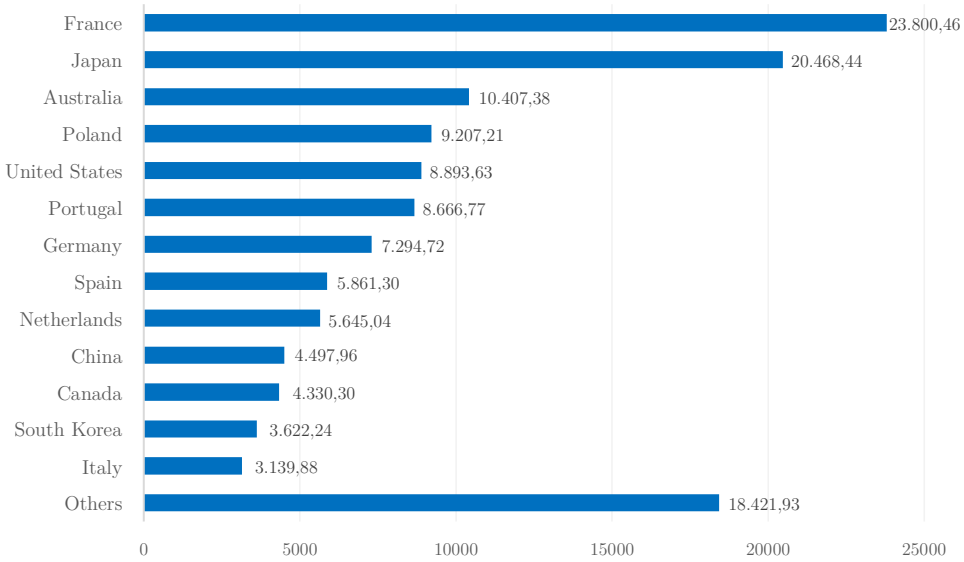



Figure 6.41: Energy produced from renewable energy added per country (GWh).

Considering averaged values, outcomes change a lot. In particular, as shown in Figure 6.42, the best performer is Japan, with about 27,482 MWh of renewable energy produced every million euro. This is followed by Austria and Australia with 7,868 MWh/€mln and 7,458 MWh/€mln of energy generated respectively. France, which excels in absolute terms (as French bonds are very numerous in the dataset), does not perform so well here, recording around 2,032 MWh/€mln of energy produced.

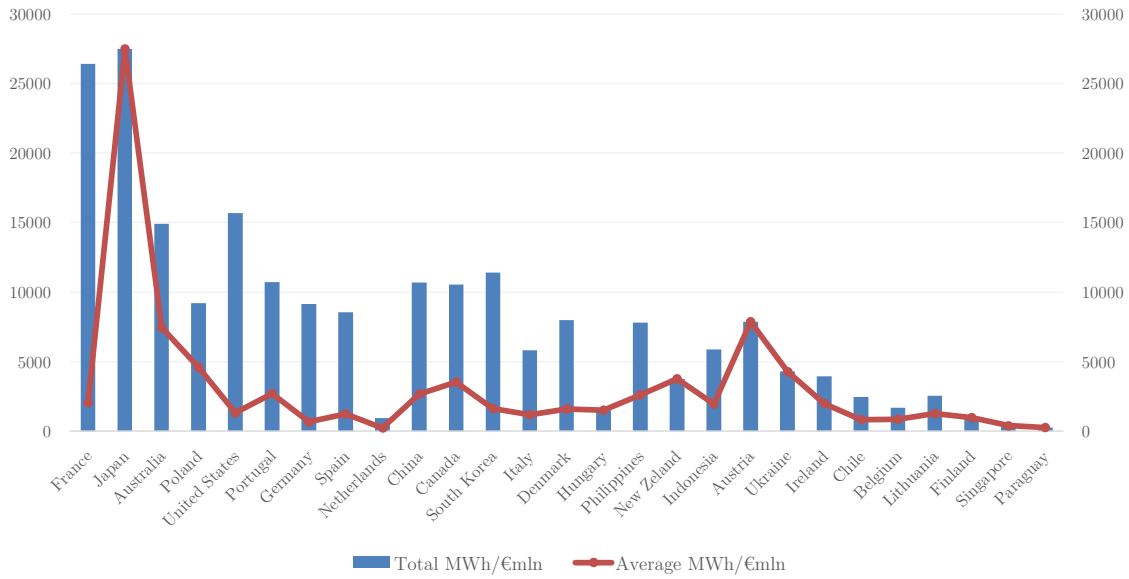



Figure 6.42: Total and average energy produced from renewable energy added (per million Euro) per country.

Talking about geographic regions, Figure 6.43 illustrates that Europe leads with 52.6% of the total energy generation, followed by Asia-Pacific (31.4%), North America (9.2%) and Supranational issuances (6.1%). The remaining minority portion (0.7%) is represented only by Latin America issuances, as there is no data available for African bonds. Overall, these findings are more or less consistent with those previously demonstrated for the $CO_2$ avoided and/or reduced metric, indicating that regions that have an impact according to one metric frequently outperform others in terms of environmental indicators.

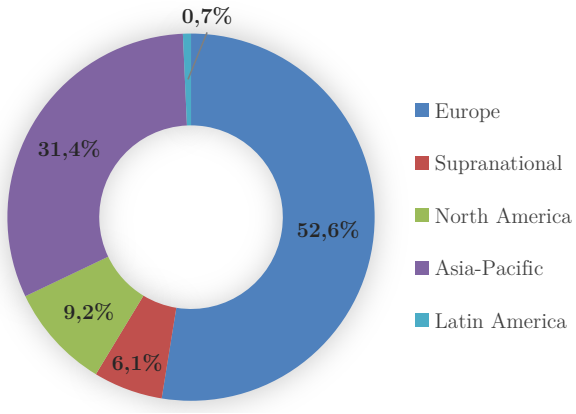



Figure 6.43: Proportion of regions per MWh of energy produced from renewable energy added.

Considering average results (Figure 6.44), looking at the top three regions, Asian bonds are once more the ones with the highest impact value per €1mln. Each million issued in the Asia-Pacific region, in particular, allows producing an average of 3,579 MWh of renewable energy. In this case, North America has the second-highest impact (1,749 MWh/€mln), outperforming Europe, whose bonds finance the production of 1,452 MWh of renewable energy for every €1mln issued. Again, due to a lack of sufficient data, the results from Africa and Latin America are hardly noteworthy.

Overall, based on the findings for the three metrics under consideration, it appears that bonds issued by European and Asian issuers have the greatest positive effects on society, at least in terms of tonnes of $CO_2$ avoided and/or reduced, MWh of renewable energy produced, and MW of capacity added. Moreover, aside from Supernational issuances, European bonds are the ones with the most impact reports available. This highlights once and for all how, when compared to other geographical areas, the European market for Green and Sustainability Bonds is likely the most mature and developed. In contrast, although the United States is one of the nations that issues the most green and sustainable debt instruments overall, the impact reporting percentage is still quite low, and the impact metrics computed perform worse than those of the other regions. This demonstrates how

much room there is for improvement in the American market, both in terms of impact reporting procedures and real impact on society.

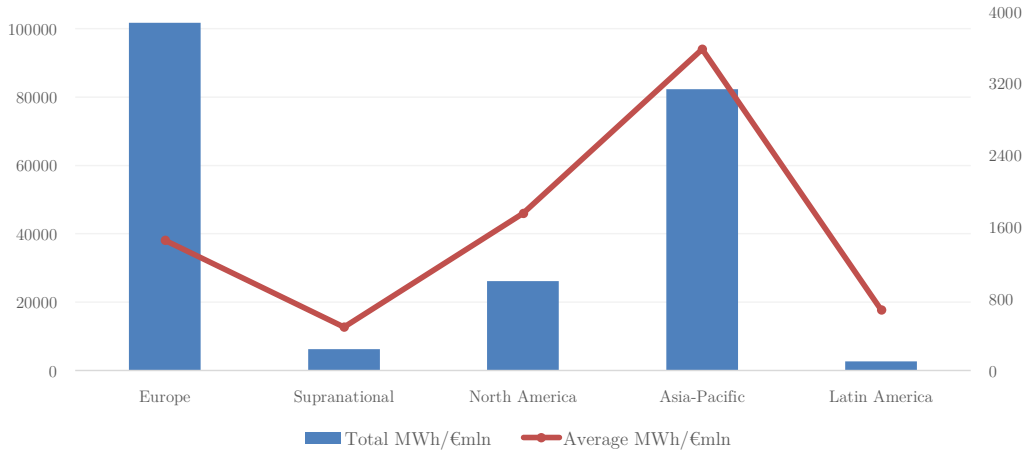



Figure 6.44: Total and average energy produced from renewable energy added (per million Euro) per region.

Instead, taking into account the analysis by issuer typology, the results are once more consistent with the GHG emission reduction findings, demonstrating the possible strong correlation between these two metrics. Indeed, Figure 6.45 underlines that, also in this case, corporates account for the vast majority of renewable energy produced (81.5%). Behind them, the remaining share is divided between Government issuances (12.4%) and Supranational issuances (6.1%). Again in this case, Municipal issuances represent only a very insignificant portion of the total.

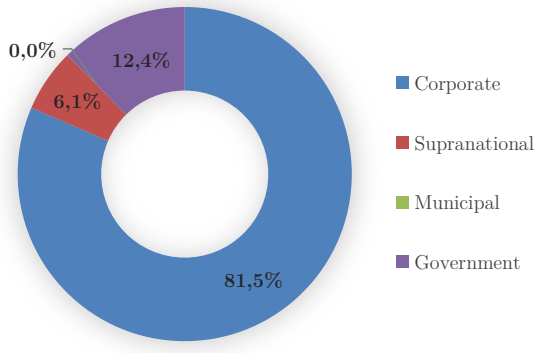



Figure 6.45: Proportion of issuer's type per MWh of energy produced from renewable energy added.

Even when looking at the averaged results (Figure 6.46), they appear to be very similar to those previously presented for $CO_2$ mitigation. In particular, in this case corporations

result to perform the best, as these players contribute to produce on average 1,960 MWh of renewable energy for each million euro issued. Slightly below are the Supranational players who contribute to generate on average 1,626 MWh of renewable energy for each million euro issued. This is not surprising, as these big issuers generally issue Green and Sustainability Bonds for financing large and long-term projects

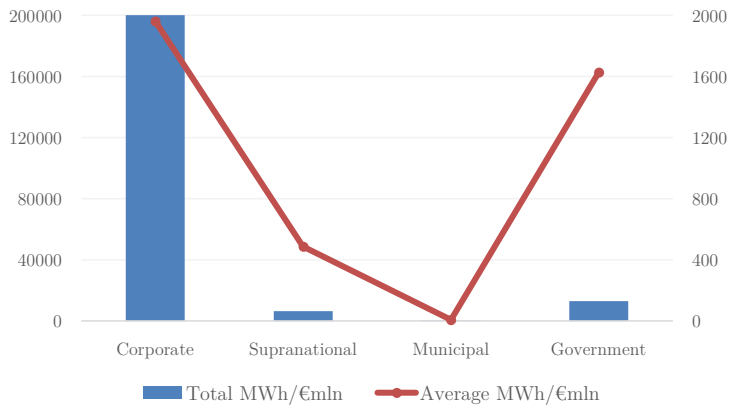



Figure 6.46: Total and average energy produced from renewable energy added (per million Euro) per issuer's type.

We conclude this discussion by analysing this impact metric in relation to bond size at the time of issuance. Figure 6.47 displays that, again in this case, bigger bonds result to be the most impactful. Indeed, 85.0% of the energy generation in the dataset comes from bonds above the €500 million threshold. It must be emphasized again that this result is clearly distorted by the fact that these bonds are the most numerous within the database, given the focus of MainStreet Partners. The remainder part (15.0%) is allocated to bonds in the range 100m-500m, while smaller bonds recorded aggregate values of essentially zero.

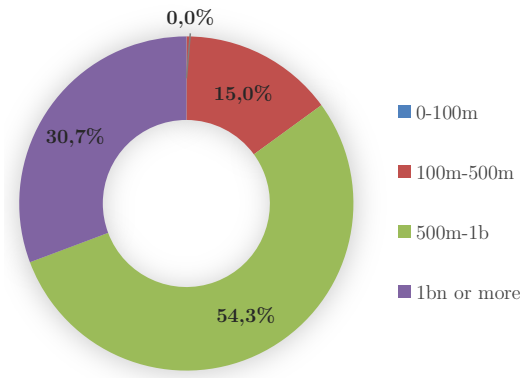



Figure 6.47: Proportion of deal-sizes per MWh of energy produced from renewable energy added.

Considering the averaged values, the results are more or less confirmed, albeit with slight differences. In particular, Figure 6.48 shows that bonds in the 500m-1bn range still perform the best, with an average of 2,205 MWh of renewable energy generated. Next we find bonds in the range 100m-500m and the instruments grater or equal than one billion, with an average energy generation of 1,606 MWh and 1,335 MWh respectively. Again, due to lack of relevant data, the smallest bonds performed the worst.

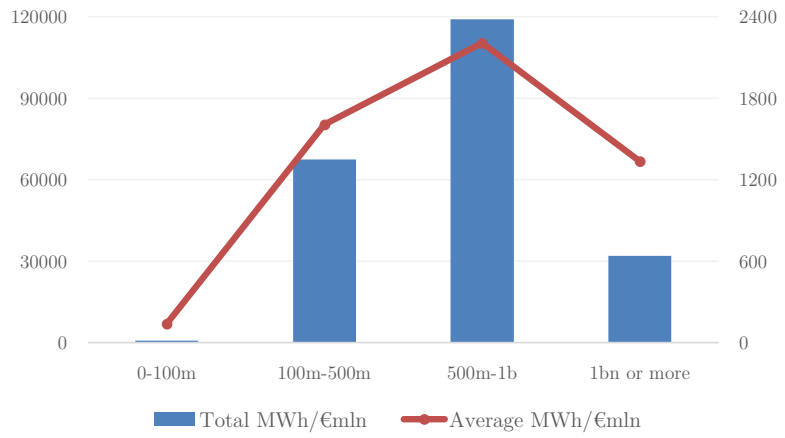



Figure 6.48: Total and average energy produced from renewable energy added (per million Euro) per deal-size.

We conclude reiterating that the impact data for the other metrics that were initially included in the dataset are too limited, as was stated at the beginning of this section, to allow for any useful analysis. Consequently, they are not taken into account in this section to avoid reporting approximate and statistically irrelevant outcomes.

