CBS COPENHAGEN BUSINESS SCHOOL
HANDELSHØJSKOLEN

Performance of Green Bonds in the Energy Sector

Master Thesis

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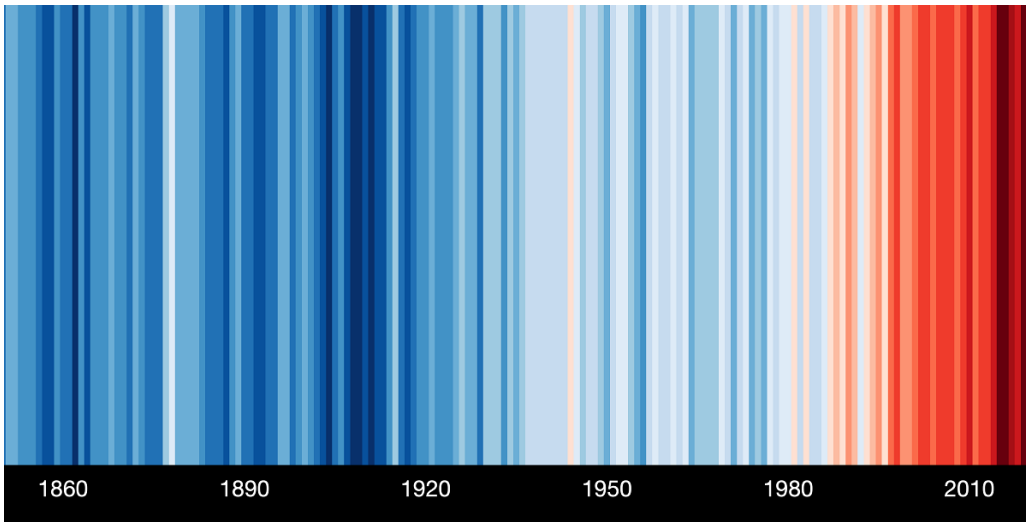

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Abstract

This thesis investigates green bonds and seeks to answer whether this financing tool is effective in funding the green energy transition. It is argued that decarbonising the energy sector is vital in the fight against climate change and the question of how to finance this transition is a global concern increasing in importance. The purpose of this study is to investigate the connection between the corporate debt market and the energy transition. The focus is on corporate green bonds, whose proceeds finance climate-friendly energy projects. Conducting a natural experiment, this study analysed two areas related to energy green bonds, i.e., the bond pricing in the primary market and the post-issuance firm-level performances of energy bond issuers, and discuss the results against similar studies. The empirical predictions are tested on a unique data set of energy green bonds and firms. To isolate the effect of the "green" factor from the effect of a bond issuance, the average treatment effect of the treated (ATT) is measured by means of the differences-in-differences regressor. The results show that green bond do not achieve a lower cost of debt compared to comparable vanilla bond from the same issuer. However, green issuers improved their post-issuance environmental performance, i.e., lower CO_2 emission to revenues and more renewable energy produced, but experienced a lost in equity ownership percentages of long-term and institutional investors.

Dedication

Edoardo:*"To my grandparents, Primo and Alba."*

Esben:*"Til Mor"*

Acknowledgement

Throughout the writing of this Masters thesis, we have received support and assistance.

We would first like to thank our supervisor, Professor Tooraj Jamasb, whose expertise was invaluable in framing the research questions and discussing the methodology. Your insightful feedback pushed us to sharpen our thinking and brought our paper to a higher level.

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Edoardo:

"I would like to thank my professor of econometrics, Drs. Natalia Khorunzhina, for her precious guidance throughout my thesis; and my professor of international finance, Dr. Peter Feldhütter, whose paper has inspired the choice of the topic. In addition, I would like to thank my parents for their wise counsel and sympathetic ear. I am lucky to have you always there for me. Finally, I couldn't have completed this thesis without the support of my friends, who provided stimulating discussions as well as happy distraction to raise my mind outside of my research."

Contents

Chapter 1

Introduction

1.1 Introduction

This thesis pivots on the question of how the 1.5 degrees Paris Climate Goals can be achieved, and more importantly how transitioning to a globally sustainable economy is effectively funded. The study begins by introducing the context in which this challenge is situated and further singles out one sector that could turn out to be the solution to achieving this goal while simultaneously also being the biggest hindrance in achieving the goal; the energy sector. Additionally, three markets are brought into focus due to their importance in governing, leading and financing transitioning the energy sector. The study quickly turns its attention to greenhouse gas emissions as this is the most material factor in greening the energy sector. Accordingly, the bond market is identified as a potential financing tool, more specifically, the green bond. The factors that influence the green bond market in these three markets is then examined in the context of the energy sector of each market.

This thesis contributes to existing literature on corporate green bonds from a unique angle. Few studies have made use of the multidisciplinary approach adopted in this thesis, providing more in depth coverage of the studied topics. While literature investigating environmental impact of green bonds is increasingly common, the topic of investigating green bond effectiveness in the specific context of enabling a green energy transition is unique. Due to the multidisciplinary approach our study is able to contribute with data that balances qualitative findings and social factors, as well as quantitative analysis and results. By using the EU, China and the USA as case studies, a wider array of underlying factors affecting the conclusion could be taken into account. Thus, by adopting a varied research approach this study presents a holistic account of green bond environmental

impact.

The central objective of the thesis is to measure and eventually draw statistical (if significant) conclusions regarding the effectiveness of the corporate green bond market as a driver of the energy transition. In many fields, such as psychology and medicine, a causal effect is calculated by employing experiments. For instance, a medical trial of a new drug consists in a randomized controlled experiment where some patients receive the actual drug, while the rest takes an ineffective substitute (a "placebo" equivalent). Eventually, the drug is authorized in case there is convincing statistical evidence that the drug does not produce side effects and it cures the targeted disease. Similarly, our thesis wants to find statistical evidence that corporate green bonds are efficacious means to improve the energy transition and we thus employ such a methodology. However, this thesis also incorporates a more interpretivist approach to answering this question.

The context of our study is a non-experimental setting or quasi-experiment. The randomization of the study derives from the variations in individual circumstances, that makes it appear "as if" the treatment is randomly assigned. Fortunately, the statistical insights and method of randomized controlled experiments can carry over to quasi-experiment (Stock & Watson, 2012). The usage of the quasi-experiment implies a main issue: how can we be sure that the control group is a valid and reliable term of comparison for the treated group? Often, quasi-experiments rely on a matching method that matches two individuals by forming a pair whose individuals have minimal differences between themselves (Strumpf, Harper, & Kaufman, 2017).

Basing our research method on natural experiments and the matching method, we can investigate whether green bonds are effective tools to promote the green energy transition. To answer the main research question, we delimit our analysis to the pricing of green bonds in the primary market as well as the post-issuance performance of energy firms that are green bond issuers. The primary quantitative analysis was complemented with a range of semi-structured interviews with asset managers, investment advisors, policy makers, diplomats and multinational/supranational development bank advisors. The discussions with these industry experts represent highly valuable insights that helped guide our investigation as well as shedding light on our main research question.

1.1.1 Delimitation

This thesis exclusively covers corporate bonds, focusing on green corporate bonds of publicly listed issuers in the global energy sector. As this paper investigates corporate strategy and motivations for issuing green bonds, it would not make sense to investigate green bonds issued by supranational, multinational development bank, government backed or sovereign entities. The main reason for picking corporate bonds is due to their straightforward and relatively identifiable effect on the green energy transition. However, this decision was also made on the back of significant challenges we faced in gathering suitable data on green bonds issued by these entities. Public entity corporate green bonds however, provide rich sources of information and data particularly suited for our quantitative analysis.

The choice of delimiting the thesis further to investigate green bond effectiveness in terms of enabling a green energy transition is motivated both by interest in the subject matter as well as believing in the potential value the study could contribute. A thorough explanation of why green bonds were chosen over other sustainability or target-linked bonds were chosen is provided later in the paper. Choosing to focus on three markets instead of the global green bond market has numerous reasons. Firstly, due to limited space we are unable to provide a global overview, while focusing on every market would weaken the conclusions of the paper considerably. Secondly, these markets are the top issuers in green bonds, as well as being market leaders each in their own right. Lastly, these three markets also happen to be top greenhouse gas emitters, and thus this choice seemed to be most logical as well as providing coherence in both qualitative and quantitative data and discussion.

1.1.2 Research Question

As a result of our delimitation and the context described in the introduction this thesis poses the research question: *"Are green bonds an effective tool in enabling the green energy transition?"*

Chapter 2

Green Bond Market Overview

2.1 Fundamentals of Sustainable Finance

Sustainable finance covers a range of different financing tools that can further the green energy transition. Sustainable finance can be defined 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." (EC, 2021c). This section will focus on the environmental aspect in sustainable financing, specifically green bonds. However, other financing tools will also be introduced as long as they consider environmental considerations such as climate change mitigation and adaptation, pollution prevention or the environment in a general sense.

To begin introducing a range of financing tools that fight for climate action alongside green bonds, Socially Responsible Investing (SRI) and Green Finance will be introduced first. SRI is a hugely influential tool in driving sustainability, and to a lesser extent decarbonisation. The approach to investing integrates ESG criteria into investment and financial management decisions in a systematic and traceable manner (BNP Paribas, 2018). One of the most recent estimates finds that alongside consistent growth in SRI globally, an estimated $23 trillion of assets were managed using responsible investment strategies (SRI-Research, 2021). Thus, the SRI approach entails portfolio managers to consider ESG criteria when selecting investments and asset values (BNP Paribas, 2018). Examples of SRI products are sustainability-linked bonds, green or social bonds, green or social loans, ESG funds, ETFs, and Mutual Funds.

In its essence, SRI goes against the Friedman doctrine, or shareholder theory of business

ethics, that states a firm's sole responsibility is to its shareholders thereby ignoring any notion of responsibility coming from the side of the business (Friedman, 1970). SRI has sprung up from such authors as Hamilton and Statman (1993) in their article "Doing Well while Doing Good? The Investment Performance of Socially Responsible Mutual Funds" which claims financial products do better if they avoid sin stocks such as alcohol, tobacco, weapons and in extension, heavy polluters crippling climate action (Hamilton, 1993).

Green Finance

As opposed to the comparatively comprehensive SRI, green finance combines all financial transactions that favour climate action, the energy transition, and fighting climate change. The green finance approach differs from SRI in that it does not focus on ESG but rather aims to decarbonise investor portfolios by financing companies with a mitigating, low or positive environmental impact. Notably one of its main components and financial tools is green bonds purposely issued to finance ecological projects and initiatives (BNP Paribas, 2018). Green finance tools and products include green bonds, green loans, green development funds, green insurance, markets for pollution control and international cooperation (Center on Global Energy Policy, 2021).

The following section will briefly elaborate on why green bonds have been chosen as our focus area in this thesis. While the green finance market reached 1.002 trillion in cumulative issuance since its inception in 2007, with green loans accounting for $28.9bn (Jones, 2020). Green loans, while they commit funds to climate and environmental projects, are issued by banks who commonly have lower risk tolerances thus making this a less attractive method of raising capital for energy sector players investing in green infrastructure projects. This especially holds true for fossil fuel energy players as funds from a green loan can be tied to ESG performance of the company in determining the interest rate of the loan (Sustainalytics, 2019). Besides, after the publication of the Sustainability-Linked Loan Principles by ICMA in 2019, the global sustainability-linked loan market has leapfrogged past green loan levels (Nordea, 2020). This indicates to us that narrow focus on green should be adopted, meaning we will not investigate sustainability loans either. A further argument to focus on green rather than sustainable tools is our narrow focus on decarbonisation in the energy sector. In fact, use of proceeds from green bonds have channelled $381bn into energy (CBI, 2020). The remaining uses of proceeds are illustrated in figure 2.1 below.

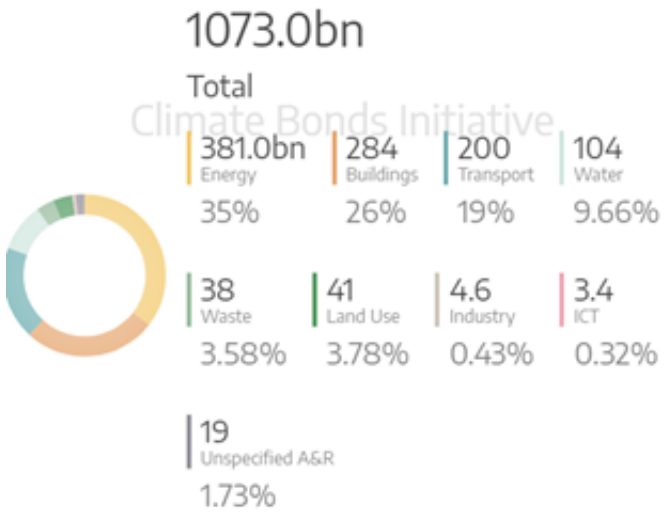


Figure (2.1) Source: (CBI, 2020)

Later sections on specific energy industries will elaborate further on the aforementioned green financing methods to achieve a green energy transition.

2.2 An Overview of Green Bonds

In 2020, the size of the global stock market was $89.5tn, while the global bond market was around $128.3tn (Ali, 2020) & (ICMA, 2020). Notably, the difference in size of the stock market hints at the significance of bonds in terms of financing capacity alone compared to other methods such as green investment funds. The bond market is comprised of Sovereigns, Supranational, and Agencies (SSA) making up 68% of total bonds while the remaining 32% are corporate bonds (ICMA, 2020). In 2020, green bond issuance was $269.5bn, while in 2019 and 2018 was $266.5bn and $171.4bn, respectively. Growth in green bond issuances has seen a constant upward trend for the past ten years at a 60% average annual growth rate since 2015. (Jones, 2021). While this thesis exclusively investigates corporate green bonds, a complete overview of issuer types is illustrated below in figure 2.2.

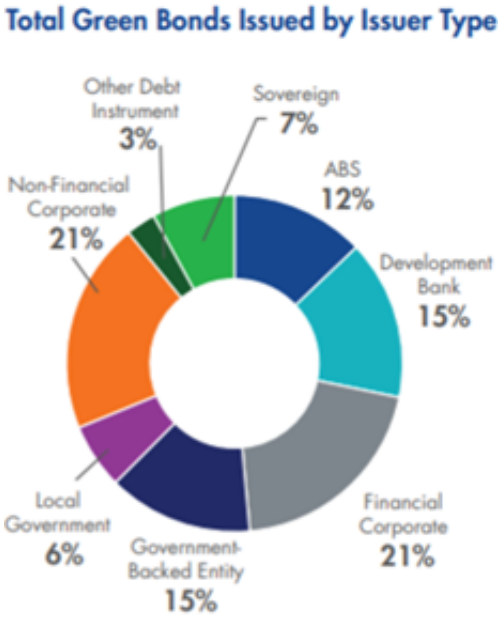


Figure (2.2) Source: (VanEck, 2020).

The Emergence of Green Bonds

To answer why green bonds are a key tool in enabling a green energy transition, it is useful to explain inherent qualities of this financial instrument, the reasons for their emergence, and what the raised capital is put towards. As this thesis exclusively looks at the energy sector, the following sections will focus on the effectiveness of green bonds with this sector in mind. This in turn requires us to explore the meaning of "green" when taking differing markets or regional energy mix's into account in later sections. This overview of the sustainable bond market will serve to justify the choice to examine green bonds as opposed to other targeted-linked bonds as well as choosing only three markets to focus the qualitative analysis on; the EU (28), China and USA.

Broadly green bonds can be defined as a debt instrument issued in order to fund a project resulting in positive climate or environmental impact. An additional characteristic is that use of proceeds from such bonds are to be directed towards green projects while the bonds are backed by an issuers entire balance sheet. Green bonds first appeared on the market after the EIB issued a Climate Awareness Bond in 2007 which was listed on the Luxembourg Stock Exchange (LSE, 2021). The term 'green bond' was also adopted by the World Bank and, since then the popularity and market size of green bonds has grown dramatically along with interest in many other types of climate-focused assets. This lead to an acknowledgement of debt and fixed income instruments as vital tools to finance the

transition to a low-carbon economy. Consequently, green bonds have grown substantially in importance since (BNEF, 2015).

As this paper focuses on green bonds, this short section serves to justify our choice of doing so. In the same family as green bonds are sustainability-linked and social bonds, these began to appear in 2014 and have since grown considerably in market size. The growth progress of these three products is illustrated below based on Bloomberg and SEB data from October 2018.

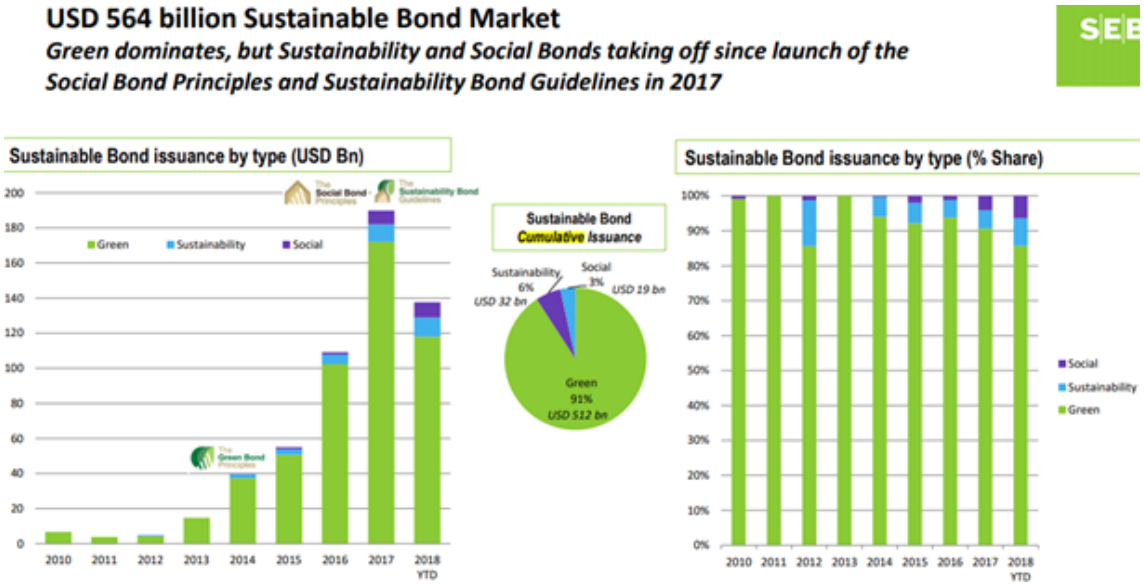
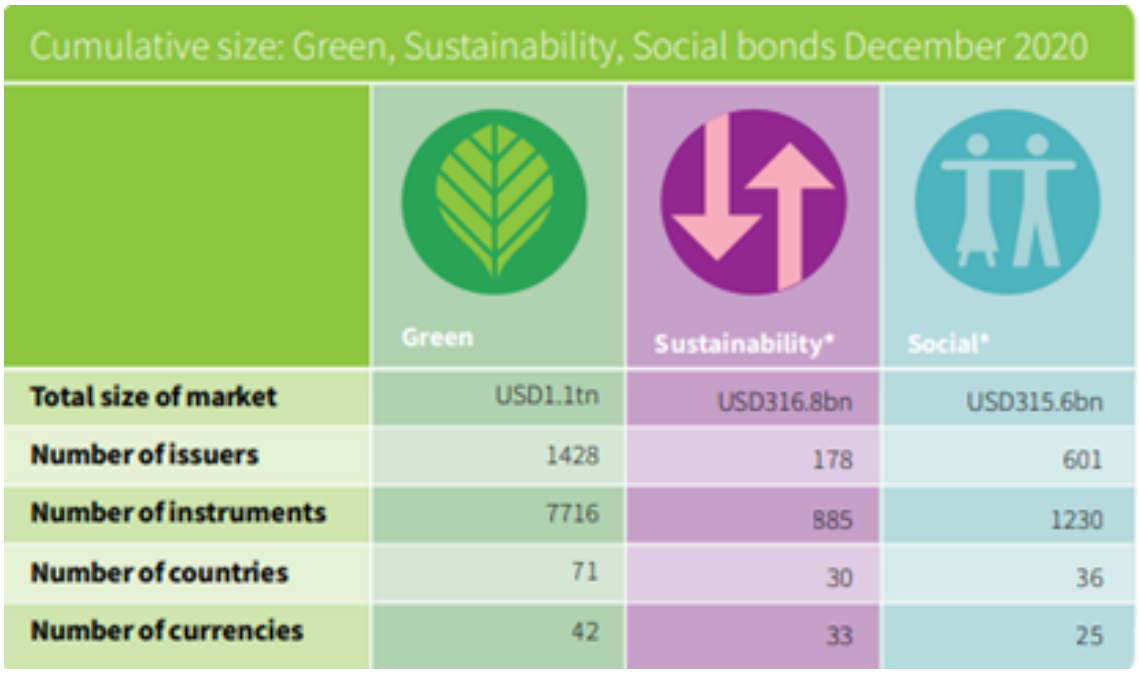


Figure (2.3) Source: (SEB, 2021).

It is clear that green bonds, marked in green, are the most dominant in terms of market share and growth, indicating its relative importance in raising capital and channelling financing towards sustainable activities, especially climate-related activities. Undoubtedly sustainability bonds may have somewhat of an effect in financing a green energy transition, however, by very definition social bonds and sustainability bonds do not focus on this endeavour specifically. As illustrated in figure 2.4 below, by the end of 2020 green bonds still dominated the market and therefore we view green bonds as having highest potential in financing a green energy transition out of the bonds covered. We therefore justify focusing on green-labelled bonds due to our research focus on climate impact mitigation and adaptation, and in extension green finance in the energy sector.



Cumulative size: Green, Sustainability, Social bonds December 2020

	Green	Sustainability*	Social*
Total size of market	USD1.1tn	USD316.8bn	USD315.6bn
Number of issuers	1428	178	601
Number of instruments	7716	885	1230
Number of countries	71	30	36
Number of currencies	42	33	25

Figure (2.4) Source: (CBI, 2021d)

2.3 Key Green Bond Markets

This section will briefly outline key green bond markets and further narrow our research focus for later discussions. The global green bond market lies at a cumulative issuance of green debt of $1.1 trillion, with 1428 issuers, 7716 instruments, issued by 71 countries in 42 currencies. In order to gain the bigger picture this thesis focuses its discussion on three markets with the highest CO_2 emissions, representing the significant markets in terms of an urgent energy transition to avoid climate warming; EU (28), China, and USA. We consider 2020 as an anomaly in terms of global emissions data, and thus choose to use 2019 data since instead as data from 2021 is not yet available. In fact, 2021 data from IEA indicates that global CO_2 emissions may rebound 5% from 2020, again approach peaks reached in 2018-19 (IEA, 2021d). In 2019, China emitted 10.17 billion tonnes in CO_2, with the USA and EU (28) emitting 5.28 billion tonnes and 3.29 billion tonnes, respectively (Ourworldindata, 2021). Besides, we bolster our argument for picking these three markets as our research focus based the three currencies most often seen in green bond issuances; EUR, USD, and CNY. An overview of cumulative issuance divided in currency is illustrated in figure 2.5.

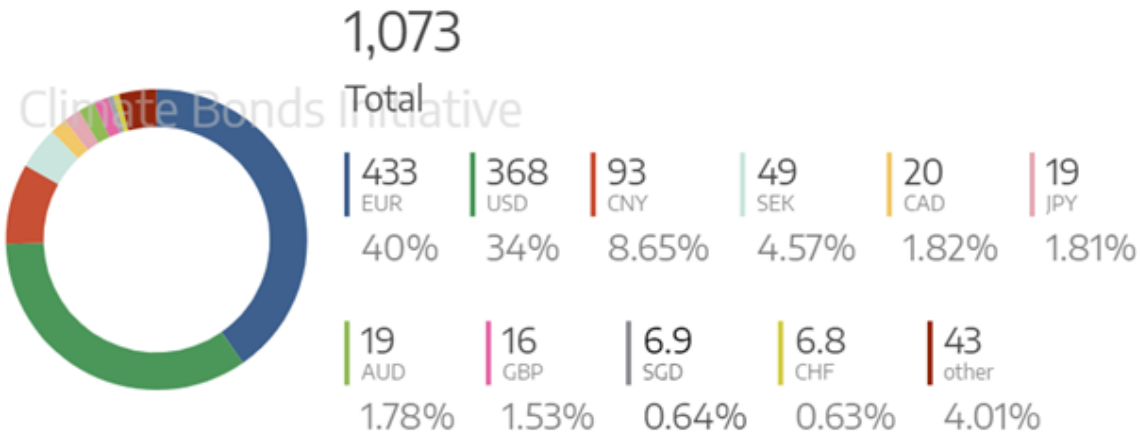


Figure (2.5) Source: (CBI, 2021b)

EU (28)

Climate change is affecting the EU several ways depending on geographical location, with Southern Europe is experiencing heat waves and droughts while Northern Europe is becoming more and more prone to flooding. The EU considers climate change and environmental degradation an existential threat (EC, 2021b). According to the IEA around 38.5% of CO_2 emissions in 2018 originated from electricity and heat generation together with other energy industries, making it the biggest emitter after the transport sector, which accounted for around 29% of emissions (IEA, 2021a). The cumulative issuance of green bonds of the EU is $444.8 billion with $261.7bn having been issued in the last two years alone (ending 2020.12.31). 2020 saw an increase of 28.6% in green bond issuance compared to the 2019 (CBI, 2021a). An overview of the five key issuing Member States is illustrated below.

Country	Green
France	124.3
Germany	93.3
Netherlands	54.4
Spain	35.7
Sweden	43.0

Figure (2.6) Source: (CBI, 2021d).

China

With China being the largest emitter of CO_2 in the world, the country is significantly strained by climate change in terms of its effects on the economy, society and the envi-

ronment. This is largely due to its energy infrastructure which is heavily centred around fossil fuels such as coal (China, 2019). Ever since the 2013 'airpocalypse' that resulted in numerous Chinese cities including its capital Beijing being drowned in clouds of smog that were so toxic they exceeded maximum measurement levels, the government has been waging war against its environmental crisis. Pollution control became known as one of three tough battles to be won before the year 2020, with poverty and financial risk being the other two. Between 2018 and 2020 some coal mines were shut down while new coal-fired power plants near highly developed areas have been prohibited (J. L. Shapiro, 2020). Viewing China through the myopic lens of Paris Agreement goals, it is the country in the world that must decarbonise its energy sector with the most vigour and determination. China is responsible for most of the CO_2 emissions seen today by far, with 54.% released from electricity and heat generation together with other energy industries and 27.9% from industry (IEA, 2021b). The cumulative issuance of green bonds of China is $129.6 billion with $53.8bn having been issued in the last two years alone. 2020 saw a decrease of 28.7% in the issuance of green bonds compared to 2019 (CBI, 2021a). While a slowdown in green bond issuance in China is worrying, particularly due to its energy sector infrastructure being most urgently in need of decarbonisation globally. The issue of urgency is framed in the context of achieving Paris climate agreements, however, if we take a look at the illustration below showing cumulative CO_2 emissions it could be argued that the EU and the USA should feel more urgency than China to achieve a green energy transition as soon as possible.

Figure (2.7) Source: (Ourworldindata., 2020).

While the topic of common but differentiated responsibilities (CBDR) is not the focus of this paper, figure 2.7 above shows that the USA is responsible for 25%, the EU 22% and China 12.7% of cumulative CO_2 emissions. CBDR is a principle which was formalised in international environmental law in 1992, establishing that all states have a responsibility to address climate change, yet not equally. The reason for this is that differences in economic development between states must be taken into account when taking climate action (Epstein, 2013). CBDR will be brought up in the discussion on shades of green to a small extent later.

USA

Climate change impacts the USA in a wide variety of ways, notably extreme weather such as hurricanes and droughts that lead to severe wildfires (U. S. Global Change Research Program, 2014). The new administration under President Joe Biden is providing an impetus for change in the view of climate change. The U.S President Biden considers climate change an existential threat not just to the environment but also national security economic well-being and health. Notably, his 'Clean Energy Revolution' is closely tied to the topic of this paper (Democrat National Committee, 2021). According to IEA data, we deem a green energy transition is also urgently needed since 42.7% of CO_2 emissions in

2018 resulted from electricity and heat generation together with other energy industries, while transport came in second at 35.8% of emissions (IEA, 2021c). The cumulative issuance of green bonds in the USA is $223.7 billion with $105bn issued in the last two years. 2020 saw a decrease in the issuance of green bonds of 1.53% compared to 2019 (CBI, 2021a).

2.3.1 EU, China & the USA - Globalising Green Bonds

Compared to the first issuance of green bonds, green bonds as well as sustainability and social bonds have become far more standardised both in financial markets and in the eyes of society. One major driver towards standardisation and formalisation has been the EU's adoption of the EU regulation (Regulation (EU) 2020/852) on the establishment of a framework to facilitate sustainable investment, or more commonly known as the EU Taxonomy Regulation (Gambro, 2021). The following sections will explore various entities, stakeholders and interest organisations operating in our three chosen green bond markets, such as second party certifiers and green bond standard setters. The section will look at how these aim to find a balance between defining precise standards and implementing strict regulation to combat greenwashing, while at the same time avoiding overly rigid and heterogenous frameworks that inhibit the development of green bonds going forward.

2.4 Developing a Common Language For 'Green' - Use of Bond Proceeds

A global green energy transition requires large amounts of private capital in order to be successful, and in extension, closing the funding gap is a prerequisite for a truly sustainable economy to arise and halting climate change. Noting the global bond market size, it is likely that green bonds will play a vital role in this transition in the coming years. However, while green bonds have been receiving attention from both issuers and investors the world over, the scale of issuance needs to be scaled up enormously in a short period of time in order for the energy sector, and economies in general, to decarbonise. The growth in green bonds can be attributed to government actions in addressing climate change and sustainable finance by working towards a standardised definition of what a green bond is as well as developing standards allowing for better evaluation of the green bond (VanEck, 2020). The various frameworks guiding the green bond market towards a more

standardised and commoditised stage will be examined in the following section on green bond frameworks.

Developing a common language for 'green' bonds is vital for several reasons. The initial reason being that in the first few years since the first issuance of green bonds in 2007 resulted in a degree of seemingly arbitrary self-labelling of bonds as green, causing concern in the market that issuers were greenwashing the debt instrument. Greenwashing meaning using proceeds of green bonds towards energy projects that were not green in the sense of positive environmental impact in either mitigation, adaptation, or decarbonisation (VanEck, 2020). While these green bonds enabled investors to direct funding towards projects or activities with positive environmental impact with risk-return profiles not dissimilar to tradition, guarantees of use of proceeds were weak due to missing green bond frameworks (SBN, 2018).

Green Bond Frameworks – Combatting Greenwashing

A variety of market failures pose a threat to the growth of green investment vehicles such as green bonds to serve as a tool to finance the green energy transition. Such barriers are the potential for greenwashing, high transaction costs for monitoring and certification, inadequate transparency and investment infrastructure, and regulatory uncertainty (ADBInstitute, 2020). In order to combat greenwashing and allow for further growth of green bonds through enhancing their legitimacy, the International Capital Market Association (ICMA) established the Green Bond Principles (GBP) in 2014, seven years after the issuance of the first green bond (VanEck, 2020). The focus of the GBP has always been on use of proceeds with the aim to support issuers in transitioning away from an environmentally damaging business model towards greater sustainability through specific projects (ICMA, 2018). Since then, a handful of other frameworks have emerged to help identify the types of projects considered truly green.