# 7 | Empirical Research

In the last chapter, we emphasized how Green and Sustainability Bonds represent key instruments for the transition to a low-carbon economy, thanks to the objective impact these debt instruments have on society, which can be measured through a set of environmental metrics. However, the impact of this type of bond certainly does not stop at the social context. Indeed, as we saw in Chapter 2, many studies are aimed at examining the financial impact, mainly of Green Bonds, they have on issuers and also on possible investors. In particular, several authors have examined the effects of the issuance of these instruments on overall corporate environmental performance, while some other authors have attempted to relate Green Bonds to the issuer's financial and operational performance.

However, of all the papers concerning Green Bonds that are in the literature to date, none of them takes into consideration a fundamental aspect that we analysed in Chapters 4 and 5: the bonds' alignment to the European Taxonomy. This dissertation, therefore, aims to enrich the current literature by attempting to include this parameter, which today, but especially in the future, will be of fundamental importance and will be a determining factor in the choices of Green Bond issuers and, above all, investors. In the coming years, with the arrival of the new regulations already discussed in the previous chapters, corporates and institutions will be called upon to invest in increasingly sustainable projects, while investors will be more and more inclined to direct their capital towards investments that comply with standards and regulations.

Specifically, this thesis project aims to analyse if a relationship between the pricing at the time of issuance of Green Bonds and their alignment with the EU Taxonomy exist or not, in order to verify whether this fundamental parameter has any influence on the price of these debt instruments at the time they enter the market. Consequently, the organization of this chapter is as follows. The research questions that underpin this study will first be developed after a thorough explanation of the reasons why it was decided to focus on this particular feature. Next, the methodology followed to investigate these hypotheses will be explained in detail, starting with the analysis of our own data and ending with

the definition of the econometric model used in the subsequent studies. Finally, the key conclusions drawn from these investigations will be adequately discussed, along with the study's limitations and the need for additional research.

## 7.1. Research objectives

Despite being a relatively recent phenomenon, Green Bonds have been thoroughly examined by academic and managerial research, as outlined in the second chapter of the current thesis. A particularly active area of study is that of the potential effects of these novel debt instruments on the companies issuing them. Many academics have attempted to link the issuance of Green Bonds to the issuer's overall environmental performance. Others have gone further, researching the potential effects of the issuance of these instruments on various financial metrics of the issuers. However, we can state that most of the literature on Green Bonds is focused on studying the presence or absence of the so-called "*greenium*", which, as explained in previous chapters, represents a higher price for green instruments than the corresponding "traditional" ones. The objective of this thesis, therefore, is to identify a gap in the existing literature and a new, worthwhile research direction.

As previously stated, the Green Bond phenomenon is relatively new. Although the first green issuance took place in 2007, the market has only recently reached sizeable volumes. Therefore, despite the extensive academic research that has already been done on this subject, it is still possible to find new research areas, particularly when it comes to the topic of how Green Bonds relate to the European Taxonomy. In particular, this thesis aims at studying if a relationship between Green Bonds pricing and their EU Taxonomy alignment already exist or not. By concentrating on a particular aspect that has not yet been explicitly taken into account by existing literature, the current dissertation makes a novel and significant contribution to the field of research looking into the impact of Green Bonds. Furthermore, it's critical to emphasize how this research differs from the already crowded field of study that examines the performance of Green Bonds generally in comparison to conventional debt instruments. In fact, this study's objective is not to determine whether Green Bonds can be issued at a discount to "traditional" bonds.

Before describing the specific research questions on which this work is based, it is necessary to first explain why it was decided to concentrate on this particular field, outlining the factors that led to the formulation of the following research hypotheses. The subsequent paragraphs, in particular, will begin with a more general viewpoint before concentrating on the particular context of Green Bonds.

The significance of ESG (Environmental, Social, Governance) continues to rise and has

become a major area of focus for a variety of stakeholders, especially investors, as they recognize that environmental and social issues present some of the most difficult challenges of the decade. Large investors and the companies they hold in their portfolios now view the risks posed by conventional business models and the potential for long-term value creation differently as a result of the ESG movement. By taking into account ESG factors, investors get a more comprehensive understanding of the businesses they support, which can help reduce risk and spot opportunities for expansion and improvement. As a result, over the past five years, investors' interest in ESG issues has grown. According to recent estimates, ESG funds manage assets worth more than $330 billion, and more ESG funds are expected to be established in 2022. According to the Harvard Business Review, a number of distinct factors have contributed to this increased focus:

- *Investment firm size*: the top 15 asset managers hold 56.7% of the assets that are externally managed, reflecting the extreme concentration of the investment market. Due to their size, large investment firms are no longer able to reduce system-level risks using modern portfolio theory. This means that companies handling trillions of dollars have grown to a size where they are no longer able to prevent the collapse of the world economy;
- *Financial returns*: according to research from Harvard Business School, companies that started using organizational systems to track, manage, and communicate ESG performance in the early 1990s outperformed a carefully matched control group over the course of the following 18 years. Positive correlations between strong financial performance and strong performance on pertinent ESG issues have been found in numerous studies;
- *Growing demand*: Asset owners are increasingly asking asset managers for sustainable investing strategies because they are no longer in need of convincing about the value of doing so. Many asset management companies are rushing to create new options in response to the rising demand for ESG investment solutions;
- *Evolving view of fiduciary duty*: many investors still believe that sustainable investing entails forgoing some financial gain, and many have ignored ESG factors out of concern that they will have a negative impact on bottom-line returns. However, more recent judicial rulings and regulatory directives make it abundantly clear that failing to consider ESG factors constitutes a fiduciary duty violation;
- *Top-down adoption*: senior investment executives are also having an impact on ESG trends by mandating that analysts and portfolio managers conduct ESG analyses as part of their primary financial responsibilities. By incorporating ESG into financial

analyses, BlackRock, the largest asset manager in the world with $6.1 trillion in assets under management, has elevated itself to the position of ESG leadership. The company's CEO, Larry Fink, has long been a supporter of sustainable investing and has worked to fully incorporate ESG considerations into the firm's investment strategy over a number of years.

In general, we can say that the reasons investors care about ESG in their investment can be broadly classified into four categories: financial, competitive, strategic, and perception. Overall, investors consider ESG investments safer and more stable bets. In particular, the top five risks for investors are:

1. *Asset devaluation and long-term risk*: today, a crucial ESG focus is climate risk. The long-term financial viability of organizations is already impacted by potential infrastructure and property losses caused by climate change. When assessing a company's ESG profile, many investors look at its assessment of its readiness for various climate threats, as well as its ability to anticipate and respond to them. There are three main categories of risk to take into account as businesses start their risk assessments:

    - *Transition risk* refers to the climate policies and laws shifting the global economy away from fossil fuels. Examples of transition risks are policy and regulatory risks, technological risks, market risks, reputational hazards, and legal risks. These risks are connected, and investors frequently consider them as they attempt to negotiate a more aggressive low-carbon agenda that could have operational and financial repercussions for their assets;

    - *Litigation risk* surrounding $CO_2$ emissions. Class-action lawsuits and other legal issues that hold companies accountable for their role in contributing to global warming are more likely to be brought against those that produce and emit more $CO_2$ than others;

    - *Physical risks*, such as extreme weather and record temperatures, are now recognized as events that can be predicted and factored into financial planning. Chronic issues include things like warming temperatures, the spread of tropical pests, illnesses in temperate regions, and a quickening loss of biodiversity. Acute and long-term threats expose investors to both idiosyncratic and systemic risks.

    Investors also take into account the costs associated with the political unrest and conflicts that climate change may precipitate as well as supply chains that may be

impacted by extreme weather events in addition to these three main risks.

2. *Social and governance risk events*: ESG social factors can include things like how employees are treated, boycotts, labour laws being broken, and product recalls. These problems are varied, qualitative, and frequently have an immediate effect on every company stakeholder, from employees and clients to suppliers and local communities, upsetting the stability of the portfolio. A company's success depends heavily on its ability to maintain relationships with these stakeholders, especially if that company's success depends on the public's trust. Although the majority of investors are aware of good governance practices, there is no "one-size-fits-all" method. Finding out where and how best practices might affect business performance can be challenging. While most investors are aware of good governance practices, it can be challenging to pinpoint the specific areas and ways in which these practices might affect business performance;

3. *Access to information*: lack of regulations dictating what ESG measures and risks businesses must disclose, as well as the patchy, inconsistent nature of ESG communications, are major issues in the world of ESG investments. Investors frequently cite the inability to satisfy limited partner (LP) requests for ESG information as a major concern as they incorporate ESG data into their investment decision-making processes more and more. Investors have the chance to monitor progress and gather the vital data they need for peer comparison and risk reduction when the data is trustworthy, factual, and consistent. Businesses can collect enormous amounts of structured and unstructured data by using financial data, industry benchmarking, and artificial intelligence. All of this information can be used to reassure investors and report on advancements in ESG performance. Investors want to know in advance what LPs will ask for. Investment firms can outperform general partners by being prepared for those requests before they arise. Companies are being forced to better communicate their results as a result of the demand for meaningful ESG data and transparent information on sustainable practices;

4. *Perception*: Investments without a strong ESG program are perceived as being "backward" or "risk-averse," which can harm perceptions and reduce investment value. According to McKinsey, businesses that take ESG issues into account create more value. A strong ESG strategy is associated with higher stock returns, both from a tilt and momentum perspective. Higher credit ratings and lower loan and credit default swap spreads are just two examples of how better ESG performance is linked to better perceptions and lower negative risk. In particular, these are the strong ESG propositions found by McKinsey:

- By fostering a sense of trust, you can give your portfolio companies access to new markets and help them enter already-existing ones, giving them new opportunities for growth;
- Increase strategic freedom for businesses by easing regulatory pressure, lowering their risk of government action, and winning government support;
- Help companies attract and retain quality employees, enhance employee motivation by instilling a sense of purpose, and increase productivity overall. This is important because shareholder returns and employee satisfaction are positively correlated.

5. *Regulatory risks*: In Gartner's 2021 Emerging Risks Monitor Report, the regulatory risk associated with ESG disclosures quickly climbed to the second-top concern. A survey of 153 senior executives found that ESG regulatory requirements present enterprises with both significant risks and opportunities. The demand for ESG disclosures is anticipated to increase even further in 2022 as a result of ongoing climate-related disasters, unpredictable weather patterns, stricter regulations regarding GHG emissions, growing demand for renewable and sustainable energy, ethical issues with supply chains, and concerns over social and governance issues. Executives have long worried about investor pressure on ESG disclosures, but in some jurisdictions, established legal frameworks are just now beginning to take effect. The Securities and Exchange Commission (SEC) supported a proposed rule requiring companies to disclose their climate risks and information on greenhouse gas emissions (GHG) in annual SEC filings by a vote of 3-to-1 in April of this year. Currently, a lot of businesses publish data on their GHG emissions. Approximately 92% of the S&P 500 companies, according to the Governance & Accountability Institute (G&A), already publish a sustainability report. The new proposal, however, will mandate that businesses track, manage, and plan their environmental data as well as view transition risk in a more organized, methodical manner. Companies and funds alike need to implement ESG frameworks and strategies from the top down in order to get ready for upcoming mandates. Cross-functionally mapping out ESG strategies and risks while working to gather information on pertinent, important ESG metrics should be the first step in those ESG efforts.

As we have just explained, there is a clear increase in investor interest in environmental and social issues, both for risk mitigation reasons and to take advantage of new opportunities in the financial markets, but also for regulatory compliance reasons. This topic is increasingly of paramount concern as we stand on the eve of the COP26 climate change

conference, where powerful crosscurrents are confronting leaders who are charting a course for their institutions and the planet. Decarbonizing the global economy is an enormous task with wide-ranging economic trade-offs that will test nations, industries, companies, and individuals, and that is one unavoidable reality. Another is the expanding influence of the environmental, social, and governance (ESG) movement, which prompts major investors and the businesses they hold in their portfolios to reevaluate the dangers of conventional business models and the prospects for future value creation that is more sustainable.

Summarizing all these considerations, it seems reasonable to study the relationship between the Green Bond yield at issuance and the alignment to the European Taxonomy. This is because, as we have seen, the growing interest in investing more and more in environmental projects is a trend that characterizes the present of the financial markets, and will be increasingly marked in the future. Moreover, to date there is no study that considers the alignment of a bond to the EU Taxonomy, and we believe this can be a key parameter for investors and asset managers to identify the goodness and quality of these debt instruments. In particular, our first hypothesis is that the yield at issuance of a Green Bond is correlated with its alignment to the European Taxonomy. This hypothesis was formulated because, as we have seen in the previous chapters, the European Taxonomy introduces fundamental parameters and requirements for Green Bonds that in the future will have to be compulsorily met by issuing companies and institutions. Therefore, our idea is that, in recent years, investors have been using this parameter for their investment decision-making. Going more specific, it is reasonable to assume that a Green Bond with a high score in terms of alignment to the European Taxonomy has a lower yield at issuance than Green Bonds with a lower alignment. This translates in a negative correlation between the yield at issuance of a Green Bond and its degree of alignment with the EU Taxonomy. This hypothesis stems from the results of the study by Löffler, Petreski and Stephan (2021) on the existence of greenium. In particular, the hypothesis of a negative correlation between the yield of a Green Bond and its level of alignment with the EU Taxonomy stems from the fact that, as a result of the aforementioned study, it appears that investors are willing to accept a lower return of their investment in exchange for a higher quality green investment, both because of the lower underlying risk associated and because "*they have a pro-environmental preference*". Therefore, it is reasonable to assume that an investor would be willing to "give up" part of his financial return in order to grab a Green Bond with the highest degree of alignment to the EU Taxonomy, and thus a debt instrument that is as close as possible to the requirements defined by regulation. Summarizing, the first research hypothesis is formulated as follows:

**H1a**: The yield at issuance of a Green Bond is correlated to its level of alignment with the European Taxonomy.

On the other hand, it is reasonable to assume that a correlation between these two parameters does not exist at this time. This claim stems from the fact that the EU Taxonomy is currently just a best practice rather than a rigid rule. As a result, it is possible that businesses, institutions, and governments are not yet fully implementing all the new standards and criteria introduced by this new regulation. Summarizing, the second research hypothesis is formulated as follows:

**H1b**: The yield at issuance of a Green Bond is not correlated to its level of alignment with the European Taxonomy.

By means of these two hypotheses, the primary goal of this thesis is to significantly contribute to the body of knowledge on the topic of Green Bonds. After this discussion, the following section will explain how the two research questions were examined and the methodology used to evaluate their validity.

## 7.2. Methodology

After outlining the research questions, the next few paragraphs will describe the methodology that was employed to test it. In particular, in order to test our hypothesis, it has been decided to use a cross-sectional OLS (Ordinary Least Squares) regression model. Before delving into the definition of the model itself, however, the bonds' database at our disposal will be presented and the phase of collecting additional data needed to perform our analysis will be analysed.