The use of proceeds clause provides sustainability goal oriented investors with a form of transparency and assurance in that issuers must live up to a green bond investment mandate and disclose key information. The use of proceeds clause provides the fundamental argument for the effectiveness of green bonds as a financing tool for a low carbon economy. Yet, three additional pillars provide guidance and sets standards to bolster green bonds as a tool for genuine sustainable finance. Besides the ICMAs GBP, other organisations and stakeholders have developed or are in the process of developing individual frameworks

(SBN, 2018). Examples of other frameworks are the Climate Bonds Standard (CBS) & Certification Scheme by the Climate Bonds Initiative (CBI), the Chinese central bank People's Bank of China's (PBOC) green bond guidelines, the EIB Climate Awareness Bond Framework, the World Bank Green Bond Framework, and the EU Green Bond Standard developed by the European Commission. The main difference between these frameworks is their geographical focus while all frameworks largely construct standards based on the GBP model.

ICMA - Green Bond Principles

The ICMA defines a green bond as a debt instrument where proceeds are only to be used to finance or re-finance, new and/or existing eligible green projects either in part or in full. ICMAs GBP have traditionally been the most widely used in the market, and aim to promote integrity in the green bond market through its guidelines on transparency, disclosure, and reporting. The GBP are based on the following four pillars: use of proceeds, process for project evaluation and selection, management of proceeds, and reporting (SBN, 2018).

As mentioned, use of proceeds clause is the focal pillar of the GBP. The clause states proceeds from a green bond issuance towards green projects should be documented and described in detail in the legal documentation for the financial instrument. Additionally, the financing or re-financing of a the project should have a clear positive environmental impact that will be assessed and, if possible, quantified by the issuer. In case of re-financing, it is recommended that the issuer give an estimate of the share of re-financing compared to financing when describing investments, specific projects or project portfolios. Projects may be considered green projects if they fall under one of the several eligible broad categories with objectives of climate change mitigation, climate change adaptation, conservation of natural resources or biodiversity, and pollution prevention and control (ICMA, 2018). Typical projects in the energy sector that would fall under these categories are renewable energy (wind, solar, hydropower, geothermal, biomass), carbon capture utilisation or storage, R&D spending with positive environmental objectives, pollution prevention and control, and climate change adaptation (ICMA, 2018).

The process for project evaluation and selection is the second pillar and aims to guide the issuer to communicate how the green projects have been selected and identified, while supplementing this with the specific eligibility criteria (ICMA, 2018). In the energy sector,

this pillar can be important when fossil fuel companies issue green bonds and, particularly when it is unclear whether the proposed positive environmental impact will affect the business model of the given corporate issuer as a result of the issuance. A telling example of this, is the Spanish energy and petrochemical company Repsol. The company issued a green bond in 2015 claiming to save 1.2 million tonnes of CO_2 p.a., however, its $500 million five-year corporate green bond was excluded from most of the main green bond indices (Cripps, 2017). The NGO Climate Bonds Initiative (CBI) claimed the bond was not eligible for the green label as it did not indicate a change in the fundamental business model. Bloomberg Barclays MSCI defended their decision to exclude Repsol's green bond from its index, noting little evidence to indicate that the proceeds would go towards activities that go beyond the 'business as usual' scenario in energy efficiency improvements within its fossil fuel operations. SP DJI and Solactive on the other hand only list green bonds that have been given the green light by CBI, further stressing the importance of signalling legitimate greening of the business model to avoid public backlash (Environmental Finance, 2017). This is arguably an example of an attempt at using green bonds for greenwashing. Additionally, this example indicates that green bonds enjoy a degree of protection in terms of legitimacy due to their inclusion on indices and reduced the confusion some investors might feel toward the definition of green. This could mean indices reduce barriers for investors and increase the demand for green bonds.

The third pillar is the management of proceeds and is closely tied to addressing the issue of transparency. Proceeds should be credited to a sub-account or sub-portfolio or, otherwise be tracked by the issuer in a transparent way. This opens the possibility for continuous tracking of capital and, enables the issuer to inform investors about possible changes to the allocation of funds in green projects. Lastly, ICMA recommends issuers let a third party verify this information (ICMA, 2018).

The fourth and final pillar is reporting. This pillar states that issuers should collect and store information on the use of proceeds on a rolling basis until the full green bond's proceeds have been allocated to green projects. This should be done either in accordance with the completion of the green project or on an annual basis. If qualitative and quantitative KPIs can be utilised, then this is encouraged. It is also recommended to include a description of the methodology in order to make the report on expected impact of all green projects related to the bond as understandable and comprehensive as possible (ICMA, 2018).

2.5 Green Bond Framework Universe

Since the inception of the ICMAs GBP, other voluntary standards have emerged. ICMA has aided in lending green bonds increased legitimacy and undoubtedly contributed to green bond market growth. Further complementary frameworks have been developed and are gaining traction and popularity as global leaders come under mounting pressure from society, investors, and corporates to facilitate swift climate action.

European Union Green Bond Standard

In 2018, the EU Commission acknowledged the role and importance of green bonds in financing assets and projects needed for a decarbonised economy. Consequently, the report by the High-Level Expert Group on sustainable finance outlined goals of developing a European green bond standard. Following the 2018 Action Plan on financing sustainable growth, the EU began developing uniform green bond standards intended to provide the region with its own framework (EC, 2020). The role of the Commission's Technical Expert Group (TEG) on Sustainable Finance has been to develop an Action Plan on four areas: "...1) a unified classification system for sustainable economic activities, 2) a European Union (EU) Green Bond Standard, 3) benchmarks for low-carbon investment strategies, and 4) guidance to improve corporate disclosure of climate-related information." (EC, 2019, p. 8). The recommendations for an EU Green Bond Standard (EUGBS) was released in June 2019 and its key points focused on creating a EUGBS that would increase the effectiveness, comparability, transparency, and credibility of the green bond market. As with other green bond frameworks, the EUGBS functions as a mean to encourage green bond market participants to invest and/or issue in green bonds, while this framework specifically promotes EU green bonds (EC, 2020). This represented strong signals to the market that not only policy support exists but also that leaders acknowledge the need to clearly define and create a uniform green bond market to solidify legitimacy and trust in such bonds.

Today the EUGBS exists as a voluntary standard for issuers wishing to align with best practices in the European market specifically, but also other markets around the world. Before giving an overview of the EUGBS, the EU Taxonomy will be examined since the standards are largely based on and aligned with this taxonomy. The EU Taxonomy is "...a classification system that categorises economic activities consistent with the low carbon

transition, adaptation, and other environmental objectives." (CBI, 2021d, p. 25). The taxonomy further clarifies what can be considered environmentally sustainable economic activities, stating that such an activity must do no significant harm or make a substantial contribution to one of the six environmental objectives. These objectives are: climate change adaptation, climate change adaptation, water and marine resources, circular economy, pollution prevention and control, and biodiversity and ecosystems. Additionally, environmentally sustainable activities must meet minimum safeguards and follow technical screening criteria requirements (CBI, 2021d).

The overarching aim of the EUGBS is to create a gold standard regulation for issuers, both private and sovereigns, to facilitate financing sustainable investments. While there is a lot of investor appetite for green bonds, the EUGBS aims to expand and increase the inherent environmental ambition of the green bond market itself. The EUGBS should therefore be a tool to further cement how this financial tool can be used to raise funds on capital markets to finance a green energy transition while meeting tough sustainability requirements as well as protecting investors from greenwashing (EC, 2021a). Notably, the EUGBS is open to issuers of green bonds outside the EU as well, meaning the framework may have a global influence in terms of alignment of standards. The four key requirements proposed in the framework are:

1. "The funds raised by the bond should be allocated fully to projects aligned with the EU Taxonomy;

2. There must be full transparency on how bond proceeds are allocated through detailed reporting requirements;

3. All EU green bonds must be checked by an external reviewer to ensure compliance with the Regulation and that funded projects are aligned with the Taxonomy. Specific, limited flexibility is foreseen here for sovereign issuers;

4. External reviewers providing services to issuers of EU green bonds must be registered with and supervised by the European Securities Markets Authority. This will ensure the quality and reliability of their services and reviews to protect investors and ensure market integrity. Specific, limited flexibility is foreseen here for sovereign issuers" (EC, 2021a).

People's Bank of China Green Bond Catalogue

At the end of 2015, the People's Bank of China (PBOC) announced its Green Financial Bond Guidelines (GFBG) as well as an associated Endorsed Project Catalogue. The GFBG became the first official national framework of rules for the issuance of green bonds (IISD, 2016).

The 2015 PBOC project catalogue provided a list of eligible projects that are not dissimilar to ICMA and EUGBS and thus included energy and resource conservation, clean energy, reducing pollution, clean transportation, and ecological protection. However, a conspicuous difference was the inclusion of 'clean coal' projects. To onlookers, it may seem contradictory to include 'Clean Utilization of Coal' in the name of positive environmental impact (GFC, 2015). In fact, this could be counterproductive to the growth of Chinese green bonds on international markets – potentially raising concern of greenwashing or issues related to comparability. However, this criticism and worry is not necessarily fair. A telling comment in the initial catalogue can explain why the discussion on this issue is divisive: "The definition ... of the green bond is based primarily on the environmental performance of the green bond endorsed projects. The different focus on environmental performance by various institutions reflects the different focus on problems to be solved, which stems from the differences in stage of development and natural environments in different countries and regions." (IISD, 2016, p. 1).

Notably, the current 2021 version of the Green Bond Endorsed Project Catalogue no longer lists 'green coal' projects as eligible projects, while other new fossil fuel projects may not be financed through green bonds issuance (CBI, 2021c). Additionally, PBOC together with the China Securities Regulatory Commission have issued Green Bond Assessment and Verification Guidelines introducing regulatory requirements for verifiers to ensure legitimacy of third-part verifiers, and in extension, green bonds (GreenFinancePlatform, 2017). Complementary to the PBOC project catalogue, the Green Bond Guidelines that were issued by the top regulator, the National Development and Reform Commission, essentially define what qualifies as green in the context of China's economic development (CBI, 2021c).

Naturally, what is defined as green can depend on a geographical and/or economic development levels, the current energy mix, pollution levels, available resources. Therefore when defining the meaning of green it should be placed in the context of energy security and demand. Doing so, allows for change in the interpretation of green-ness of a bond depen-

dent on geographical location of use of proceeds. From a global perspective, new coal-fired electricity plant projects cannot be considered green, while from the Chinese perspective it is perfectly reasonable to make that judgment, if indeed that new coal project replaces a highly inefficient and polluting plant. Regardless, this may deter some international investors from investing in Chinese green bonds. In 2018, only $31.2bn of a total of 42.8$bn issued green bonds aligned with global standards and criteria. Consequently, the PBOC announced plans in 2020 to exclude fossil fuels from its catalogue completely, and thus align much better with global standards for sustainable finance (Bloomberg Green, 2020).

2.6 External review & second party opinions

As is evident from the wording of the various frameworks described in previous sections, they merely serve as guidelines for what a green bond should be. This leaves some uncertainty as to what extent the proceeds of a given green bond are being allocated towards truly green projects. Since green bonds exist without a true governing body, independent external reviewing have become mainstream. These essentially fulfil the role of a governing body, providing assurance to investors of green bonds as well as providing an objective and independent opinion on the 'green-ness' of a given green bond (ICMA, 2018). In fact, definitions of eligible projects for green bonds depend on the priorities, needs and portfolios of the issuers . For example, a coal-fired energy producer might issue a green bond in order to achieve better efficiency while a solar energy producer wishes to construct a solar panel farm in a new location. This is where external review and second party opinions demonstrate their importance in bolstering the legitimacy of green bonds in enabling a green energy transition. Second party opinions and reviewers verify and confirm that all of the eligible projects are indeed in line with project categories as defined by the GBP or another widely used green bond framework (EC, 2017).

The reports produced by external reviewers judge how well a green bond aligns with a given green bond framework and subsequently makes the report available to investors and the general public. An external evaluation or review report can differ in scope and may be based on various criteria other than its framework alignment such as the individual green bond issue or its underlying assets and/or procedures. However, broadly speaking they can be grouped into four different types: second party opinion, verification, certification, and green bond scoring/rating (ICMA, 2018).

The second party opinion is commonly provided by an independent institution with environmental expertise. This evaluation focuses on use of proceeds - one of the four core aspects most green bond frameworks are built on. The other three areas which are examined are the process for project evaluation and selection, management of proceeds, and reporting. A second party opinion essentially assesses alignment with a green bond framework such as ICMAs GBP of an issuer. Here, the issuer is evaluated based on overall objectives, firm strategy, policy, and environmental impact of use of proceeds (ICMA, 2018). However, the value of this process is debated. On the one hand, he informational value coming from a confirmation of alignment between the GBP and green bonds can be quite limited since the definitions of project eligibility contained in the GBP are somewhat broad. On the other hand, stakeholders are able to reduce transaction costs related to assessing the green-ness or overall quality of a green bond as well as increasing comparability which may reduce the likelihood of greenwashing (EC, 2017).

A verification entails a process in which an assessment of issuer alignment with a designated set of criteria is made – commonly related to business practices and/or environmental criteria. The process is mainly conducted by actors such as the Big Four auditing companies and may focus on alignment with internal or external standards as well as environmental impact claims of the given issuer. Verification can also involve an evaluation of the environmentally sustainable characteristics of underlying assets. The method in which the issuer manages and tracks the use and/or allocation of proceeds in order to deliver positive environmental impact is also part of the evaluation in this process (ICMA, 2018).

Certification is essentially a confirmation that a given green bond framework, a green bond, or the use of proceeds aligns with an externally recognised standard with well-defined criteria. This process is usually carried out by a qualified and accredited third party such as KPMG, Deloitte, Ernst & Young, or Price Waterhouse Coopers.

Finally, green bond scoring/rating is based on materiality of environmental risks pertaining to the specific bond. This service can be provided by qualified third parties such as specialised research providers and rating agencies, with CICERO being a notable player in the green ratings sphere. The focus remains on environmental performance data, the best practice processes described in a given green bond framework or another benchmark such as Paris climate goals (ICMA, 2018). An overview of financially material risks in the energy sector, as identified by the Sustainability Accounting Standards Board, are listed in figure 2.8 below.

Sector Level Map Source: SASB https://materiality.sasb.org/

Issue is likely to be material for more than 50% of industries in sector	
Issue is likely to be material for fewer than 50% of industries in sector	
Issue is not likely to be material for any of the industries in sector	

		Extractives & Minerals Processing	Infrastructure	Renewable Resources & Alternative Energy
Dimension	**General Issue Category** ⓘ			
Environment	GHG Emissions			
	Air Quality			
	Energy Management			
	Water & Wastewater Management			
	Waste & Hazardous Materials Management			
	Ecological Impacts			

Figure (2.8) Source adapted from: (SASB, 2021).

Chapter 3

The Green Energy Transition

3.1 Green Bonds in the Energy Sector

The following sections will highlight why and how green bonds are able to finance a green energy transition and the required infrastructure. As previously stated, China, USA and the EU (28) will be looked at in particular to better assess and evaluate factors affecting energy sector players' strategy and planning when it comes to green bond issuance.

Background

In 2007, the UN Intergovernmental Panel for Climate Change (IPCC) published a report providing scientific data on climate change and its political and economic effects that linked human activity to global warming, and in extension the adverse impacts of climate change mentioned in previous sections. This one of the starting points and motivations for issuing green bonds, as financial institutions were called on to tackle these risks and create positive impact through financing (WorldBank, 2019). The most recent IPCC report, the AR6, concludes that human influence irrefutably have caused warming of the atmosphere, ocean and land since the mid-20th century (R. McSweeney, 2021). Regarding the energy sector, UN Secretary-General António Guterres stated "We need immediate action on energy. Without deep carbon pollution cuts now, the 1.5°C goal will quickly be beyond reach. This report must sound a death knell for coal and fossil fuels, before they destroy our planet. There must be no new coal plants built after 2021. OECD countries must phase out existing coal by 2030, with all others following suit by 2040. Countries should also end all new fossil fuel exploration and production, and shift fossil-fuel subsidies into renewable energy. By 2030, solar and wind capacity should quadruple and renewable

energy investments should triple to maintain a net-zero trajectory by mid-century." (UN, 2021).

Since the signing of the Paris Climate Agreement in 2015 by 195 UNFCCC member countries, the urgence to reduce global emissions has become far clearer to China, USA and the EU. Indeed, the goals of combatting climate change are inseparable from the need to overhaul the global energy sector and bring it in alignment with Paris climate goals. In order to limit further global warming and fight climate change, the decarbonisation of energy sources has since become a main concern. Developing and strengthening sustainable finance tools that facilitate a green energy transition in terms of decarbonisation, mitigation, and adaptation has been and still is urgently needed (Agliardi & Agliardi, 2019). If global leaders fail to take climate action by mitigating negative environmental impact through transforming the sources within their energy mix, catastrophic climate change may be unavoidable. As the IPCC stated in the beginning of 2018; in order to achieve Paris climate goals, no more than 420 Gigatonnes (Gt) of CO_2 may be released into the atmosphere. Once this 'carbon emissions budget' is spent, it is highly unlikely that global warming can be limited to 1.5°C above pre-industrial levels. Yet, each year we consistently hit the 40+ Gt CO_2 equivalent emissions mark globally (Agliardi & Agliardi, 2019).

While 2020 saw a 6.4% decline in CO_2 emissions due to the COVID-19 pandemic, the resulting reduction of 2.3Gt in CO_2 is still not aligned with adequate climate action required to align with Paris climate goals which require a 7.6% reduction p.a. for every year going forward in order to reach its goals (Tollefson, 2021). While this is the largest absolute drop in emissions ever recorded, the human-caused CO_2 emissions still totalled 40Gt (A. McSweeney R. Tandon, 2020). In 2020, 31.5Gt of CO_2 alone was caused by energy-related activities, while the development of emissions over the past 20 years is illustrated in 3.1 (IEA, 2021e).

3.1.1 Decarbonising the Energy Sector

The need for an rapid energy transition is pressing and is becoming far more prominent both for society as well as for governments and politicians. As illustrated in the IEAs sustainable development scenario (2019-2070, see 3.2) towards global sustainable economies, CO_2 emissions from all sectors must fall drastically, none more so than the energy sector. The global energy sectors' CO_2 emissions split up by industry is shown in figure 3.2. In

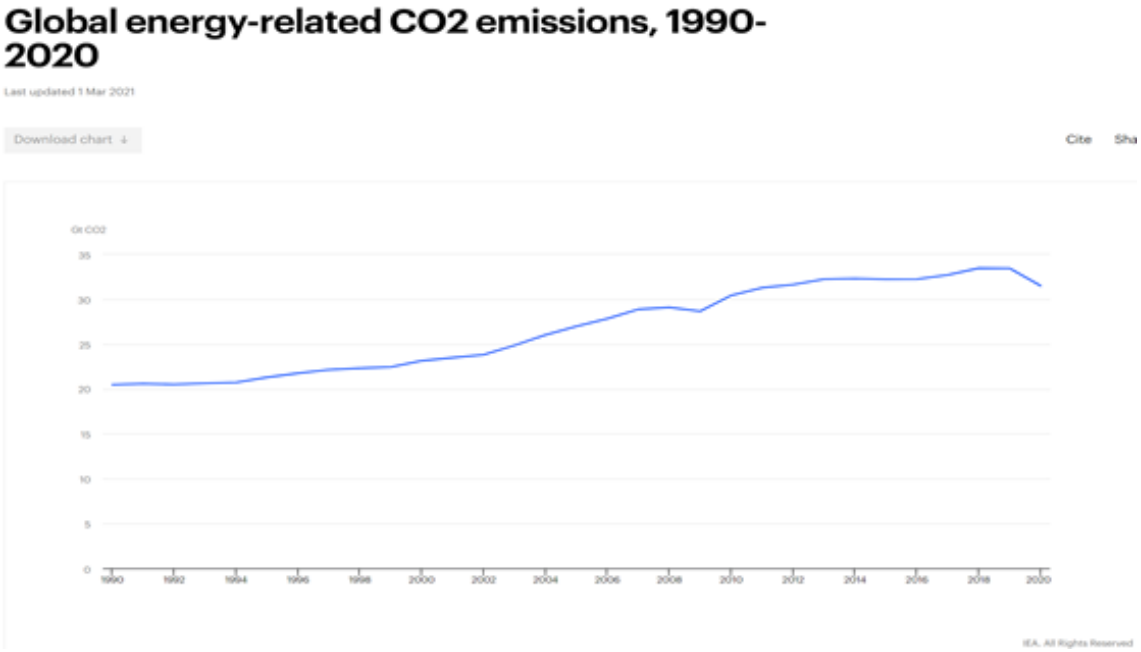


Figure (3.1) Source: (IEA, 2021e)

order of mention, power, industry, transport, buildings, other energy transformation, and agriculture are the biggest sources of emitters of CO_2.

As UN Secretary-General António Guterres stressed, the energy sector must go from brown to green, or from fossil fuel dependency to renewable energy reliance. The energy transition entails a transformation of the global energy sector, more specifically shifting away from fossil fuel-based energy systems towards renewable means of energy production and consumption. The transition must occur in order to achieve a carbon neutral sector by the second half of this century and prevent catastrophic climate change (IRENA, 2021). Fossil fuels such as oil, natural gas and coal must be replaced by on-and-offshore wind, solar and hydropower. This is to be achieved by increasing the percentage of renewable sources of energy in the global energy supply mix, global infrastructure electrification and increased capabilities in energy storage technology (Standard and Poor's Global, 2020). The primary goal of a green energy transition is to decarbonise the sector and mitigate its current adverse effects on the environment. Global and coordinated action by key polluters is required to reduce CO_2 emissions, while renewables have the potential to achieve 90% of the needed CO_2 emissions reductions. Climate action can be enabled through policy frameworks, technological innovation and market instruments such as green bonds (IRENA, 2021).

The energy sector currently accounts for around 75% of global carbon emissions and, as

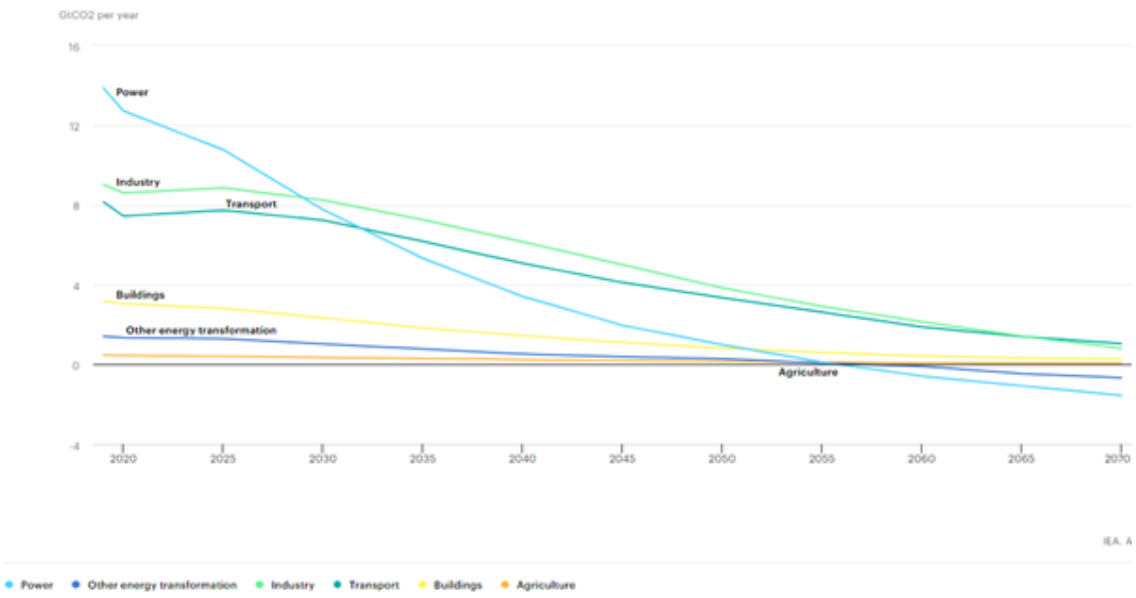


Figure (3.2) Source: (IEA, 2020a)

such this sector requires a complete overhaul in order to prevent further environmental harm (Vandycke, 2020). The energy sector encompasses a wide variety of industry and company categories in the business of exploration, refinement, marketing, storage, production, equipment manufacturing, transportation, and supply of energy. Energy can be defined as non-renewables such as petroleum products and oil, gas, coal, nuclear, gasoline and diesel, while renewable sources include biofuel, hydropower, wind, and solar. Thus, types of energy sector industries are oil/gas drilling and production, pipeline and refining, mining companies, and renewable energy (CFA, 2021). Due to the significance of these industries in terms of emissions, this thesis interprets positive environmental or climate impact of a green bond as decarbonisation as this is the most pressing sector-wide issue in order to circumvent climate change.

Currently, policy instruments in place such as emissions trading schemes are inadequate in reducing CO_2 emissions globally (A. McSweeney R. Tandon, 2020). One of the key issues in enabling a green energy transition is the high upfront costs that are associated with energy infrastructure projects. These infrastructure projects consequently may be at a disadvantage when seeking lending from banks due to a potentially higher risk compared to other investment activities.

3.2 Financing The Transition

Globally, a huge demand for capital directed towards more sustainable solutions exists. Consequently, a substantial increase in the supply of capital market instruments that are effective in purpose as well as attractive to both retail and institutional investors are required (IRENA, 2020b). The demand for capital far outweighs the current supply – both public and private capital sources. Decarbonising the energy sector will require scaling up renewable energy sources to satisfy energy security while aligning the global energy sector with Paris climate goals. The majority of capital will undoubtedly need to come from the private sector. Yet, public capital providers such as multilateral or national development institutions such as the World Bank and the European Investment Bank (EIB) also have a significant function in terms of mobilising private capital providers (IRENA, 2020a). As at end 2020, the WB had issued over 160 green bonds in 22 different currencies totalling close to $15bn since 2008, while the EIB had issued $39.9bn in 17 currencies of its Climate Awareness Bond (CAB) labelled green bonds (World Bank, 2021) & (European Investment Bank, 2021)).

The task of mobilising institutional capital requires a massive shift in how capital is allocated. In order for the world to fulfil Paris climate goals public capital providers, such as the abovementioned multilateral development banks (MDB), can play a key role in directing capital towards low-carbon technologies such as renewables (IRENA, 2020a). Yet, despite an upward investment trend into renewable energy projects, global investment needs to more than double. Innovative sustainable finance vehicles like green bonds can be instrumental in directing significant global capital into renewables. An estimated total $110tn gap stands in the way of greening global energy infrastructure by 2050, averaging around $305bn every year. Of this investment gap, 20% or $22.5tn alone must be dedicated towards greenfield renewable power generation capacity, resulting in an approximate investment of $662bn p.a. (IRENA, 2020b). However, more recent estimates put this number at $800bn p.a. (IRENA, 2020a).

Worryingly, filling this financing gap seems daunting and rather overwhelming to say the least. This, particularly since the 2020 Climate Action Tracker (CAT) gave the US a 'critically insufficient' score, China a 'highly insufficient' score, and the EU a 'insufficient' score (CAT, 2020c) & (CAT, 2020a) & (CAT, 2020b). The International Energy Agency provides an overview of what global investment trends may look like in order to transform and indeed decarbonise the global energy sector in the 'Sustainable Development Scenario'.

This describes a scenario in which three SDGs related to energy are achieved; achieving universal access to energy (SDG 7), reducing severe health impacts of air pollution (SDG 3) and tackling climate change (SDG 13) (IEA, 2020b). Thus, green bonds could be suitable to finance CO_2 reduction through directing capital to the various areas as illustrated below.

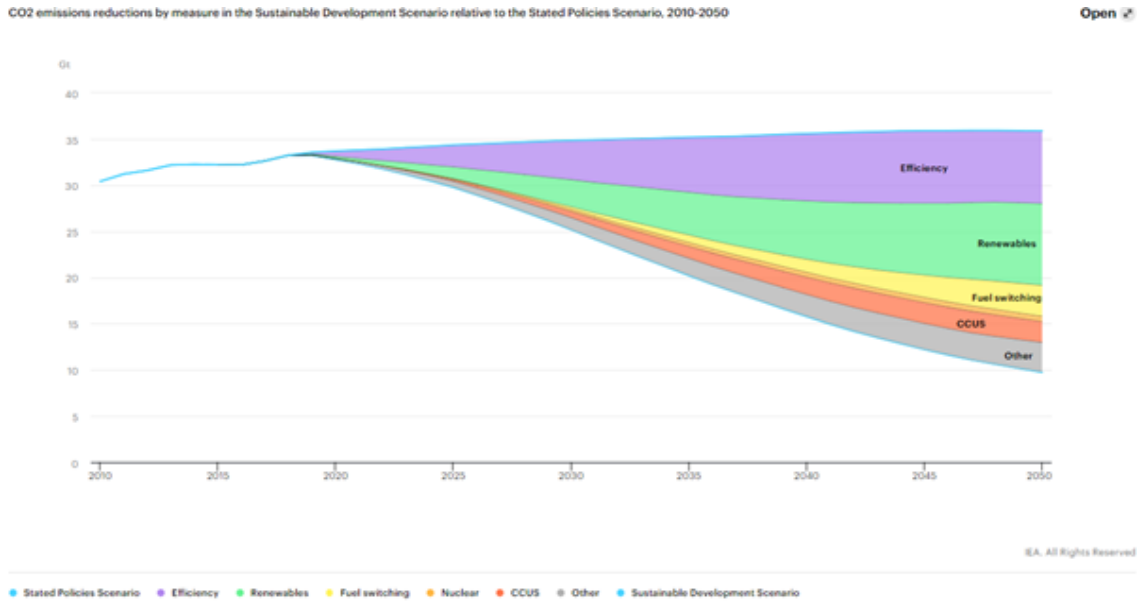


Figure (3.3) Source: (IEA, 2019)

The CAT measures and rates climate action in relation to Paris climate goals largely based on long-term policy goals and plans as well as concrete action, investment, and achievements. The rating ranges from 'critically insufficient' being the least aligned with Paris climate goals with a 4°C+ global temperature increase, down to the 'role model' rating indicating an overachievement of Paris goals with a less than 1.5°C global increase. As this thesis investigates the effectiveness of green bonds in facilitating a green energy transition, it makes sense to look at the three geographical areas with the highest amount of green bond issuances; namely, EU, China and the USA. Another aspect that is important to understand, is where the demand is coming from and, especially why demand is likely to increase in the given region.

3.2.1 The Advancement of Green Finance Legitimacy

In the EU, China and the USA, policy and green financial systems are growing and becoming integral parts of the economy to fight climate change. In section 2 key green bond markets and what, from now on will referred to as baselines, were highlighted. Baselines

describe differences in economic development and energy supply of these three markets. Baselines are a reflection of different political, legal, economic and social systems and affect the effectiveness of green bonds in enabling a green energy transition. Boiling down the different roles each market has, the EU appears as setting a gold standard for the policy development of green bonds, China as an innovator of top-down climate policy, and the USA as a dominant market developer and driver of green bond market legitimacy (Larsen, 2020). The importance of this dynamic will form the basis for discussion in chapter 8 while the following section will further elaborate on baselines of these energy sector markets.

3.2.2 Determinants of Green Bond Demand – EU, China & the USA

It is clear, that achieving a global green energy transition requires massive efforts in infrastructure development and transformation. As shown above, IEAs sustainable development scenario for the global energy sector shows that power is currently the highest emitter within the energy sector. The global energy mix is shown below and illustrates the work that lies ahead. The pie chart shows the global share of electricity generation in 2019.