### 7.2.1. Dataset composition and data collection

In order to perform this analysis, it is necessary to have a database of sustainable bonds in which, for each debt instrument, a specific analysis was performed to determine its alignment with the EU Taxonomy. Therefore, to perform the analysis, we will use the bond database that was built together with MainStreet Partners, and already presented in Chapter 5.

However, in order to ensure consistency and quality of the results obtained from our analysis, it was necessary to remove some bonds from the dataset. In particular, our analysis will focus, as already stated, only on Green Bonds and therefore not on other

debt instruments. Therefore, 91 Sustainability Bonds, 5 Transition Bonds and 1 Thematic Bond were removed from our initial database of 462 bonds, resulting in a sample of 365 Green Bonds. Subsequently, we decided to focus on a specific time interval of analysis, depending on the amount of data at our disposal. In particular, we decided to conduct the study for bonds issued in the years 2017-2020, thus eliminating all debt instruments in our dataset that are not part of this range. In particular, we removed 1 bond from 2021, 9 bonds from 2016, 6 bonds from 2015, 4 bonds from 2014 and 1 bond from 2012 (removed in total 21 bonds), thus arriving at a sample of 344 bonds.

At this point, we realized that there were 8 perpetual Green Bonds in our dataset, which we decided to remove to ensure uniformity of the final results. A perpetual bond, also known as a "consol bond" or "perp", is a fixed income security with no maturity date. Because of this, this type of bond is often considered a type of equity, rather than debt. Issuers of these types of instruments pay coupons forever, and they do not have to redeem the principal. Perpetual bond cash flows are, therefore, those of a perpetuity. Given the strong distinctiveness of these types of instruments, their low number in our sample, and since the maturity date will be a key parameter that we will use in the later stages of the analysis, these bonds were extracted from the database, which thus now consists of 336 Green Bonds.

After an initial skimming of the data already at our disposal, a data collection phase became necessary. The main source used to gather the needed information was Eikon, a set of software products provided by Refinitiv for financial professionals to monitor and analyse financial information. In particular, through this platform, we carried out a manual bond-by-bond check and collected the necessary information to continue with the analysis. Going more specific, the parameters we needed were:

- *Coupon type*: through this parameter we defined, for each bond in our dataset, whether the coupon type is *fixed* or *floating*. Most bonds on the market, in fact, are of the fixed rate type, and this means that coupons are set at issuance and do not change over the life of the bond. Floating rate bonds, instead, have variable coupons, equal to a money market reference rate, like LIBOR or federal funds rate, plus a quoted spread (the spread is a rate that remains constant);
- *Bond's ratings*: a bond rating is a way to measure the creditworthiness of debt instrument. These ratings typically assign a letter grade to bonds that indicates their credit quality. Private independent rating services such as Standard & Poor's, Moody's Investors Service, and Fitch Ratings Inc. evaluate a bond issuer's financial strength, or its ability to pay a bond's principal and interest, in a timely fashion.

We have, therefore, for each bond in our dataset, defined its rating according to these three main rating agencies. Clearly, not every bond had a rating from all three agencies, while a few bonds did not have any of this rating information at all;

| Long-Term Rating Scales Comparison | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Standard & Poor's | AAA | AA+ | AA | AA- | A+ | A | A- | | |
| Moody's | Aaa | Aa1 | Aa2 | Aa3 | A1 | A2 | A3 | | |
| Fitch IBCA | AAA | AA+ | AA | AA- | A+ | A | A- | | |
| Standard & Poor's | BBB+ | BBB | BBB- | BB+ | BB | BB- | B+ | B | B- |
| Moody's | Baa1 | Baa2 | Baa3 | Ba1 | Ba2 | Ba3 | B1 | B2 | B3 |
| Fitch IBCA | BBB+ | BBB | BBB- | BB+ | BB | BB- | B+ | B | B- |
| Standard & Poor's | CCC+ | CCC | CCC- | CC | C | D | | | |
| Moody's | Caa1 | Caa2 | Caa3 | Ca | C | | | | |
| Fitch IBCA | CCC+ | CCC | CCC- | CC | C | D | | | |

Figure 7.1: Comparison between Moody's, S&P, and Fitch rating scales.

Source: Bank for International Settlements.

- *Bond "callability"*: through this parameter, we defined if the bond under analysis is categorized as *callable bond*. A callable bond, also known as a redeemable bond, is a bond that the issuer may redeem before it reaches the stated maturity date, allowing the issuing company/institution to pay off their debt early. An issuer may choose to call its bond if market interest rates move lower, which will allow it to re-borrow at a more beneficial rate. Callable bonds thus compensate investors for that potentiality, as they typically offer a more attractive interest rate or coupon rate due to their callable nature;
- *Yield at issuance*: lastly, the key parameter we need is the yield at issuance for each bond in the dataset. The yield at issuance of a bond can be defined as the yield to maturity of such bond from the initial date of delivery.

In our Green Bonds dataset, we found only 32 floating rate bonds (9.5% of the sample), which we decided to omit from the study. We decided to focus the study on fixed rate bonds because, as already mentioned, the objective is to analyse the pricing of these instruments, so the difference in coupon payment methods could affect the final results, and therefore provide unreliable outcomes.

Finally, we removed from the sample 33 Green Bonds for which no information was available regarding yield at issuance. Clearly, as this is a key parameter in our analysis, it must be present for each observation. Therefore, from the 462 starting bonds, the official database used to conduct the analysis consists of 271 Green Bonds. A summary of the

entire evolution of the dataset can be found in Figure 7.2.

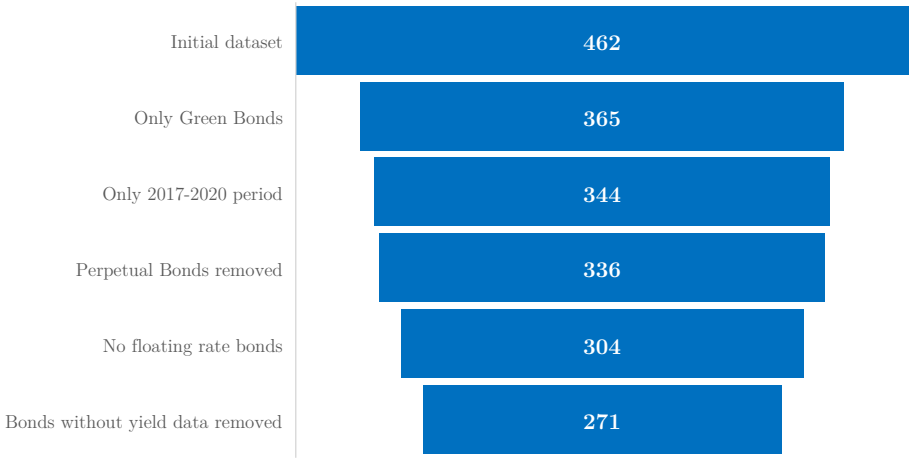



Figure 7.2: Evolution of the bonds' dataset (number of bonds).

Now, before proceeding with the discussion of the model used for the analysis, it is necessary to present the main characteristics of our final database. This allows us to understand and focus on what the main attributes and connotations of our sample are.

Starting with a geographical analysis, Figure 7.3 shows the regional distribution of the 271 Green Bonds in the dataset. Not surprisingly, the most represented regions resulted to be Europe (59.7%), and this is due both to MainStreet Partners' focus on European bonds and to the fact that, as we have extensively emphasized before, the Eurozone is a reference point for investments in environmental sustainability. This is followed by the North America region (17.3%), Supranational issues (11.4%) and the Asia-Pacific region (11.1%). Finally, again, the Latin America and Africa regions play only a marginal role, accounting for the remaining 2.2% of the database. In general, the results are fairly consistent with what was presented in Chapter 5 (Figure 5.9).

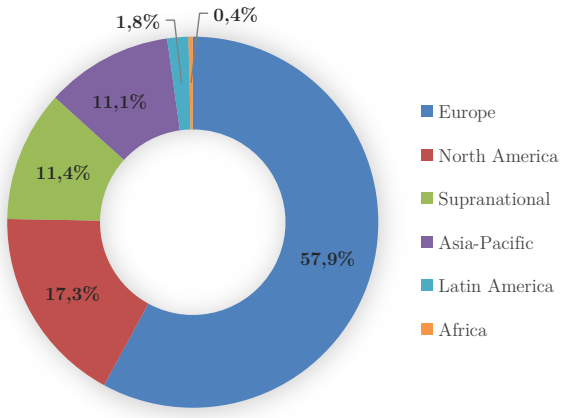



Figure 7.3: Geographical distribution of the reference sample (regions).

Speaking of individual nations, we can see from Figure 7.4 that France remains the most represented, with no less than 35 bonds. Again, the results are quite compatible with what was shown in previous chapters (Figure 5.8), as we see that the other most represented nations are large countries such as United States (27), Netherlands (26), Germany (23) and Canada (20). Here, Italy ranks seventh, with 11 Italian Green Bonds in the database (4.1% of the overall sample).

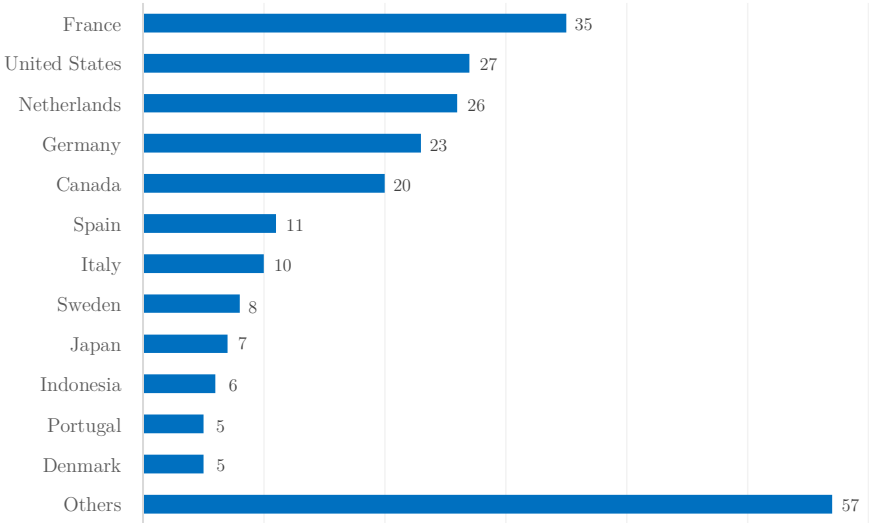



Figure 7.4: Geographical distribution of the reference sample (countries).

After briefly defining the geographic scope of the database, we turn the discussion towards the type of issuers of the 271 Green Bonds that make up our final sample. As expected, most of the bonds in the database were issued by corporations, with Non-Financial players taking the majority stake (59.0%), while Financial firms accounted for "only" 19.9%.

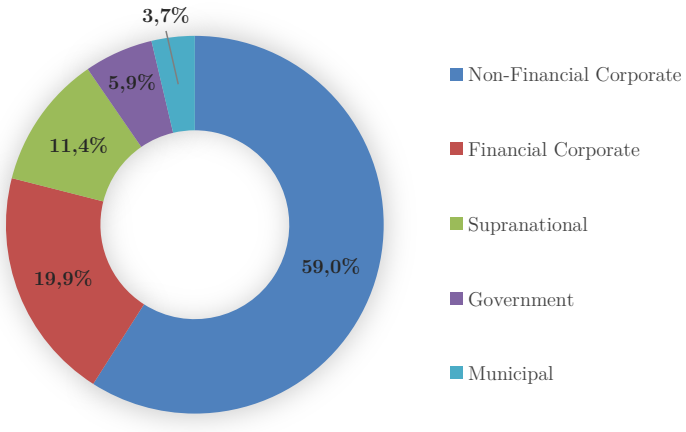



Figure 7.5: Issuers' typology distribution of the reference sample.

The remaining 21.1% is mainly represented by Supranational players (11.4%), while Governments (5.9%) and Municipalities (3.7%) account for only a marginal part of the total sample.

These results are particularly misaligned when compared to what was seen in Chapter 3 (Figure 3.10). There, in fact, we saw how Financial and Non-Financial corporates account for only about half (53.4%) of Green Bonds issuers, whereas in our dataset, these two types of issuers account for almost 80%. This misrepresentation of Supranational, Governmental and Municipal issuers is probably due to the research work carried out by MainStreet Partners. As we noted during data collection, indeed, the documentation provided by the individual companies is most often more comprehensive, detailed and more easily accessible in the various communication channels (mainly websites).

In order to further enrich this analysis, we went to check, bond by bond, the sector of the entities issuing Green Bonds in our database. The results of this brief search are summarized in Figure 7.6. As is clearly visible, the main sectors of issuers are banking (28.9%) and energy (26.0%). This seems to make a lot of sense, since banks are known to be the financial institutions most likely to issue these types of instruments. On the other hand, since the present discussion focuses on Green Bonds, it is normal to find companies operating in the Power and Energy sector, since the intrinsic objective of these instruments is precisely that of mitigating climate change as much as possible, also through investments in energy sources and plants that are increasingly aimed at zero impact (solar, wind, hydroelectric, geothermal, . . . ).

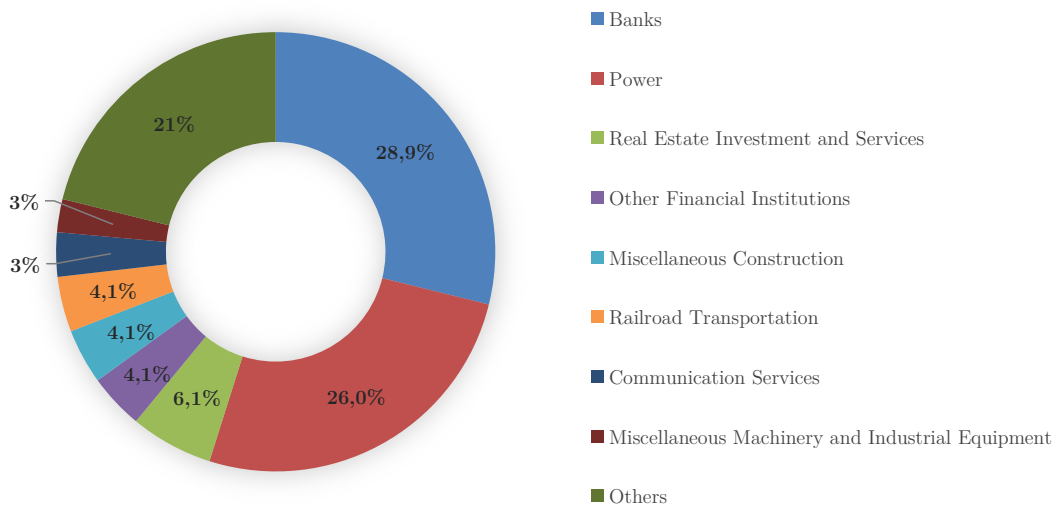



Figure 7.6: Sector distribution of the reference sample.