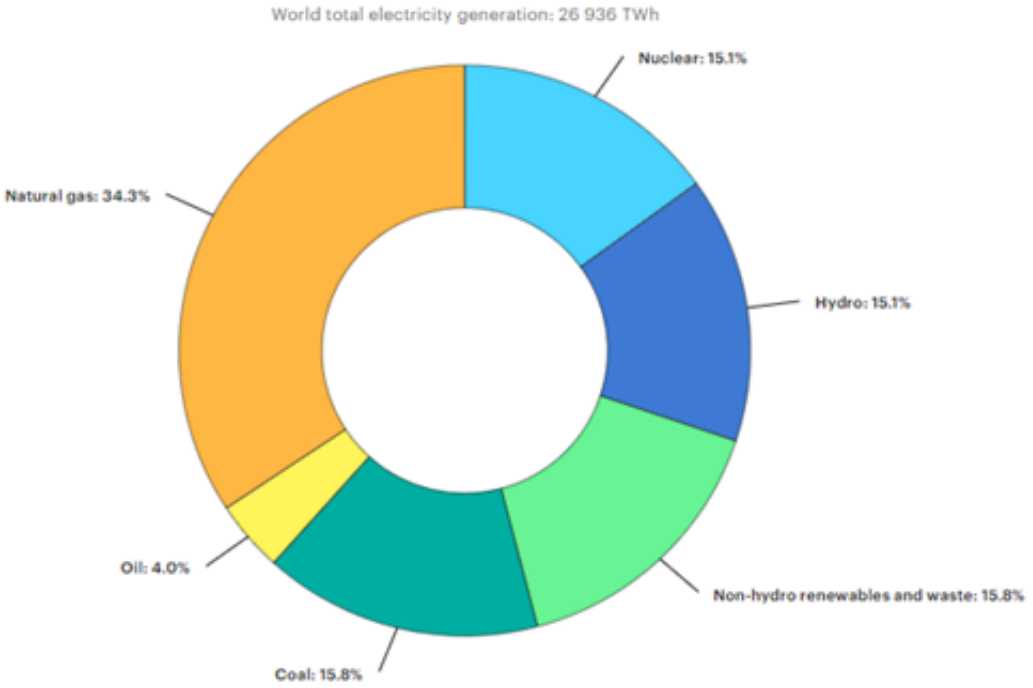


Figure (3.4) Source: (IEA, 2021f).

In order to concisely summarise the baselines of the three key markets of this study, the

development of each energy mix of the EU, China, and USA from 1990 until 2018 is pictured below.

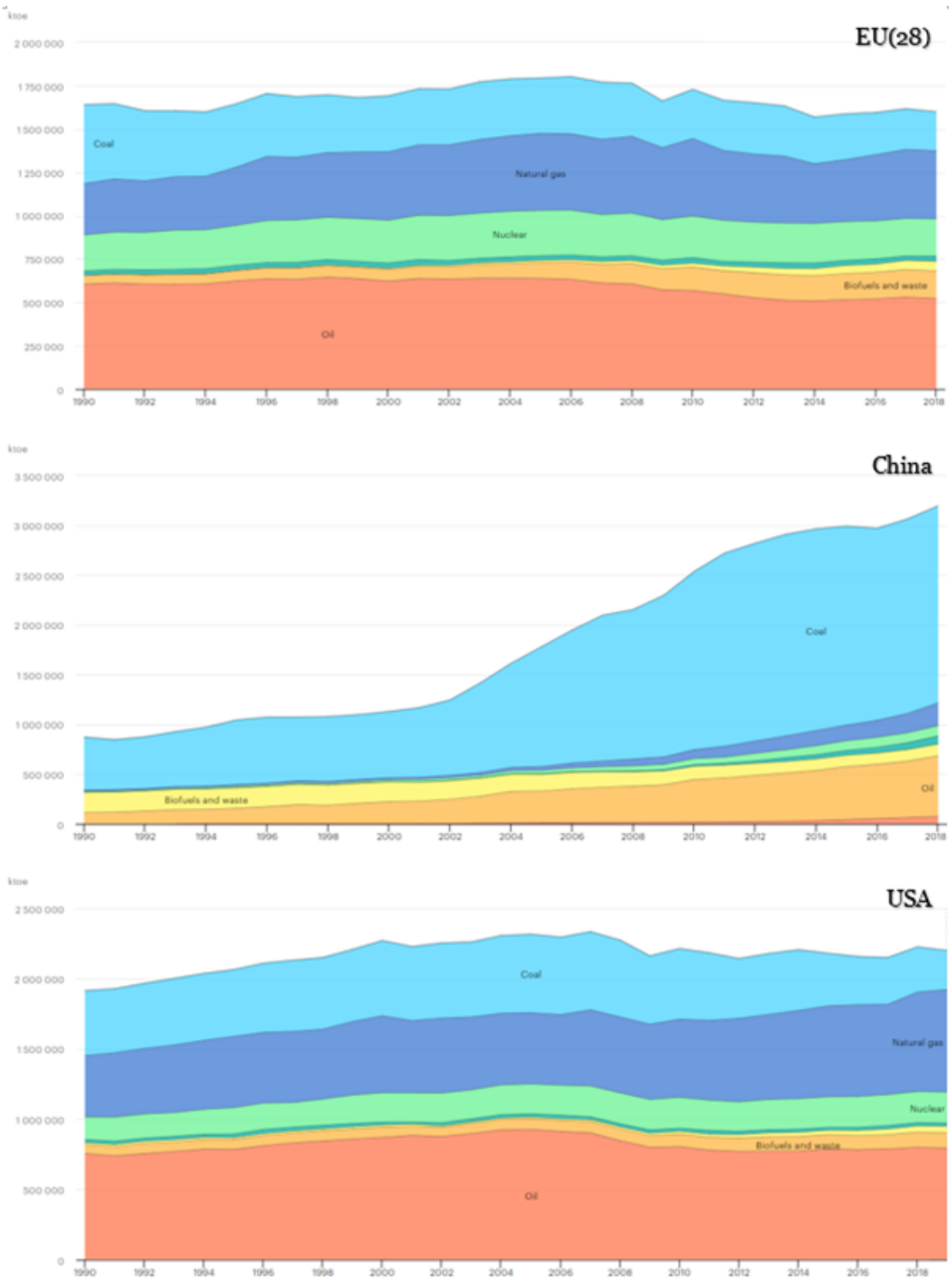


Figure (3.5) Source: (IEA, 2020b).

As this overview shows, China is in a completely different stage of developing their energy mix and securing alternative energy supplies. It is clear that both the EU and USA have much more diversified sources of energy, while China relies heavily on coal. On one hand, all three governments face a tremendous green energy infrastructure financing gap, while on the other hand corporates are faced with mounting pressures from stakeholders such as government, investors, financial markets, society as well as other stakeholders pushing for climate action. Approximately 2/3 of CO_2 is emitted from power consumption, therefore decarbonising the high emitters will become more urgent as time passes (Brewer, 2021). Thus, in order to retain their social licence and legitimacy to operate, companies need to adapt their strategy and implement a business model that is sustainable – both in the environmental and the competitive sense. The differences in energy mix ultimately reflects the underlying demand factors that influence green bond issuance for a green energy transition in the particular region. These factors are discussed in more detail in chapter 8 and will be supplied with findings from primary data collected in interviews.

Chapter 4

Literature Review

4.1 Disharmonious findings of the greenium

The theoretical idea that investors may value security beyond their expected risk and return attributes is not novel. Fama and French (Fama & French, 2007) demonstrate that when a group of investors has a taste for a certain type of assets, equilibrium prices shift and the capital asset pricing model fails to explain asset returns. This being said, this study is investigating the equilibrium price of green bonds to check whether the green bond factor, which implies a link between the capital raised by the green bond and the company's investment into environmentally friendly projects, could attract a certain type of investors.

Is there a Greenium?

Among all the capital market participants, the sustainable investor is the main character of this research. The sustainable investor is risk-averse, i.e., she favors the safe cash-flows originating from the credit market rather than the volatility of stock returns, and she is willing to trade part of her return on investment for the environmental benefit that derives from decarbonizing the energy sector. This trade-off can be summarized by the term "greenium". In order to better understand the phenomenon of the greenium, the following literature review critically revises previous scientific studies about it. The following academic articles seek the greenium in the context of the fixed income market.

Literature supporting greenium's existence

Part of the literature on the greenium suggests that the sustainable investor is willing to pay a positive premium in the context of the debt market. For instance, Nanayakkara

and Colombage (Nanayakkara & Colombage, 2019) find that green bonds are traded at a premium of 63 basis points (bps), compared with a comparable corporate bond. Such a finding represents a relevant incentive for firms to label their issues as green, i.e., raising funds for environmentally friendly projects. In parallel, the same paper advocates for the diversification advantage of green bonds and encourages investors to interact with those securities to variegate the return of their investments.

Another promising result is found by Hyun et al. (Hyun, Park, & Tian, 2020), whose green bonds belong to a sample of green bonds issued from 2010 to 2017 that comply with the GBP (Green Bond Principle) as of 31 December 2017. The authors succeed in isolating the fixed effect of the green bonds certified by an external reviewer, as they collected the external review and CBI certificate information manually from the CBI website (Hyun et al., 2020). The sample of green bonds certified by an external reviewer enjoys a discount, namely greenium, of about 6 bps. Furthermore, the Climate Bonds Initiative certification determines a discount of even 15 bps. If the greenium is detected in those magnitudes, it can benefit the development of the green bond market (Hyun et al., 2020).

Institutional Players

Other authors explore the issuance of the green debt within the governmental institutions' context. Bachelet et al. (Bachelet, Becchetti, & Manfredonia, 2019) attempt to explain the premium of green bonds compared to their closest counterparts (vanilla bond) based on bond characteristics, green bond verification, and the nature of different issuers. The authors focus on both the difference in the role of private and institutional issuers and the independent third-party rating/verification such as green rating agencies. The paper uses a sample of 89 green bonds coupled with as many comparable vanilla bonds which enjoy the same characteristics. It finds that green bonds relish lower returns' volatility, experience higher yields, and remain more liquid than their vanilla counterparts. What is unique about Bachelet et al. (2019)'s research is the inclusion of the green bonds issued by institutional issuers. The findings suggest that such securities present higher liquidity compared to their brown counterparts and negative premium before correcting for their lower volatility (Bachelet et al., 2019). Another outstanding conclusion is that green bonds from private issuers have lower liquidity, higher volatility compared to an institutional green bond and those have a positive premium over brown bonds (Bachelet et al., 2019). Additionally, a private green bond issued without an independent third-party certification has a higher premium and lower liquidity than their private verified green counterparts (Bachelet et al., 2019). It can be concluded that green bond issuers'

reputation and/or green third-party verification from rating agencies are important factors in reducing information asymmetries, lower/avoid suspicion of green-washing, and ensuring more favorable financing conditions (Bachelet et al., 2019).

Their findings suggest that green bonds (from institutional investors) see a negative premium and green investments of this sort may be able to be financed at a discount. This may be caused by investors being willing to pay for environmentally sustainable investments and/or due to lower stakeholder risk (Bachelet et al., 2019). The paper proves that the nature of the issuer matters when it comes to obtaining a negative greenium at issuance.

The Dilemma of the Sustainable Investor

Municipal green bonds offer a unique setting to explore whether investors are willing to forego financial benefits in the real market settings when the risk on the return is known ex-ante (Larcker & Watts, 2020). In fact, green bonds function similarly to vanilla debt securities.

In the US municipal bonds secondary market, a study conducted on the yield structure of green and vanilla bonds, matched as a pair from the same issuer, has demonstrated that an overall mean spread in returns between vanilla and green bonds is positive (23 BPS) and statistically significant (Karpf & Mandel, 2017). This means that green bonds were traded at a discount rather than a premium. Possible causes of the positive spread might be details in the official issuance statement or specific characteristics of the project which is supposed to be financed by the issued security (Karpf & Mandel, 2017). The authors interpret the result as a lack of awareness or skepticism towards green finance.

Other articles address the US municipal bond market. Baker et al . (2018) focus on green municipal debt as the market is more developed than green corporate debt. The authors retrieve a unique dataset containing 2,083 green bonds and 643,299 vanilla bonds. By framing the security pricing with a simple asset pricing model, the research measures the sustainable investor preference for a non-pecuniary feature. Such a preference translates into a lower cost of capital for the green debt group of about 6 BPs, after controlling fixed and time-varying factors (Baker et al., 2018). Moreover, the paper concludes that green bond ownership is more concentrated, i.e., a small group of investors retaining green municipal bonds at higher weights, arguing for the existence of the sustainable investor. Indeed, the authors suggest that a subset of investors exist that are willing to sacrifice

monetary returns for non-pecuniary benefit in the context of the fixed income market.

Finally, Zerbib (2019) examines a heterogeneous sample of 1065 green bonds retrieved from Bloomberg in December 2017. The sample includes seven types of issues: supranational, sub-sovereign and agency, municipal, corporate, financial, and covered bonds. A negative 2 BPS green bond yield premium is identified. Such a finding reinforces the reality of a sustainable investor who is eager to fund the green security at cost of her pecuniary returns (Zerbib, 2019).

Critics at Baker et al. (2018) and Karpf & Mandel (2017) methodologies

The aforementioned papers argue for the presence of a difference in pricing between the green bond and the comparable vanilla bond.

However, isolating the effect of the sustainable content of debt security in a real market setting has proven challenging. Larcker & Watts (2020) review the methodology designed by Baker et al. (2018) and Karpf & Mandel (2017), finding flaws related to the comparison between taxable and non-taxable securities. Indeed, both papers ignore the taxation's effect on the US municipal bond market. In detail, Larcker & Watts (2020) conclude that the fixed-effect model drafted by Baker et al. (2018) does not adequately control for non-linearities and issuer-level time variation, causing eventually spurious inferences.

To circumvent the threat of drawing inexact conclusions, Larcker & Watts (2020) ideate a matching methodology that is tighter than their predecessors. i.e., pairing each green bond to a quasi-identical vanilla bond of the same issuer. After implementing this technique, the greenium accounts for 0 BPs. This finding is a robust argument that sustains those researchers who take a position against the concept of the sustainable investor.

Corporate Bonds Research

Although a branch of academia reports findings of the greenium, the overall results have produced mixed results. One of the causes could be the variation of sample selection, time periods, methodologies, and the type of issuer and the bond characteristics (Liaw, 2020).

It is not a secret that the paper called "Corporate green bonds" (Flammer, 2021) is a role model for those who investigate reasons that drive firms in issuing debt labeled as "green". Flammer (2021) suggests three independent motives for a firm to issue green bonds, i.e., signalling, greenwashing, or lowering the cost of capital.

The last argument, namely the greenium, is investigated by following the methodology of Larcker & Watts (2020), i.e., matching each of the corporate green bonds to the most akin vanilla bond from the same issuer.

Similar to Larcker & Watts (2020), Flammer (2021) finds that the mean difference between the two bond types being small and statistically insignificant, i.e., there is no greenium (Flammer, 2021). To go to the source of the issue, the paper reports some witnesses from industry experts, such as investment bankers, portfolio managers, and fixed income traders who unanimously stated that they would not invest in green bonds if the returns were not competitive.

Corporate Green Bonds and the Energy Market

Finally, the research outlined in the following section attempts to find a common working ground for the energy green bond market to serve as an effective funding tool for the green energy transition compared to vanilla happen.

In line with this objective, the literature reviews the energy greenium, i.e., green energy companies honor a lower cost of capital, concludes with the showcase of few research articles about the energy greenium. For instance, Díaz & Escribano (2021) design an alternative scrutinizing method for labeling an energy company debt issuance as green. In fact, the authors verify the listing of the energy company in the Dow Jones Sustainability Index (Díaz & Escribano, 2021).

The paper researches significant differences in the yield spreads at issuance and concludes, after controlling for bond fundamentals and market condition, that energy greenium accounts for 66 BPs, ranging from 23 BPs and 261 BPs for investment-grade and junk bond, respectively (Díaz & Escribano, 2021).

A separate paper, published in 2019, examines publicly reported green bond proceeds allocation from 53 firms from 2008 to 2017 (Tolliver, Keeley, & Managi, 2019). The main trends about the use of the proceeds from green debt reveal increasing disbursement to renewable energy, clean water, low carbon transportation, and other Paris Agreement and SDG-related investment categories. Moreover, the environmental performance related to green energy bond, included in the study, is measured and estimated to account for 108 million tonnes of carbon dioxide equivalent (tCO_2e) in greenhouse gas emission reductions and over 1500 GW in renewable energy capacity (Tolliver et al., 2019).

4.2 Signalling Theory

One reason for investigating whether green bonds are a more effective tool for funding the energy transition compared to vanilla bonds is that it is much easier to say that green bonds matter than it is to show how and why.

Among the peer-review papers related to the investigation of the greenium, two studies were inspiring for the research conduct in this thesis on the corporate green bond. Both Larcker & Watts (2020) and Flammer (2021) find insignificant differences between the yield at the issue of green bonds and comparable vanilla bonds. The following review presents the signalling theory, which could explain why energy industry players issue corporate debt with a green label when the energy greenium is not present.

The impact of green bond issuance on the green energy transition is more consequential when examined through the lens of signal theory. The signalling role of corporate green bonds is often mentioned in anecdotal accounts. For instance, Patrick de Nijs, a climate change specialist at EIB's, stated during his interview for this thesis that green bonds are a signal from issuer to investors.

If the role of the issuance of a green bond is to signal a commitment toward the environmental purpose, then the reaction of investors to such a signal should be investigated (see 5.1).

The Origin of Signalling Theory

The central dogma in traditional equilibrium theory is that an economy leverages information when it is based on prices. The "invisible hand" of Adam Smith suggests that market agents need to know nothing about the other agent's behavior when operating in a world of private goods. However, a critic of such a theory is that market agents need to have the same information about the characteristics of the traded commodities.

In the paper "The Market for Lemons: Quality Uncertainty and the Market Mechanism", Akerlof (1970) demonstrates how the quality of goods traded in a market, e.g., the second-hand car market's can degrade if the agents do not have access to the same information. Such a possibility needs to be addressed in the context of the energy debt market: while green bonds and vanilla bonds might present similar characteristics, e.g. similar yield at issuance, to potential investors, the underlying energy projects, that the bond is linked to, may embody hidden knowledge, i.e., the actual quality of such a project may be lower

than the expected one, or even the use the proceeds from the bond may drift from what planned. Such a threat may translate into an adverse selection of low-quality investments, and eventually entail a qualitative impoverishment of the traded goods (Riley, 2001). To reduce such a risk, firms engage naturally in marketing practices. In signalling theory, Michael Spence (1973) concludes that, in a market where firms compete for the customers, sellers invest in costly "signals" to show buyers their above-average quality products. In detail, a signal is credible if it is costly to mimic by firms with less desirable characteristics. Flammer (2021) says that it is in the company's best interest to reduce this information asymmetry by sending a signal that is by taking actions that credibly convey this information. Such theories can frame the energy bond market, explaining why some energy companies invest in costly green bond certifications from third-party organizations.

Signal of environmental commitment

The sustainable investor seeks investments that fulfill ESG requirements. However, she often lacks information sufficient to evaluate the actual commitment to the ESGs. Such misinformation of investors could be a cause of greenwashing. Lyon and Maxwell (2011) propose an economic model of "greenwash" in which a firm manages information disclosure about its environmental impact and an activist may threaten the firm with an audit. Although the activist's auditing threat remedies the greenwashing behavior, the firm restrains the overall environmental information disclosure (Lyon & Maxwell, 2011). Once again, sustainable investors do not have the same access to environmental information, compared to the energy company itself, hence the sustainable investors might take wrong investment decisions, and consequently, the energy green bond market might reduce its overall quality.

Flammer (2021) sheds the light on the raison d'être for corporate bonds to be marketed as a green financial instrument. The author argues that companies can signal a sincere commitment towards a green energy transition by issuing a corporate green bond. Flammer (2021) lists three arguments: firstly, firms commit substantial proceeds to environmentally friendly projects. Secondly, if a corporate hire an independent third party, the market can be ensured that the proceeds will be employed in the actual low-carbon project. Last but not least, if the aforementioned corporate fails to comply with the independent third-party certification, management will be considered responsible for the non-compliance and the certification will be revoked.

4.3 Institutional Theory

This study further applies an institution based theoretical framework to discuss the significance and effectiveness of green bonds in financing a green energy transition. This theory will underline the often overlooked effects that social actors can have After a brief summary of the framework, literature will be highlighted.

The IBV provides a means to explain strategic choices of energy sector players related to the issuance of green bonds and how a given markets' institutional setup affects such choices. Institutional logic further allows us to view green bonds not only as a tool to finance decarbonisation of a given business model but also as a means for firms to gain social legitimacy in the sense of signalling a shift in strategy towards better environmental performance, and in extension, moving towards a green transition. The concept of institutions is popularly described as 'the rules of the game in society' while Davis and North (1971) described institutional frameworks of a given market as a set of fundamental political, legal and social ground rules that dictate action (W. M. Peng, 2002).

The IBV theory emphasizes the role that institutional frameworks play in shaping company strategy and action. The theory stresses the importance of understanding country-specific institutional environments when analysing how companies behave, particularly since these frameworks can differ widely and consequently how they give different cues to how a firm should and can act, as well as how frameworks outline boundaries for legitimacy and limiting uncertainty (M. S. Peng, 2009). Institutional frameworks influence company strategy by signalling which choices are supportable and acceptable. This has the implication that sound institutional frameworks made up of formal and informal constraints can reduce uncertainty for companies (North, 1990). Formal constraints refer to political rules, regulation, legislation and economic contracts while informal constraints refer to social norms of behaviour embedded in culture, values and ideology (North, 1990) & (Scott, 2005). Furthermore, North goes on to specify that in cases where formal institutions are weak, underdeveloped or simply fail, informal institutions gain in importance. Institutions thus directly influences strategic choices as a result of dynamic interaction between organisations and the formal and informal institutions (W. M. Peng, 2002).

Similarly, Oliver (1991) has advanced literature on organisational conformity to a given institutional environment, exemplified by organisational resistance to institutional pressures through adopting alternative strategic responses. Energy sector players are thus capable

of responding to institutional influences in a variety of ways (Oliver, 1991). Companies can be viewed as non-passive actors in guiding 'the rules of the game'. If institutional environments are conflicting or ambivalent then alternative strategic behaviour become more common (Scott, 2005).

As this study seeks to answer the questions of whether green bonds are effective in enabling a green energy transition, the focus lies on how these may effectively channel private capital through legitimate and trustworthy means towards funding greening the energy sector. Therefore this framework highlights legitimacy vis-à-vis greenwashing of green bond issuance in the energy sector. According to Scott (1995), institutions provide structure that provide stability and meaning to social life while they can be categorised as regulative, cultural-cognitive and normative. Social legitimacy of actors can be obtained once rules and systems are adopted (Scott, 2005). The IBV, supplemented by Signalling Theory allows us to discuss strategic choices and motivations for issuing green bonds. By looking at concepts such as greenwashing and legitimacy, the literature contributes to a more comprehensive analysis of companies' strategic choices and behaviours in efforts to signal and match corporate values of climate action with societal as well as political values. By focusing on these factors in terms of a green energy transition, external validation or legitimacy gained or lost by issuing green bonds can be better understood.

4.3.1 Green Bond Legitimacy

Greenwashing is often placed in juxtaposition to the legitimacy of green bonds in terms of enabling positive environmental impact. Due to examples of fossil fuel companies and other high emitters issuing questionable green bonds in terms of legitimacy of the 'green-ness' of their use of proceeds, one must be vigilant of greenwashing particularly in high-emitting industries in the energy sector. As highlighted before, the key material factor in greening this sector entails greenhouse gas emissions reduction. While closely tied with signalling theory, the legitimacy of green bonds through the lens of institutional theory will be the focus of this section. This study argues that a transparent and legitimate green bond market is a prerequisite for any ability to effectively direct capital towards a green energy transition.

Marquis et al. (2015) notes that organisations may respond to new institutional demands, whether these be informal institutions (societal values, norms) or formal institutions (regulation, legislation, frameworks), by selectively disclosing positive impact and thereby giving

the impression of better environmental performance while hiding the actual performance. Additionally, by looking at different markets with differing institutional frameworks, these contexts allows for better analysis of organisational behaviour as a result of normative and regulative institutions (Marquis, n.d.). Institutional pressures such as civil society as well as governmental efforts therefore act as deterrents for green bond issuers who do not intend to improve their environmental performance post-issuance. Importantly, the green bond characteristic of the use of proceeds clause provides a potent tool in the fight against issuance merely being symbolic.

Berrone et al. (2017) incorporates signalling and institutional theory, and analyses the impact of environmental actions as a means to gain environmental legitimacy. The study finds that environmental legitimacy can only be obtained by an organisation if environmental performance improves after an environmental action, such as issuing a green bond. In the case our this thesis study the issuance of a green bond is the environmental action. Additionally, pressure from nongovernmental organisations act as enforcers of institutional frameworks that guide 'the rules of the game' and that pressure corporates to adopt regulative and normative structures. Thus, third-party verifiers fulfil the role of enforcing the use of proceeds clause of green bonds, making it difficult for issuers to engage in greenwashing while giving the green bond social legitimacy and decreasing the likelihood of scaring away investor capital into the financing tool (Berrone, 2017).

Delmas et al.(2011) defines greenwashing as misleading consumers of a green product about its environmental performance or environmental benefits. Factors that lead to diminished legitimacy and increasing the likelihood of greenwashing related to green bonds, this study points to drivers of greenwashing as being poor or weak regulation (Delmas, 2011). Formal institutions are thus equally, if not more important than informal institutions of civil society. A study by Weber et al. (2020) confirms the view of institutional theory stating that formal institutions are often weaker in developing and emerging markets. By using the example of the emerging green bond market in the India the study shows that in instances where formal institutions fail or are uncertain, institutional pressure will emanate from informal 'invisible' social norms demanding climate action (Weber, 2020). Lashitew (2021) however, highlights the importance of formal institutions such as EU regulation in driving transparency in environmental impact reporting, and in extension green bond legitimacy. Investment decision-making by investors and stakeholders will be adversely affected by non-transparent disclosure and information asymmetry (Lashitew, 2021). Through a study of the Swedish green bond market, Maltais (2019) provides in-

sight into the role of green bonds in facilitating and developing sustainable financing on a much broader scale, with green bonds representing an innovation that will drive the overall green finance market and thereby indirectly enable a green energy transition also. Additionally, the effectiveness of green bonds in attracting institutional investors towards financing green energy infrastructure projects is a result of improvements in the liquidity of infrastructure assets. In fact, investors are incentivised to engage with sustainable finance and direct investment towards green assets, away from brown assets, out of self-interest that would arise in the long run due to economic un-sustainability (Maltais, 2019).

Chapter 5

Methodology

5.1 Research Method Road-map

The following section explains the plan and research strategy intended to achieve the goal of this thesis.

Firstly, the research question that this thesis seeks to answer is presented:

Are green bonds an effective tool in enabling the green energy transition?

Section 2.2 unveils the inherent qualities of green bonds, presents the reasons for their emergence, and explains what characterises their use of proceeds. As stated before, the thesis exclusively examines the energy sector and the effectiveness of corporate green bonds with this industry sector in mind. Additionally, the effectiveness should be understood in the context of enabling the energy transition.

Hereafter, the section presents the thesis' interpretation of the research question to delimit the thesis's scope. Indeed, the issue that arises from such a research question is not trivial, i.e., how to measure the contribution of the event of issuing a green bond in the green energy transition context. The paper focuses on two areas of investigation related to the issuance of a green bond, i.e., the pricing of energy sector green bonds at issuance and the post-issuance firm-level performances of such bond issuers.

Milestones of the Methodology Roadmap

The initial milestone achieved is the isolation of energy sector corporate green bonds in the data set used for quantitative analysis. Despite numerous other constraints faced when collecting the sample, it is worth highlighting that we were able to isolate green bonds

issued by energy firms in order to best suit our research topic and address our research question in the most effective way.

To perform the data collection, a list of SIC codes - exclusively related to the energy sector, was collected and subsequently matched to the raw corporate green bond data. Such a list includes more than 32 SIC codes (see 10.1), and among those, the following are the most important energy sector classes, e.g., oil and gas extraction, coal mining and electricity generation facilities, and electric services. This thesis therefore presents a unique view on the analysis of the corporate green market debt by focusing on the energy sector as well as the green energy transition. These features make the thesis specified in nature and method. Furthermore, the selection and extraction of the data sample included other specific constraints which will be explained in detail in section 6.1.

Another major phase in the investigation roadmap was the specification of the matching method (see 5.3). This method was fundamental in conducting the analyses. Indeed, if a valid and reliable control group was not selected, all the quantitative analyses would not have been possible. The matching method varies depending on the given subject of the analysis, e.g., when the subject is the bond, the set of covariates used in the matching process related to the bond characteristics. On the other hand, when the subject is the firm, namely, the bond issuers, the set of covariates relates to firm-level dimensions, e.g., company size, company debt, or company profitability.

After the matching phase, the actual data analysis was performed. The most urgent matter that the thesis needed to unravel was whether there is a greenium in the primary bond market for energy green bonds, compared to the energy vanilla bonds [1]. Besides comparing the average yield of green and vanilla fixed income instruments, such a topic has also been discussed within the industry experts' interviews (see 10.1). Therefore, by means of literature review, quantitative, and qualitative analysis, the discussion section sheds light on whether there is a greenium in the corporate green bond market in the context of the energy industry.

Finally, the investigation focuses on the firm-level performances, both from the environmental and ownership structure [2] perspectives. In this case, the usage of an effective

[1] Plain vanilla is the most basic or standard version of a financial instrument, usually options, bonds, futures, and swaps. It is the opposite of an exotic instrument, which alters the components of a traditional financial instrument, resulting in a more complex security CITE.

[2] Cyrus Tarapovela, president and CEO of State Street Global Advisor, said:" ESG issues have become much more important for us as long term investors". (Eccles & Klimenko, 2019)

matching method has been essential in seeking a statistically significant effect between the issuance of a corporate green bond and the post-issue performances. Without such a method, it would not have been possible to compare the results between the treated (green) and the control (vanilla) bond. Furthermore, the differences-in-differences statistical framework offers the chance to possibly capture the causal effect of the independent on the dependent variables, excluding the change that the dependent variables would have had anyway. Moreover, the multivariate linear regression served as a reliable instrument to calculate such casual effects, once its assumptions were ascertained true. Once again, using a combination of literature review, and quantitative analysis, the final paragraphs answer whether green bond issuers achieved better results than vanilla bond issuers in the post-issuance period in terms of environmental performance and ownership structure.

5.2 Quasi experiment

In this section, the concept of a quasi-experiment or natural experiment is presented, alongside with the statistical framework that captures the average treatment effect in the treated. A quasi-experiment takes place in a no experimental setting, i.e., the randomness in the assignment of the treatment is introduced by variations in individual circumstances (Stock & Watson, 2012). Such a variation in individual characteristics simulates the random assignment of the treatment. In the case of this specific study, these variations might happen because of different firm strategy in financing with debt, legal constitutions, firm life cycle, or other factor that are unrelated to the causal effect under study. In the instance of this quasi-experiment, the "as if" random variation only partially determines the treatment (Stock & Watson, 2012). Therefore, the causal effect is estimated by instrumental variables regression (Stock & Watson, 2012).

Differences-in-differences

If the treatment was randomly assigned, then the treatment effect could be estimated using the differences regression (Stock & Watson, 2012). However, given that we did not have control over the randomization of which firm were green bond issuers and which were vanilla issuers, some differences between the matched firms might bias the causal effect (Stock & Watson, 2012). To account for the possible differences that might remain between matched pairs, the causal effect is measured as a comparison between, not the outcome of the dependent variable, but the change in the outcome pre- and post-treatment values

in Y of the pair. As the estimator is the difference between the two groups in the change over time within the same group, such an estimator is named differences-in-differences. For instance, this study examines the effect of issuing a green bond on the environmental performances of bond issuers, using a differences-in-differences estimator to compare the change in environmental performance in the green issuers with the change in environmental performance in the vanilla issuers.

Looking closely at the differences-in-differences estimator, it is calculated by means of a simple algebraic equation.

$$\begin{aligned}\beta_1^{diffs-in-diffs} &= (\bar{Y}^{treatment,after} - \bar{Y}^{treatment,before}) - (\bar{Y}^{control,after} - \bar{Y}^{control,before}) \\ &= \Delta\bar{Y}^{treatment} - \Delta\bar{Y}^{control}\end{aligned} \tag{5.1}$$

Let $\bar{Y}^{treatment,before}$ be the sample average of Y for those in the treatment group before the experiment, and let $\bar{Y}^{treatment,after}$ be the sample average for the treatment group after the experiment. Then, let $\bar{Y}^{control,after}$ and $\bar{Y}^{control,before}$ be the post- and pre-treatment sample average for the control groups, respectively. The differences-in-differences estimator is the average change in Y for those in the treatment group, minus the average change in Y for those in the control group.

The differences-in-differences estimator can be written in regression notation. Let $\Delta\bar{Y}_i$ be the post experimental value of Y for the i^{th} individual minus the pre-experimental value. The differences-in-differences estimator is the OLS estimator of $beta_1$ in the regression,

$$\Delta\bar{Y}_i = \beta_0 + \beta_1 * X_i + u_i \tag{5.2}$$

Multiple linear regression

To accurately estimate the relationship between the dependent and independent variables, an ordinary least squared (OLS) multivariate model is applied. The OLS method can be used in determining the differences-in-differences estimator, as the lack of data renders time-series or panel data regression impossible (Stock & Watson, 2012).

The dataset used to estimate the causal effect is an imbalanced panel dataset, as the availability of data over time is poor for a large fraction of the energy firms. Retrieving

data on financial fundamentals in a quantity that would allow for a panel data regression was not possible through any available databases if the data even exists.

The multiple regression model is

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + ... + \beta_k X_{ki} + u_i, i = 1, ..., n \tag{5.3}$$

where Y_i is i^{th} observation on the dependent variable; $X_{1i}, X_{2i}, ..., X_{ki}$ are the i^{th} observation on each of the k regressors; and u_i is the error term. β_1 is the expected change in Y_i resulting from changing X_{1i} by one unit, holding constant $X_{2i}, ..., X_{ki}$. The intercept β_0 is the expected value of Y when all the X's equal 0.

OLS and Differences-in-differences assumptions

A multiple regression model must respect the OLS assumptions. The three assumptions are the same as the one for the univariate regressor model, whereas the fourth is specific to the multivariate regressor model.

1. The conditional distribution of u_i, given $X_{1i}, X_{2i}, ..., X_{ki}$ has a mean of zero.
2. $(X_{1i}, X_{2i}, ..., X_{ki}, Y_i, i = 1, ..., n,)$ are independently and identically distributed.
3. There is a linear relationship between the dependent and the independent variables.
4. There is not perfect multicollinearity

Validation of OLS assumption

Tests to validate the assumptions of the multiple linear regression are conducted prior to the analysis.

The assumption number one is also known as homoskedasticity. The assumption implies that the variation of the error terms u_i observed around the regression line is constant.

The second assumption of the multiple linear regression states that for a given value of a X_{ki}, the error terms ε_i of the Y_i are independently and identically distributed, i.e., normally distributed. It is possible to examine such a distribution by means of a "Normal Q-Q" plot and Figure 5.1 shows that the normality assumption is invalid. Also, it is possible to test for normality by means of the hypothesis test Shapiro-Wilk test, see Table 5.2. The logarithm

Studentized Breusch-Pagan test	
BP	39.288
p-value	0.7805

Table (5.1) The table above describes a white t's test. Such a test uses the following null and alternative hypotheses: the null hypothesis equals homoskedasticity, whereas the alternative hypothesis equals heteroskedasticity. Since the p-value is not less than 0.05, we fail to reject the null hypothesis. We do not have sufficient evidence to say that heteroskedasticity is present in the regression model (S. S. Shapiro & Wilk, 1965).

Shapiro-Wilk normality test		
	Pre	Post
W	0.763	0.848
p-value	2.671e-08	7.132e-06

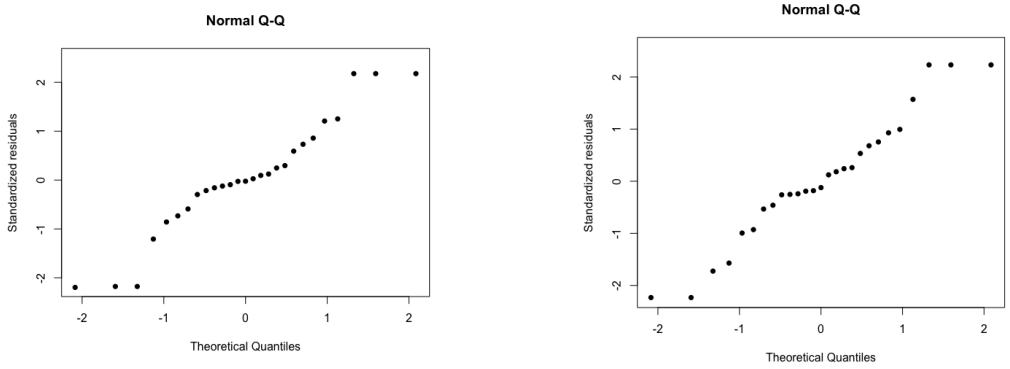
Table (5.2) The table above describes a Shapiro-Wilk's hypothesis test. The test uses the following null and alternative hypotheses: the null hypothesis means that the data distribution follows a normal distribution, whereas the alternative hypothesis implies the opposite. Since the p-value is less than 0.05 both in the pre- and post-data manipulation, we cannot reject the null hypothesis.

transformation of the CO_2 emission dependent variable is performed. Moreover, we seek for outliers among the sample, as you can see in Figure 5.2. In Table 5.2, the result of those manipulations is clear, the p-value is higher after both the logarithm transformation and the outliers' omission.

Furthermore, the third assumption requires a linearity between the dependent and the independent variables. The plot in Figure 5.3 presents the OLS residuals against the fitted values. The linearity assumption holds in that case.

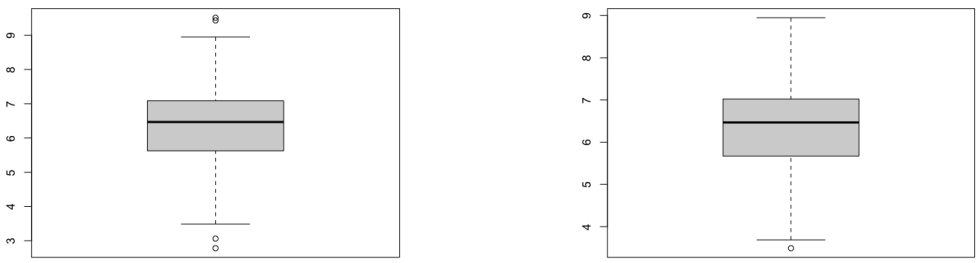
Finally, the level of a multicollinearity, namely, the assumption number four, is evaluated through a Variance Inflation Test (VIF). The tolerance threshold is calculated as such: $tolerance = 1 - R^2$ and the $VIF = 1/tolerance$. A VIF value equal to 10 or higher indicates it multicollinearity problem. In the instance of CO_2 regression model, the $R^2 = 0.989$, hence the $tolerance = 0.011$, and consequently the $VIF = 90$.

Differences-in-differences assumptions



(a) (b)

Figure (5.1) In order for normality to hold, the standardized residuals should fall on the diagonal line. The solution for a violation of such an assumption are outliers' removal and logarithm transformation of the data. Figure (b) shows the results of a logarithm transformation of the dependent variable. As you can see, the Normal Q-Q plot is a less severe tailed.



(a) (b)

Figure (5.2) As you can see, there are data points outside of the quarterlies' borders. After trimming the outliers, the boxplot shows almost not data points outside the quartiles.

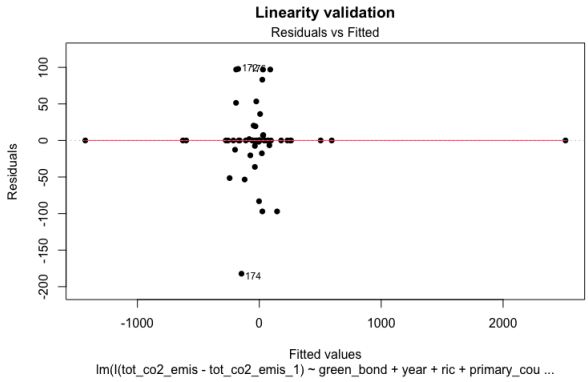


Figure (5.3) This case relates to the CO_2 emissions model. As you can see, this instance witnesses a valid linearity assumption.

Since we are using the differences in differences modelling, two further assumptions are needed to be satisfied to perform the multivariate linear regression (Strumpf et al., 2017).

1. The control group must be and adequate proxy for the counterfactual outcome.
2. The treatment must be exogenous, i.e., the treatment should not be driven by pre-treatment cause, nor by any unmeasured time-varying common cause of the treatment or the outcome.

To ensure the validity of the statistical framework, a plausible argument is present. The treatment and the control group are in fact exchangeable, or highly comparable, as they present substantive statistical similitudes. In fact, the control group is created by means of a matching method, which is a valid practice when using a differences-in-differences estimator. Indeed, matching is a way of controlling the pre-treatment differences between the two groups. In other words, the matching minimizes the pre-experiment difference between the control and treated group, a fundamental practice especially in a quasi-experiment setup (Stuart & Rubin, 2011). Section 5.3 is going to explain the details of the matching method of this study. However, Stuart and Robin (2007) define five key steps to do, when performing matching methods for causal inference:

1. Choose the matching covariates
2. Define what constitutes similar measures, i.e., a distance measure from the mean.
3. Perform the matching through an algorithm.
4. Repeat step two and three until the optimal match data sample is obtained.

5. Analyse and model the data.

5.3 Matching framework

The following section describes the theoretical framework behind the methodology of the matching process. Such a process is a key milestone in the research methodology utilized in this paper. Indeed, the goal of this paper is to create an identification strategy, which is the way a researcher uses observational data, i.e., data not generated by a randomized trial, that approximates a real experiment. The analysis design is not a randomized controlled experiment, but rather a non-experimental research (Almeida, 2012).

One empirical challenge in doing a non-experimental research is omitted variable bias. In fact, the issuance of green bonds is endogenous with respect to firm outcomes, i.e., unobserved variables may drive a spurious relation between the issuance of green bonds and firm outcome. In an ideal setting, the endogeneity concern could be solved by the usage of an instrument variable strongly correlated with the treatment, namely, the green bond attribute (Flammer, 2021). Unluckily, we did not find such an instrument, as the issuance of a green bond is not random, and it has been hard to find an empirical setting in which firms (quasi-)randomly issue green bonds (Flammer, 2021).

One way to tackle omitted variable bias is to estimate differences between a plausibly counterfactual outcomes and those of the treated group (Almeida, 2012). A counterfactual explanation in statistics describes a causal situation in the form: "if X have not occurred, Y would not have occurred.", which specifically translates in "If the green bond was not issued, the improvement in environmental performance would not occurred" (Molnar & Dendl, 2021).

A standard method under the counterfactual explanation is to use a parametric regression, i.e., a model that requires the estimation of a finite number of parameters, where the group of interest is identified by means of a dummy variable (Almeida, 2012). The differences in the outcome are then estimated between the group dummy and the control group by means of the parametric regression. Controls such as size, profitability, and leverage may be added to the specification to capture additional sources of firm heterogeneity (Almeida, 2012). However, the inclusion of the controls in the regression per se does not address the fact that the groups being compared me have very different characteristics (Almeida, 2012).

Almeida (2012) first and Flammer (2021) later are instances of a "design-based" test, i.e., a combination of a natual experiment and matching estimators, i.e., it is a method that compares the outcomes of program participants with those of matched not participate where matches are chosen based on similarity in observed characteristics (Todd, 2010). The matching estimators select first the treated observations, i.e., bond issuance with a green attribute, and then, from the population of non-treaded observation, namely all the bond issuance without a green attribute, individuate control observations that best "match" the treaded ones in multiple dimensions (Almeida, 2012). The following section is describing how the thesis has evaluated and chosen among different matching methods.

Planning of the matching

During the initial phase of the study, i.e., prior to the data collection, three central questions need to be addressed and answered:

1. What type of causal effect do we want to estimate?
2. What is the population to which the treatment effect is to generalize?
3. What covariates lead to an unbiased estimate of the treatment effect?

The type of causal effect that the thesis is meant to estimate is the treatment effect, i.e., the average effect of a binary variable on an outcome variable of scientific or policy interest. The term treatment effect originates in a medical literature concerned with the causal effects of binary, yes or no 'treatments', such as an experiment drug or a new surgical procedure. Nowadays, the term has been adopted by different scientific field. The matching of a green bond and a vanilla bond allows to estimate the average treatment effect in the treated (ATT), i.e., the expected causal effect of the treatment for individuals in the treatment group. Look at Equation 5.4:

- Y^0: population-level random variable for outcome Y in control state.
- Y^1: population-level random variable for outcome Y in treatment state.
- δ: individual-level causal effect of the treatment.
- π: proportion of population that takes treatment.

Given the above notation, the ATT is $E[\delta|D = 1]$, i.e., what is the expected causual effect of the treatment for individuals in the treatment group. This can be decomposed more meaningfully as:

$$E[\delta|D = 1] = E[Y^1 - Y^0|D = 1] = E[Y^1|D = 1] - E[Y^0|D = 1] \tag{5.4}$$

Notice that $E[Y^0|D = 1]$ is unobserved so it refers to a counterfactual variable which is not realised in our observed sample.

To answer the second question, the target population is defined as the population to which the estimated effects is to generalize (Imai, King, Stuart, Whitworth, & Greifer, 2021). Normally, the estimated effect in a sample generalizes to the population from which the sample is a probability sample. If the sample is not a probability sample for any population, the target population can be unclear. Oftentimes, the target population is a group of units who are eligible for the treatment (Imai et al., 2021).

To answer the third and last question, the theoretical framework used to select the covariates of the matching formula is hereafter presented. Selecting covariates carefully is critical for ensuring that the resulting treatment effect estimate is free of confounding and can be validly interpreted as a casual effect (Imai et al., 2021). In general, the covariates selection depends on the matching method implemented. Commonly used firm-level characteristics are selected: size, Tobin's Q, ROA, and firm's leverage. It is commonly accepted that covariates capture a lot of otherwise an observed firm heterogeneity (Almeida, 2012). Moreover, we select the company's environmental, social, and governance scores (Flammer, 2021). Furthermore, each covariate is measured in two points in time, i.e., in the year preceding the bond issuance (i.e., t-1) and the year before that year (i.e., t-2), which captures the "pre-trend" (Flammer, 2021).

The covariates selection is meant to ensure the maximum similarity between the treaded and the matching-control firms ex ante. In this case, a similar environmental score implies that the treaded and control firm had similar environmental performance before the bond issuance. The same rationale applies to the other two scores, namely the governmental and the social scores (Flammer, 2021).

To preclude concerns that the treated firm might be more remunerative or have better growth potential, the profitability's measure ROA and the firm value measure (Tobin's Q) are included. Furthermore, similarity in the size and the debt capacity (leverage) rejects

the hypothesis that the treated firms may have a better access to capital markets (Frésard & Valta, 2016).

Matching method

In the section 4.5.5., the matching results from three different matching methods are compared. Despite being different, such matching methods have a similar matching goal, i.e., associating at each treated observation the nearest neighbour.Hereafter, three matching algorithms are presented.

Nearest Neighbour

The nearest neighbour matching is also known as greedy matching. It involves running through the list of treated units and selecting the closest illegible control unit to be paired with each treated unit. It is greedy in the sense that each pairing occurs without reference to how other units will be or have been paired, and therefore does not aim to optimise any criterion (Imai et al., 2021).

Optimal pair matching

Optimal pair matching is like nearest neighbour matching in that it attempts to pair each treated unit with one or more control units. Unlike the nearest neighbour matching, however, it is optimal rather than greedy, i.e., it is optimal in the sense that it attempts to choose matches that collectively optimize an overall criterion. The criterion used is the mean of the absolute pair distance in the matched sample (Imai et al., 2021). Generally, however, as a subset selection method, optimal pair matching tends to perform similarly to nearest neighbour matching in that similar subsets of units will be selected to be matched.

Genetic matching

Genetic matching is less a specific form of matching and more a way of specifying the distance measure for another form of matching. In practice, though, the form of matching used is the nearest neighbour pair matching. Genetic matching uses a genetic algorithm, which is an optimisation routine used for non-differentiable objective functions, to find scaling factors for each variable in a generalised Mahalanobis distance formula (Imai et al., 2021). Mahalanobis distance is a scalar quantity that measure multivariate distance between individuals in different groups (Diamond & Sekhon, 2013).

5.4 Qualitative Research Strategy & Design

In both chapters 2 and 3 the green bond market and its relevance to the energy sector in the context of the green energy transition is described. This thesis presents a snapshot in time in terms of market development and growth, regional policies, regulations, frameworks, and standards regarding green bonds. This has the implication that the resulting discussions and analysis may become progressively less relevant if these external factors change as time passes. However, by consulting experts and practitioners within the field of both climate finance, green bonds, capital debt markets, and the energy sector we are able to gather insights from interviews that reflect long-standing knowledge on green bonds and its role in enabling a green energy transition. These interviews, as found in the appendix, were a great help in formulating a research strategy while they also can guide us in the discussion of our results.

As this thesis is of an interdisciplinary nature, quantitative research methods are supplemented with qualitative research in the form of interviews. This thesis uses an exploratory approach to research both in collecting data from secondary sources such as reports, research papers, regulatory and legislative documents, as well as in collecting primary data through interviews. Therefore inductive reasoning is the predominant research approach as it fits most adequately with the research question of this thesis. This thesis begins by recognising observations and patterns in energy sector green bonds (Saunders, 2015). This inductive approach creates a point of departure for cementing our research question and framing of later quantitative analyses. The general inductive approach was chosen to condense and later evaluate and discuss large amounts of raw qualitative data from both secondary and primary sources. This approach allows us to link the condensed findings with our research objectives and adapt our analyses as well as identifying underlying structures and frameworks found in the raw data. Inductive research provides the thesis with a straightforward approach to extract specific findings from general observations in the context of a focused evaluation question such a green bond performance in enabling a green energy transition (Thomas, 2006).

Since the ultimate goal of this thesis is to measure performance of green bonds in the energy sector, the context of green energy transition and material risks associated with this context guided the research. The material risks of key industries within the energy sector are illustrated below to provide an overview of possible metrics to investigate.

Industry Level Map Source: SASB https://materiality.sasb.org/

Not likely a material issue for companies in the industry

Likely a material issue for companies in the industry

		Extractives & Minerals Processing					Infrastructure			Renewable Resources &		
	SIC Code		1382			1389	4911			2869		
Dimension	General Issue Category	Coal Operations	Oil & Gas – Exploration & Production	Oil & Gas – Midstream	Oil & Gas – Refining & Marketing	Oil & Gas – Services	Electric Utilities & Power Generators	Engineering & Construction Services	Gas Utilities & Distributors	Biofuels	Solar Technology & Project Developers	Wind Technology & Project Developers
Environment	GHG Emissions	■	■	■	■	■	■					
	Air Quality		■	■	■		■			■		
	Energy Management										■	
	Water & Wastewater Management	■	■		■	■	■			■	■	
	Waste & Hazardous Materials Management	■			■	■	■				■	
	Ecological Impacts	■	■	■		■		■			■	

Figure (5.4) Source adapted from: (SASB, 2021)

Philosophy of Science Position

In the context of a green energy transition, or rather decarbonising the energy sector, using CO_2 as a metric most relevant and feasible due to data availability. While the quantitative analysis deals with econometric methods, the underlying research philosophy is positivism as the subject matter deals with facts and hard data rather than impressions. The findings are based on observable social realities and the results, similar to natural science, makes generalisation that are law-like and follow a inductive method (Saunders, 2015).

The qualitative research on the other hand, while still inductive, uses institutional theory in order to analyse and discuss a few of the underlying factors that affect the performance of green bonds and their ability to develop and drive the green energy transition. Therefore, the epistemological position adopted for this part of the thesis is based on interpretivism. While combining positivism and interpretivism could result in very conflicting conclusions, this study combines the two in order to merge the multidisciplinary aspects that define the thesis. By adopting an interpretivist approach to the qualitative research and the results of the quantitative research, we are able to go beyond the relative simplification of laws that positivism produces. As researchers, an interpretivist approach allows us to discuss complexities observed in various green bond markets that a positivist might overlook or ignore i.e. the importance of social actors and their idiosyncratic interpretations of what constitutes 'green'. Additionally, this approach provokes an empathetic stance by the researcher, something that is key in the discussion of common but differentiated responsibilities related to fighting climate change (Saunders, 2015).

Primary Data Collection Methodology - Interviews

In order to collect data that fits into the specific and highly narrow scope of our thesis,

primary data was obtained through interviews. The interviews were conducted with energy sector experts, climate scientists, as well as professionals within finance that have extensive experience working with fixed income markets and green bonds. The full transcripts of these interviews can be found in the appendix and serve to provide context to answers we have quoted or paraphrased in the discussion. This ensures that we do not misquote or misconstrue any of their statements, while we have also left out names of interviewees who asked to remain anonymous.

In order to enable a most effective interview in terms of producing knowledge and usable data, a semi-structured interview technique was applied to every interview. This structure not only fits with an inductive approach as it allows the interviewee to introduce us to topics we might not have known about, but the structure also allows for better flexibility in posing the right questions that are better tailored to the individual interviewee's background and knowledge. This structure, as opposed to structured interviews which are highly standardised, allows for more in-depth questions about certain topics or answers and ultimately lead to interviews that produce more knowledge and usable data. The unstructured interview structure was not chosen because the interviews needed to be highly focused on the exact scope of the thesis and their experience and background information always was integrated into developing interview questions beforehand to get the best results (Saunders, 2015).

Chapter 6

Data

6.1 Energy-sector population

The data source for firm-level data is EIKON [1]Refinitiv [2] . EIKON has been chosen as the main data sources as it gives the possibility to students to access their database from home. It has been just easier to access information from home during the corona lock-down period. Moreover, I could save the research made as EIKON offers CBS students the chance to sign up directly with their own CBS mail account. Specifically, we found one of the many advanced research tools particularly useful. It is called "Government and Corporate Bonds". It gives the user the possibility to define a universe, in this case the universe of governmental and corporate bonds, and filter such a large universe, i.e., 882.879 results, with multiple conditions.

The first condition is that the selected sample must include only bonds issued by corporations as we follow the methodology of (Flammer, 2021). Moreover, the bond type must be a bond and not a certificate of deposit or a commercial paper. The certificates of deposit (CDs) are different from bonds regarding the investment horizon. In fact, although both financial instruments are debt-based, fixed-income securities, CDs are a short-term investment vehicle, whereas bonds are long-term ones. Similarly, the difference between

[2]Refinitiv is an American-British global provider of financial market data and infrastructure, whose head quarter is in New York. Refinitiv main parent organization is the London Stock Exchange Group. It was founded in 2018, and it was formerly known as Thomson Reuters.

[2]EIKON Refinitiv is one of the software products of the Refinitiv portfolio. EIKON Refinitiv is a software application that allows financial analyst to monitor and analyse financial information. It makes available data on different asset classes, e.g., currency market, stock market, commodities, and last but not least fixed income market. Among the different market application embedded in EIKON Refinitiv, the equity research aims at helping financial analyst to closely follow and analyse listed companies.

commercial paper and corporate bonds is that the former is typically used for raising short-term funding requirements such as working capital.

Another relevant condition is that the Sukuks bonds are excluded, i.e., specially tailored financial products that conform to the set of ethical and common law– based financial transaction principles laid out in Shari'ah, or Islamic law (Safari, Ariff, & Mohamad, 2014).

An important condition regards the choice of timeline. In fact, the issue date for a bond in the sample selection is set between the 1/1/2012 and 31/12/2020. We chose to start in 2012 as the first ever corporate green bonds have been issued for the first time in 2012. Since then, the market has exploded, from $10 billion in 2013 to over $40 billion in 2015 and is projected to exceed $100 billion in 2016 (Rosembuj & Bottio, 2016). We ended our timeline in 2020 as the post-issuance performance of corporations is measured in the period following the bond issuance.

The final constraints consist in setting the SIC codes equal to the industries that we wanted to analyse. A list of 32 different SIC codes is presented in 10.1. The result of such research is a dataset of 10895 unique rows called "Universe of bonds". Each row is a bond issuance which is described by 121 different variables. Summary statistics for the "Universe of bonds".

6.2 Energy bond-level data

Data set selection

This section describes the research methodology applied in the study of the greenium. The delimitation of what the greenium is has been presented in the literature review section. Hereafter, the data collection and the data manipulation methodology are declared.

In summary, to study whether a premium is present in the primary bond market for green bonds, I estimate the difference in the average yield at issuance of two groups of comparable bonds. To determine the individuals within those two groups of comparable bonds, I operate the matching between the green bond group and the corresponding vanilla group. I apply the Flammer's (2021) methodology, i.e., matching a green and a vanilla bond from the same bond issuer. I assume that the reader bears in mind that the paper investigates the market of "corporate" green bonds, therefore I avoid repeating the

corporate attribute hereafter.

Hereupon, a step-by-step description of the how the analysis will be conducted is outlined. First of all, I filter the universe of 10896 rows to select only green bonds, which account for 509. Each of the bonds has an issuer who is attributed to a unique code identifier. Eventually, the subset of 509 green bonds determines a list of 155 unique firm-code identifiers.

On the 6th of May 2021, I operated the second data collection for the universe of comparable vanilla bonds, using the list of 155 unique issuers as a selection filter. The resulting dataset contains 1502 potentially analogous vanilla bonds, hence, each of the green bonds has about 3 potentially comparable vanilla bonds to be matched with.

Moving to the data manipulation, it has been realized in the working environment of RStudio. There, it is possible to read xlsx files and manipulate the data. The xlsx file containing only green bonds was named Green Universe and consists of 509 observations, whereas the one containing only vanilla bonds is named Vanilla Universe and contains 1502 observations. Both data sets have 121 different character variables. Out of 121 characteristics, I have selected the 10, e.g., (SIC, Ticker, Maturity, 'Coupon', 'Coupon Type', 'Issue Date', 'Yield to Maturity', 'Amount Issued (USD)', 'Green Bond', 'Country of Issue'). The data sets are merged into one and further data manipulation where conducted, e.g., creating a dummy variable for the green bond attribute or mutating the nature of some variables from text into numerical. Also, the data cleaning consists in omitting the missing value, decreasing the data population of about 20%.

To standardize the sample and have a better comparison, I require the bond type to be only "Fixed Income" as opposed to "Variable income". Indeed, the latter have a return based on some underlying benchmark measure such as short-term interest rates. This process decreased the observations' number from 1627 to 1464.

Finally, two last manipulations are performed. Firstly, the variable "yield to maturity" is investigated to find possible outlier. To mitigate the impact of outliers, the variable is winsorized at the 1st and 99th percentiles of its empirical distribution. Secondly, I take the logarithm transformation of the "amount issued in US dollars millions" variable to make it as "normal" as possible so that the statistical analysis results become more valid, as log-transformation reduces skewness from the data.

Initial imbalance

To conduct the pricing analysis, i.e., comparing the yield at issuance of a green and a corresponding vanilla bond, each green bond needs to be matched to a comparable vanilla bond. Prior to matching, it can be a good idea to view the initial imbalance in one's data that matching is attempting to eliminate, by looking at Table 6.2 .

	Control	Treated
All	1217	247

Table (6.1) The table above shows the number of green bond (treated) and the vanilla bond observations (control). The ratio is almost one green bond observation every five vanilla bonds, i.e., each treated has five potential matching.

No matching	
$\sum_{j=1}^{4} \lvert SMD_j \rvert$	2,681
$\sum_{j=1}^{4} \mathbf{E}(eCDF_j)$	0,571

Table (6.2) We can see severe imbalances as measured by the standardized mean differences (Std. Mean Diff.), variance ratios (Var. Ratio), and empirical cumulative density function (eCDF) statistics. Values of standardized mean differences and eCDF statistics close to zero and values of variance ratios close to one indicate good balance, and here many of them are far from their ideal values.

After assessing the initial imbalance, the actual matching algorithm is run. It runs by means of the R function "matchit" which comes with the R package called MatchIt (Imai et al., 2021). Although MatchIt can perform matching based on prosperity score or a variety of other matching procedures, the intent of this analysis is to match the two nearest neighbors, i.e., finding those subjects whose co-variance matrix are the most similar (Daniel HoKosuke Imai et al., 2021). A matching algorithm, that simultaneously minimizes distances across the four matching covariates (Frésard & Valta, 2016), is implemented by means of MatchIt. The formula argument of matchit is

$$Green\_Bond = Maturity + Coupon + Issue\_Date + Log(amount\_issued\_in\_USD) \quad (6.1)$$

where *Green Bond* is the binary treatment indicator and the rest of the included variables the pre-treatment covariates. The "method" argument specifies a matching method. I opted for the genetic matching method. Such a method is described in the matching framework in the literature review section. Furthermore, the "distance" argument specifies the method used to estimate the distance measure. Although a variety of distances are

available, the Mahalanobis distance is preferred [3].

6.3 Energy firm-level data

Data set selection

In 6.1, the methodology used to retrieve the universe of fixed income issued by energy companies has been outlined. The following section presents two other types of data, i.e., the covariate employed in the matching process and the post-issuance data, used in the causal effect specifications.

Accounting Pillar Score

About the matching covariates, two types of data are included to ensure that the matching pair consist in two firms as similar as possible. Firstly, the accounting data are obtained from the equity research app of EIKON Refinitiv. Such research consisted in retrieving ten different type of accounting data, which were then used to calculate commonly used variables in econometric studies. Therefore, four firm-level characteristics were built: size, Tobin's Q, ROA, and firm's leverage. It is accepted that covariates capture a lot of otherwise unobserved firm heterogeneity (Almeida, 2012). The four variables are computes as follows:

- *Size* is the natural logarithm of the book value of total assets
- *The return on assets (ROA)* is ratio between the operating income before depreciation (EBITDA) to the book value of total assets.
- *The Tobin's Q* consists in the ratio of the market value of total assets obtained as the book value of total assets plus the market value of common stock minus the book value of common stock) to the book value of total assets.
- *The Leverage* is the ratio of debt, calculated as the long-term debt plus the current liabilities, to the book value of total assets.

[3] For each treated firm i, we find a matched firm j such that the Mahalanobis distance between the i's and j's covariates (matching variables) is the smallest. The Mahalanobis distance is given by: $||X_iX_j|| = [(X_iX_j)\sum^1(X_iX_j)]^{1/2}$, where X is a k-dimensional vector of covariates and W1X is the inverse of the covariance matrix of the covariates.

To identify each specific firm within the EIKON database, I used the unique Reuters Instrument Code (RIC) [4].