With regard to the remaining sectors mentioned, in third place we find the "Real Estate Investment and Services" sector, although we are already talking about a much smaller representation than the sectors just mentioned (6.1%). Other areas worthy of mention include "Miscellaneous Construction"[19] (4.1%), "Railroad Transportation" (4.1%), "Communication Services" (3%) and "Miscellaneous Machinery and Industrial Equipment" (3%).

We conclude this brief presentation of our database used for the analysis by looking at the distribution of these bonds over time. In particular, we will look at both the issuance period of these debt instruments and the maturity date.

As we have already mentioned, the final database includes Green Bonds issued in the 2017-2020 timeframe. Figure 7.7 displays that the majority of the bonds in the dataset were issued in 2020 (40.6%) and in 2019 (34.3%). This is mainly due to the fact that, although the first Green Bonds were issued as far back as 2007, the green finance market has been booming especially in recent years. Therefore, it is understandable that MainStreet Partners has bonds from these years within its systems, as they are numerically more relevant than those issued in the past. The remaining part of the database is divided between Green Bonds issued in 2018 (15.1%) and 2017 (10.0%), which represent the minority.

[19]Miscellaneous construction elements means a variety of construction elements or activities such as, but not limited to: reservoir linings, parapet walls or low berms for wave containment, minor reconstruction of isolated portions of the impounding barrier, internal drainage improvements, and erosion protection.

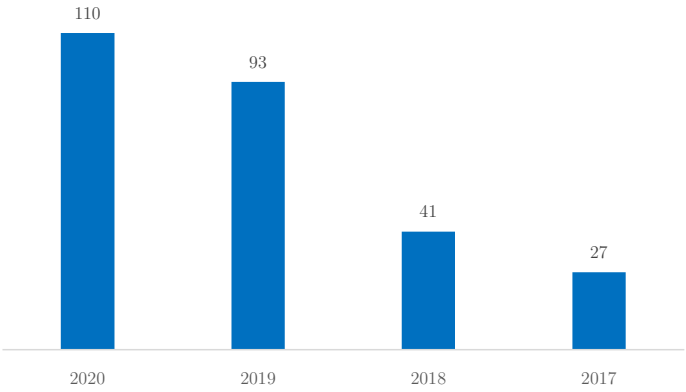



Figure 7.7: Yearly distribution of the reference sample (issuance).

Turning now to the termination dates of these debt instruments, as shown in Figure 7.8, these turn out to be spread over much longer time horizons. Most of these Green Bonds have a maturity date that falls in the time frame 2024-2027, which indicates a rather short average life of these instruments if one takes into account that they were issued in the years 2017-2020. Another outcome to keep an eye on is the peak of deadlines in 2030. Clearly this date is related to the United Nations 2030 Agenda for Sustainable Development, an action programme for people, planet and prosperity signed in September 2015 by the governments of the 193 UN member states. In particular, these states have committed to achieving the 17 Sustainable Development Goals by 2030. Therefore, in all likelihood, these bonds were issued in an ad hoc manner so that they would mature precisely in 2030 so that the issuers of these bonds could demonstrate their compliance with this programme. Finally, we can note that as many as 35 Green Bonds showed longer maturities, i.e. beyond 2033. In particular, it is interesting to mention the presence of a Green Bond with a maturity date in 3017. This is a Green Bond issued by Ørsted A/S, Denmark's largest energy company, in 2017, so we are talking about a 1,000-year bond. When thinking about a bond of this long duration, one might wonder which investor would be interested in such an instrument. What we can say is that the offer for this bond was heavily oversubscribed, with the company receiving an order book of 2.4 billion euros. Essentially, with this issuance, Ørsted's 1,000 year bond has been issued in perpetuity, even if the first "par call" on the debt is scheduled for 24 November 2024, and this will give the company the opportunity to redeem funds at a value equal to or slightly above the issue price.

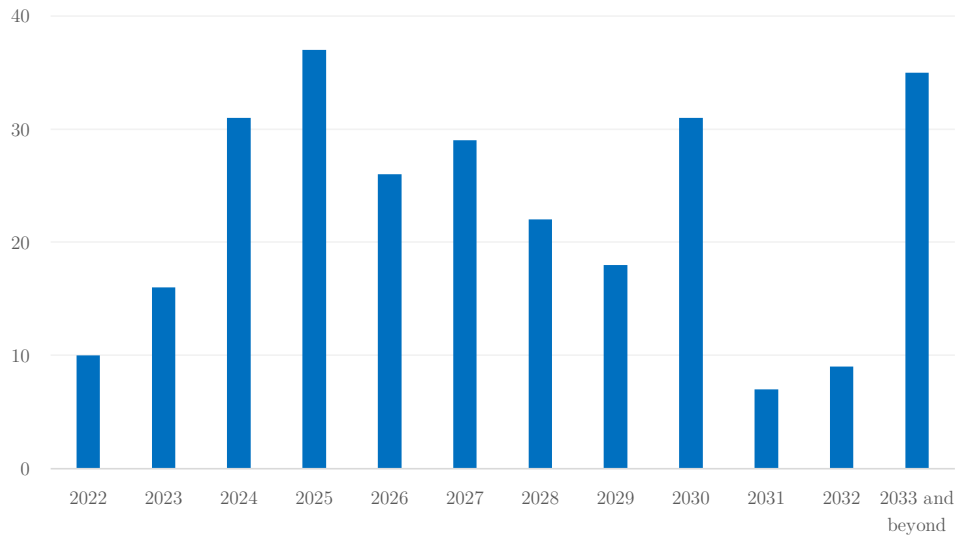



Figure 7.8: Yearly distribution of the reference sample (maturity).

### 7.2.2. The econometric model

Having defined our analysis database, in this section we will briefly present the OLS regression model, i.e. the econometric model that will be used to test our hypotheses.

Starting with the basics, we can say that in financial econometrics, two main types of data can be identified:

- Time series data;
- Cross-section data.

Time series data refer to observations performed sequentially in time, where, these are data coming from a single phenomenon, observed in different successive periods. In particular, it is possible to distinguish between continuous and discrete datasets. Discrete datasets are the most used in econometric studies and generally observations are performed at regular intervals, and the time unit of observation could be of different scale such as day, week, month, or year. Exploiting this type of data, time series models attempt to analyse and forecast a time series. Time series models can be classified in:

- Univariate;
- Multivariate.

The former analyse a single time series, while through the latter it is possible to analyse and predict many time series jointly. Time series are represented by plots where along

the x-axis is the time reference and on the y-axis the corresponding value. Time series are characterized by five main features:

- Trend;
- Cycle;
- Seasonality;
- Structural breaks;
- Outliers.

On the other hand, cross-section data refers to different units observed at a single point in time or in the same time period. In particular, this type of dataset is created by collecting the data of interest across a range of observational units simultaneously. The cross-sectional data therefore show the spatial variation (one cross-sectional unit), while the time series data show the temporal variation (within periods).

It is also possible to identify a third very important category of data: panel data (or longitudinal data). Panel data models come from the combination of time series data and cross-sectional data, and these are used to study a phenomenon concerning different units that change over a time series. Panel data differs from independently pooled cross-sections (IPCS) data across time: while panel data have to deal with the observations on the same subjects in different times, IPCS observes different subjects in different time periods. IPCS data represent the results of independent surveys, each representing a random sample from the population, so only by chance will the same individual appear more than once in the pooled dataset. On the other hand, when panel data are collected, information from the same individual units are recorded at each point in time.

## OLS regression model

Ordinary Least Squares (OLS) is a type of linear least squares method for estimating coefficients of a linear regression model. This model is characterized by a linear regression equation that describes the relationship between one or more independent variables and a dependent variable (simple or multiple linear regression). Least squares stand for the minimum squares error (SSE), indeed OLS chooses the unknown parameters by minimizing the sum of the squares of the differences between the observed dependent variable in the given dataset and those predicted. The OLS linear regression model is undoubtedly the simplest and most widely used model in all areas of econometrics, although there are some good but less famous alternatives, such as maximum likelihood and generalized least squares models.

In the case of a simple linear regression, the OLS regression model is the following:

$$Y_i = \alpha + \beta X_i + \epsilon_i \tag{7.1}$$

where:

- $Y_i$ is the dependent variable;
- $\alpha$ is the intercept;
- $X_i$ is the dependent variable;
- $\beta$ is the variation of the dependent variable when the independent one has a unitary variation;
- $\epsilon$ is the error term.

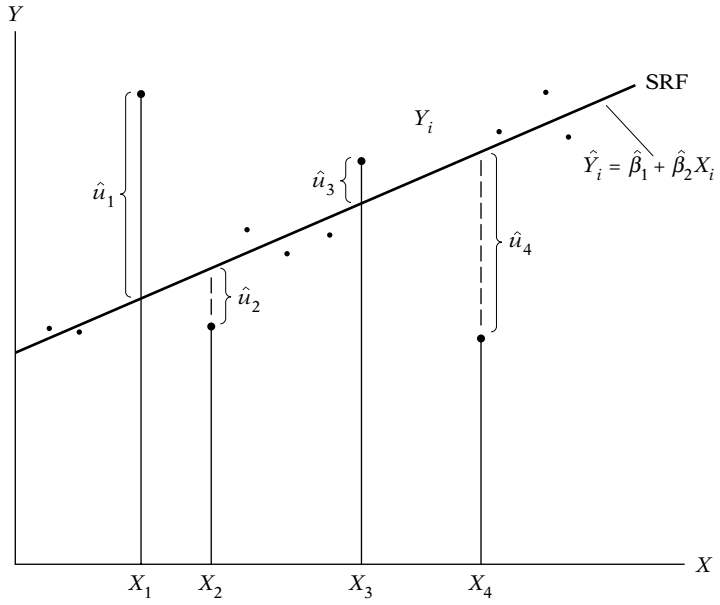



Figure 7.9: Least-squares criterion.

The fundamental idea of Simple Linear Regression is finding those parameters $\alpha$ and $\beta$ for which the error term is minimized. More precisely, the OLS model will minimize the squared errors, as we do not want that positive errors will be compensated by the negative ones, since they are equally penalizing for our model. An error term represents the margin of error within a statistical model. This parameter refers to the sum of the deviations within the regression line, which provides an explanation for the difference between the theoretical value of the model and the actual observed results.

$$\hat{\alpha} = \min_{\alpha} \sum_{i=1}^{n} (y_i - \alpha - \beta x_i)^2 = \min_{\alpha} \sum_{i=1}^{n} \epsilon_i^2 \tag{7.2}$$

$$\hat{\beta} = \min_{\beta} \sum_{i=1}^{n} (y_i - \alpha - \beta x_i)^2 = \min_{\beta} \sum_{i=1}^{n} \epsilon_i^2 \tag{7.3}$$

Thus, the OLS model can be considered as a useful method to obtain what we can call a "straight line" that is as much close as possible to the data points. Although OLS is not the only optimization method used by econometricians, it produces the Best Linear Unbiased Estimators (BLUE) of the real values of $\alpha$ and $\beta$.

## 7.3. Analysis and findings

This section aims to discuss the primary analysis that was carried out using the information gathered, and the methodology described in the earlier sections. Before to going deeper into the specifics of the OLS regression analysis, which form the basis of the current study, it is interesting to take a closer look at the variables that are investigated.

### 7.3.1. Variables definition

As we said in the previous sections, a regression analysis is used to search for an influence of Taxonomy alignment on bond's yield, by taking also in consideration other factors such as the credit ratings, the time to maturity, the issue size and if the bond is callable or not and the issuer type. In particular, considering the type of analysis that we want to perform, and the dataset that we have created (cross-sectional dataset), an Ordinary Least Squares (OLS) model using *Gretl*[20] software is used to reach the objective of the study.

The variables we considered, some of which were mentioned earlier, were adjusted so that they could be used within our econometric model to perform the analysis. In particular, the different variables were defined analytically, as follows:

- *Yield*: this variable represents the dependent variable of the model, and this is simply the yield at issuance of the Green Bond;
- *Alignment*: this variable represents the bond's EU Taxonomy alignment, and it is parameterized with a number between 0 and 1;

[20] Cross-platform and open-source software package for econometric analyses.

- *Rating_Score*: this variable represents the "score" obtained by a bond on the basis of the available credit rating. In particular, the *Rating_Score* is defined as a number between 0 and 21. To perform this parameterization, we started by taking the rating scales of the top three rating agencies (S&P, Moody's and Fitch) for which ratings were present on the Refinitiv database we used to obtain credit ratings. For each Green Bond, we then assigned an increasing value from 1 to 21 for each rating from the different agencies, as shown in Figure 7.10. To obtain the final result, an average was taken of the three numbers obtained when all three ratings were present for the individual bond. When, on the other hand, one (or two) of the ratings was not present, a 0 was fictitiously assigned to the absent rating, but this value was not taken into account when the average was performed. This was done so as not to penalize excessively the absence of a rating, which might not have been requested for many reasons, and if requested, might have resulted in a similar outcome to that already obtained by other rating agencies. Conversely, for those bonds where there was not even a rating, the final score was obviously 0;

| S&P Rating | |
|---|---|
| AAA | 21 |
| AA+ | 20 |
| AA | 19 |
| AA- | 18 |
| A+ | 17 |
| A | 16 |
| A- | 15 |
| BBB+ | 14 |
| BBB | 13 |
| BBB- | 12 |
| BB+ | 11 |
| BB | 10 |
| BB- | 9 |
| B+ | 8 |
| B | 7 |
| B- | 6 |
| CCC+ | 5 |
| CCC | 4 |
| CCC- | 3 |
| CC | 2 |
| C | 1 |

| Moody's Rating | |
|---|---|
| Aaa | 21 |
| Aa1 | 20 |
| Aa2 | 19 |
| Aa3 | 18 |
| A1 | 17 |
| A2 | 16 |
| A3 | 15 |
| Baa1 | 14 |
| Baa2 | 13 |
| Baa3 | 12 |
| Ba1 | 11 |
| Ba2 | 10 |
| Ba3 | 9 |
| B1 | 8 |
| B2 | 7 |
| B3 | 6 |
| Caa1 | 5 |
| Caa2 | 4 |
| Caa3 | 3 |
| Ca | 2 |
| C | 1 |

| Fitch Rating | |
|---|---|
| AAA | 21 |
| AA+ | 20 |
| AA | 19 |
| AA- | 18 |
| A+ | 17 |
| A | 16 |
| A- | 15 |
| BBB+ | 14 |
| BBB | 13 |
| BBB- | 12 |
| BB+ | 11 |
| BB | 10 |
| BB- | 9 |
| B+ | 8 |
| B | 7 |
| B- | 6 |
| CCC+ | 5 |
| CCC | 4 |
| CCC- | 3 |
| CC | 2 |
| C | 1 |

Figure 7.10: Credit Ratings parameterization.