The second group of data that it is involved in the matching process is the three pillar scores of EIKON. Basically, each company get assigned a rating from EIKON rating agents based on its performance on different subjects. The environmental pillar measures a company's impact on living and non-living natural systems, including the air, land and water, as well as complete ecosystems. It reflects how well a company uses best management practices to avoid environmental risks and capitalize on environmental opportunities in order to generate long term shareholder value. The social pillar measures a company's capacity to generate trust and loyalty with its workforce, customers and society, through its use of best management practices. It reflects the company's reputation and the health of its license to operate, which are key factors in determining its ability to generate long term shareholder value. The corporate governance pillar measures a company's systems and processes, which ensure that its board members and executives act in the best interests of its long-term shareholders. It reflects a company's capacity, through its use of best management practices, to direct and control its rights and responsibilities through the creation of incentives, as well as checks and balances in order to generate long term shareholder value.

Environmental performance

The review of existing literature sets the foundation for the sub research question presented in the methodology chapter. In particular, the former literature about investment's performance is a serviceable resource when investigating non-financial firm-level performance. (Brest & Born, 2013) define social- and environmental impact of firms' investments. Specifically, the authors state that an investment has social impact if it improves the quality or quantity of the enterprise's social outcomes, beyond what would otherwise have occurred. This concept is embedded in the word *additionality*. Furthermore, Brest & Born (2013) decompose the enterprise's social impact to two sub-categories:

- Product impact is the impact delivered by goods or services that are produced from the enterprise's operations, e.g., clean energy and water.
- Operational impact is the impact related to the enterprise's operations and covers

[4] A Reuters Instrument Code, or RIC, is a ticker-like code used by Thomson Reuters to identify financial instruments and indices. The codes are used for looking up information on various Thomson Reuters financial information system (Reuters, 2021)

the environmental footprint.

From the understanding of the aforementioned concepts, two environmental measures have been chosen to serve as a proxy for corporate environmental performance. Such measures represent the dependent variables changing because a company issues a green bond. Such environmental measures are draft by the "EIKON ESG Data Framework" and the "EIKON ESG Scores Methodology". The database for such information is the ESG app in EIKON.

The first is the "Total CO_2 Equivalent Emissions to Revenues USD in million". This variable is well documented in EIKON, which has been reporting such data constantly for many different companies within our firm's universe. It is about the total CO_2 and CO_2 equivalents emission in tones divided by net sales or revenue in US dollars in million. Such a measure is meant to address the operational impact defined by Brest & Born (2013), because it works as a proxy for the energy firm's environmental footprint. On the other hand, the second variable is related to the product impact defined by Brest & Born (2013), as it evaluates the impact from enterprise's operations. It is called "Renewable Energy Produced", i.e., the total energy produced from primary renewable energy sources in gigajoules. It takes into account the waste-to-energy, bio energy produced only when the company reports it as renewable, and solar energy alongside wind farm, hydro, geothermal and biomass. Such a measure is specific for the energy sector.

Ownership structure

The thesis is interested in the behaviour of the largest shareholder category among equity owners [5]. Specifically, the reaction of institutional players to the issuance of a green bond, i.e., the change in institutional ownership share in the post-issuance year, is measured, excluding the change in institutional ownership of comparable vanilla issuers. Table 6.3 shows that the percentage of institutional ownership share is on average 45%, which is aligned with the findings from (OECD, 2021).

To capture changes in the equity ownership structure of a bond issuer, I have retrieved equity ownership holding data from the StarMine EIKON Refinitiv app. In particular, the StarMine Overview is an EIKON's application which includes financial models, and business analytic. As a matter of example, the StarMine Overview contains the Ownership Overview panel which allows analysts to visualize equity ownership holding data.

[5] At global aggregate level, institutional investors represent the largest investors category by holding 43% of the world market capitalisation, followed by private corporation holding 11% the public sector holding to 10% and strategic individuals calling 9% CITE.

Variable	obs	mean	median	sd
% Institutional Investors	765	0,457	0,356	0,334
% Longterm Investors	765	0,548	0,589	0,232

Table (6.3) reports summary statistics for sample of energy firms involved in the ownership structure regression model.

I measure the equity ownership based on two variables. The *institutional ownership* is the yearly total percentage of shares held by institutional investors. Institutional investors are defined by StarMine as follows: bank and trust, endowment fund, finance company, foundation, government agency, edge fund, investment advisory, insurance company, pension fund, private equity, venture capital, investment advisory, sovereign wealth management, investment Management Company, and miscellaneous investment manager.

The *long-term ownership* is the yearly total percentage of shares held by long-term investors [6]. StarMine EIKON calculates the investor turnover, after analysing the previous 12 quarters of her portfolio holding. Generally, an investor is labelled as a low turnover investor if its annual portfolio turnover rate is less than or equal to 50%, i.e., the average holding period exceeds two years, indicating a general preference for long term investing.

Data wrangling and control group selection

In this section, a series of manipulations applied to the retrieved dataset is presented. First, from the bond universe, I select 509 green bond observations. As the regression model involves mostly firm-level data, I select few variables from the bond universe, such as a unique issuer identifier code, a unique bond identifier code, the SIC code of the issuer, and finally the issue date. Moreover, I omit the observations that miss any of covariate. Moreover, I retrieved from StarMine EIKON the primary country of risk for the issuer.

After completing the green bond issuer selection, a universe of plain vanilla bond issuers is needed for the comparison. In this case, if the issuer had issued both a green and a brown bond, she was excluded from the plain vanilla bond issuer list. The same variables were required for the plain vanilla bond issuer, and I have eventually merged the two data sets into a unique dataset, consisting of 4218 observations (3985 brown and 233 green bond issues).

[6] More than eight in 10 individual investors believe that corporate ESG practice can potentially lead to a higher profitability and may be better long-term investment (Stanley, 2019)

From the unique dataset of bond issuer, I have extracted the companies' identifier codes and use those to retrieve the accounting, environmental and equity ownership data. Eventually, I had thirteen different panel data sets, ranging from 2010 until 2020, one for each variable involved in the regression model. The time span is determined by the issue date of the first and last bond issuance in the dataset.

At this point, it would have been difficult to perform statistical analysis across thirteen separate files. To facilitate the analysis in the statistical software environment, I have selected only the data points that participate in the regression model. Specifically, the following regression model capture the effect that the corporate green bonds issue attribute has on the firm-level performances. Therefore, the variables related to firm-level accomplishments are measured in the year following the bond issue, whereas the variables involved in the matching process are chosen in the two points in time, i.e., in the year preceding the bond issuance (t_1) and the year before that year (t_2), which captures the "pre-trend" (Flammer, 2021). In this way, I was able to reduce the set of information to a second unique dataset, consisting in 151848 data points, or 4218 excel rows and 36 columns.

Covariate balance

In this section, the covariate balance achieved through the matching process is assessed. The covariate balance is the degree to which the distribution of covariates is similar across levels of the quasi-experiment, i.e., the better the covariate balances are, the more similar the treated and the control groups are. It has three main roles in casual effect estimation using matching:

1. As an optimisation target for the matching algorithm
2. As a method of assessing the quality of the matches
3. As an evidence to an audience that the estimated causal effect is close to the true effect.

Indeed, when covariate balance is achieved, the resulting effect estimate is less sensitive to mode misspecifications, and ideally close to through treatment effect. The benefit of a randomization is that covariate balance is achieved automatically, which is why the treatment effects estimated from randomised trial data can be validly interpreted as causal effects. When using matching to recover causal effect estimates from observational data,

balance is not guaranteed and it must be assessed. In this section, we will assess and report the covariate balance as a part of the matching analysis.

Assessing the initial balance

Before the actual matching, an assessment of the initial imbalance in the one's data that the matching is going to exclude is performed.

	Control	Treated
All	735	57

No matching	
$\sum_{j=1}^{14} \lvert SMD_j \rvert$	1,849
$\sum_{j=1}^{14} \mathbf{E}(eCDF_j)$	0.712

We can see an imbalance as measured by the absolute sum of the standardized mean differences (SMD), and the absolute sum of the empirical cumulative density function statistics. The SMD is the difference in the means of each covariate between treatment groups standardized by a standardization factor so that it is comparable across all the different variables. In this case, the standardization factor is the standard deviation of the covariate in the treatment group as we target the average treatment effect on the treaded (ATT). The latter statistics are the empirical cumulative density function, i.e., statistics related to the difference in the empirical community intensity function of each covariate between groups which allow assessment of imbalance across the entire covariate distribution of that covariate rather than just its mean or variance.

Best matching specification

Choosing the best matching specification for the "method" argument depends on the unique characteristics of the dataset as well as the goal of the analysis. For example, because different matching methods can target different estimates, when certain instruments are decided, specific methods must be used. Some methods may be more effective than others when retaining that the target estimand is less important. In general, multiple methods can be tried as long as the treatment effect is not estimated until method has been settled on (Imai et al., 2021).

The criteria for optimal matching specifications are the matching balance and the remaining sample size after matching (Imai et al., 2021). Different matching specifications have

been tested, starting with the one requiring the primary country of risk and the SIC code to be exactly the same, like Flammer (2021) did. As we can see, the remaining sample size decreases substantially:

	Control	Treated
All	735	57
Matched	24	24
Unmatched	711	33

More than half of the treated observations were left unmatched, when requiring both the primary country of risk and the industry sector to be the same. Therefore, I reduce the "exact" constraints to only one, which addresses the necessity for the matched firms to operate in the same country, but not necessarily to be classified in the same energy sector.

In regards to the matching methodology, this study follows the guidance of Imai et al. (2021) and it compares five different combinations of matching procedures. The first criterion evaluated is the remaining sample size. Despite the five different matching procedures, this value remains constant, as follows:

	Control	Treated
All	735	57
Matched	51	51
Unmatched	684	6

When matching the energy firms that are located in the same country, only six treated individuals remain unmatched. This result is twenty seven times better than the previous matching setting.

In the following pages, the matching balance between the treated and the control firms is assessed. Hereafter, a comparison based on two key statistics related to the matching performance is presented:

As we can see, 6.5 and 6.4 show the same exact statistics when looking at both the prosperity score and the Mahalanobis distances. In general, the values of both statistics range from 0 to 1, with values closer to zero indicating better balance. There are no specific recommendations for the values that these statistics should take, though high values may indicate imbalance on higher moments of the covariates.

Nearest neighbour matching		
	Propensity Score	Mahalanobis
$\sum_{j=1}^{14} \lvert SMD_j \rvert$	1,849	1,914
$\sum_{j=1}^{14} \mathbf{E}(eCDF_j)$	0,712	0,681

Table (6.4) Summary statistics of the Nearest neighbour matching process.

Genetic matching when pop.size = 100		
	Propensity Score	Mahalanobis
$\sum_{j=1}^{14} \lvert SMD_j \rvert$	1,849	1,914
$\sum_{j=1}^{14} \mathbf{E}(eCDF_j)$	0,712	0,681

Table (6.5) Summary statistics of the genetic matching process when the population size parameter is set to 100.

The choice of the best matching practise is independent from the algorithm, as the nearest neighbour logarithm performs as good as the genetic one in the case of both distances. However, the prosperity score distance has both the $\sum_{j=1}^{14} |SMD_j|$ and the $\sum_{j=1}^{14} \mathbf{E}(eCDF_j)$ closer to the zero. Therefore, the best matching procedure for the matching is either the genetic or the nearest neighbour algorithm and the prosperity score distance.

To clarify the dilemma: "which algorithm should we choose?". the population size, i.e, a parameter of the genetic algorithm that represents the number of individuals that the matching algorithm uses to solve the optimization problem, is increased from 100 to 1000. The genetic algorithm finds good solutions which are asymptotic in population size. Therefore, it is important that this value not be small (Imai et al., 2021). However, the higher the population size, the more complex is the optimization problem that the software needs to solve, i.e., it is a longer matching solution.

As you can see from 6.6, the two key statistics remain the same in both cases when

Genetic matching when pop.size = 1000		
	Propensity Score	Mahalanobis
$\sum_{j=1}^{14} \lvert SMD_j \rvert$	1,849	1,914
$\sum_{j=1}^{14} \mathbf{E}(eCDF_j)$	0,712	0,681

Table (6.6) Summary statistics of the genetic matching process when the population size parameter is set to 1000.

population size is 1000 individuals. This result confirm that the matching process is independent from the algorithm used. In conclusion, as long as the matching process is using the prosperity score distance, it will return the best outcome.

Model "Difference in difference specification"

To examine how firm-level outcomes evolve following the issuance of a corporate green bond, I use the Difference-in-Differences statistical framework, and a combination of four different fixed effects. The indices of the regression are the following:

$$i = ric(firm)$$

$$t = year$$

$$c = primary\_country\_of\_risk$$

$$s = SIC(industry)$$

$$y_{i,t} = \alpha_i + \alpha_t + \alpha_s + \alpha_c + \beta \times_i GreenBond_{i,t} + \epsilon_{i,t} \tag{6.2}$$

where the dependent variables are presented in section 4.5.1. α_i is firm fixed effect, i.e., the effect that remain fixed across entities, but that evolves over time. α_t is the variation in the time. The fixed effect comes from omitted variable that vary over time but not across entities. The intercept is excluded to prevent perfect multicollinearity. α_s is the industry fixed effect, i.e., the fixed effect constant across industries. Because industry regulation is introduced nationally, it affects all entities belonging to that industry. Finally, α_c represents the countries' fixed affect. As aforementioned, country regulation affects all entities at the same time as it is introduced nationally.

6.4 Reliability, validity and data credibility

The data in section 2 and 3 has been collected using secondary sources such as industry reports, data platforms, policy and legal documents, frameworks and research papers sourced from the CBS digital library and web searches. The primary qualitative data collected through interviews serves the purpose of providing the study with valuable insight on the highly specific topics covered. Furthermore, implementing semi-structured

Matching characteristic	Type	Count	Mean	Median	Std. Dev.	P-value (diff. in means)
roa_1	Green	51	0.084	0.087	0.033	0.356
	Vanilla	51	0.092	0.090	0.052	
leverage_1	Green	51	0.500	0.531	0.166	0.711
	Vanilla	51	0.512	0.508	0.160	
tobinq_1	Green	51	1.175	1.139	0.405	0.472
	Vanilla	51	1.126	1.094	0.266	
size_1	Green	51	23.510	23.720	1.141	0.378
	Vanilla	51	23.750	23.910	1.563	
size_dif	Green	51	0.089	0.033	0.234	0.197
	Vanilla	51	0.043	0.030	0.094	
roa_dif	Green	51	-0.009	0.000	0.053	0.455
	Vanilla	51	-0.003	-0.002	0.021	
tobinq_dif	Green	51	-0.026	-0.005	0.274	0.439
	Vanilla	51	0.006	0.012	0.106	
leverage_dif	Green	51	0.008	0.002	0.038	1.000
	Vanilla	51	0.008	0.005	0.037	
gps_1	Green	51	54.640	55.870	20.993	0.737
	Vanilla	51	56.060	57.700	21.606	
sps_1	Green	51	51.825	53.126	23.746	0.417
	Vanilla	51	55.870	59.100	26.349	
eps_1	Green	51	51.857	52.085	26.455	0.416
	Vanilla	51	56.070	59.230	25.624	
eps_diff	Green	51	4.737	0.734	15.153	0.679
	Vanilla	51	3.727	0.564	8.474	
gps_diff	Green	51	3.751	0.784	14.770	0.527
	Vanilla	51	2.139	1.467	10.533	
sps_diff	Green	51	5.627	2.878	12.086	0.400
	Vanilla	51	3.800	1.879	9.579	

Table (6.7) This table presents descriptive statistics comparing treated and matched control firms. Levels (e.g., size) are measured in the year preceding the bond issue (t – 1), while pre-trends (e.g., size_diff) are measured in the two-year window preceding the bond issue (changes from t – 2 to t – 1). The last column report the p-value of the difference-in-means. *, **, and *** denotes significance at the 10%, 5%, and 1% level, respectively.

interviews opens the possibility to ask inquisitive questions as opposed to structured interviews which would have added comparatively little value. The data is compiled in the appendix and consists of five interviews which can be split into three categories: fixed income specialist (2), energy sector expert (2), and climate finance specialist (1). Preferences regarding anonymity have been fully respected. Besides providing insights, the interviews provided opportunities to present views from our literature review and hear views from industry practitioners.

According to (Carmines & Zeller, 1979), a study can only gain scientific acceptance if the underlying data is reliable and valid. Reliability refers to whether the data collection techniques and analytical procedure would reproduce consistent findings if they were repeated on another occasion or if they were replicated by another researcher. To ensure reliability, the methodology and analysis of this paper were designed to possibly avoid any error or bias. Although the data collection and methodology were already explained, this section reflects on the errors and biases that this scientific paper may have encountered, and it clarifies the solutions implemented to avoid possible fallacies.

When addressing the causal effect, unmeasured or time-varying common causal effect could affect the measurement of the causal relationship between the variables which we focus on. By selecting a global and spread across different energy sectors bond population, we exclude the threat of participant biases, i.e., unmeasured and time-varying common causes. A similar type of biases is omitted variables bias (OVB). To minimize OVB, different fixed effects are integrated with the differences-in-differences models, e.g., the firm fixed effect, the country fixed effect or year fixed effect. Although considering such fixed effects, other factors may influence the relationship between our randomized treatment and the outcome variable. For instance, Flammer (2021) uses a combination of fixed effects, i.e., a product between two single fixed effects, e.g., the industry by year fixed effects, or country by year fixed effects.

Regarding data credibility, this study uses Eikon as a database for quantitative analysis. Eikon is a valid source for scientific studies, due to its reliance on accurate representation of data for the future of their businesses. The study can be repeated by other researchers since the data is publicly available, and we rely on data of primarily a quantitative nature.

Talking about errors that may have occurred during the research, the following paragraph addresses some. To avoid typos in writing the formulas for the data collection ourselves, we received those directly from the help desk of Eikon. Moreover, the scripts written in R

were double-checked by an extensive search for obvious errors in the analysis outcomes.

Finally, for a research paper to be reliable, research biases cannot be ignored. The matching method used to pair green bond observations with comparable vanilla bonds could be a source of bias. The research chooses the variables involved in the matching equation. However, in choosing such variables, we rely on previous peer-reviewed literature which has dealt with the problem before.

We believe that our research respects validity since the paper follows a highly structured research approach. Such a research approach is typical in the research of causal effects, i.e., the identification of the extent and nature of the cause-and-effect relationship. In this case, the cause-and-effect relationship relays between the issuance of a green bond and the post-issuance firm-level performances of energy companies (business research methodology).

We are aware that causal research comes with both advantages and disadvantages. For instance, coincidences in events may be measured as cause-and-effect relationships. Another threat to the validity of the paper is the difficulty of reaching an appropriate conclusion based on casual reference findings. This is due to the impact of a wide range of factors and variables in social environments. In other words, while causality can be inferred, it cannot be proved with a high level of certainty ().

However, our research design follows the best practices, which are hereafter explained, of explanatory research. Firstly, we conduct an experiment, which is the most popular primary-data-collection method in studies with causal research design (). Moreover, the three main requirements of any causal relationship that claims to have validity were considered when designing the experiment. Our experiment complies with the temporal sequence component, i.e., the issue of the green bond occurs before the firm-level performance measurement. The second component, namely concomitant variation, is also respected as the variation of the two variables occurs systematically. Last but not least, the issuance of green bonds is endogenous with respect to firm outcome, i.e., unobservables may drive a spurious relationship between the issuance of green bonds and firm outcomes (Flammer, 2021). In an ideal setting, the threat of endogeneity would be addressed using an instrument for the issuance of green bonds (Flammer, 2021). However, an empirical setting in which companies randomly issue green bonds has not been found. Our paper makes a plausible counterfactual of how firm-level outcomes would involve absenting the green bond issuance, using the matching approach.

Finally, multivariate OLS regression is chosen, as a significant and causal inference is sought. This cannot be achieved, to the same extent, using descriptive research solely. However, a causal inference could be confused with a simple correlation and lead to misinterpreted conclusions (Stock & Watson, 2012). Time series and panel data regressions may have alleviated some of these shortcomings through Granger causality tests, but sufficient historical data does not exist to allow for these approaches.

Chapter 7

Analysis

7.1 Summary statistics of energy-sector population

The method to create a data set for corporate energy bonds is described in 6.1. In essence, I extract all the corporate bonds in Eikon database that were issued by energy companies. In particular, industry selection is performed by means of the SIC code, i.e., the Standard Industrial Classification (SIC) codes are four-digit numerical codes that categorize the industries that companies belong to base on their business activities. Besides the industry criterion, a series of other criteria is described in 6.1. Given the comprehensive coverage of Eikon's fixed income database, the resulting data set is likely to closely map the full universe of energy green bonds. To facilitate comparisons, I convert all amounts into US dollars, and in the following section, three tables summaries key statistics of the energy green bond universe.

Table 7.1 is a proof of the rapid rise of the energy green bond market over the past decade. From 2013 until 2015, few energy firms issued green market debt, whereas from 2016 on, the growth of the market has undertaken a positive trend, although in 2017, the yearly growth rate was negative. Table 7.2 groups the energy green bonds by industry sector of the issuer. As can be seen, energy green bonds are more common in industries where the environment is likely core to the firms' operations, e.g., electric utilities and alternative electric utilities. Finally, Table 7.3 provides a breakdown by countries. As is shown, green bonds are especially prevalent in the US, Europe and Asian countries.

Year	# Bond	$ Tot Amount (billion)
2013	1	0,424
2015	1	0,360
2016	10	3,061
2017	6	0,465
2018	12	3,293
2019	30	9,219
2020	38	8,035
Total	98	24,857

Table (7.1) Energy green bond over time

This table reports the sum of the amount issued (in $B) as well as the count of energy green bonds issued on an annual basis from 2013 until 2020

Industry Sector	# Bond	$ Tot Amount (billion)
Electric Utilities	46	16,687
Alternative Electric Utilities	12	0,799
Renewable Energy Equipment & Services (NEC)	6	0,464
Hydroelectric & Tidal Utilities	6	0,585
Multiline Utilities	5	1,857
Independent Power Producers (NEC)	4	0,257
Water & Sewage Construction	4	0,309
Fossil Fuel IPPs	3	0,160
Oil & Gas Refining and Marketing (NEC)	3	0,325
Renewable IPPs	2	0,156
Geothermal Electric Utilities	2	1,580
Electrical Transmission & Grid Equipment	1	0,601
Coal (NEC)	1	0,439
Courier, Postal, Air Freight & Land-based Logistics (NEC)	1	0,077
Photovoltaic Solar Systems & Equipment	1	0,200
Electrical Components & Equipment (NEC)	1	0,360
Total	98	24,857

Table (7.2) Energy green bonds by sector

This table reports the average annual amount issued (in $B) as well as the number of energy green bond by industry sector issued on an annual basis from 2012 until 2020. The industry SIC codes are listed in 10.1

Country	# Bond	$ Tot Amount (billion)
United States	23	12,946
Thailand	15	0,909
Norway	11	0,653
China (Mainland)	10	1,412
France	7	0,824
Japan	5	0,402
New Zealand	5	0,500
Sweden	4	1,025
India	2	1,000
Spain	2	0,390
United Kingdom	2	0,840
Bermuda	2	1,580
Switzerland	2	0,365
Netherlands	2	0,961
Belgium	1	0,721
Singapore	1	0,200
Portugal	1	0,061
Argentina	1	0,035
Latvia	1	0,030
Italy	1	0,001
Total	98	24,857

Table (7.3) Energy green bond issuer by country of incorporation
This table reports the annual average amount issued (in $B) as well as the number of energy green bond by country issued on an annual basis from 2012 until 2020.

7.2 Bond-level pricing analysis

Matching assessment

In section 5.4, the assessment of the pre-matching balance and the methods of the matching algorithm, run by means of the matchit R function, have been presented. In the following pages, the post-matching performance of such a matching algorithm follows. It

	Vanilla bonds	Green bonds
All	1217	98
Matched	91	91
Unmatched	1126	7

Table (7.4) Overview on the matching performance

is critical to report on the matching balance to demonstrate that the resulting estimate is approximately unbiased and relies little on extrapolation or correct outcome model specification. To make sure the reader remembers the matchit object obtained by means of matching, a brief summary of the objective follows:

- method: 1:1 genetic matching without replacement

- distance: Mahalanobis

- number of obs.: 1464 (original), 182 (matched)

- target estimand: ATT

- covariates: maturity, coupon, issue.date, log.amount.issued.(usd), ticker.

As you can read, the matching method relies on a genetic algorithm. Such an algorithm is explained in 5.3. The "without replacement" attribute implies that control units, namely the vanilla bonds can only be matched to one treated unit each, forming a unique pair of bonds whose issuer is the same. Among the various method for measuring a spatial distance available, I have chosen the Mahalanobis distance. Furthermore, the Green bond group has lost 7 observations, after the matching process has been deployed, leaving the experiment with 91 pairs of bonds. Finally, the list of covariates includes, besides the four listed above, the "ticker" covariate which is meant to be identical for each of the matching pair, i.e., each pair of bonds contains a green and vanilla bond issued from the same issuer.

Table 7.4 shows the sample size before and after matching for both the treated and control groups. The matching procedure left 7 green bonds and 1126 control units unmatched. Ideally, unmatched units would be those far from the treated units and would require greater extrapolation were they to have been retained.

We can visualize the distribution of propensity scores of those who were matched using a jitter plot in Figure 7.1. On the other hand, Figure 7.2 and Figure 7.3 provide a summary

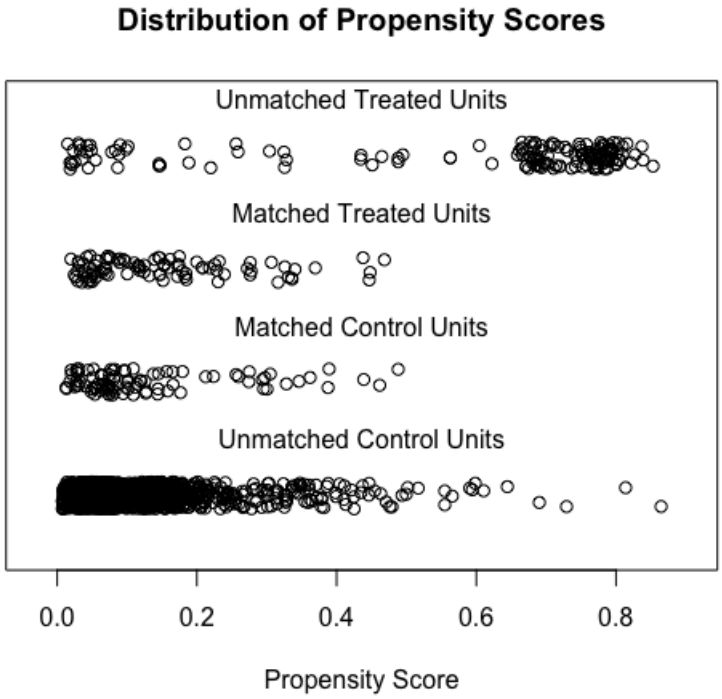


Figure (7.1) This is a table of the sample sizes before and after matching. We use a jitter-type plot to visualize the distribution of propensity scores of those who were matched. The matching procedure left 156 treated and 1126 control units unmatched. Ideally, unmatched units would be those far from the treated units and would require greater extrapolation were they to have been retained.We can visualize the distribution of propensity scores of those who were matched using jitter.

related to the balance of the full marginal distribution of a covariate, beyond just the mean and variance.

Figure 7.2 shows six eQQ plot related to three covariates, reported before and after the matching. As you can see, the matching algorithm has performed well in the case of the coupon variable, reaching a good balance. In the cases of the maturity and the issue_date, the achieved balance is slightly worse than the coupon's one, and, as we can see, t the observations fell out the 45 degrees line still. Similar conclusions can be drawn by looking at the Figure 7.3. However, in this case the imbalance between the treated and the control groups in regard to the issue_date variable is much clearer.

After plotting the data, basic statistics related to the four covariates are reported. Table 7.5 shows the mean, the median and the standard deviation of the two experimental groups. Moreover, it also reports the result of a t-test that determines if there is a signifi-

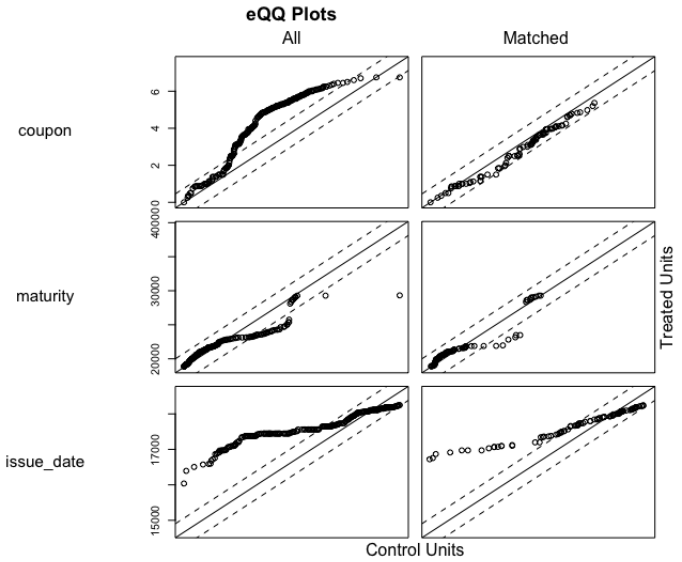


Figure (7.2) The y-axis displays the each value of the covariate for the treated units, and the x-axis displays the the value of the covariate at the corresponding quantile in the control group. When values fall on the 45 degree line, the groups are balanced. Above, we can see that issue.date remains somewhat imbalanced, but coupon and maturity have much better balance after matching than before.

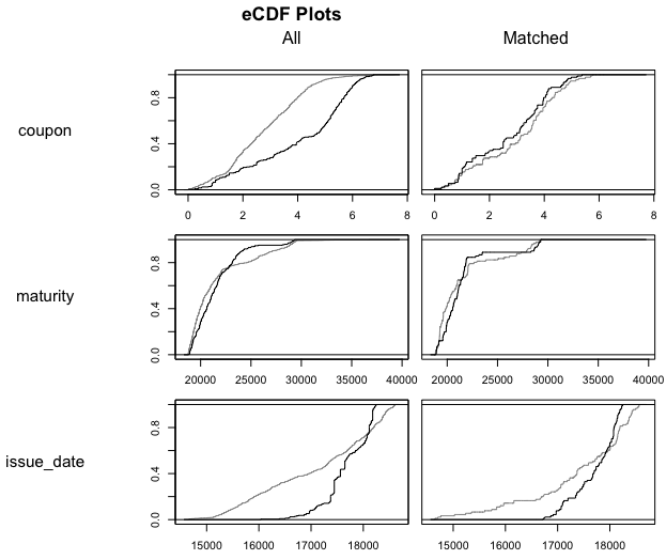


Figure (7.3) Visual diagnostics such as eCDF plots, can be used to see exactly how the covariate distributions differ from each other, i.e., where in the distribution the greatest imbalances are (Ho et al., 2007).

cant difference between the means of the two groups. A t-test looks at the t-statistic, the t-distribution values, and the degrees of freedom to determine the statistical significance. This test is a fundamental proof to check whether the matching process has output two groups which are similar in the covariates chosen.

Table 7.5 shows the covariate balance for the matching characteristics. Although the issue_date covariate results in being significantly different in the two groups, the remaining three covariates reports a difference in means which is not significantly different, confirming there is no significant difference between the green bonds and matched vanilla bonds from the same issuer.

Table 7.6 follows the same scheme applied for the previous table. It provides an answer to the question: "Is there a premium on corporate green bonds in the energy industry?". On average, there is no appreciable difference between the yields of green versus vanilla bonds issued from the same issuer. The mean difference is small in economic terms (0,091%) and statistically insignificant (p-value = 0,695).