- *Issue_Amount*: this variable simply represents the amount raised with the issue of the bond, expressed in billions of euros;

Table 7.1 summarizes the basic descriptive statistics for each of the variables just described, namely the mean and the standard deviation, together with minimum and maximum values.

Table 7.1: Variables descriptive statistics

| | Mean | Std. Deviation | Min | Min |
|---|---|---|---|---|
| **Yield** | 1.6487 | 1.4737 | -1.6800 | 8.7500 |
| **Alignment** | 0.61148 | 0.36277 | 0.0000 | 1.0000 |
| **Rating_Score** | 14.753 | 5.2766 | 0.0000 | 21.000 |
| **Issue_Amount** | 0.91421 | 1.4206 | 0.041119 | 15.690 |

- *Maturity_Range*: maturity was defined as the difference between the bond's issue date and its maturity date, expressed in years. Subsequently, maturity was divided into three year ranges and, for each of them, a dummy variable was introduced:
  - $<$ 5 years ($d_{1M}$);
  - between 5 and 10 years ($d_{2M}$);
  - $>$ 10 years ($d_{3M}$);

  A dummy variable takes value 1 if the bond in question falls into that maturity category, 0 otherwise. However, only two of the three dummy variables were included in the econometric model ($d_{1M}$ and $d_{2M}$), as otherwise the so-called *collinearity problem* would occur, causing the failure of the analysis;
- *Callability*: the callability of a bond was also defined through the use of a dummy variable. Specifically, if the bond turns out to be callable then the dummy variable takes on a unit value, otherwise 0. As in the previous case, only one dummy variable was included in the econometric model ($d_{1C}$);
- *Issuer_Type*: with regard to the type of issuer, five dummy variables were again parameterized, based on the five issuer categories considered:
  - Non-Financial Corporate ($d_{1T}$);
  - Government ($d_{2T}$);
  - Financial Corporate ($d_{3T}$);
  - Supranational ($d_{4T}$);
  - Municipal ($d_{5T}$);

Again, to avoid the problem of collinearity, only the first four variables were considered.

After defining all variables, the final econometric model useful to test our research hypotheses can be illustrated by the following equation:

$$\begin{aligned} Yield = {} & \beta_0 + \beta_1 Alignment + \beta_2 Rating\_Score + \beta_3 Issue\_Amount \\ & + \beta_4 d_{1M} DMaturity\_Range\_1 + \beta_5 d_{2M} DMaturity\_Range\_2 \\ & + \beta_6 d_{1C} DCallability\_1 + \beta_7 d_{1T} DIssuer\_Type\_1 \\ & + \beta_8 d_{2T} DIssuer\_Type\_2 + \beta_9 d_{3T} DIssuer\_Type\_3 \\ & + \beta_{10} d_{4T} DIssuer\_Type\_4 \end{aligned} \tag{7.4}$$

## 7.4. Results and discussion

After introducing all variables and entering them into the *Gretl* software, the results of the regression analysis on the 271 Green Bonds in the final database are shown in Figure 7.11.

```
Model 4: OLS, using observations 1-271
Dependent variable: Yield
Omitted due to exact collinearity: DMaturity_Range_3 DCallability_2 DIssuer_Type_5

                     coefficient   std. error   t-ratio   p-value
  ---------------------------------------------------------------
  const                2.89424     0.652620      4.435    1.36e-05 ***
  Alignment           -0.198428    0.231960     -0.8554   0.3931
  Rating_Score        -0.0767206   0.0174903    -4.386    1.68e-05 ***
  Issue_Amount        -0.198580    0.0682298    -2.910    0.0039   ***
  DMaturity_Range_1    0.782684    0.397700      1.968    0.0501   *
  DMaturity_Range_2    1.19229     0.409988      2.908    0.0040   ***
  DCallability_1       0.638689    0.215336      2.966    0.0033   ***
  DIssuer_Type_1      -1.17032     0.474143     -2.468    0.0142   **
  DIssuer_Type_2      -0.292605    0.599213     -0.4883   0.6257
  DIssuer_Type_3      -1.13520     0.465868     -2.437    0.0155   **
  DIssuer_Type_4      -0.691703    0.489151     -1.414    0.1585
```

Figure 7.11: Results of the OLS regression model.

However, before going on to comment on the results obtained, it is necessary to make a brief explanation of the parameters shown in the figure above, so that they can be understood. In particular, the 4 basic parameters for understanding the results are:

- *Coefficient*: the coefficients in a OLS regression represent the relationship between each independent variable and the dependent variable. The sign (positive or negative) of these coefficients is useful to understand whether there's a positive or negative correlation between each independent variable and the dependent variable.

A positive measure shows that as the value of the independent variable increases, the mean of the dependent variable also tends to increase. On the other hand, a negative measure expresses the opposite: as the independent variable increases, the dependent variable tends to drop. The value of the coefficient is a measure used to identify the impact of the change in the mean of the dependent variable, given a shift of 1 unit in the independent variable, while holding other variables in the model constant. It is pivotal to hold other variables constant, because in doing that you are able to isolate each variable from the others, and so assess the effect impacting only that variable;

- *Standard Error*: the standard error of the regression is identified as the average distance between the observed values and the regression line. In other words, it is a measure of how much the observed values are spread around the mean. It is calculated through the following formula:

$$s(b_1) = \sqrt{\frac{1}{n-2} \times \frac{\sum(y_i - \hat{y}_i)^2}{\sum(x_i - \bar{x})^2}} \tag{7.5}$$

where:

  - $n$ is the total sample size;
  - $y_i$ is the actual value of response variable;
  - $\hat{y}_i$ is the predicted value of response variable;
  - $x_i$ is the actual value of predictor variable;
  - $\bar{x}$ is the mean value of predictor variable.

Lower standard error values are preferable because it indicates that the observations are closer to the regression line. This measure can be very useful in assessing the accuracy of predictions. Indeed, roughly 95% of the observations should fall within $\pm$ 2 times the standard error from the regression line (95% confidence interval);

- *t-ratio* and *p-value*: the correlation between an independent variable and a dependent variable is measured using linear regression and, whenever we conduct this type of analysis, we are interested in determining whether this correlation is statistically significant. In order to determine the significance of the results of a regression model, a *t-test* is used. For a *t-test*, the following null and alternative hypothesis are used:

  - $H_0$: $\beta_1 = 0$ (the slope is equal to zero);

– $H_A$: $\beta_1 \neq 0$ (the slope is not equal to zero).

The test statistic is then calculated as follows:

$$t - statistic = \frac{\hat{\beta}_j - \beta_{H_0}}{S_{\hat{\beta}_j}} \tag{7.6}$$

where:

– $\hat{\beta}_j$ is the estimated regression coefficient;

– $\beta_{H_0}$ is the value of estimate under $H_0$;

– $S_{\hat{\beta}_j}$ is the standard error of estimated coefficient.

T denotes the calculated difference, expressed in standard error units. The amount of evidence against the null hypothesis increases as T's magnitude increases. This indicates that there is more proof that there is a noticeable difference. The likelihood that there is no discernible difference increases as T approaches 0. The null hypothesis is rejected, and we come to the conclusion that there is a statistically significant association between the independent variable and the dependent variable, if the *p-value* associated with t is less than a certain threshold, such as 0.05. Each independent variable's *p-value* indicates whether there is a statistically significant link between it and the dependent variable. This *p-value* must be smaller than 0.05 in order for us to successfully reject the null hypothesis. In particular, in Figure 7.11 we can quickly identify the significance of a variable by looking at the asterisks marked on the side:

– * means $p < 0.1$, thus a moderate evidence against the null hypothesis;

– ** means $p < 0.05$ thus a good evidence against the null hypothesis;

– *** means $p < 0.01$ thus a strong evidence against the null hypothesis.

With regard to the intercept term ($\beta_0$) and its relation to the *p-value*, it is important to emphasize that we do not usually give much importance to the *p-value* of the intercept term. We continue to include the intercept factor in the model even if the *p-value* is not below a certain level of significance (such as 0.05).

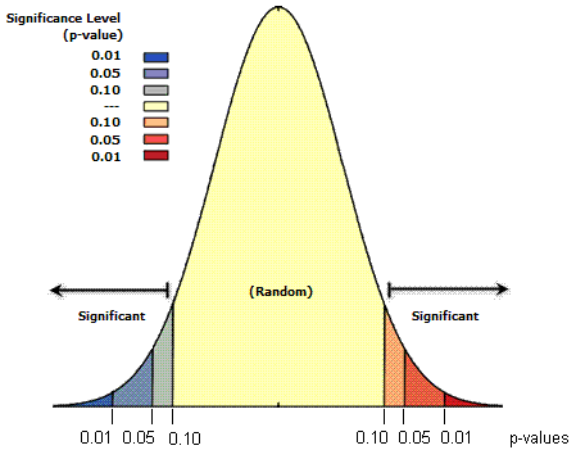



Figure 7.12: p-value on a Standard Normal Distribution.

Having briefly explained the different parameters characterizing the output of an OLS regression analysis, we will now proceed to comment on the results obtained (shown in Figure 7.11).

As for the Rating Score, it turns out to be negatively correlated to the Yield of the bond at the time of issuance, in particular the coefficient is -0.0767206, and the standard error associated with this measure is 0.0174903. This means that as the Rating Score increases, the Yield decreases, and this turns out to be in line with what we expected. In fact, the higher the Rating Score, the lower the risk of default for that bond. Consequently, it is logical that a lower risk is associated with a lower yield. This result turns out to be particularly significant, as the *p-value* associated with this parameter is 1.68e-05, which is well below the threshold of 0.05.

Turning now to Issue Amount, it too turns out to be negatively correlated with Yield, with a coefficient of -0.198580 and a standard error of 0.0682298. Here too, the result is significant, as the *p-value* is 0.0039.

As for the two maturity dummies, they both have a positive yield correlation coefficient of 0.782684 and 1.19229, respectively. This result is also in line with what we expected, since as the maturity increases (and thus moving from the first to the second dummy), the risk for investors to buy that given bond increases, and consequently so does the return for them. In fact, it can be seen that the correlation coefficient grows from the first to the second dummy. This result is particularly significant for the second dummy (*p-value* is 0.0040), while for the first dummy it is still significant but somewhat less (*p-value* is 0.0501).

The dummy on callability also has a positive correlation coefficient with the yield of

the bond at the time of its issue, equal to 0.638689. Moreover, the standard error is nevertheless small (0.215336) in relation to the coefficient. For a categorical variable such as this, it is important to note that the difference between the predicted value of the dependent variable for the categories where the predictor variable is equal to 0 and the predictor variable is equal to 1 is represented by the regression coefficient. In this case, callability is a categorical variable that takes on the following values:

- 1 if the bond is callable;
- 0 if the bond is not callable.

As we have seen, the regression result shows a positive correlation coefficient, indicating that a callable bond leads to a 0.638689 point higher yield than if the bond is not callable. This result is also in line with our expectations, as a callable bond is a bond for which the issuer has reserved the right to repay the same title before the final deadline for a set price. If the level of market prices is exceeded by the bond's coupon at the day of repayment, the issuer will have to advantage to refinance its investments at lower costs over the remaining life of the bond. Therefore, this raises the risk for investors in this type of bond and consequently also raises the yield. This result is also particularly significant with a *p-value* of 0.0033.

Next, we go on to analyse the results on the dummies of the issuer type. They all have a negative correlation coefficient with the bond yield, with the first and third having a stronger coefficient than the second and fourth. Given the low coefficient values of the latter two dummies, and their particularly high standard errors in relation to the two coefficients, accompanied by a particularly high *p-value* coefficient, these two results are not significant. This is probably due to the scarcity of data for these two issuer types compared to the others.

Finally, we move on to analyse alignment and its correlation with yield, the main part of this thesis work. The coefficient turns out to be negative at -0.198428 and thus alignment would be negatively correlated with yield. This result implies that as alignment increases, yield decreases. This result would be in line with H1a and not with H1b, as investors should be willing to receive a lower yield in exchange for a higher alignment to the Taxonomy of the bond in question. In fact, a greater alignment translates into more sustainable investments, a topic that is particularly topical and on which more and more investors are focusing. However, the standard error is very high (0.231960) and the *p-value* is also well above the threshold (0.3931). Consequently, this value is not significant and therefore not statistically reliable. Therefore, we cannot attribute a correlation between alignment and yield, and we can say that the first research hypotheses (H1a) is negated, while the

second one (H1b) is validated.

The feeling is that, nowadays, investors are not yet ready to take the final step towards fully sustainable investments at the expense of a partial reduction in economic return. In fact, even though, as we have seen, it is possible to glimpse a growing interest in greener financial instruments, the regulations introduced by the European Taxonomy do not seem to influence the behaviour of practitioners much.

This mistrust on the part of investors is also highlighted in research by PwC on the ESG economic realities, conducted in September 2021. In this study, they surveyed 325 investors globally, the majority of whom were self-identified active asset managers making investments for the long-term. While, in a wide variety of ways, those investors expressed commitment to ESG objectives in their investments and as a priority for their portfolio companies, most (81% of) respondents expressed reluctance to take a hit on their returns exceeding 1 percentage point in the pursuit of ESG goals. When assessing ESG priorities, many also expressed serious concerns about the quality level of the information at their disposal, including data on the carbon emissions of their investments.


Figure 7.13: Investors' attitudes toward ESG risks and opportunities (% of respondents).
Source: PwC 2021 Global Investor Survey.

This study's key finding is that investors are poised to act as a result of their increased awareness of the ESG risks and opportunities facing the companies they invest in (see Figure 7.13). Nearly 80% of respondents said that ESG was a crucial factor in their investment decision-making, while almost 70% thought ESG factors should figure into

executive compensation targets. Moreover, about 50% of respondents indicated that they would be willing to divest from companies that didn't take sufficient action on ESG issues. These findings were supported by additional in-depth interviews conducted as part of the study. In particular, the head of ESG at one important investment firm stated: "*we are at a tipping point where ESG has gone mainstream. You can not walk into a financial institution now to talk about long-term themes without mentioning ESG*".