Matching characteristic	Type	Count	Mean	Median	Std. Dev.	P-value (diff. in means)
maturity	Green	91	08/2029	07/2027	2908	0,519
	Vanilla	91	10/2028	07/2025	3006	
issue_date	Green	91	07/2018	12/2018	417	0,0001
	Vanilla	91	02/2017	10/2017	1040	
log(issued amount) in(usd)	Green	91	19,593	19,807	0,845	0,764
	Vanilla	91	19,557	19,549	0,769	
coupon	Green	91	2,742	3,100	1,442	0,046
	Vanilla	91	3,185	3,410	1,527	

Table (7.5) Covariate balance for the within-issuer matching of green bonds to vanilla bonds. This table shows descriptive statistics studying green and matched vanilla bonds from the same issuer. The matching is described in Section 4.4.1. Log (amount issued) is the natural logarithm of the issuance amount. Maturity is the maturity of the bond. Coupon is the coupon rate. Issue_date is the issue date of the bond. The last column reports the p-value of the difference-in-means t-test. When the P-value is less than 0.05 (P¡0.05), the conclusion is that the two means are significantly different.

Matching Characteristics	Type	Count	Mean	Median	Std. Dev.	P-value (diff. in means)
yield at issue (in%)	Green	91	1,870	1,781	1,575	0,695
	Vanilla	91	1,962	1,985	1,525	

Table (7.6) Is there a premium on corporate green bonds?
The table above reports the mean and the median of the yield at issue for green bonds and matched vanilla bonds of the same issuer. The last column reports the diff. in means tests, along with the corresponding p-value. When the P-value is less than 0.05 (P¡0.05), the conclusion is that the two means are significantly different.

By design, this matching procedure provides for each green bond a matched brown bond

by the same issuer that is as similar as possible except for the "greenness". In section 7.something, we will discuss the result of our analysis.

7.3 Firm-level performances analysis

This section is dedicated to the report of the analysis of the four linear regression models. Such models describe the firm-level post-issuance performance. There are two categories of post-issuance performance that the thesis investigates: energy firms' ownership structure and environmental performance.

The sample of the four models changes based on the time series' availability of dependent variables in Eikon. In fact, ownership structure's time series have been reported for longer than the environmental performance's one. This is also possible to observe when looking at the regression outcome presented hereafter.

Talking about the dependent variables, the ownership structure's variables represent two kinds of investors, i.e., the institutional investors and the long-term investors (look at section 6.3 for a detailed explanation of the dependent variables). Those two variables are reported in the form of percentage, i.e., the percentage of the specific kind of investor among all other kinds of investors.

On the other hand, the environmental performance outcome variables are not expressed in the form of percentages, but they are reported in the same unit of measurement that is used within the Eikon's database. Specifically, the total CO_2 equivalent emission to revenues US dollars in million is presented as a ratio between tones and US dollars, whereas the renewable energy produced is expressed in gigajoules (see section 5.5.1.). The model equation is Equation 7.1:

$$\Delta y_{i,t} = \alpha_i + \alpha_t + \alpha_s + \alpha_c + \beta_1 \times GreenBond_{i,t} + \epsilon_{i,t} \tag{7.1}$$

Figure 7.4 is a visualization of differences-in-differences principle. The legend explains what each line represents. As you can read, the green line relates to change in the percentage of long-term investors for green issuers. Such a line has a higher slope than the red line, which represents the change in the percentage of long-term investors for vanilla issuers. Finally, the green dashed line is a parallel line to the red one, and it represents

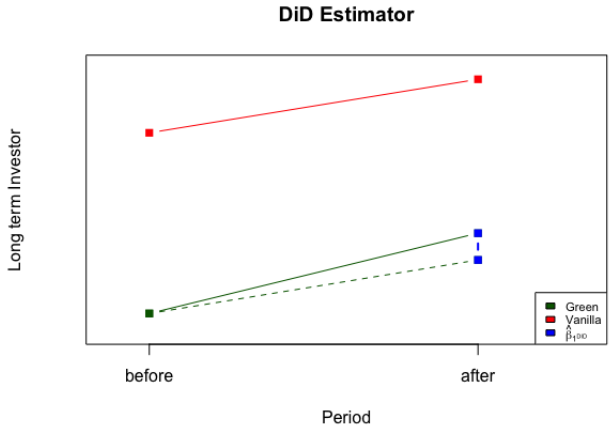


Figure (7.4) The plot above is a visualization of the DiD regressor. As you can see in the legend, it compares the change in the percentage of long-term equity investors holding the issuers' stocks. The percentage of long-term investors is positive in both cases, although the increase of long-term investor is higher for green bond issuers than vanilla issuers.

the increase that green issuers would have had if they stayed vanilla issuers, i.e., they were not treated. There is also the blue vertical dashed line, which visualize the positive DiD coefficient. The graphs points were calculated by means of equation: (3.1). Such equation does not take into account the fixed effects that a regression method can address.

Finally, Table 7.7 and Table 7.8 report the four different differences-in-differences regression models related to the post-issuance performance of energy firms.

Table (7.7) This table reports estimates of the differences-in-differences specification in equation 4.1. *Green bond* is dummy variable that is equal to one if the firm has issued a green bond. *Institutional ownership* is the percentage of institutional investors who hold a share in the firm. *Long-term ownership* represents the percentage of long-term investors who hold a share in the firm. The sample includes all the firm-year observations of the treatment and matched control films from 2012 to 2020. Standard errors (reported in parenthesis) are cluster at the two digit SIC industry level.

	Ownership Structure	
	Long-term Ownership	Institutional Ownership
	(1)	(2)
Green Bond	−0.108	−0.130
	(0.078)	(0.022)
Firm fixed effect	X	X
SIC fixed effect	X	X
Year fixed effect	X	X
Country fixed effect	X	X
Observations	102	102
R^2	0.850	0.961
Adjusted R^2	0.388	0.839
F Statistic (df = 75; 25)	1.839**	8.090***

Note: *p<0.1; **p<0.05; ***p<0.01

Table (7.8) This table reports estimates of the differences-in-differences specification in equation 4.1. *Green bond* is dummy variable that is equal to one if the firm has issued a green bond. CO_2 *Emission* is the total CO_2 and CO_2 equivalents emission in tones divided by net sales or revenue in US dollars in million. *Renewable Energy Produced* is the total energy produced from primary renewable energy sources in gigajoules. The sample includes all the firm-year observations of the treatment and matched control films from 2012 to 2020. Standard errors (reported in parenthesis) are cluster at the two digit SIC industry level.

	Environmental Performance	
	CO2 Emissions	Renewable Energy Produced
	(1)	(2)
Green Bond	−500.432***	22,860,529***
	(112.474)	(6,109,747)
Firm fixed effect	X	X
SIC fixed effect	X	X
Year fixed effect	X	X
Country fixed effect	X	X
Observations	54	28
R^2	0.989	0.911
Adjusted R^2	0.574	0.105
Note:		*p<0.1; **p<0.05; ***p<0.01

Chapter 8

Discussion

8.1 Underlying Factors of Green Bond Effectiveness

In order to discuss and analyse whether green bonds are an effective tool in enabling a green energy transition, this study highlights the inherent characteristics of green bonds compared to vanilla bonds in chapter 2. In order to provide context, chapter 3 explains exactly what effectiveness signifies in this study: decarbonisation of the energy sector.

In its essence this discussion pivots on the argument that green bond effectiveness should be measured on its ability to fulfil its fundamental function: improve environmental performance - whether this be mitigation, adaptation or efficiency improvements in the energy sector. Therefore, it is relatively simple to conclude whether or not it is effective in terms of financing the energy transition if it can be proven that environmental performance increases post green bond issuance. However, the degree of effectiveness in enabling a green energy transition can be argued.

Critics of green bonds and their legitimacy point to the potential for greenwashing, or more specifically in the issuance of green bonds not leading to improved environmental performance. While instances of green bond issuance in China, with use of proceeds funding 'green coal', could be interpreted as muddying the definition of green, interview 1 and 2 in the appendix shine a light on why this is not the case. As both these interviews reveal, baselines and energy mix distribution define what projects can be considered eligible for green bond financing. As Patrick De Nijs and expressed, these baselines are strictly defined and therefore highly regulated. This indicates that issuing a green bond within the EU, the temptation of greenwashing is faced with formal institutional frameworks such as the EU Taxonomy regulation as well as the EU GBS which together subject

social actors in the corporate energy sector to institutional pressures. Furthermore, under the EU GBS external opinion providers such as CBI or CICERO must be verified as a capable third part, a requirement that separates the framework the ICMA GBP. These pressures act as deterrents for greenwashing and enable green bonds to better gain social legitimacy, and in extension, fertile ground from which to grow exponentially thereby financing the green energy transition effectively. As exemplified by Repsol's issuance of a green bond that caused public backlash, informal institution's in the EU act as additional institutional pressures, essentially dictating the rules of the game and enforcing regulative and normative structures. This was further exemplified by the exclusion of the bond from certain indices and third-party publicly stating misalignment with green definitions.

While insitutional theory may give an explanation to how certain corporates behave when faced with institutional pressures, the significance of the detterent-factor of these pressures could be overvalued. While not covered in this study, an analysis examining the correlation between public backlash related to an instance of green bond greenwashing and stock market price could shine a light on both causes. However, the chosen theory is very well suited to explain invisible, or rather underlying factors that affect the legitimacy of the green bond as a financing tool.

As all our interviewees indicated, green bonds are a tool to project a certain type of behaviour that is viewed as positive or sends a message to social actors. As Patrick De Nijs responded when asked whether green bonds are a means to signal shift in business strategy: "a huge part of it is still also kind of PR presentation, wanting to highlights the good work they're doing, you know, which is fair enough. I think diversification of investors is also a part of, part of the reason. Greenium, maybe not as much because it's probably offset by the reporting process and that sort of framework costs" (Appendix 10.1). Thus, as both Emrah Oztunc and Patrick De Nijs expressed, what should be considered green needs to be taken in the context of the given market. Indeed, interviewee J. was also adamant that definitions of green-ness are dependent on the maturity of development of a given country or market, here specifically referring to China and its heavy reliance on coal. Throughout all three was argued that social factors must be taken into consideration when evaluating impact and judging what is sustainable behaviour. It is therefore key to balance social considerations with the urgency to push a energy transition.

Since the discussion set out to test whether or not green bonds facilitate improved environmental performance in corporate issuers in the energy sect, a significant aspect of the analysis has been dedicated to proving that green bonds do not just talk the talk but also

walk the walk. This is meant in the sense that the green label which denotes its use of proceeds and supposed positive or mitigating impact on climate change must be deserved, and once this is fulfilled it can be concluded that in this context it is more or less effective. The most significant result from our analysis is showing the environmental performance increase post-issuance compared to vanilla bonds.

While green bonds may be an effective tool to facilitate decarbonisation in the energy sector, another perhaps more important aspect to consider is the financing gap and project gap that exists in greening the energy sector. Patrick De Nijs stated that in the EU green bonds will most likely be the most important financing tool in financing a sustainable economic transition. This, especially in the energy sector due to its transparency of information, being a high-quality and already proven financing tool, as well as an indirect effect that will now be discussed in more detail. In fact, interviewee J. stated that in the context of the broader financial markets, green bonds are part of building the infrastructure that will help finance the transition ahead. The institutions emerging as a result of green bonds are thus highly effective in enabling a more broad change in behaviour. In fact, interviewee J. stated that the green bond is acting as a catalyst for the broader market and instigates a snowball effect on sustainable financing, indubitably further enabling a green energy transition. The effectiveness of EU green bonds in enabling a transition thus goes beyond simply measuring and analysing quantitative data.

In fact, if taking the three markets of the EU, China and USA under investigation, it is clear that these green bond markets exist in a kind of symbiosis. While their differences might initially appear to undermine each other in terms of definitions of green and differing energy mix, they in fact complement each other. As pointed out by Larsen (2020), these three markets are green bond or green finance leaders each in their own way. As confirmed by interviewee J. "typically it is the US, historically it's been the US. And on a broader scale, in a global context, it is still the US that is the market leader undisputed market leader, when it comes to the complexities and abilities of the financial market. But when it comes to sustainability overall, politically, but also in the context of sustainable finance Europe is the epicenter, not the US." (See Appendix 10.2). As indicated in the interview with Emrah Oztunc, China is a pioneer in climate policy, particularly in the energy sector. Green finance development, is thus driven by these three markets. China is driving large scale climate policy which affects the entire world of sustainable finance as well as shaping global institutions, the EU is a pioneer in building formal regulations around sustainable finance and green bonds in particular thereby driving legitimacy, while the USA is a

leader in developing the green bond market and its wider acceptance in financial markets, essentially opening this market to more and more investors. All these factors influence the green bond, and in the context of this study, it is argued that these factors are largely positive in enabling a green energy transition through this financing tool, whether directly or indirectly.

8.2 Pricing Dynamics in the Primary Market

In this section, the findings of the analysis regarding green bond pricing are discussed. The analysis consisted of running a t-test to determine if there is a significant difference between the overall price of green and vanilla bonds. The result suggests that the difference in means is small in economic terms (0,091%) and statistically insignificant (p-value = 0,695). It can be concluded that the "greenness" of a corporate bond does not imply a lower return for investors, i.e., investors do not value the "green factor" when purchasing fixed income instruments.

This finding also is consistent with the industry practices. Hereafter, witnesses related to the bond market at the California State Treasurer's Office from January 2017 bring reflection from green bond market participants (Chiang, 2017). The author interviews a sample of U.S. participants in Sacramento, San Francisco, New York, Boston, and Los Angeles between February and August 2016. The key findings of green bond pricing were two: firstly, the U.S. institutional investors unanimously say they are not currently willing to sacrifice yield for green bonds. Secondly, other market participants say a green bond premium may eventually emerge as market development draws in new buyers (Chiang, 2017). The second report from August 2018 expresses other interesting considerations about green bond pricing (Chiang, 2018). It says that "with traditional bonds standardized and widely accepted ratings by a major rating agency offers an opinion on the creditworthiness of a bond, which correlates directly to pricing. Given the early stage and size of the green bond market, many rating agencies failed to weigh environmental factors with the same emphasis -or even at all when rating green bonds" (Chiang, 2018). The author suggests that in practice the green aspect of security does not affect its creditworthiness.

Other interviews were conducted by Caroline Flammer in her paper "Corporate Green Bonds". The interviewees were industry practitioners, e.g., asset management firms, a green bond research analyst at a leading financial institution, and the director of the

sustainable division of one of the world's largest banks. Those experts affirmed that they would not invest in green bonds if the returns were not competitive.

We talked to experts on the debt market to cross-examine our findings. However, at the time we were not done with the analysis, therefore we did not question the findings, but more about their opinion on the green bond premium. Henceforth, we quote a specific interview with the director of an insurance consolidating group with more than a decade of experience in derivatives solutions in multiple asset classes. We asked his opinion about whether green bond issues deserve to be rewarded with a greenium by investors. Although he does not trade green bonds directly, his answer helps us to better understand our findings.

He said: "The market will determine whether issuers deserve a greenium. Given how the market is right now, the answer is probably yes, as there is a demand for those kinds of bonds. There are a lot of funds that want to create good returns on ESG cases. So, it's pure economics demanded, supply and demand. If the demand is out there for ESG products and green bonds, then that will drive the interest rates on those down. The markets are never a question of what's fair and what's not fair. Investors decide the price at the end of the day, and you'll get the greenium if it's there and you won't if there is not."

The interviewee suggests that investors do not make investment decisions based on what is fair and what is not. She suggests that investors do not pay a higher price for the green bond factor. However, she says that many ESG funds want to create good returns from ESG cases. This implies that demand for green financial products is high. A survey (395 respondents; Respondents who have sustainable investment activities in progress or plan to) run from July to September 2020 reported that investors stated they 18 percent of their assets was invested sustainably in 2020, but this share was expected to grow up to 37 percent by 2025 (Statista, 2020).

A second question that he found worthy of discussion was: "Why should investors issue green bonds if the adjusted-for-issuing-costs price is not a premium?". Again, his reply was enlightening. He said: "Issuers may get the greenium later if they have a successful bond. Maybe, it's an investment for the future, but it can also be other things. For example, it might be that a regulator requires the company issuing green bonds to do so, therefore, the company does not have a choice. Moreover, the company might have certain governance policies that require issuing green bonds because it is perceived as the right thing to do". It

is correct to say that a green bond might experience a greenium in the secondary market. However, this thesis studies the greenium at issuance. Having the criteria of additionality (footnote Brest & Born (2013) stresses that a particular investment only has social impact if it increases the quantity or quality of the enterprise's social outcomes beyond what would otherwise have occurred (Brest & Born, 2013).) in mind, one must understand that it is alone green bond investments in the primary markets that have the potential to provide direct environmental impact. Investing in the secondary markets is merely a transaction of ownership. No increase in quantity nor quality of social outcomes occurs beyond what already has been established from the issue in the primary markets.

8.3 Firm-level performances discussion

The following section frames the multivariate OLS model outcomes through the lens of signalling theory. Throughout section 4.2, the thesis finds that the issuance of a green bond by an energy firm is a signal of environmental commitment [1]. If it is true that a green bond is a signal of environmental commitment, then there should be a positive correlation between a green bond issue and the post-issuance environmental performance of an energy company. The second empirical expectation relates to the post-issuance change in the equity ownership structure of energy firms: as a green bond is a signal of environmental commitment, and given that environmental commitment creates long-term value for institutional and long-term investors 6.3, then the percentage of shares held by such investors should increase in the year after the bond issuance [2].

Hereafter, the regressions' results are discussed for both categories of dependent variables. As the qualitative investigation has already demonstrated, green bonds deserve the green label in the context of the green energy transition, in other words, the green financial tool fulfills the goal of mobilizing private capital towards generating suitable resources to face environmental challenges.

This conclusion is also demonstrated by the empirical analysis, which indicates that the issuance of a green bond is correlated with a reduction in the CO2 emissions to revenues ratio of about 500 tons per 1 USD million revenues, a reduction by 20,8% (given the mean

[1] Flammer (2021) argues that companies can signal a sincere commitment towards a green energy transition by issuing a corporate green bond

[2] Such an empirical prediction is also confirmed by Tang & Zhang (2020), which show that institutional ownership, increases after the firm issues green bonds (Tang & Zhang, 2020)

of 2500). Moreover, the renewable energy produced, which is the total energy produced from primary renewable energy source in gigajoules, is positively correlated to the green bond issuance, and increases by 22,860,529 gigajoules in the year after the issuance of the green bond, compared to the change that non-green bond issuers experience. It represents a improvement of 5% (given the mean of 457,210,580 gigajoules). This result indicates that an improvement of firm-level environmental performance following the issuance of green bonds. Flammer (2021) experienced similar results. The author remakes that these improvements are unlikely to be directly driven by the projects that are financed by the green barn proceeds, as those are an order of magnitude smaller compared to the size of the issuer (Flammer, 2021). She continues saying that this is inconsistent with the greenwashing motive for green bonds according to which companies issuing bonds without any intention to improve their environmental footprint.

Shifting the focus of the discussion towards the ownership structure, the results do not respect the empirical expectations. In fact, by looking at the differences-in-differences regressor's coefficient, we can say that there is a negative correlation between the announcement of green bond issuance and the number of shares held by the two categories of investors 5.1 studied by this thesis. The change in percentage of shares is about –10% and –13% for long-term and institutional investors, respectively 7.7. Although the regression results are not statistically significant, we have further investigated what reasons institutional and long-term investors could have to sell equity of energy firms after the issuance of a green bond. There could be that those types of investors are selling sustainable financial instruments. For instance, the global sustainable investment agency has reported in 2018 that although institutional investors tend to dominate the financial market, interest by retail investors in sustainable and responsible investing has been steadily growing since the report began differentiating between these two investment classifications in 2012 (Global Sustainable Investment Alliance, 2018). Moreover, 10.2 shows that between 2016 and 2018 the share of institutional investors owning sustainable investing assets has decreased by 6%.

8.4 Critical Assessment of Findings & Limitations of Analysis

While the theories of institutional theory and signalling theory have been chosen to analyse green bonds and discuss their effectiveness in financing a green energy transition, these

theories do not take basic market dynamics into account when making conclusions. Ultimately green bonds are affected by all the factors that any financial product that exists in the market, meaning investor motivation and causalities are near impossible to pinpoint or collect data on. Therefore the results of the discussion and its findings of the thesis may have value specifically in the context of decarbonising the energy sector through green bonds alone, while it cannot account for the effectiveness of other financial tools available to enable and incentivise climate action.

Limitation of analysis

The phenomenon of the issuance of green bonds in the energy sector is relatively new, the time series data are therefore highly constrained. 7.1 shows that energy green bonds have mostly been issued between 2016 and 2020. Hence, the analysis of the short-term effects of +1 year post-issuance was considered to be the most appropriate. We believe that the average green project financed by green bonds is not completed and ready to deliver impact immediately. The lack of data beyond +1 year post-issuance is, therefore, a limitation to the analysis. Repeating the study when more data is available would possibly provide different results.

As already discussed in 6.4, the multiple linear regression model is influenced by omitted variable biases. Omitted variable biases occur in two situation(Stock & Watson, 2012):

1. the variable is omitted and it correlates with one of the included independent variable
2. the variable that has been omitted possesses explanatory power on the dependent variable

It is improbable that one can include and collect data for all possible variables in order not to meet these conditions.

8.5 Further research

This section presents considerations regarding different approaches that could have been undertaken to answer the research question. Studying certified green bonds would have been a better sample, as they would have told more about what to expect of green bonds in the near future. The Climate Bonds Initiative has built a fixed income database that

comprises the whole population of certified green bonds. At the moment, Copenhagen Business School has not initiated an academic collaboration with Climate Bond Initiative. A similar study to the thesis conducted on a bond population only energy green bonds certified by external reviewers like CICERO or Sustaninalytics would possibly have yielded different results.

Chapter 9

Conclusion

This thesis contributes to existing literature on corporate green bonds from a unique angle. Few studies have made use of the multidisciplinary approach adopted in this thesis, providing more in depth coverage of the studied topics. While literature investigating environmental impact of green bonds is increasingly common, the topic of investigating green bond effectiveness in the specific context of enabling a green energy transition is unique. Due to the multidisciplinary approach our study is able to contribute with data that balances qualitative findings and social factors, as well as quantitative analysis and results. By using the EU, China and the USA as case studies, a wider array of underlying factors affecting the conclusion could be taken into account. Thus, by adopting a varied research approach this study presents a holistic account of green bond environmental impact.

The thesis pivots on the argument that green bond effectiveness must be measured on its ability to fulfill its fundamental function in the context of the energy sector: decarbonisation of energy infrastructure. By looking at the pricing dynamics in the primary market, we were able to conclude that green bond do not experience a significantly different price compared to a vanilla bond from the same issuer. Therefore, it can be concluded that green bond do not foster green energy firm's achievement of a lower cost of debt when facing the debt market.

After reaching this first milestone, we could focus on other reasons for green bonds to be considered effective tools to enable the green energy transition. Framing the role of green bonds through the lens of signalling theory, the paper studied the firm-level post-issuance dynamics related to the environmental performance and ownership structure of green bond issuers, comparing those performance to the one of similar vanilla bond issuers. The changes in environmental impact of energy firms indicate that energy firm improve their

environmental performance following the issuance of green bonds as seen in section 8.3, both from a product and an operational impact's point of view as evidenced in section 6.3. It can be concluded that green bonds are, far more often than not, a legitimate signal that an energy firm will reduce adverse environmental effects of its product and an operational impacts in the period following the green bond issuance.

On the other hand, the second area of analysis, namely the trend in the equity ownership structure of energy firms, presents results that contrast the empirical hypothesis drawn from the signalling theory framework, i.e., green bonds act as a signal to investors in the hope of retaining institutional and long-term investors, who typically are characterised by a long-term investment vision. However, our findings suggest that institutional and long-term investors sell shares of energy firms that issue green bonds more than they would have done only in the case of vanilla bond issuers. Despite the surprising result of the analysis, it is not statistically significant, therefore we can neither reject or confirm the hypothesis that a green bond is a signal for retaining institutional and long-term equity investors based on this data alone.

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Chapter 10

Appendix

10.1 Appendix - Patrick De Nijs

Esben 0:00 All right, so I'm here with Patrick De Nijs from EIB. So first I'd like to start with some introductory questions. Could you tell us briefly about your background and what you do at EIB.

Patrick 0:16 So my background is in climate science so back in 2012 I was in a Master's course for carbon management, which is essentially climate science, business studies economics, and then moved to the UK civil service to the Department of Energy and Climate Change, we work there in the energy sector regulation for a while, and then move to join the EIB in the climate policy unit more specifically. first as a consultant, and then now, full time capacity, predominantly looking at yeah climate policy issues, such as, you know, move, moving to align to the EU taxonomy Paris alignments climate risk considerations, physical transition and credit risk, but also my involvement in free markets and I, in between my consultant and full time capacities at the EIB and working at the Luxembourg Stock Exchange, sustainable finance officer, were basically looking at onboarding and quality proofing green bonds and, you know, green bond frameworks, working on through new, new initiatives like green bonds market training and green indices, and all that kind of stuff. So that's it in a nutshell.

Esben 1:52 Thank you very much. I know you've touched upon the green bonds already, but can you briefly elaborate on how you work with green bonds at the EIB.

Patrick 2:03 Yeah, So, in too many cities first of all the commercials to align to the logic of the EU green bond standards, which means moving, moving to the light of the EU taxonomy, as a kind of a gradual expansion of the use of proceeds associated with climate

awareness bonds, also come as activities that are broader than what was traditionally in the CABs (climate awareness bonds). Traditionally, they are focused on renewable energy and energy efficiency. Now, we've expanded them to incorporate to electrified public transport, some research and development and innovation or AI RTI activities. And my role is essentially to ensure that some of the documentation behind it is online that's that are the move to to accomplish all these new activities, is actually aligned with the EU taxonomy. And then, furthermore, my involvement was also, as part of the technical assistance facility to market participants to help them set up their green bond frameworks, also specifically to align with the EU green bond standard / the EU taxonomy.

Esben 3:23 I have a quick question regarding the research and development that the ceibs are starting to fund. So, would one of these technologies would do consider carbon capture use or storage as one of these new avenues that the CABs might fund?

Patrick 3:40 might just at the moment is very few and far between so we don't ever really, I don't think we have any involvement in carbon capture and storage. We're kind of a future. I mean it's part of it could be funded in the future if an initiative comes forward, but there just hasn't been any.

Esben 4:02 I read something about the valley of death in funding and commercialization of technologies like that. But yeah, we might get to that later, which industries have you worked with most in terms of lending. And

Patrick 4:20 so, I mean, setting up the climate policy, you have to kind of have an umbrella view of all the separate sectors. We tend to quality, manage the data that comes through from the sector teams. So from the water teams, energy teams, etc, etc. So we kind of have a holistic view across all the sectors, more generally, but most effective I would say just based on the climate finance numbers themselves, most of it is renewable energy, energy efficiency, low carbon transport. However, you know it is purely based on volume.

Esben 5:03 Now, could you define what green financing or lending means to you, working at the EIB.

Patrick 5:12 I mean, there's a clear distinction, obviously between green finance and climate aligned, finance, green finance as such it's, I mean, for the EIB something that is aligned with the taxonomy. As per the definitions that are contained therein. It is finance that contributes substantially towards climate mitigation or resilience. Climate Resilience objectives from the climate perspective and also other environmental objectives such as

biodiversity, pollution Prevention and Control. That isn't related to GHGs and water investment for example. There are also certain environmental sustainability finance but there has to be a distinction between activities that substantially contribute to these objectives and activities that do no significant harm to these objectives. In that sense, so as part of the, the climate bank commitments. We are committed to the Paris Alliance in all of our lending means that not only the finance that directly contributes to climate objectives but also all the other finance does no harm, towards the achievement of the 1.5 degree path. This means you know investment in fossil unabated fossil fuels, for example, and also some tough decisions to be made in relation to airport, financing, normal capacity expansions, for example, but also in relation to other areas like agriculture, you know, as to be sustainable, animal farming for example. But yeah, yeah, that's what it means to me. Yeah.

Esben 7:05 When you said when you said before you mentioned you invest in efficiency, but here now you say you don't invest in fossil fuels at all. So you do make this distinction you do not invest in fossil fuels, even if it's related to energy efficiency, I mean, making these fossil fuels, more effecient

Patrick 7:27 Energy efficiency. There has to be the activity as a whole, or counterparts as such, even has to be Paris aligned, so it has to be in an activity that doesn't do harm towards the achievement of the Paris Agreement goals. So what this means in practice, we wouldn't finance refurbishment of gas pipelines, for example. For these reasons, yeah.

Esben 7:57 Related to this question as well. Now referring a bit to China, because of their green coal green bond issuances in the past, but does the EU taxonomy definition of climate action, and environmental sustainability vary compared to definition seen in China or the US.

Patrick 8:17 Yeah, I mean, we the EIB has had an initial surge with China, and their definition of their sort of climate finance definitions as such. However, China has gone a bit beyond that to also include other areas which, you know, we wouldn't consider to be climate finance I mean the most prominent of all the clean coal aspects. But, so they are different baselines as to you know, what does mean green finance, obviously, there are different definitions. This is fundamentally, If you look at the ICMA green bond principles for example, they're intentionally very light on the definitional sides right, just so that a set of lowest common denominator in terms of procedures can be found but then you know what the actual definitions are, they kind of left towards suit to the actual issuer

and and or in the sort of country or region, as to what it is because there are different baselines for different economies, for the EIB it's very easy. In that sense, because most of our, 90% of lending is in the EU, so we have a very defined baseline. Very much regulated. So, it is easier in that sense, so but other MDBs which are more active in developing countries, for example, they probably focusing. They probably have a very difficult time to find these kind of common baselines because yeah, putting in place a top of state of the arts, you know, technology in a developing country it's very unrealistic, and at the same time, putting, you know, a wastewater treatment plants which, you know, would replace for example, Much more carbon intensive ways of dealing with wastewater. In, in Mozambique, would be a very would be considered climate action. However, the same as what you have planned in Portugal wouldn't be because of different baselines as such.

Esben 10:26 well definitely well I'll touch upon that a bit later. Also regarding baselines, but I've been looking at the energy mix of different regions, and how this might affect basically what the definition of green is depending on your baseline. So, another question that a bit on another topic is a while, while you work on the lending side. What do you think is the main motivation for green bond issuance, for, for an energy sector company.

Patrick 11:03 Well, I think that's a huge part of it is still also kind of PR presentation, wanting to highlights the good work they're doing, you know, which is fair enough. I think diversification of investors is also a part of, part of the reason. Greenium, maybe not as much because it's probably offset by the reporting process and that sort of framework costs and all that kind of stuff. It is I think also a trend that is those being follows in terms of in finance, but you know the corporation's want to be seen to be pulling their weight they also want to be seen to be going in the right direction. And they're using green finance vehicles to do that, but also the fact that it is, if you are creating a new bond it tends to be oversubscribed that tends to be, you know green bonds are being sold very quickly. And that's also an advantage.

Esben 12:07 So would you say it's essentially a signalling device for for corporates to issue a green bond.

Patrick 12:16 Yeah, I think so. Mainly.

Esben 12:19 Yeah. So the benefits and what are the main benefits and drawbacks for companies to that companies would experience post issuance of green bonds?