Additionally, the survey indicates that investors are conflicted about their fiduciary duties to their clients and what they see as their responsibility to the environment and society (see Figure 7.14).

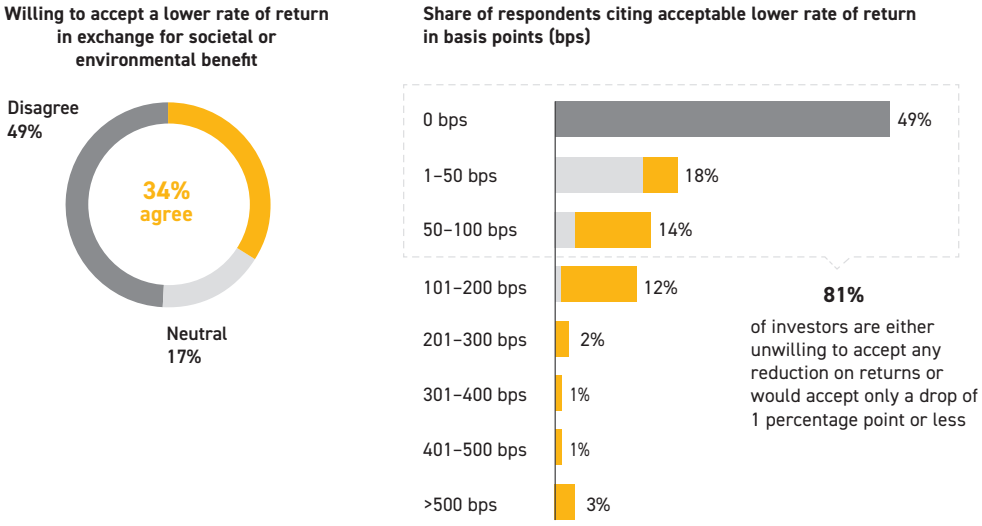



Figure 7.14: Breakdown of what institutional asset managers and asset owners will accept (% of respondents).

Source: PwC 2021 Global Investor Survey.

The majority (75%) of the investors we polled believed it was worthwhile for businesses to forego short-term profitability in order to address ESG issues. However, as noted above, a comparable percentage (81%) stated that they would be content to accept a 1 percentage point or smaller reduction in their investment returns in order to pursue those goals. In that group, nearly two-thirds were unwilling to accept any reduction in exchange. None of this is surprising, as investors operate in competitive markets, where capital chases returns and underperformers are weeded out. Moreover, in the case of asset managers, they have a fiduciary duty, and therefore they can not prioritize environmental and/or social issues over return on investment.

Another fundamental point to emphasize is that, recently, reporting has come under the spotlight as a result of investors' increased attention to companies' ESG-related commit-

ments and actions. Indeed, investors are using the sustainability reports of the companies they invest in and creating investment screens based on benchmarks that monitor everything from emissions levels to human rights to diversity in the boardroom. Despite how helpful these benchmarks are, the survey conducted by PwC revealed a number of flaws in the way that ESG reporting is currently performed. In particular, on average, only one-third of investors believe the reporting they are seeing is of a high enough quality level. Simply put, investors find it difficult to differentiate between different companies based on their ESG performance. Investors are sceptical that much of today's ESG reporting provides them with the pertinent, accurate, timely, comprehensive, and comparable data they need to make informed decisions. Better reporting would make it easier for investors to understand how a sustainable business model contributes to long-term viability, evaluate how ESG strategy translates into value creation, and determine whether a company's actions have the potential to negatively affect the environment or people.

Climate-related issues bring the complexity of ESG reporting challenges into stark relief. As a result of the aforementioned survey, just over a third of investors said the quality of the information they receive on environmental issues is sufficient. For investors, many of whom are hungry for information about carbon emissions, these informational barriers can be problematic. Reducing Scope 1 emissions (direct emissions from a company's operations) and Scope 2 emissions (indirect emissions from purchased or acquired electricity, steam, heat, and cooling) were by far the most mentioned ESG issues when we asked investors which issues companies should prioritize (see Figure 7.15).

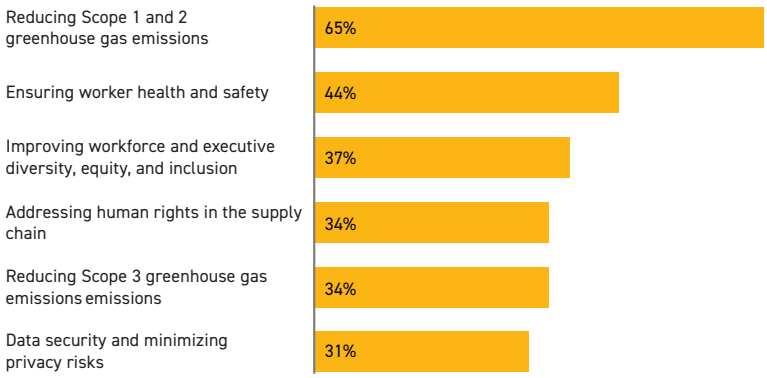



Figure 7.15: Top-cited ESG issues (% of respondents).

Source: PwC 2021 Global Investor Survey.

The monitoring and reporting of Scope 3 emissions (those resulting from actions beyond a company's direct control) is particularly challenging today. That such emissions were lower on investors' ESG priority lists is probably not a coincidence. However, these types

of emissions, according to the Carbon Trust[21], represent 65–95% of most companies' broader carbon impact. The significance of disclosing all types of emissions should nevertheless increase as regulations are put in place requiring investors like investment firms, pension funds, and insurance companies to track and report on the carbon footprint of their portfolios.

Concluding, the main takeaway from this result is that, since the European Taxonomy is a best practice but not a rule, a correlation between alignment and yield cannot yet be identified to date. However, when this Taxonomy becomes a mandatory standard for companies to which all must adhere, it will be possible to repeat this study with a new bond database that will be constructed in the manner already described in this study. It will also be possible to exploit the regression model with all the secondary parameters already described in this study, and it is expected that at a more mature stage of the EU Taxonomy introduction process, it will be possible to identify a correlation between alignment and the pricing of a bond, as we stated in the first hypothesis.

[21]Non-profit association that helps companies reduce their carbon footprint in the atmosphere by improving energy efficiency, managing their greenhouse gas (GHG) emissions and developing low impact technologies.

# Conclusions

Numerous topics were covered in this study, and numerous insights came to light during the discussion. This thesis's concluding section aims to effectively summarize the various contributions made by the study, while demonstrating how each section into which it was divided actually has a close relationship with the others.

As seen, the Green Bond phenomenon can be examined from a variety of angles, despite being relatively new. It has been decided to divide the current thesis into seven macro-sections in order to better address this heterogeneity of viewpoints. Each of these was devoted to the in-depth examination of a particular element of the Green Bond and the sustainable finance context, helping to create a tangible and comprehensive understanding of the phenomenon under study.

Starting from Chapter 1, we introduced the concept of Sustainable Finance and sustainable financial instruments. In particular, we highlighted the history of sustainable investments in the last recent years, and we presented the main sustainable investment strategies and instruments. Moreover, in this chapter, we introduced the concept of Green Bonds, giving the definition and the other main information.

The second chapter (Chapter 2) was devoted to a review of the most pertinent papers that have been published on this subject to date. This analysis was crucial for defining the main characteristics of Green Bonds and for identifying the main areas of research that had already been examined by earlier studies. As a result, potential research gaps that needed to be further investigated in this study were identified.

Unlike the previously mentioned chapter, Chapter 3 was more market-driven. In fact, Green Bonds were initially developed as a cutting-edge financial tool within the larger field of sustainable finance. Only later, as a result of the recent market's explosive growth, did academic research on Green Bonds also start to frequently include them. Therefore, the purpose of this section was to look into how Green Bonds evolved from a novel financial product to a commonplace debt instrument. In this regard, the major market trends that have emerged over the past few years have been carefully examined from a variety of perspectives. Moreover, the discussion has widened to analyse how Green Bonds stan-

dards and regulation evolved over time. Indeed, the most pertinent current regulatory frameworks, such as the ICMA's Green Bond Principle, the CBI's Climate Bonds Standards, and the EU's European Green Bond Standards were discussed, with a focus on one particular and essential component of regulation: impact reporting. As discussed, impact reporting is one of the central ideas of the ICMA's Green Bond Principles and is crucial to ensuring the credibility of the Green Bond market.

After that, Chapter 4 was fully dedicated to the discussion about the new topic of the European Taxonomy. In particular, this chapter contextualized this classification system and its implications. After introducing some background information, the discussion moved on to the practical application of the principles of the EU Taxonomy and analysing which entities it is directed at.

Chapters 5 and 6 presented two different kinds of analysis, both performed in collaboration with MainStreet Partners, a London-based company operating in the fields of investment advisory and portfolio analytics on sustainable, ESG and impact investments. In particular, the first analysis aimed to investigate the level of alignment to the European Taxonomy of a dataset composed of both Green Bonds and Sustainability Bonds. Thanks to this study, it was possible to get a comprehensive overview of the level of compliance of the bonds in our dataset with respect to a regulation such as the EU Taxonomy that will become mandatory in future for issuers, so that they can contribute to achieving environmental goals by the 2050 target date. The second analysis performed was an in-depth impact analysis on both Green, Social and Sustainability Bonds. This chapter's objective was to investigate, using a set of pre-defined environmental metrics, the true impact that these debt instruments can have on society. It was eventually possible to determine, in a reliable and objective manner, how these kinds of bonds can represent a valid financing tool in the difficult challenge towards a low-carbon economy, thanks to an ad-hoc dataset and a meticulous impact data collection.

Taking advantage of the results gathered in Chapter 5, Chapter 7 aimed at bringing a pertinent and innovative contribution to the body of literature on this topic in order to conclude this in-depth analysis of Green Bonds. In particular, we wanted to focus on an aspect that, to date, has not been considered by the various academic researches on Green Bonds. In fact, we wanted to enrich the current literature by considering the parameter of alignment with the EU Taxonomy. The objective of this chapter was to analyse whether any correlation between this parameter and the yield at issuance of Green Bonds is already visible. In particular, our two research hypothesis were:

**H1a**: The yield at issuance of a Green Bond is correlated to its level of alignment

with the European Taxonomy;

**H1b**: The yield at issuance of a Green Bond is not correlated to its level of alignment with the European Taxonomy.

In order to test these two hypotheses, a simple but very effective OLS regression model was used, which related the dependent variable of the yield at issuance of Green Bonds and several other relevant variables, including alignment to the EU Taxonomy. This analysis was performed using the same dataset as the analysis in Chapter 5, constructed in collaboration with MainStreet Partners. In fact, to date, there is no database that includes the specific level of alignment to the Taxonomy of bonds, and therefore this analysis represents an innovative practice.

After performing the econometric analysis, we found that it is not possible to attribute a correlation between the yield of a Green Bond and its alignment to the EU Taxonomy with statistical significance. Therefore, the result of this analysis negated the validity of the first research hypothesis, while verifying the second one. In contrast to some findings in other studies, which underline the new tendency of investors to prefer investments towards sustainable topics, it seems that the requirements defined by the EU Taxonomy are not yet fully taken into account by companies, institutions and investors. This may be due to several reasons, mainly due to the fact that the EU Taxonomy currently represents a best practice and thus only a set of indications defining which financial instruments are more or less qualitative in terms of environmental sustainability.

Overall, the conclusions drawn from this study are varied and pertain to various, yet closely related, facets of Green Bonds. While this study did, from a literature and market perspective, accurately reflect the current state of the phenomenon under investigation, it also made unique and significant contributions. Indeed, the detailed Taxonomy alignment analysis and the impact reporting analysis, as well as the empirical research on the correlation between Green Bonds yield and EU Taxonomy alignment provided with new information that broadens the discussion on these green debt securities.

However, this study needs more investigation in future. The fact that Green Bonds have evolved over the past few years from being a niche financial innovation to a mainstream product illustrates how fluid and quickly changing the current situation is. Overall, this phenomenon's growth seems unstoppable, at least for the foreseeable future. In reality, businesses, governments, and supranational organizations will use sustainable finance tools more and more in order to meet the environmental goals outlined in the Paris Agreement. In such a situation, Green Bonds will undoubtedly aid in the shift to a low-carbon economy. However, new instrument typologies have also entered the market at the same

time and account for sizeable volumes, such as Social and Sustainability Bonds. Therefore, it is likely that new tools will become more accessible, given the aforementioned need to speed up this green transition. It will be interesting to examine how Green Bonds will behave in this ambiguous and mutable scenario. For the time being, all that can be said is that as more data becomes available, future research could offer better and more comprehensive proof of the long-term effects Green Bonds have on society and issuer outputs. Future research may offer more accurate and trustworthy proof of Green Bonds' dependence on their alignment with the EU Taxonomy once the regulatory framework is, hopefully, more harmonized and once enforcement mechanisms are better defined. Specifically, it will be interesting to see whether, with the introduction of compulsory regulations on Green Bonds, the European Taxonomy directives can directly affect the financial market. In particular, we suggest carrying out this same study in the future, when the requirements of the Taxonomy become mandatory, in order to verify whether the pricing of Green Bonds can be correlated with the quality of the investments financed with these instruments, as we firstly hypothesized in this dissertation.

# Bibliography

Time series and cross sectional data. Finance Train.

European green bond standard. European Commission.

Green bonds - mobilising the debt capital markets for a low-carbon transition. OECD, December 2015.

Green bond principles - voluntary process guidelines for issuing green bonds. Technical report, ICMA, June 2018.

Climate bonds standard version 3.0. Technical report, Climate Bonds Initiative, December 2019.

About green bond principles. Sustainalytics, November 2019.

Faq: What is the eu taxonomy and how will it work in practice? Technical report, European Commission, 2020.

Taxonomy: Final report of the technical expert group on sustainable finance. Technical report, EU Technical Expert Group on Sustainable Finance, March 2020.

Green bond principles & climate bonds standard. Climate Bonds Initiative, 2020.

Iffim prices us$500 million 3-year benchmark vaccine bonds. International Finance Facility for Immunisation Co (IFFIM), October 2020.

Regulation (eu) 2020/852 of the european parliament and of the council. Technical report, June 2020.

Taxonomy regulation: Climate mitigation annex 1 - delegated act. Technical report, European Commission, June 2021.

Certification under the climate bonds standard. Climate Bonds Initiative, 2021.

Green bond principles - voluntary process guidelines for issuing green bonds. Technical report, ICMA, June 2021.

Sustainable debt market summary h1 2022. Technical report, Climate Bonds Initiative, August, 2022.

Harmonised framework for impact reporting. Technical report, ICMA, June 2022.