Patrick 12:34 think it would be, I mean, we'll have to look at you know who are the main

sort of investors for these kinds of identity, institutional investors who increasingly now have, maybe, are looking at fiduciary duty in a different way. Where now they increasingly have to look at kind of environmental performance of the ESG considerations as they call them, and therefore, this is the client need, and, and the best companies are catering to that needs, as well, by setting up these, these green bonds. Well, I think the key considerations perhaps also are coming for regulatory developments like the non-financial reporting directive, where institutional investors have perhaps more of a need for sort of information flow, in terms of what exactly the person is used for, and their reporting framework is under the green bonds, it's actually a very useful way of tracking these, these investments

Esben 13:49 from that now we're gonna go a bit more into the energy, energy sector and also what you mentioned before like some of the metrics so you mentioned GHGs. And now you just mentioned, some non financial reporting. Here I'm thinking about CO2 reporting. So, in the context of the energy sector, could you define what climate action, environmental sustainability means to you in the context of the overall energy sector.

Patrick 14:23 mainly, mainlyit's about decarbonisation and energy savings. So, energy efficiency, both on the consumer and consumer ends, not only the production and produce consumer and so climate finance is particularly, you know, anything that that aids the integration of renewables into the, into the energy grid. It's about utilizing previously non used forms of energy. For example, in terms of bioenergy. Trying to, to expand bio energy portfolio. It's about decarbonization of infrastructure you know in terms of switching gear, you know usage of non GHG sensitive gases and switching gear infrastructure for example, it's about turning away from fossil fuels, fundamentally, making a switch but yet it is very much also the chicken and egg situation with the, with the networks, some networks have to be able to deal with that. Interconnectors is another big area there as well. Relative, basically at the end in the creation of the European energy market and outside the EU ETS for playing an increasing role here as well, to drive that switch to renewables on the energy efficiency side a huge problem still remains in terms of the renovation of buildings, existing building stock to actually be more energy efficient. In that sense, but there are some sort of informational problems still because, I mean, obviously, we'll be talking about millions of households, for example, alone, is sharing different building envelopes and you know they have to be reached it is extremely difficult to to renovate existing building stock in that sort of holistic way. And I think that that is a key issue that needs to be sort of addressed as best as possible,

Esben 16:32 it is definitely a very daunting task, but like us, you believe green bonds can change some of that right?

Patrick 16:43 Yeah, I think so, yeah, they're part of that part of the solution I think that's ultimately that just, yeah, just one part of the arsenal of tools that you can employ. Yeah.

Esben 16:59 I'm not entirely sure but did you mention carbon intensity as one of the things you look at.

Patrick 17:06 Yeah, yeah, for example, more in terms of the production of goods, such usually what we're doing is we're trying to lower the carbon intensity of anything that is produced without at the same time, leading to sort of capacity expansion. So, the idea is, if we label something as climate finance in the manufacturing sector, then the intensity of a produced good should not be the lowering of the intensity of a produce good should not be upset by the sort of total emissions of the plants right. If you have investing something we can call it climate finance, actually, total emissions are higher than the previous plants right. So so that's something that isn't good.

Esben 17:54 Do you (EIB) differentiate between a high performer, like a low carbon emitter. So a company that seeks to lend who is low carbon?

Patrick 18:16 Yeah, so basically they will differentiate between a low carbon sort of Counterparty and a high carbon.

Esben 18:21 Does it change any considerations you make when evaluating eligibility. In a sense

Patrick 18:28 Yeah in case of the Paris alignment of Counterparty framework, which looks at the overall strategy of the counterparty to align to the Paris Agreement. So, do they have a strategy in place to, you know, go to align all of the operations to a 1.5 degree pathway. If not, can we help them put this in place. If not, then we just don't do business with them.

Esben 18:57 situation. So you make an effort of making sure that it's that there's a big component of additionality and not just business as usual or.

Patrick 19:10 Exactly, yeah, I mean, business as as usual, will be the case if they have a strategy in place to align with the Paris alignment to the Paris agreement but not if they don't,

Esben 19:21 yeah, of course, yeah. Now, what is the biggest challenge or the main challenge facing the energy sector in the EU, in terms of achieving Paris climate goals.

Patrick 19:35 It's very much different compared to member states, obviously, I think the some, I mean, I say this without being an actual sort of energy sector engineer and or economists, but in my experience, what do you know for example, it's just Germany's facing, probably, maybe, network related. The issues that countries like like Poland experience are perhaps more of a social nature where, you know, a very part of their considerations and kind of a just transition for all one as well, right, if we can our completely adjusts their energy system to renewables, what happens to the coal generating regions and people who rely on that income. What can they do, you know, are they doing to poverty, yes. And these are all the 2022 2030, is the critical decade of turning the flagship around, environmentally, good way but also in a socially good way because there's no point in doing this, and generating social unrest decision extended completely basically politically will lead towards the total achievement of climate targets right so it has to be that we, we can't forget the human sort of human well being at the center of this discussion as well, because ultimately we are, you know, the EU needs to be cohesive that social disturbances in that sense, don't help towards the achievement of the goal. Yeah, sure.

Esben 21:24 Now, we highlighted the funding gap as being one of the main challenges, but like you said, it is about upgrading the whole infrastructure, but the cost like a social aspect needs to be considered as well.

Patrick 21:43 Yeah, I think, that's not what it is, there's a funding gap, but there's also a project gap right and they aren't for green finance tends to be significantly oversubscribed, both on itself according to in the capital markets, but also in the project, so the finance market as well. There the key issue is there aren't that many projects, or more projects to finance to help that drive. And then the question is why is that, yeah. So, we have assets that are already being committed to, you know that haven't reached the end of life and there isn't, perhaps, public enough public funding to write off significant liabilities that are still outstanding on these assets. But for an institution like us, there's as much of a project gap with that relates to the funding gap. So there's

Esben 22:41 an issue with avoiding stranded assets that are already. Yeah, so there's the discussion of divestment versus engagement with with these carbon intensive emitters.

Patrick 22:59 Yeah, if you just think back to that means, you know, economic levers that

you call like the EU ETS, for example, increasing co2 Price increasing in value is good news to make that switch more economical.

Esben 23:15 Yeah. So are the challenges that we, we just spoke about, are they constant across regional or national energy sectors such as China and the US, as compared to the EU. So here we're looking now I'm referring to the divergent energy mixes.

Patrick 23:42 I mean, there's a there's a degree of history at play here as well, and then sort of political affiliation as well. So I mean in the US, traditionally has been very fossil fuel pro past administrations, which means that there's more infrastructure being committed to in the past that relates to fossil fuels, perhaps as which hasn't been made as early as and the EU, two degrees as is obviously the case in the EU as well but you know increasingly over the last couple of years that the switch to renewables has obviously been, you know, accelerated and the China and the big problem has been the availability of energy sources, I think the main reason for the expansion to coal was the availability of coal, and the massive economic expansion that needed energy. But I think now increasingly there are also signs that in China that the massive investments in renewables are being made to, to, to clean up the energy mix, but also to generate capacity. However, this doesn't mean that you know the coal plants are being made redundant because that energy is still needed for the economic expansion so there's this one issue of priorities and political priorities that drive, also what they call green finance, i.e. green coal

Esben 25:06 it again it's a social aspect of all those millions and millions of people that are dependent on jobs within coal and you can't just switch from one day on the other. Now I had a question about like you in the you EIB climate bank roadmap. There's a section about a just transition for all. My question was, in what ways does the EIB take responsibility for creating sufficient demand for green bonds that finance, developing countries low carbon energy investments.

Patrick 25:52 I think the two issues that have kind of tangentially related I think the thing is, for the EIB generating demand for for financial products isn't perhaps as much of a as much of a objective, I think the key objective for us is improving, trying to improve the quality of those instruments, rather than the quantity. The EU commission has proposed, well the technical expertise that was instructed by the Commission has proposed a Eu Green Bond Standard, which is based on the taxonomy, and we are now engaging with counterparties to, to try to adopt this new EU green bond standard. But, as well as the TA gets companies to, to actually draw up their own green bond frameworks, not

necessarily on the basis of the EU green bond standard, but by helping them assess their portfolios, you know what is green and so on. And therefore, the idea is that more green financing instruments are being generated, which can then be the kind of alleviating the existing high demand for green bonds,

Esben 27:11 but will other countries' green bond standards build on the EU's green bond standards or will they have to take into account their own. Let's say energy mixes or baseline as we refer to it earlier?

Patrick 27:29 international standards are comparable to that international capital markets, associations, bond principles, it just builds a couple of additional layers of quality standards and top EU alignment to the EU taxonomy but also kind of unregulated role for the, for for external opinion providers. Under the EU GBS an external opinion provided needs to be verified stamped as being able and capable of providing its opinion.

Esben 28:10 now a bit more about the EIB is lending and more on green bonds in general. So for cooperation from their point of view, in which case would a, an EIB loan, be more convenient than issuing their own green bond for financing, various activities.

Patrick 28:32 I've seen that, hopefully you'll also be having interview with my colleagues and in the finance department, hopefully hopefully be able to give you a bit of a better idea than me but how I understand it, I mean, I'm not an economist, so it does really delve into, you know, funding options and you know what is what is more attractive than the other. I think yeah be project finance is a kind of is a loan, which you know can perhaps be more secure as the fundamentals of that finance that is being provided is just about a lot clearer, in the long term, than perhaps tapping into the capital markets where you're more of a more at a whim of you know whatever the capital markets are doing currently at that time. However, I think also in terms of reporting, it's probably going to be less difficult over time, after signing the loan, and to to engage with the EIB because the our bilateral relationship versus having to, you know, provide public documentation, via the green, green bond reporting is a lot more costly. Having said that, the initial appraisal, that the EIB does and the project is very sort of time consuming, perhaps infuriating infuriatingly so. So, tapping into the capital markets if you have an existing one framework is probably a lot easier to do, and free from having in terms of having to put in the work upfront, but after, after the initial agreement I think in terms of workload, it should be easier,

Esben 30:29 so it is easier for larger companies to lend from the EIB, as opposed to small

and medium.

Patrick 30:36 I cannot, I cannot possibly say unfortunately I do not know exactly what the mechanics are behind it, I think so. I think so.

Esben 30:45 we'll ask your. Okay, so I'll try and one last question slightly related to finance but what benefits do green bonds have over other green finance products, such as a green fund fund in in driving climate action, and vice versa. So, here we're looking at the different risk appetite or the different risk tolerance of investors, the liquidity and perhaps also the investment horizon of investors.

Patrick 31:29 It's an interesting question, but it really depends on the, you know, funds strategy for example, you know, are we looking at innovation. You know, are we looking at providing liquidity to startups that that perhaps developing the technologies and processes that can drive the decarbonisation in their respective sectors. That is perhaps something that a green bond won't be able to, to achieve. So a very targeted funds, it's going to be very effective with it's driving the sort of innovation, to small to medium sized enterprises, for example, or even mid caps. The thing is, for green bonds, they're going to be the capital markets is usually unreachable for these smaller companies. So, you're then looking at some form of aggregator that promotes their needs and then taps into the capital markets, in terms of making machine rebond, which is extremely rare. If not, like, I don't think has really ever happened before, because it's very difficult to do. So I think we need looking at different objectives, you know, the green bond market is probably going to be more interesting for, for the huge corporates, you know, looking to to tap in to the capital market because they used to issue bonds anyway, looking for funds and funds that we don't usually be utilized more, you know, for financing small to medium sized enterprises. And also we're looking at you know what are what are the actors actually do. Funds are usually the asset managers that are dealing with that, and then the bonds that usually the corporates that use it. I think they're the interesting part is would be perhaps the institutional investors that, that, you know, invest both funds and the bonds, the client side, who really much rely on information on, you know, the sort of performance climate performance of the underlying activities is here and this is really the massive, the massive building sites, because there really is very little information currently, particularly on small, medium sized enterprises and mid caps and here is a bit of a Wild West in terms of ESG rating, and all that stuff, which is very transparent to a lot of the large asset managers cycle wire what basis does ESG ratings made, you know what methods are following methodologies and so on. And a lot of them have their own methodologies in

place to, to, to assess and assess the use of ESG rating behind it but instruments like green bonds, really a pioneer to transparency of climate information, and this is still to beach dead that still needs to trickle through to the fund business.

Esben 34:39 So, a, an advantage of a green bond as opposed to an ESG fund would be that a green bond is much more standardized. And you know what you're getting for your book,

Patrick 34:53 essentially, yeah, I mean, usually it already has underlying investments right that the entity that issued the bond usually already has a portfolio of stuff they want to spend that money on. In terms of funds, it's not always the case, it's usually then forward looking, they say look this is my strategy. I want to invest in X, Y, Z, but I don't actually have these investments yet. This is my team you know that we're very experienced. To do this, please trust us, give us your money. Right. So it's very different in that sense it's more forward looking, rather than than bonds which is really more looking at the existing assets, or maybe the upcoming expenditures which are very fond the horizon.

Esben 35:45 How do you see the green bond market developing next to the ESG market in the coming decades?

Patrick 35:56 how I view it. I see it growing. I think there'll be perhaps increasing level of standardization in terms of what we consider to be green, at least in the EU. There'll be more, I guess more standardized reporting on the allocations and the impact achieved by the bonds, for the ESG market and how the ratings and so on but I really wish to be the cases there to be a bit more transparency of, you know, how, how these, these ratings are actually generated. On what basis. Hopefully, also in terms of referencing the EU taxonomy, in terms of, you know what they consider to be green. As such, my biggest pet peeve with ESG for example is that a lot of them are very heavy on the G and light on the E and S.

Esben 36:59 Yeah.

Patrick 37:01 Which, you know, company good company has incredible governance, but it doesn't mean that they're very well performing in terms of the E and S so bundling it all into an ESG rating actually very, it's, it's fairly meaningless, that sort of performance two to five objectives I

Esben 37:20 have spent my time with ESG reports and I agree with you on that one.

Patrick 37:25 I think a lot of active managers come to that same realization when looking at these numbers and they think you know what this is mean, you know like, how, how well we perform in terms of climates. So it's not often actually sort of intentional obscure in both, you know how well they achieve in terms of climate it's more, they don't really know because there isn't very much information in the wider market in terms of where the, sort of, you know, how well performing the individual sort of companies are that receive this funding, in terms of climate so climate related reporting is really essential behind it all, and I really hope that you know the non financial reporting directive the US economy, your EU green bond standard and all that kind of create a bit of momentum in terms of, and also tcmd bit of good momentum in terms of the availability of federated information on which basis, then better ratings can be can be can be generated. So therefore then, my hope is that in the future. As a Climate Fund and ESG fund businesses, a lot more a lot as a solid more solid foundation in definitional terms.

Esben 38:47 For now, this is sort of our research question, but we thought we might run it by you just to see. Do you think green bonds as a financing tool mobilizing private capital will be the most important tool in financing a green energy transition. And if not, which other financing tools could be your favorite alternative, or most effective.

Patrick 39:21 It's a very good question. A) I think it's probably. Yeah, it's probably fair to say that they're going to be most important, because, because of their, I mean, we as the EIB have a very good opinion of green bonds right considering that we have issued the first one, kind of dissolved we were proud of the fact that you know yeah we generated all this, but probably would have come anyway, that's, I think the whole sort of transparency of information and all at the end of the day the green bonds really pioneered on that alone bootable drive more quality, and other forms of financing is sort of indirectly, confirming your research question that it is probably most important not terms of generating the volume but also the softer, sort of, kind of information transparency angle. On in terms of the energy business, I think so, because it's easiest issue green bonds in the energy space, as well. Usually, I mean renewable energy is the easiest form of assets to define and in terms of their contribution towards climate mitigation. So, I think, I think, Yeah, especially in the energy sector. That will be right, I think, a good contender, I guess, to consider new research would probably also be sustainability link bonds, where, which kind of drive Paris alignment of the sort of institution as a whole, not only because this is the key of the difference between both of them are, and obviously the sustainability-linked bonds finance in general corporate purposes, so everything the company does versus the green

bonds which are very much at the whim of the actual green assets that are underlying the company can't really source the green renewables, maybe because they are in the power generating business and not in the network business and they don't have networks to support the power generation, Then, they can't do much. So, what they can do is they can issue sustainability-link bond, they can't and say look we want to get there and you know we can do this by doing X, Y, Z, in terms of our future strategy but then until then we wait on the sort of infrastructure that can support our business in terms of lowering the GHG footprint. So, yeah, I think, I think this is my rambling answer to you.

Part two.

Esben 0:01 No no, it is very useful information. You touched upon what motivates different players in the energy sector? Now, now utilities are usually a natural monopoly, right. But when they issue green bonds, what is their motivation as opposed to a fossil fuel cooperation or renewable energy?

Patrick 0:43 I think often it's about the slight differences between bond markets with a vanilla bond market with the fact that you can diversify your investor base, and you can, it's a form of risk management, essentially. And you can be sure that they'll be fields at the best possible financial outcome for yourself, compared to the two to open up vanilla just by the fact that green bonds usually always oversubscribed three times, I think, and I think those are probably the two biggest reasons. I usually like to pull out, its not in the energy business, but it's very comparable, is the another utility and British Transport for London. Issued vanilla bonds, they do it by financing their, their their public transport, which is green finance, they had never issued green bonds up until the point at which that is and the reason they did it was to diversify their investor base because they figured out usually there they won't only have UK based investors, then they want to reach out to international investors as well. So I think utilities in the energy business and probably very similar.

Esben 2:16 Now we'll move on to one of the last topics regarding the alignment of EIB and EU plans. How far are the current eligibility criteria from the one that you expect to develop in the future?

Patrick 2:38 So from the 24th, from the beginning of this year, we sort of officially aligned to the EU Taxonomy, that is that substantial contribution element of it. There is obviously also do not significant harm part of it. So if you're financing a rail line, you cant do

significant harm to for example, climate adaptation, by generating very steep... generating flood zones, for example, you know, that aspect of DNSH is in place we'll (EIB) do that by 2022 by reviewing environmental and social standards, so the conditions that our counterparties to fulfill environmental impact assessments and social impact assessments and blah, blah, blah. All that documentation needs to be in place to support the climate finance allocation, along with the EU taxonomy. So by next year, we expect to be in a position that we are the conditions are in place that will last us until the next version of the taxonomy.

Would I be right in saying that currently, environmental impact assessment will be biased towards looking at carbon and GHG related KPIs and metrics as opposed to ecological.

No, it's very much based on EU regulation and you know, what needs to be provided? I mean, it will separate check in terms of the climate performance Paris alignment and for example, this is kind of different as a separate to the to the EIA (environmental impact assessment) various, regulated, defined process. But yeah, we we have our due diligence in place to to ensure that there aren't any sort of adverse climate impacts. For example, a separate check on capacity of counterparties. We have climate credit risk check as well, where we ensure that accounting banking itself with financial risk of the impacts of climate change. There's also physical risk screening tool that we have in place where automatically for us to figure out you know, the where's project located you know what are the climate pressures, and has the counterparty adapted to these pressures? You know, like, for example, if the infrastructure is being built, is it aligned to a climate that is prevalent in 20 years or will it be washed away. These checks are separate to the EIA but they still take place.

So we did we did discuss this a little bit earlier but then the EIB wants to align not only with the EU Taxonomy but also wants The EU green bond standard to sort of help other standards to move towards each other. What is needed for an alignment international?

Well what we have been part of the common principles of climate mitigation group, that's that's where all the research As essentially read on a common set of definitions to what what is climate finance for In relation to development finance. And we use that that is really also aligned to that. But on top of that, I realize also that For your taxonomy, but the EU taxonomy still has gaps Doesn't technically relate to anything outside of the EU. For example in explain for example what is climate finance when it comes to financing telecommunications very well So we have our own set of definitions which are based on

these common principles. Over time, I would expect the world develops. become engaged and also other segments. Institutions become engaged. That will Use a set of common principles, Which are continuously also informed by other developments. Each year, every two years there are some updates about the Institute. To these definitions, which are formed by EU taxonomy, and I think most of us have Are we clearly feeding the most stringent definitions which apparently there's taxonomy probably raily lax rule. institution in Australia, for example. We also highlight their good work they can say, you know, we have aligned to the EU taxonomy definitions. It's got a bit of lighthouse effects

Esben 8:06 yeah, yeah I was about to say that EU regulations have shown in the past that they can affect global regulations for example, the PFCs banning on pfcs that lead to a global ban on the whole. So I think

Patrick 8:18 That is certainly in the ambition to achieve that with the EU taxonomy.

bringing the world in line with EU green bond standard Obviously we'll have a lot of challenges and hurdles that you need that the world needs to overcome. But do you think the EU would be able to influence The big main players like the US or China, Here I specifically referring to China's comprehensive green bonds endorsed project category that includes "green coal". Does the EU have the power, essentially?

Well looking at the past Performance in climate negotiations in the COP for example, I would say not really because each nation is kind of sovereign. They can decide upon themselves and use the arguments that suit them most. I think the key question will be how much will the EU enforce their policy on imports. For example That they're currently discussing a Carbon, It was called the border adjustments mechanism or something. That applies to ETS. So You know, it's Carbon Tax is a tax on imports from the prevalent EU ETS price so that you normally importing steel you Not undercutting local eu producers. So that being said, leverage, you know in terms of punishing or adjusting you know creating common level playing field. We address carbon intensive forms productions, not so much in the energy business but more manufacturing?

Esben 10:31 Yeah, yeah. Well, we could. I'll stick to the plan and we have three questions. So we might just managed to keep it under an hour. One last question regarding the The shades of green Like the pboc the People's Bank of China's is that is sort of, would you be able to characterise that as greenwashing when they sell a green bond on the Luxembourg Stock exchange that actually funds green Coal in China. But for The average investor

they might not actually be aware of this or?

Patrick 11:11 Green bonds are all about transparency right? and we touched on baselines in the beginning of our disucussion. The key to the green bond market into sort of justification behins green bonds and why that's okay to list PBOC Green bonds on the Luxembourg stock exchange is because they've been clear See, you know what standards are being aligned to, its not green washing as such If they are clear that, you know, this could include green coal. See it's green washing to an extent in that they call it a green. If you are an investor in that green bonds you are aware what That means. You know, the documentation behind that green bond and you know That's what they are calling green It's actually green coal as well. So investors can figure that one out. Yep. That's the whole sort of transparency angle. There's also elements of trying to, to walk in the right direction it's not all about 100% green or nothing. A bit of gray in between is also important and better than nothing yeah. I think that that is the position Luxembourg stock exchange has had and the That's why I think also they're separated, clearly the Chinese green bonds from the other green bonds just to make that distinction a bit clearer but it is a difficult question. I think it's a baseline question.

Esben 12:55 It has to be taken in the context of a lot externalities so now to learn last three questions. Now concerning the demand of green bonds, the trend of growth and demand of green bonds upwards and upwards, but do you think Increased regulation and the connected transaction costs, so environmental impact reporting etc etc. With enough regulation will it reach a point where the benefits you gain From issuing the green bond are suddenly outweighed by the costs

Patrick 13:46 depends on what the actual eventual regulations are on conventional finance as well. I mean institutions may want to To capitalise on the fact that they've already had to invest on infrastructure for non financial reporting and conventional finance This may be the position to easily identify The part of their portfolio that contributes towards e.g. climate objectives and then then they may be in a posititon to more easily issue green bonds. It's It's a difficult question. I think It really relates to what the actual regulations, maybe so was quite hypothetical but I think it could actually lead towards the issuance of more green bonds rather than fewer.

Esben 14:43 Now to the final question. I think you pretty much already answered the second-last question. Great. Are green bonds, enough to close the financing gap that we mentioned before?

Patrick 15:01 They are not enough because, for example, they're they're only looking at What mainly looking at capex investments or big infrastructure investments There are tools that are employed by big corporations that are big enough to tap into the Capital Markets. There are other forms of finance that are necessary sto switch to climate innovation in small to medium sized enterprises. Mid caps are very important economic players in Europe. Their funds essential, essential role to support that. But also the loan market you know, of course what the EIB are doing to for example, provide liquidity to to financial institutions which then lend their finance to smaller entities. You know the EIB is too big to do facilitate that direct lending to smaller enterprises. It is key to be able to track the kind of information between them and we've got a system in place to do that. Beyond the EIB financial institutions need to be better to track their investments to know what and which company can be considered green and one can't. The lending business is key as well. Capital markets is just really a part of this solution.

Esben 16:34 Okay. Well That was it. Those were all the questions.

Patrick 16:43 We managed it all in an hour even though I am rambling sometimes.

Esben 16:49 No no, it was all useful. Well, we want to thank you again. It was a pleasure talking with you.

Patrick 17:01 Yeah absolutely, I wish you all the best, let me know if I can be of any help to clarify anything.

Esben 17:01 Likewise, Alright, happy to hear that. Bye thank you.

10.1.1 Semi-structured Interview Questions

Interview outline

Patrick De Nijs

Introductory questions

Could you tell us briefly about your background and what you do at EIB?

Briefly, can you elaborate on how you work with Green bonds?

In your opinion, what is the best and worst characteristic of green bonds?

Which industries have you worked with most?

Could you define what 'green' financing/lending means to you working at the EIB?

Does this definition change when looking at the energy sector?

Does the EU taxonomy definition of climate action and environmental sustainability vary compared to definitions seen in China or the US?

While you work on the lending side, what do you think the main motivation is for a green bond issuance by an energy sector company?

What benefits and drawbacks do such companies experience post-issuance?

Energy sector Decarbonisation

Could you define what climate action and environmental sustainability means to you in the context of the overall energy sector?

Does this definition change when viewed from the perspective of a carbon intensive green bond issuer vs. a low-carbon issuer in the energy sector? Here I refer to shades of green of a given project.

What is the biggest challenge facing the energy sector in the EU in terms of achieving Paris climate goals?

We found various estimates on the financing gap that stands in the way of greening the energy sector: An estimated total $110tn gap stands in the way of greening global energy infrastructure by 2050, averaging around $305bn every year. Of this investment gap, 20% or $22.5tn alone must be dedicated towards greenfield renewable power generation capacity, resulting in an approximate investment of $662bn p.a. However, more recent estimates put this number at $800bn p.a. (IRENA, 2020).

Are challenges constant across national/regional energy sectors such as China USA vs. EU? We frame this question in the context of divergent energy mixes.

Looking at the role of EIB in the world and referring to the goal of ensuring a just transition for all; in what ways does the EIB take responsibility for creating sufficient demand for green bonds that finance developing country low-carbon energy investments?

Green Bonds Green Finance

For a corporation, in which case would an EIB loan be more convenient than issuing a green bond for financing?

In theory, how does EIB agree on the cost of debt for the borrowing company?

What benefits do green bonds have over other green finance products such as green funds in driving climate action and vice versa?

Differing risk appetite? Liquidity? Investment horizon?

How effective is invested capital in furthering the green energy transition? To what degree does this vary in these two types of financial vehicles?

Green Bond Energy Market

What is the biggest advantage green bonds have over other financial instruments in financing green energy projects? (green loan, guarantees)

What is the main disadvantage? As a financial product as well as a means for corporations to finance decarbonisation in the energy sector?

How do you see the global green bond market developing in the coming decades?

Do you think green bonds, as a financing tool mobilizing private capital, will play the most important role in financing a green energy transition?

If not, which financing tool could it be (both private and public)?

Why not CEF Debt Instrument? (In the context of public grant issued by EIB, I read that CEF Debt Instrument supposedly enhances Europe's energy security while enabling wider use of renewables. In addition to grant, CEF offers guarantees and project bonds, levering the use of EU budget, to attract further funding from the private sector and other public sector actors. CINEA forecasts that the upgrading of existing, and development of new energy transmission infrastructures of European importance will require investments of about €140 billion in electricity and at least €70 billion in gas.)

Is the overall cost of debt of a EIB green loan lower than the one of a corporate green bond for an energy company that wants to fund a green project? This question is similar to the one I have asked before; my actual interest is whether the same answer holds true for energy companies.

In your opinion, what kind of energy-related companies benefit the most from accessing green loans? Primary or secondary energy companies, public or private energy companies. Highly risky projects or more low risk projects

Could you elaborate on what motivates different industries to engage in the green bond market? e.g. utilities (grid providers) vs. Fossil fuel vs. Renewable energy

Which metrics/KPIs are used most often when evaluating eligibility of projects in the energy sector? - Does a threshold exist?

Among the difference strategies/funds/pool to finance energy transition, which one do you think will have the most impact result soon?

Alignment of the EIB with EU plans

From "EIB CB road map: Accelerating the transition towards green finance" (pag 20)

"Consistent EU taxonomy, the EIB is now developing its initial environmental sustainability eligibility criteria and finetuning its climate action eligibility criteria to align the classification of its lending activities. In turn, the EIB will reflect such alignment to the capital markets via progressive extension of CAB and SAB eligibilities, and – as set out in Chapter 5 – the development of the required due diligence procedures to ensure compliance with the EU Taxonomy requirements of SC (substantial contribution), DNSH (do no significant harm) to environmental objectives, and MSS (minimum social safeguard) (as far as necessary)."

How far are the current eligibility criteria from the one that you expect to develop?

The EIB aims for an Alignment of principles in green bonds – What is needed for this to happen?

Regulations?

What about internationally?

What will the benefits and implications be for the broader green bond market?

How does the EU GBS fit in? Does it change anything for global players/issuers in USA and China?

Shades of green: Does the PBOC comprehensive green bonds endorsed project catalogue

(China) pose a threat to the legitimacy of the definition of green when considering green bonds have been issued in order to fund "clean coal" projects in China?

Is this greenwashing?

Further discussion: Regulation

Will more regulations alongside the EU GBS/EU Taxonomy slow the growth in demand for green bonds?

Quantitative and qualitative environmental impact reporting goes beyond the (simple) requirements in ICMAs GBP; thus, issuers must decide how to balance the cost of preparing a comprehensive impact report against the value it then brings to investors and other stakeholders. And in the extensions, the value that stronger relations with your investors may bring. link

Do you think the increase in transaction costs may outweigh the benefits of a green bond issuance?

Does the market reward long-terminism in corporate strategy of issuers sufficiently to negate higher transaction costs?

Does this affect investor appetite or confidence related to green bonds?

Driving the demand for green bonds to close the green transition financing gap:

How does EIB Group help meet green ambitions within the energy sector of the EU through financial products? Here we point to a quote from the EIB Climate Bank Roadmap

"delivery on the mandates will be contingent to (i) market demand for climate and environmental sustainability financing, as the EIB will only be able to support these activities as long as new policies and regulations set the enabling environment and market actors embrace the low-carbon transition; and (ii) alignment of principles and standards across the financial sector, as well as other multilateral development partners and implementing partners."

Are green bonds enough to close the financing gap? Investment priorities of the EIB

Is it necessary to expand the list of eligible projects to include higher risk projects such as CCUS technology?

Innovation finance tools similar to InnovFin EDP or CEF Future Mobility for clean mobility solutions (or their successors under InvestEU) will likely remain key to support projects in earlier stages of maturity and presenting higher risk profiles. Such tools address innovative, first-of-a-kind green technologies which face a "valley of death" on the way from demonstration to commercialisation.

Starting June 2020, per the EU Taxonomy Regulation, the proceeds from CABs can be used to support other areas of our work to fight climate change, including research, development and deployment of innovative low-carbon technologies, electric rail infrastructure and rolling stock, and electric buses.

Does this blur what CAB are? Does it redefine 'green'?

Equity, funds and other innovative financial products can support increased levels of finance related to climate action and environmental sustainability. Greater use of investment in equity funds or subordinated debt/quasi-equity (as well as first-loss provisions) can leverage greater private sector capital and improve the bankability of higher-risk projects.

10.2 Appendix - Anonymous Interview J.

Edoardo 0:00 Hi, J., or J.

J. 0:00 whichever you prefer.

Edoardo 0:01 And nice to meet you, I am Eduardo and I'm a master student at CBS, and i'll conduct the interview. But just to introduce you to our research, and make the questions that we prefer then the first one will be. If you would like to briefly introduce your experience with the fixed income market. And if you want to be specific about the green bonds or just say what you think is most relevant for for this.