Socially responsible investing. Robeco, 2022.

Green bond principles (gbp). Climate Bonds Initiative, 2022.

What is 'soft currency'. The Economic Times, 2022.

E. Agliardi and R. Agliardi. Financing environmentally-sustainable projects with green bonds. *Environment and Development Economics*, 2019.

E. Agliardi and R. Agliardi. Pricing climate-related risks in the bond market. *Journal of Financial Stability*, 2021.

J. Aing. The eu taxonomy: what is the impact for investors and corporates? BNP Paribas, November 2021.

L. Alessi, E. Ossola, and R. Panzica. What greenium matters in the stock market? the role of greenhouse gas emissions and environmental disclosures. *Journal of Financial Stability*, 2021.

G. S. I. Alliance. Global sustainable investment review 2020, 2021.

M. Almeida and P. Lonikar. Post-issuance reporting in the green bond market 2021. Technical report, Climate Bonds Initiative, May 2021.

V. Alto. Understanding the ols method for simple linear regression. Towards Data Science, August 2019.

Y. Amihud and H. Mendelson. Asset pricing and the bid-ask spread. *Journal of Financial Economics*, 1986.

T. G. Assembly. Transforming our world: the 2030 agenda for sustainable development. Technical report, United Nations, October 2015.

E. B. Authority. Eba report on management and supervision of esg risks for credit institutions and investment firms, eba/rep/2021/18, 2021.

M. J. Bachelet, L. Becchetti, and S. Manfredonia. The green bonds premium puzzle: The role of issuer characteristics and third-party verification. *Sustainability*, 2019.

M. Baker, D. Bergstresser, G. Serafeim, and J. Wurgler. Financing the response to climate

change: The pricing and ownership of u.s. green bonds. Technical report, National Bureau of Economic Research, October 2018.

F. Baldi and A. Pandimiglio. The role of esg scoring and greenwashing risk in explaining the yields of green bonds: A conceptual framework and an econometric analysis. *Global Finance Journal*, 2022.

E. C. Bank. Climate-related risk and financial stability, July 2021.

U. S. Bhutta, A. Tariq, M. Farrukh, A. Raza, and M. K. Iqbal. Green bonds for sustainable development: Review of literature on development and impact of green bonds. *Technological Forecasting and Social Change*, 2022.

E. Biørn. *On Models and Data Types in Econometrics*. ECON3150/4150 Introductory Econometrics, Department of Economics, 2013.

M. W. Brandt and K. A. Kavajecz. Price discovery in the u.s. treasury market: The impact of orderflow and liquidity on the yield curve. *The Journal of Finance*, 2004.

J. Chalmers, E. Cox, and N. Picard. The economic realities of esg. Technical report, PwC, 2021.

L. Chen, D. A. Lesmond, and J. Wei. Corporate yield spreads and bond liquidity. *The Journal of Finance*, 2007.

W. Y. A. Choi. Can the green bond market reverse the tide of 'greenwashing'? : an ecosystem mapping of international voluntary governance mechanisms. Master's thesis, Université de Genève, 2020.

E. Commission, D.-G. for Environment, F. Eisinger, D. Hogg, A. Cochu, J. Skolina, I. Georgiev, C. Glenting, R. Agster, S. Fawkes, T. Chowdhury, and M. Jespersen. *Study on the potential of green bond finance for resource-efficient investments*. Publications Office, 2016.

M. A. Delmas and V. C. Burbano. The drivers of greenwashing. *California Management Review*, 2011.

F. Dembele, R. Schwarz, and P. Horrocks. Scaling up green, social, sustainability and sustainability-linked bond issuances in developing countries. Technical report, OECD, October 2021.

A. Dudout, C. Vitulano, and C. François. Expoloring the implementation of the eu taxonomy for financial institutions. Technical report, Reply, September 2021.

T. Ehlers and F. Packer. Green bond finance and certification. *BIS Quarterly Review*, September 2017.

Eurosif. Responsible investment strategies. https://www.eurosif.org/responsible-investment-strategies/, 2021.

K. Farnham. What is transition risk and how can today's organizations tackle it? *Diligent*, July 2021.

B. Faske. Turning Billions into (Green) Trillions: Tracking the Growth and Development of the Green Bond Market in China, France, India, and the United States. *Tulane Environmental Law Journal*, 2018.

S. Fatica, R. Panzica, and M. Rancan. The pricing of green bonds: Are financial institutions special? *Journal of Financial Stability*, 2021.

W. Febi, D. Schäfer, A. Stephan, and C. Sun. The impact of liquidity risk on the yield spread of green bonds. *Finance Research Letters*, 2018.

J. Fioretti. Link reit raises $510 mln in largest green convertible bond globally. Reuters, 2019.

C. Flammer. Corporate green bonds. *Journal of Financial Economics*, 2021.

J. Forjan. ime-series data vs. cross-sectional data. Analyst Prep, 2019.

J. Frost. 7 classical assumptions of ordinary least squares (ols) linear regression. Statistics By Jim, 2018.

G. Gianfrate and M. Peri. The green advantage: Exploring the convenience of issuing green bonds. *Journal of Cleaner Production*, 2019.

J. Giráldez and S. Fontana. Sustainability-linked bonds: The next frontier in sovereign financing. *SSRN Electronic Journal*, 2021.

B. Hachenberg and D. Schiereck. Are green bonds priced differently from conventional bonds? *Journal of Asset Management*, 2018.

H. A. Hacıömeroğlu, S. Danışoğlu, and Z. N. Güner. The grass is greener on the other side: Comparison of for-profit and blended-value debt securities. *SSRN Electronic Journal*, 2021.

C. Harrison, C. Partridge, and A. Tripathy. What's in a greenium: An analysis of pricing methodologies and discourse in the green bond market. *ERN: Other Econometric Modeling: Capital Markets - Asset Pricing (Topic)*, 2020.

C. Harrison, M. MacGeoch, and C. Michetti. Sustainable debt global state of the market 2021. Climate Bond Initiative, April 2022.

*Green Bond Principles - Voluntary Process Guidelines for Issuing Green Bonds*. ICMA, March 2015.

*Guidelines for Green, Social, Sustainability and Sustainability-Linked Bonds External Reviews*. ICMA, June 2022.

G. Inderst, C. Kaminker, and F. Stewart. Defining and measuring green investments: Implications for institutional investors. *OECD Working Papers on Finance, Insurance and Private Pensions*, OECD Publishing, 2012.

J. Kapraun and C. Scheins. (in)-credibly green: Which bonds trade at a green bond premium? *Paris December 2019 Finance Meeting*, 2019.

A. Karpf and A. Mandel. The changing value of the 'green' label on the US municipal bond market. *Nature Climate Change*, 2018.

C. Kennedy and J. Corfee-Morlot. Mobilising investment in low carbon, climate resilient infrastructure. *OECD Environment Working Papers*, 2012.

S. Kleimeier and M. Viehs. Pricing carbon risk: Investor preferences or risk mitigation? *Economics Letters*, 2021.

J. Kreipl. The green bond and esg chartbook - january 2022. Technical report, Unicredit, January 2022.

M. Krishnan, H. Samandari, J. Woetzel, S. Smit, D. Pacthod, D. Pinner, T. Nauclér, H. Tai, A. Farr, W. Wu, and D. Imperato. The net-zero transition: What it would cost, what it could bring. Technical report, McKinsey, January 2022.

B. Lagas. Five benefits of embracing sustainability and green manufacturing. *National Institute of Standards and Technology*, 2015.

P. Lau, A. Sze, W. Wan, and A. Wong. The economics of the greenium: How much is the world willing to pay to save the earth? *Hong Kong Institute for Monetary and Financial Research*, 2020.

M. Lebelle, S. Lajili Jarjir, and S. Sassi. Corporate green bond issuances: An international evidence. *Journal of Risk and Financial Management*, 13, 2020.

S. Liberatore and R. Karla. Enel's sustainability bond was greenwashing, says nuveen. *Environmental Finance*, October 2019.

K. U. Löffler, A. Petreski, and A. Stephan. Drivers of green bond issuance and new evidence on the "greenium". *Eurasian Economic Review*, 2021.

C. Lucarelli, C. Mazzoli, M. Rancan, and S. Severini. Classification of sustainable activities: Eu taxonomy and scientific literature. *Sustainability*, 2020.

S. MacAskill, E. Roca, B. Liu, R. Stewart, and O. Sahin. Is there a green premium in the green bond market? systematic literature review revealing premium determinants. *Journal of Cleaner Production*, 2021.

A. Maltais and B. Nykvist. Understanding the role of green bonds in advancing sustainability. *Journal of Sustainable Finance & Investment*, 2020.

U. Nations. The sustainable development goals report 2022. Technical report, United Nations, 2022.

R. Pachauri, M. Allen, and colleagues. *Climate change 2014 synthesis report. contribution of working groups I, II, and III to the fifth assessment report of the Intergovernmental Panel on Climate Change*. IPCC, 2014.

B. Paranque and C. Revelli. Ethico-economic analysis of impact finance: The case of Green Bonds. *Research in International Business and Finance*, 2019.

S. K. Park. Investors as regulators: Green bonds and the governance challenges of the sustainable finance revolution. *Stanford Journal of International Law*, March 2018.

S. K. Park. Green bonds and beyond: Debt financing as a sustainability driver. *Cambridge Handbook of Corporate Law, Corporate Governance and Sustainability*, 2019.

C. Partridge and F. Medda. Green premium in the primary and secondary u.s. municipal bond markets. *SSRN Electronic Journal*, 2018.

S. Patel. Five key esg risk considerations investors care about. Conservice ESG, July 2022.

R. Preclaw and A. Bakshi. The cost of being green. *Barclays Research*, September 2015.

R. Riordan. Transition bonds. *Institute for Sustainable Finance*, 2020.

E. S. Sartzetakis. Green bonds as an instrument to finance low carbon transition. *Economic Change and Restructuring*, 2021.

K. Schumacher. The shape of green fixed income investing to come. *SSRN Electronic Journal*, 2020.

S. Spinaci. Green and sustainable finance. Technical report, European Parliment, 2021.

D. Y. Tang and Y. Zhang. Do shareholders benefit from green bonds? *SSRN Electronic Journal*, 2018.

C. B. Team. Green bonds – a bridge to the sdgs. Technical report, Climate Bonds Initiative, July 2018.

I. E. Team. 7 ols regression assumptions (with explanations). Indeed, April 2022.

H. Tuhkanen and G. Vulturius. Are green bonds funding the transition? investigating the link between companies' climate targets and green debt financing. *Journal of Sustainable Finance & Investment*, 2020.

D. Uzsoki. Sustainable investing: Shaping the future of finance. Technical report, International Institute for Sustainable Development (IISD), 2020.

U. Volz. Fostering green finance for sustainable development in asia. *SSRN Electronic Journal*, 01 2018.

J. M. Wooldridge. *Introductory Econometrics: A Modern Approach*. ISE - International Student Edition. South-Western, 2009.

Y. Wu. Are green bonds priced lower than their conventional peers? *Emerging Markets Review*, page 100909, 2022.

K. Yeow and S.-H. Ng. The impact of green bonds on corporate environmental and financial performance. *Managerial Finance*, ahead-of-print, 2021.

O. D. Zerbib. The effect of pro-environmental preferences on bond prices: Evidence from green bonds. *Journal of Banking & Finance*, 2019.

# A | Appendix A

Table A.1: List of Green Bond variants/labels (alphabetical order).

| Name | Main Issuer(s) | First Issuance (Year) | Main Goal(s) | Eligible Projects | Frameworks/Guidelines |
|---|---|---|---|---|---|
| Benchmark Bonds (IDA, 2020) | Internal Developer Bank (IDA) | 2020 | SDGs | Projects and programs in eligible IDA countries as they advance the SDGs | Internal IDA/World Bank Guidelines |
| Blue Bonds (World Bank, 2018b) | The Republic of Seychelles | 2018 | Marine Resource Protection | Sustainable Fishing Practices and Marine Habitat Protection | Internal World Bank Green Bond Process Implementation Guidelines |
| Catastrophe/Disaster Bonds (World Bank, 2018a) | World Bank | 2014 | Climate Resilience and SDGs | Provide financial resources in the hands of public officials in the aftermath of climate disasters | Internal World Bank Capital at Risk Notes Program Guidelines |
| Climate Action Bonds (Snam, 2019) | Snam | 2019 | SDGs | Energy transition and sustainable development projects | Snam Climate Action Bond Framework (Snam, 2020) |
| Climate Awareness Bonds (EIB, 2020b) | European Investment Bank (EIB) | 2007 | Climate Mitigation/ Adaptation | Renewable Energy and Energy Efficiency | Internal EIB Green Bond Framework, ICMA GBPs (ICMA, 2018b), CBI Standards (CBI, 2019a) |
| Climate Bonds (CBI 2019a) | Climate Bonds Initiative | 2010 | Climate Mitigation/ Adaptation | Renewable Energy, Sustainable Land Use, Water Resource Protection | ICMA GBPs, CBI Standards |
| Climate Resilience Bond (EBRD, 2019a) | European Bank for Reconstruction and Development (EBRD) | 2019 | Climate Resilience | Infrastructure (e.g. water, energy, transport, communications & urban infrastructure); business & commerce; or agriculture & ecological systems | CBI Climate Resilience Principles (CBI, 2019e) |
| Development Impact Bonds (UBS Optimus Foundation, 2019) | UBS Optimus Foundation | 2018 | ESG (focus on "S") and SDGs | Girls' education | National laws and regulations |
| ESG Bonds (BBVA, 2019) | Nomura Foundation BBVA | 2019 | ESG and SDGs | Projects is line with sustainability principles | ICMA GBPs and SBPs (ICMA, 2018a), CBI Standards |
| Environmental Bonds (NIB, 2019a) | Nordic Investment Bank (NIB) | 2019 | ESG (focus on "E") | Renewable Energy and Energy Efficiency; Clean Transport and Green Buildings | NIB Environmental Bond Framework (NIB, 2019b), ICMA GBPs |
| Environmental Sustainability Bonds (EBRD, 2019) | EBRD | 2010 | Climate Mitigation/ Adaptation | Climate Projects and Sustainable Resource Projects (Energy, Water, Pollution Prevention) | ICMA SBPs, ICMA Sustainability Bond Guidelines |
| Forest Bonds (IFC, 2020a) | International Finance Corporation (IFC)/World Bank | 2016 | Forest Ecosystems | Reduction of Deforestation and Forest Degradation | UN-REDD and REDD+ Programme Frameworks |
| Green Bonds (IFC 2020d; Word Bank, 2019) | International Finance Corporation (IFC)/World Bank | 2010 | ESG and SDGs | Renewable Energy, Sustainable Land Use, Water Resource Protection | ICMA GBPs, CBI Standards |

| | | | | | |
|---|---|---|---|---|---|
| Green Convertible Bonds (Neoen, 2020) | Neoen | 2020 | Climate mitigation and SDGs | Financing or refinancing of renewable energy production (solar PV, wind power) or storage activities | ICMA GBPs, EU GBS (EC, 2020d) |
| Green Contingent Convertible Bonds (BBVA, 2020) | BBVA | 2020 | SDGs | Primarily energy efficiency, renewable energy, sustainable transportation, waste and water management | BBVA SDGs Bond Framework (BBVA, 2018), ICMA GBPs |
| Green Transition Bonds (EBRD, 2019; 2020) | EBRD | 2019 | Climate Transition/ Mitigation | Manufacturing, food production and green buildings | ICMA GBPs |
| Pandemic Bonds (World Bank, 2017a) | World Bank (International Bank for Reconstruction & Development) | 2017 | ESG (focus on "S") and SDGs | Efforts against infectious diseases and containment of diseases | Covered perils: Flu, Filovirus, Coronavirus, Lassa Fever, Rift Valley Fever and Crimean Congo Hemorrhagic Fever |
| SDG Bonds (Theron, 2020) | African Development Bank (AfDB) and Nedbank South Africa | 2020 | SDGs | Environmentally friendly and climatesensitive projects in areas such as renewable energy and affordable housing & ICMA Green/ Social/ Sustainability (GSS) Bond Principles | Voluntary Process Guidelines for Issuing GSS Use-ofProceeds Bonds, certified by the CBI, or issued under the EU GBS |
| SDG/Sustainability -linked Bonds (Environmental Finance, 2019a) | Enel | 2019 | SDGs | SDG-related transition activities | ICMA Sustainability-Linked Bond Principles (ICMA, 2020d) |
| Social Bonds (IFC, 2020a) | International Finance Corporation (IFC)/World Bank | 2017 | ESG (focus on "S") | Under-served populations in emerging markets incl. women and low-income communities with limited access to essential services such as basic infrastructure, finance etc | IFC Social Bond Process (IFC, 2020b), ICMA SBPs |
| Social Impact Bonds (Mair, 2017) | Social Finance Ltd. and Peterborough Community, UK | 2010 | ESG (focus on "S") | Preventive social programs with the aim of bringing medium- to long-term benefits to both local beneficiaries and regional governments | National laws and regulations |
| Social Inclusion Bonds (CEB, 2018) | Council of Europe Development Bank | 2017 | ESG (focus on "S") | Support to micro, small and mediumsized enterprises (MSMEs) to strengthen job creation/preservation; social housing for vulnerable population groups; and education and vocational training | Council of Europe Development Bank Social Inclusion Bond Framework (CEB, 2020) |
| Sustainability (Awareness) Bonds (EIB, 2018; 2020c) | EIB | 2018 | SDGs | Water Quality, Access and Sanitation and infrastructure projects in developing countries | ICMA SBPs, ICMA Sustainability Bond Guidelines (ICMA, 2018a) |
| Sustainable Transition Bonds (Robinson-Tillett, 2019) | Marfrig | 2019 | SDGs | Improving the social and environmental standards of supply chains (Brazilian meat sector) | ICMA Sustainability Bond Guidelines |
| Sustainable Development Bonds (World Bank 2020a; 2020b) | World Bank (International Bank for Reconstruction and Development) | 2017 | SDGs | Gender Equality; Sustainable Cities; Climate Resilience; Ocean and Water Resources | ICMA SBPs, ICMA Sustainability Bond Guidelines |
| Sustainable Growth Bonds (World Bank, 2017b) | World Bank (International Bank for Reconstruction and Development) | 2017 | SDGs | Gender Equality; Sustainable Cities; Climate Resilience; Ocean and Water Resources | ICMA SBPs, ICMA Sustainability Bond Guidelines |

| | | | | | |
|---|---|---|---|---|---|
| Transition/Transformation Bonds (Cripps, 2019; Naumann, 2019; Lee, 2020; Pratsch, 2020) | Repsol and Teekay | 2017 (Repsol) and 2019 (Teekay) | SDGs | Climate-related transition activities | ICMA Sustainability-Linked Bond Principles |

The extensive, though not exhaustive, list in Table A.1 demonstrates how the ecosystem for Green Bonds is gradually diversifying and how labels used by issuers are quickly growing to include an increasing number of SDG-related indicators or ESG factors at a more granular level. Green convertible bonds, for instance, are one of the newest innovation in this bond category and have already become popular in project financing for green energy infrastructure and green buildings (Fioretti, 2019; Gregory, 2020).

# B | Appendix B

Further information on the six out of seventeen Sustainable Development Goals (United Nations, 2015):

- Clean water and sanitation (SDG6):

  6.1: by 2030, achieve universal and equitable access to safe and affordable drinking water for all;

  6.2: by 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations;

  6.3: by 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally;

  6.4: by 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity;

  6.5: by 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate;

  6.6: by 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes;

  6.a: by 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies;

  6.b: support and strengthen the participation of local communities in improving water and sanitation management;

- Clean energy (SDG7):

  7.1: by 2030, ensure universal access to affordable, reliable and modern energy services;

  7.2: by 2030, increase substantially the share of renewable energy in the global energy mix;

  7.3: by 2030, double the global rate of improvement in energy efficiency;

  7.a: by 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology;

  7.b: by 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States and landlocked developing countries, in accordance with their respective programmes of support;

- Sustainable industry, innovation and infrastructure (SDG9):

  9.1: develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all;

  9.2: promote inclusive and sustainable industrialization and, by 2030, significantly raise industry's share of employment and gross domestic product, in line with national circumstances, and double its share in the least developed countries;

  9.3: increase the access of small-scale industrial and other enterprises, in particular in developing countries, to financial services, including affordable credit, and their integration into value chains and markets;

  9.4: by 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities;

  9.5: enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, by 2030, encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research

and development spending;

9.a: facilitate sustainable and resilient infrastructure development in developing countries through enhanced financial, technological and technical support to African countries, the least developed countries, landlocked developing countries and small island developing States;

9.b: support domestic technology development, research and innovation in developing countries, including by ensuring a conducive policy environment for, inter alia, industrial diversification and value addition to commodities;

9.c: significantly increase access to information and communications technology and strive to provide universal and affordable access to the Internet in the least developed countries by 2020;

- Sustainable cities and communities (SDG11):

11.1: by 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums;

11.2: by 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons;

11.3: by 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries;

11.4: strengthen efforts to protect and safeguard the world's cultural and natural heritage;

11.5: by 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations;

11.6: by 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management;

11.7: by 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons

with disabilities;

11.a: support positive economic, social and environmental links between urban, peri-urban and rural areas by strengthening national and regional development planning;

11.b: by 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015–2030, holistic disaster risk management at all levels;

11.c: support the least developed countries, including through financial and technical assistance, in building sustainable and resilient buildings utilizing local materials;

- Climate Action (SDG13):

13.1: strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries;

13.2: integrate climate change measures into national policies, strategies and planning;

13.3: improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning;

13.a: implement the commitment undertaken by developed-country parties to the United Nations Framework Convention on Climate Change to a goal of mobilizing jointly $100 billion annually by 2020 from all sources to address the needs of developing countries in the context of meaningful mitigation actions and transparency on implementation and fully operationalize the Green Climate Fund through its capitalization as soon as possible;

13.b: promote mechanisms for raising capacity for effective climate change-related planning and management in the least developed countries and small island developing States, including focusing on women, youth and local and marginalized communities;

- Life on land (SDG15):

15.1: by 2020, ensure the conservation, restoration and sustainable use of terrestrial

and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements;

15.2: by 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally;

15.3: by 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world;

15.4: by 2030, ensure the conservation of mountain ecosystems, including their biodiversity, in order to enhance their capacity to provide benefits that are essential for sustainable development;

15.5: take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species;

15.6: promote fair and equitable sharing of the benefits arising from the utilization of genetic resources and promote appropriate access to such resources, as internationally agreed;

15.7: take urgent action to end poaching and trafficking of protected species of flora and fauna and address both demand and supply of illegal wildlife products;

15.8: by 2020, introduce measures to prevent the introduction and significantly reduce the impact of invasive alien species on land and water ecosystems and control or eradicate the priority species;

15.9: by 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts;

15.a: mobilize and significantly increase financial resources from all sources to conserve and sustainably use biodiversity and ecosystems;

15.b: mobilize significant resources from all sources and at all levels to finance sustainable forest management and provide adequate incentives to developing countries to advance such management, including for conservation and reforestation;

15.c: enhance global support for efforts to combat poaching and trafficking of pro-

tected species, including by increasing the capacity of local communities to pursue sustainable livelihood opportunities.

# C | Appendix C

Table C.1: External review types

| **Pre-issuance review** | **Scope** | **Providers** |
|---|---|---|
| **Assurance** | Positive or negative assurance on compliance with the Green Bond Principles (GBP) or the Green Loan Principles (GLP) | EY, Deloitte, KPMG, etc |
| **Second Party Opinion (SPO)** | Confirm compliance with GBP / GLP. Provide assessment of issuer's green bond framework, analysing the "greenness" of eligible assets | CICERO, Sustainalytics, DNV GL, Vigeo Eiris, ISS-Oekom, etc |
| **Green bond rating** | Rating agencies assess the bond's alignment with the GBP and the integrity of its green credentials | Moody's, S&P, RAM (Malaysia), R&I (Japan) |
| **Pre-issuance verification** | Third party verification confirms that the use of proceeds adheres to the Climate Bonds Standard and sector-specific criteria | Approved Verifiers under the Climate Bonds Standard |
| **Post-issuance review** | **Scope** | **Providers** |
| **Assurance or SPO** | Assurance of allocation of proceeds to eligible green projects | Audit firms, ESG service providers, scientific experts |
| **Impact report** | Reporting that seeks to quantify the climate or environmental impact of a project/asset numerically | As above |
| **Post-issuance verification** | Assurance against the Climate Bonds Standard, including allocation of proceeds to eligible green projects and types of green projects | Approved Verifiers |

Source: Climate Bonds Initiative.

# D | Appendix D

Table D.1: List of activities recorded in the Taxonomy Analysis dataset.

| Activity Name | Number of appearances | Percentage of appearance |
|---|---|---|
| Electricity generation using solar photovoltaic technology | 241 | 52.9% |
| Electricity generation from Wind Power | 236 | 51.8% |
| Renovation of existing buildings | 110 | 24.1% |
| Installation, maintenance and repair of instruments and devices for measuring, regulation and controlling energy performance of buildings | 75 | 16.4% |
| Infrastructure for rail transport | 70 | 15.4% |
| Transmission and Distribution of Electricity | 44 | 9.6% |
| Passenger interurban rail transport | 44 | 9.6% |
| Urban and suburban transport, road passenger transport | 39 | 8.6% |
| Storage of Electricity | 37 | 8.1% |
| Infrastructure low-carbon road transport and public transport | 35 | 7.7% |
| Installation, maintenance and repair of energy efficiency equipment | 35 | 7.7% |
| Electricity generation from geothermal energy | 33 | 7.2% |
| Electricity generation from Hydropower | 27 | 5.9% |
| Construction of new buildings | 27 | 5.9% |
| Acquisition and ownership of buildings | 22 | 4.8% |
| Installation, maintenance and repair of charging stations for electric vehicles in buildings (and parking spaces attached to buildings) | 21 | 4.6% |
| Urban and suburban transport, road passenger transport | 20 | 4.4% |
| Transmission and distribution networks for renewable and low-carbon gases | 19 | 4.2% |
| Passenger interurban rail transport | 18 | 3.9% |
| Electricity generation from bioenergy | 16 | 3.5% |
| Electricity generation from ocean energy technologies | 14 | 3.1% |
| Anaerobic digestion of bio-waste | 14 | 3.1% |
| Transport by motorbikes, passenger cars and light commercial vehicles | 14 | 3.1% |
| Forest management | 13 | 2.9% |
| Anaerobic Digestion of Sewage sludge | 13 | 2.9% |
| Operation of personal mobility devices, cycle logistics | 13 | 2.9% |
| Manufacture of low carbon technologies for transport | 12 | 2.6% |
| Production of heat/cool using waste heat | 11 | 2.4% |
| Transport by motorbikes, passenger cars and light commercial vehicles | 10 | 2.2% |
| Infrastructure for personal mobility, cycle logistics | 9 | 2.0% |
| Data-driven solutions for GHG emissions reductions | 8 | 1.8% |
| Afforestation | 6 | 1.3% |
| Rehabilitation and restoration of forests, including reforestation and natural forest regeneration after an extreme event | 6 | 1.3% |
| District Heating/Cooling Distribution | 6 | 1.3% |

| | | |
|---|---|---|
| Construction, extension and operation of water collection, treatment and supply systems | 6 | 1.3% |
| Collection and transport of non-hazardous waste in source segregated fractions | 6 | 1.3% |
| Installation, maintenance and repair of renewable energy technologies | 6 | 1.3% |
| Close to market research, development and innovation | 6 | 1.3% |
| Storage of Hydrogen | 5 | 1.1% |
| Electricity generation using concentrated solar power (CSP) technology | 5 | 1.1% |
| Construction, extension and operation of waste water collection and treatment | 5 | 1.1% |
| Manufacture of Hydrogen | 4 | 0.9% |
| Cogeneration of Heat/cool and Power from Geothermal Energy | 4 | 0.9% |
| Cogeneration of heat/cool and power from bioenergy | 4 | 0.9% |
| Production of heat/cool from solar thermal heating | 4 | 0.9% |
| Production of heat/cool from geothermal energy | 4 | 0.9% |
| Manufacture of energy efficiency equipment for buildings | 3 | 0.7% |
| Manufacture of renewable energy technologies | 2 | 0.4% |
| Manufacture of other low carbon technologies | 2 | 0.4% |
| Composting of bio-waste | 2 | 0.4% |
| Freight rail transport | 2 | 0.4% |
| Inland passenger water transport | 2 | 0.4% |
| Conservation forestry | 1 | 0.2% |
| Manufacture of plastics in primary form | 1 | 0.2% |
| Manufacture of batteries | 1 | 0.2% |
| Storage of Thermal Energy | 1 | 0.2% |
| Electricity generation from renewable non-fossil gaseous and liquid fuels | 1 | 0.2% |
| Material recovery from non-hazardous waste | 1 | 0.2% |
| Low carbon airport infrastructure | 1 | 0.2% |
| Freight rail transport | 1 | 0.2% |

# List of Figures

# List of Tables