J. 0:15 Could I ask you to, to, to just outline the case, sort of the context of that because there was sort of my experience with the Green bond, with the fixed income market dates back 10 years so

Edoardo 0:20 perhaps I could introduce our research.

J. 0:21 Yes if you could just sort of recap into the context

Edoardo 0:27 The research question, starting from there. We want to investigate if green bonds are the most effective financial tool for a green energy transition. So basically, what, what we have been doing is defining an investment universe. So we said, What is a sustainable investment. So the sustainable investor is someone that prefers to invest in the credit markets, because they are risk averse, and they prefer to invest in sustainable firms. So he values, sustainable projects, in a way that he is willing to give up some returns in exchange of the social benefits that this green project is creating, therefore, from here we say, Okay, so this sustainable investor will be able to pay a greenium. So we investigate another set of green bonds, and we compare those to vanilla bonds and investigate whether there is a greenium. We also investigate the performance of a company after the issuance of a green bond. So we're making conducting an event study on whether a green issue is improving your stock returns after the issuance of a green bond. We are also, and the whole sense of, of this is investigating whether the issuance of a green bond is a signal from company to say to investor to, like, showcase to investor that they are shifting their business strategy towards something that is more eco friendly basically. We also want to investigates the greenwashing threat that green bonds encounter.

J. 3:21 so this is a master thesis or just to remind me of the scope you have to work with

Edoardo 3:26 this scope is a master thesis. Yeah, so we evaluate performance afterwards, by looking at the environmental performance. So CO2 emissions. And so, like, looking at their structure independence of ownership equity ownership in the data analysis.

J. 3:53 I mean, as an initial comment on some of the questions you have. It sounds to me you have a very broad research question, which I think can get you into difficulties getting to the point of your analysis and drawing a conclusion from that. So I just want to mention that I think there's a could be a risk for that because you're covering a lot of topics and that. Greenwashing in itself is a different question etc. etc. I will also maybe address your initial statement around the definition of a sustainable investor, I might have misunderstood. You said that a characteristic of a sustainable investment is that they are risk averse, and hence the credit market on the fixed income market is more appropriate. I don't think that's true. I don't think it's the way to look at it because it's two different financial products there are investors that are purely fixed income investors, and that are purely equity investors. There are different aspects to fixed income and equities that allows you to engage with them or to engage with companies in different ways. And for sustainable vision to sort of interact with them in a in a way that you proclaim to be a sustainable investor. I think also just very recently we had

what is called the SFDR sustainable finance, or well SFRD, sustainable finance reporting directive, something like that. And they have essentially the three definitions in there what we refer to as scope, artile six, article eight and article nine products. Article Nine products specifically mentioned the definitions on a an investor claiming a sustainable objective. So I think you can rely on that for some good guidance as to how to play in the context of a sustainable investor. Furthermore, in setting the scope, and seeing for a sustainable investor. I think you should look to what's called the principles for responsible investment, which is the UN principles for Responsible investment, which by definition, almost, the Bible when it comes to describing investors focus on sustainability. In this case, typically for investors we refer to it more as responsible investments rather than outright sustainability, or as a sustainable investor. So I would encourage you to look. They have endless amounts of data, articles etc describing different aspects of what a responsible investor is. Just a comment on that if you embark on this discussion, you have that in mind. The initial question of whether green bonds are the most appropriate tool or financial tool to address a climate transition I think it's a very relevant, and a very good question. I think the following comments you made and what I just commented on brings that a little bit into a difficulty or it muddies a little bit that initial question. So just to be mindful of it.

Edoardo 7:35 Sorry, can you repeat this last comment. (poor connection and background noise)

J. 7:39 Yes, so your initial comment your initial statement on whether green bonds are the best or most appropriate financial tool to address the climate transition I think that was more or less the wording. It is a very good question. It's a very relevant one. When you introduced, that's what we that were your opening remarks, and then you went on to the comment on your definition of sustainable investor, credit etc, or being a fixed income investor. And then you ended up into the greenwashing discussion. All of that I think muddies your initial research question. The initial question is very relevant, very specific. And I would suggest, or at least initially reflect on the fact that, for a master thesis going much broader than that initial question will become complicated for you in terms of having full coverage on the topic, allow for theoretical discussion and discussion of role so just instead of flat ground front.

Edoardo 8:53 Yes, I totally agree with that. and I think it's a very ambitious project. I see the point on the first model we made on sustainable investor case as being very simple, simplistic, but perhaps next time I will put that upfront, saying that its an initial

assessment. We will look into the responsible investment or investor guidelines, as you suggested. And we focus on the energy sector. So perhaps I could ask you do you see the green bonds as playing an important role in financing, the energy transition. Here I am thinking about the kind of green bonds you see traded in the Europe investment grade public market for example.

J. 10:05 Could you, but Edoardo, it sounds like your connection is breaking up.

Edoardo 10:17 Hi.

J. 10:19 Can you hear me?

Edoardo 10:21 Yes,

J. 10:23 I was saying, I don't know if it is on my end but it sounds like your connection is breaking up. I only hear, half of what you said.

Edoardo 10:32 I hear, like, I don't know if it's because, I am in my room right now. Esben, can you hear clearly?

Esben 10:40 Yeah well I think there's a little bit of background noise, but

J. 10:45 Esben your connection goes through much better on my end.

Esben 10:49 Okay.

Edoardo 10:50 Okay.

Esben 10:51 Well, I could continue. Which question were you at, because I couldn't hear you that well either.

Edoardo 11:03 This one.

Esben 11:03 Yes, okay. So, to pose you some questions regarding the, what role the green bonds play in terms of financing or closing the financing gap in the green energy transition, What role could these green bonds play?

J. 11:29 Again, I hate to sort of challenge the question with a question but as I said it depends on the context in which you're looking at it. If you're looking at the question from the perspective of, are you saying sort of the most relevant and most appropriate or it's a good investment tool or financing tool. Or if you look at it from the perspective of

is it the tool that is the simplest to work with, or can easily be adopted by the financial markets, this can sort of get a lot of scope of coverage and include a lot of investment, then the answer is yes, because the content of a green bond is essentially just your use of proceeds. And use of proceeds have actually been in the market for for a long long time. So the simple notion of saying I'm borrowing a certain portion of money, and I'm going to use them for this is very straightforward and relevant. And what's something that most investors if not all investors can get on board with because more than anything, it just gives you as an investor gives you transparency, if a company is increasingly being transparent and telling you what they're going to do with the money.

Esben 12:51 Yeah, exactly.

J. 12:52 It's after they're then saying, specifying it to green investments gives you that indication that there's real direct impact. Or at least that it has a strong link to being impactful. And the counter argument is then obviously that if you're looking at it from a financial markets perspective, the vast vast vast majority of, roughly, roughly half of the total financial market are in fixed income format. And the vast majority of that is what we call senior unsecured. That means that it's any given organization, corperation, bank multinational sort of sovereign institution that are issuing on the backbone of their overall credit quality, so that it's, it's just a promise that we as an organization, or an institution, will earn enough money to pay you back. In contrast to something where you'll be more specific around the assets obtained, like for instance if you take a loan in your house, you're taking a mortgage, that is asset-backed, because you're putting up collateral to obtain a loan. But if you just have a bank account where you have an overdraft facility that overdraft credit line is just based on your overall credit quality, as a person, as an individual. And so the vast vast majority is then this senior unsecured. And that means that companies, issue it on that back of not doing anything. It also means that the money are essentially a bathtub. It's a bathtub metaphor that all the money we pour into, into the bathtub. You can, you can take the same amount of money but you want to show that its the same money that you put in. So said in a different way, if you have, if you're issuing a green bond, then you can't actually legally claim that your money is financing that particular asset, because the only way that will be legally true, and logically true, would be if we're doing project financing. If you're saying I'm specifically financing this asset and in this special purpose vehicle or something similar. And that would fit in contrast to what the market can, for some people in the market, we've had this discussion around additionality, which is sort of putting this into question but. So that's why it's

really is important to understand the point of the bath.

Esben 15:27 It is definitely that our research question is framed in the context of this huge several trillion up until to 2050 financing gap that exists, and it is the question of how do you best direct Capital flows in a very high amount towards green. Greening our energy sector. And that's when we ask the question, as opposed to, for example, Copenhagen Infrastructure partners' Green Energy Fund of $15 billion Black Rocks renewable power fund of $4.8 billion. Are green bonds able to sort of direct Green Capital to a larger degree?

J. 16:21 So yes and that's, if you're framin it like that and then I'd say yes, absolutely. to my knowledge no other product allows you to, or another way allows you to do that as cleanly and as specifically as that. You might then have the contrasting argument saying look, I'm focused on real tangible, measurable, and associated impact, impact in that thing that is different. Green bonds might be a form of impact investing there's a little bit of blurred lines between whether you as an investor would consider that an impact investment. But there certainly will be investors that are very religious about it and say that a green bond is not an impact investment, because I don't get clarity in, I am not sure not enough that my money will go to that impact and generate that impact.

Esben 17:13 So now that you talk about additionality and is that perhaps something, a green bond, as opposed to a fund the green funders, makes it more attractive for investors?

J. 17:27 So I am saying, environmental finance is sort of a newsletter, a newspaper that covers specifically green bond market well, I've written a few articles and commented on a few things were, most of them are free to read. So you can just Google my name and environmental finance. I wrote an op-ed a few years ago on additionality as well so you can sort of have a look at that as well. And I appreciate comments on additionality from investors claiming that green bonds are not additional, to a certain extent its a question of semantics because also, if you look at the individual Green bond, does that have an impact. No, probably not, and is not enough to the same extent that you can find with other investments. But if you're going to talk about broad based markets, in the sort of market overall and look at, look, the impact on the financial market scale, absolutely green bonds are impactful. Green bonds probably more than anything, has been the catalyst for the financial markets to work with sustainability and been really driving the development of sustainable finance more broadly. So, on a global scale and in a longer time horizon, with that context. Absolutely. Green bond market has been impactful and has provided

additionality.

Esben 18:55 So it essentially acts, acts as a catalyst for further green investment?

J. 19:01 It acts as a catalyst for the broader market, which means that more activity is happening which allows, basically what we're working within financial markets at the moment, we're building the infrastructure in order for financial markets to help finance and transition we have to make. So it's very important to be mindful that financial markets are not the ones we need to ask to solve the climate crisis. That goes to politicians. We need to set regulations. We need to guideline overall society, it goes to asset owners in terms of allocating their capital towards more sustainable companies sustainable investments, and it goes to the companies themselves making investment decisions, cancelling investment positions from a perspective of what has the biggest possible overall impact. Those are the drivers, those are the entities that will need to solve the climate crisis. And the financial markets are there to facilitate that. So we're there to make sure that all the relevant market instruments are put into place, and all the necessary regulation can be sort of developed and worked with incentives, convince the companies to do this, work with the investors address these questions, that is what the financial market is about in this context.

Esben 20:20 When you say building your financial markets are currently building this infrastructure, are you referring to frameworks such as the green bonds, green bond principles, the EU Green Bond standard, the CBI green bond framework?

J. 20:32 Part of it.

Esben 20:33 Yeah, okay,

J. 20:33 Yes, so in this context, referring to frameworks typically more in the context of an issuer issuing green bonds under a framework, that framework is aligned typically with the green bond principles (ICMA). So, overall yes but that's just a sub-segment of it. The best one place to go for an understanding on that is defined as the European Commission's action plan on sustainable finance. The original document was announced back in 2018. They're currently working on updating, updating or revising that, and you might not see that coming out, being announced in the next couple of weeks or months, so that is what guides, more than anything and it's clear, which is very interesting, typically it is the US, historically it's been the US. And on a broader scale, in a global context, it is still the US that is the market leader undisputed market leader, when it comes to the complexities and

abilities of the financial market. But when it comes to sustainability overall, politically, but also in the context of sustainable finance Europe is the epicenter, not the US.

Esben 20:33 Yeah, I mean, I saw an article you posted on your LinkedIn, just a couple of hours ago, related to the EU taxonomy, sort of, excluding or potentially excluding natural gas. I was wondering if it's not too early to comment on, because it's simply a rumor. How do you see the EU taxonomies effect on global energy sectors. So, for example, will the exclusion of gas and natural gas in the EU lead other countries to follow suit?

J. 22:22 So it's evident that, well again as I said that, it is Europe that is a global leader and the epicenter of sustainable finance. So whatever happens here will ripple across the rest of the world and the globe. It should be noted that although the taxonomy within the EU Taxonomy it has been developed with support and guidance from global and classical national institutions. And that have been a, an incremental part of developing that. So, yeah, the EU taxonomy is euro-centric, most notably seen in terms of questions such as the do no significant harm criteria, and what those entail for the detail in terms of impact on biodiversity. For instance, on, on social matters. One of the aspects as well as that, there's a social safeguard net, we should not do any harm, or should not have a negative social impact, or sort of you should not go against the International Labor Organization standards. Some of those comments are an indirect hint towards towards for instance China.

Esben 23:44 yeah, yeah.

J. 23:45 You've had in China, you have what they call the green bond catalogue.

Esben 23:48 Yeah, the PBOC's

J. 23:49 used to, yeah exactly, which used to have, which used to have what they call green coal as a relevant category

Esben 23:58 They still have that. I think, they've mentioned that they want to phase it out. Is that correct?

J. 24:04 That's true, they're phasing it out. But before laughing at it, it's almost been yeah, it can sound certainly strange to call it green coal but you have to recognize this from a local context.

Esben 24:20 Exactly, the context.

J. 24:22 Climate change is tremendously important for all countries, not least for China. China has, among other things, and other countries are in similar situations have very urgent or critical issues with pollution. At the same time they have a big problem that they have a very large population, with a growing middle class that expects access to basic services such as electricity. Now, that's a challenge because you can't just switch over to intermittent sources because then you will have social uprising. So you need to balance the demand or stable electricity on a much bigger scale than any other continent in the world. And you need to do that in a context of addressing the most urgent needs. As in, for instance, smog. So green coal can certainly be laughable, in the context of energy and energy production, outright. But in the context of pollution, specifically smog, it is no laughing matter because you are able to produce energy in a stable manner with essentially not entirely but with essentially no or very little pollutants at least something that is visibly polluting, or something that directly impacts the quality of the air that people breathe. So sustainability, the world of sustainability context is tremendously important.

Esben 25:55 Yeah, definitely. Now that, now that you mentioned the PBOC green bond catalogue. Does it perhaps, and I'm thinking about shades of green here, does it in the global market does it undermine what we in the EU view as green. Since they're sold on the Luxembourg Stock Exchange, for example. Yeah. Do you think that the PBOC's green, what definition of green or what are eligible projects such as green coal, muddy, the definition of or the way we view, green bonds here in the EU?

J. 26:44 No, I don't think that's that's that's a risk of that because obviously I mean, again, it's very, China's largest polluter on the planet and and certainly, whatever they do or say it has a lot of weight behind it. But in the context of sustainable finance and sustainability, much smaller regions such as Europe still hold more weight in that discussion. We have more well-developed and a stronger capital market, and they are not taking indications from the People's Bank of China, rather the opposite. So, we are seeing the Chinese bank, or the Chinese government, aligning to European standards.

Esben 27:38 They would only align to a certain extent, of course, assuring their, their own energy security and social stability. I mean they have millions and millions of people of people working employed in the coal industry so it's just not feasible to completely phased it out

J. 27:56 But what we're seeing with the EU taxonomy is that it will be the precursor to

a global definition and taxonomy at one point. Whether that 5 years or that's 10 years.

Esben 28:08 Do you see the EU taxonomy or the green bonds, EU green bond standard enforcing stricter regulations in terms of it being a voluntary voluntary standard or?

J. 28:26 Yeah, so there's no question that the green bond standard (EU) simply comparing to the green bond principles (ICMA) are stricter. I mean, it doesn't get any simpler than that. The green bond standard has an explicit requirement for there to be a second party opinion. The green bond principles has a recommendation to external reviews. They are much more explicit in terms of the different types of proceeds, capital investment expenditures. So absolutely, green bond standard, the big difference between green bond principles and green bond standard is that the green bond principles are descriptive green bond standard is prescriptive - that dictates more what you need to do rather than the principles, but in all honesty, the green bond standard is one of the most anticipated documents with the least, direct impact. For what the green bond standard does, is just provide formality in a market that more or less already exists. It does require alignment with the EU taxonomy, but it is the taxonomy that dictates and sets the tone. The green bond principles, issuances aligned with the green bond principles, are entirely allowed to, and encouraged to also align with the taxonomy to the extent they can. So the green bond standard is sort of, you will be written on the, on the package. You bought a nice present, you wrapped it in in paper and tie a nice little bow on it.

Esben 30:03 Lamenting the common language, essentially.

J. 30:08 Yes.

Esben 30:09 Do you see any drawbacks in terms of formalizing these things. Here I'm referring specifically to potentially increased transaction costs or diminishing motivation by issuers, specifically from small and medium enterprises?

J. 30:28 I'm not sure if it's made publicly available, but there was a consultation on the green bond standard last year. And those were some of the questions as well, if they will raise capital, lower the cost for issuers. I think you should be able to find it. I don't think so, is the short answer. A little bit formally but not really. I need to pause for one second, I just need to pick something up.

Esben 30:52 Yeah, No problem.

J. 32:27 Hey I'm back again.

Esben 32:28 Welcome back. All right. I'll just ask a new question just to get the discussion rolling again.

J. 32:38 I have about 10 minutes, 5-10 minutes left if that's okay?

Esben 32:42 That's perfectly fine. Thank you for the time. I have a question related to stranded assets. So how important is the consideration of stranded assets in the energy sector, in transitioning the energy sector in the discussion of green bonds?

J. 32:59 Could you clarify?

Esben 33:04 For example, if an oil

J. 33:08 I am familiar with the contents of stranded assets it's more sort of I, I am not entirely sure understand the question, green bonds finance green assets, they don't finance stranded finance stranded assets. So, investors will have a bigger and bigger appetite for green investments, that means that companies have realized and will realize not directly because of that but also as a consequence of that, that they're able to get more funding, and cheaper funding by being able to present greener assets that will likely be a further shift towards green assets and away from non green assets, resulting in more stranded assets so the rise of the green bond market will give rise to more stranded stranded assets will come as a consequence of increased green bond issuance.

Esben 34:09 So what is the biggest challenge facing the energy sector in terms of achieving Paris climate goals here I take note of the World Economic Forum listing climate as the key issue back in 2020, and also I point to the 110 trillion financing gap that spans the way of global greening global energy infrastructure by 2050. What is the biggest challenge facing the energy sector in terms of achieving Paris climate goals?

J. 34:46 I don't know. If you're asking from a financial markets perspective. That's one thing but your ROI will be on transitioning. All the challenge that comes with that supposedly regulatory demand, cost, planning, execution.

Esben 35:08 In your opinion, what kind of energy related companies benefit the most from accessing green loans primary or secondary energy companies, public or private, high risk low risk.

J. 35:23 I can't say. Again, if you have green assets, you will not be making yourself more relevant to banks, financiers whether they're investors, public investors or private investors.

Overall, one of the strongest developments we're seeing in the financial markets in the context of investors, and in overall demand is demand for sustainable investments and specifically the demand for green assets, sustainable investments as a broader catchphrase, for for sustainable investments and responsible investments, green assets is a subset of that.

Esben 36:05 So the final question. Do you think green bonds as a financing tool, mobilizing private capital is playing, and will keep playing, the most important role in financing a green energy transition?

J. 36:24 Hard to say, probably not. More from the perspective that the green bond market, as I have said, has been the catalyst. We are in a market today that is much more multifaceted than simply green bonds or the green bond market allows, so it is still the more dominant component of the financial markets when it comes to responsible investing and sustainability overall, sure. But as we develop the market further, more and different products and tools will come online and become available for the market to work with; regulations, underlying investment trends, and demand will keep nuancing and developing it. So green bonds, really are just a sub segment if we will talk more broadly about use of proceeds-based instruments, where more and more investors are recognizing that it's not just about being focused on green, recognizing that green typically is referring to the concept of climate, but also it's important with regards to biodiversity, water, natural capital overall. During COVID you really see the social market rise and the focus on social aspects increasing increadibly. So, the green bond market, if you're look narrowly on green bonds, as a focus on financing climate related assets, yes, certainly for its relative importance in that it has given rise and will give rise to broader investments into other non-climate related sustainable investments. The EU taxonomy is a great example of that. Currently we have taxonomy standards now, or principles developed for for climate change mitigation climate change adaptation. But we will, within the foreseeable future have for the other environmental objectives and in one point of our livelihoods also have social objectives.

Esben 38:41 Alright, thank you very much for your time.

J. 38:45 Certainly

Esben 38:47 And of course, have a nice weekend.

J. 38:51 Likewise. And yeah if you, if you're planning to use any sort of the comments in quotes specifically with a reference please send it to me, otherwise you can of course just

refer to them as untitled sources.

Esben 39:06 yes, yes, of course, we'll make sure of that.

J. 39:10 Super

Esben 39:11 All right, thank you very much.

J. 39:13 Thank you.

Edoardo 39:13 Bye

10.2.1 Semi-structured Interview Questions

Interview outline

Introductory questions

Briefly, could you summarize your experience in the fixed income market?

Green Bonds in particular

Do green bonds play an important role in financing the green energy transition?

EUR IG CORP (Europe Investment-Grade Corporate)

Compared to other financing vehicles such as the CIP green energy fund ($15bn) and Blackrock's renewable power fund ($4.8bn) etc.

How should sustainability be incorporated in financial advice? (Fixed income market in particular) What does it mean for you to use sustainable finance as a toolbox for serving as a financial advisor? (Fixed income market in particular)

With the rise of target sustainability linked bonds, what does future growth of the green market look like globally?

How are frameworks such as the GBP, EU GBS, CBI green taxonomy, the PBOCs green bond eligibility catalogue affecting the green market positively and/or negatively?

The EU taxonomy's role globally? (Here I am thinking of the taxonomy setting a sort of global standard in regulation of what is considered green)

In your opinion, should green bonds standards/EU Green Bond standard be voluntary?

What benefits could you see emerging from stricter regulation?

What drawbacks? (Here I am referring to increased transaction costs and diminishing motivation by issuers – specifically SMEs)

Corporate Green Bond Issuance and Infrastructure Investment

Transport for London (TFL) case study: "The main driver for issuing the green bond was achieving investor diversification, particularly attracting a more geographically diverse investor base, and promoting TfL's excellent environmental performance and impressive pipeline of green assets. TfL also achieved its aim of geographic investor diversification, with 61% of the investor funds from the UK, 18% from continental Europe, 15% from Asia and 6% from the Middle East"

How does TfL benefit from having a diversified (more international) investment base?

What about in terms of energy infrastructure, both green, light green and brown and 'lighter shades of brown'?

CAN YOU ASK THIS?

Our research

We investigate whether a green bond is an effective tool for financing the green energy transition, in line with the first objective of the EU Commission action plan on financing sustainable growth that is reorienting capital flows towards a more sustainable economy.

Thus, our thesis research question is: Are Green Bonds the Most Effective Financing Tool for a Green Energy Transition?

Investment universe (PRI-research)

We start defining our simple universe, consisting of 3 types of investors

Equity investor (risk tolerant investor)

Credit investor (values highly safe cashflows)

Sustainable investor (SI)

SI prefers to invest in sustainable firm (company that provide sustainability disclosure that is reporting on climate-related actions). Here I am thinking about NFRD, which is now being review by means of a public consultation.

As SI values positive corporate governance action and has a long-term investment horizon.

SI is risk averse, therefore prefers to invest to sustainable growth in the credit market.

therefore,

SI assign a premium to Green Bond in contrast to vanilla bond.

If green bond opportunity is not there, SI invests in sustainable equity firms.

HOWEVER

Is there a Greenium?

Do you think that investor would buy into green bonds if the return were not competitive? Here I am thinking about the tradeoff between financial returns for societal benefits.

Why do company issue green bond if there is not Greenium?

Is it the fact that green energy project is profitable enough to generate competitive returns?

Or do company want to send a signal to the market? Here I am thinking about the large (and growing) literature that shows a positive relation between ESG and performance and a negative relation between ESG and risk. Investor might see a green bond as a credible commitment towards eco-friendly behavior and therefore, a value enhancing means.

Or is it just a very expensive green washing strategy?

Signaling and Green washing investigation

EVENT STUDY: Is green issuer improving its stock price?

What other factors might have determined the increase?

Can other cofounding events have determined the increase? Here I am thinking about the announcement of equity issues, (regular) bond issues, or quarterly earnings.

ENVIRONMENTAL PERFORMANCE Is green issuer improving their environmental performance?

OWNERSHIP Is green issuer improving their equity ownership structure?

What type of institutional investors buy into bonds?

From an institutional investor perspective, what factor are taken in exam when investing in bonds? Is the long-term horizon one of those?

Would be reasonable to think that the issuance of green bonds helps attract specific equity investor clienteles?

ENVIRONMETAL SCORE Is a transitional company (middle range EPS companies' curve) more propense to issuance than an extreme company?

Energy sector Decarbonisation

Could you define what climate action and environmental sustainability means to you in the context of green bonds in the energy sector?

Our research defines greening of the energy sector (positive impact in line with ICMA GBP etc.) as decarbonisation – as the sector is the largest source thereof.

Do no significant harm

Does this definition change when viewed from the perspective of a carbon intensive green bond issuer vs. a low-carbon issuer in the energy sector? Here I refer to shades of green of a given project.

What is your opinion on less than green bonds in the energy sector specifically I.e. transition bonds (bonds issued by fossil fuel companies), green bonds issued in China financing "clean coal"? Here, referring to a 2019 article: **REDACTED**

"It's somewhat hollow to say that an oil company can't issue a green bond if you would buy a green bond from any of the major banks (most of whom have significant oil-related exposure on their balance sheets)."

Do no significant harm: prolonging CO2 emissions of coal fired power plants. Here pointing to context of a given national energy mix for example.

How important is the consideration of stranded assets of the energy sector in this discussion?

What is the biggest challenge facing the energy sector in terms of achieving Paris climate goals? Here taking note of the WEF listing climate as the key issue in 2020 and:

We found various estimates on the financing gap that stands in the way of greening the energy sector: "An estimated total $110tn gap stands in the way of greening global energy infrastructure by 2050, averaging around $305bn every year. Of this investment gap, 20% or $22.5tn alone must be dedicated towards greenfield renewable power generation capacity, resulting in an approximate investment of $662bn p.a. However, more recent estimates put this number at $800bn p.a. (IRENA, 2020)."

Are challenges constant across national/regional energy sectors such as China USA vs. EU? We frame this question in the context of divergent energy mixes.

Final questions and further discussion

Do you think green bonds, as a financing tool mobilizing private capital, will play the most important role in financing a green energy transition?

Are green bonds enough to close the green energy transition financing gap?

In your opinion, what kind of energy-related companies benefit the most from accessing green loans? Primary or secondary energy companies, public or private energy companies. Highly risky projects or more low risk projects

Will more regulations alongside the EU GBS/EU Taxonomy slow the growth in demand for green bonds?

Quantitative and qualitative environmental impact reporting goes beyond the (simple) requirements in ICMAs GBP; thus, issuers must decide how to balance the cost of preparing a comprehensive impact report against the value it then brings to investors and other stakeholders. And in the extensions, the value that stronger relations with your investors may bring

10.3 Appendix - Anonymous Interview

Edoardo 0:00 Hi J. First we would like to ask if it is okay that we record the conversation?

J.S. 0:06 Okay, sure. That's fine. In terms of, I guess, how formal is this is this going

to be something where you want to quote me in your dissertation or, or is it just more informal in terms of you just getting some information.

Edoardo 0:26 Yes, so it's a, Esben knows.

Esben 0:29 Yes. I mean, it's sort of setting up our discussion in a way, we most likely won't quote you as saying, a specific statement, in that sense, but it helps us along. To find the direction of our project.

J.S. 0:52 That's fine, that's fine and I'm happy to give the guidance, it's just I just want to be sure if my name is going to be put any anywhere that you know, especially if you're recording the conversation and I don't want anything to be taken out of context and I want to be sure that, that I might have a chance to have a look at what is what is written then afterwards as well.

Esben 1:12 I mean, throughout. I mean, now we're offering you the possibility of anonymity and that's still stands. After the interview, or at any other point later down the road, of course.

J.S. 1:26 Okay. I mean, I would appreciate to see. I mean, whatever you write if it's possible, afterwards, when it's finished all sort of interests, because what you guys are writing sounds very interesting. So, and then obviously if, if there's something where you feel you need to quote me or for some reason then then obviously I'd like to just see what is, what it is that I'm saying that, that I agree with it, obviously you're recording it now so I won't be able to take my words back but I mean I doubt there's going to be anything contentious and what I what I say I'm not an expert on green bonds, by any means. So as I said to Eduardo in the emails. You know, I'm happy to talk about fixed income markets in my experience and and sort of general knowledge that you know I might have.

Edoardo 2:47 yes, we'll try to be mindfulness about the fact that we asked for 20 minutes. Let's start perhaps asking, What's your general experience with the fixed income market. If you can, you can be brief on this as we will have more key questions.

J.S. 3:16 I started working in 2002. In JPMorgan in fixed income derivatives sales for Nordics. I was primarily involved with financial institutions and the whole Nordic region, covering them on transactions involving fixed income, derivatives such as swaps and swaptions caps and floors, structured products involving, you know, all kinds of exotic options. So, not so much on the bonds directly at that point, I mean although all derivatives are

hedged. You know, directly or indirectly through the use of bonds in some context bonds for example. And then later on in my career, I also did some, some sales on what we call fixed income flow, but this was generally. This was when I was in Barclays, The last couple of years to three years I was, I was there I was working on the flow desk, and apart from derivatives we also traded a lot of government bonds, municipality bonds, I also helped with some of the swaps that were done for bond issues by financial institutions in the Nordic Region like Nordea, NCB, Kommuner Banke and kimono invest and so on. So when they were issuing bonds we would you know have a relationship on on the corporate banking so the the corporate side or the or the, the ma side or wherever it might be that, and then we would help the desk that was, was dealing with the issue with, with the hedging of the of the of the bonds. So yeah, I mean, and that was, I left Barclays in 2014. And since then, I mean I, I don't deal with bonds that much directly anymore. From a sort of, you know, buying selling perspective. So I don't look, I don't look at them intently we have my career now is, as you also asked about I think later on. Now I work in a company called NICG and that stands for Nordic insurance consolidation Group. We are involved in consolidating old guaranteed pension books from different pension funds and life insurance companies around the Nordic Region, and a lot of things related to that, including the investment strategies that we run and therefore, I have some some insight obviously in some of the, the issues involved in the asset side for pension funds, and what is efficient and inefficient asset classes for, for those kinds of investors. Yes.

Edoardo 6:45 That was very interesting. Introduction Thank you very much. And, and I just have, like, two questions in mind, given the this introduction. So, you've been on the sales and buying side of the issuing of bonds and what, what motivation do companies in general have the one that you should bond. And does this answer change if you think about like, specifically, a company that works within the energy sector, because the research we're doing is very much, answering the question, if those kind of financial instrument are facilitating also the green transition of energy companies . So to address this question. The context is very much in parallel with the energy sector. Okay,

J.S. 7:46 well I mean, bond issuance is always been a question of financing per se, right. It's all about being able to borrow money at the cheapest cheapest cost that you can get. If you're a private individual we'll never get to you and me are never going to be able to do a bond issuance by ourselves. The closest you'll get to it as, you know, borrowing some money, or when you buy a house, you know, you're essentially making a mini bond issuance but you're pulling it together with everybody else. That's that's about as close

as you'll ever get to it. But you can see the effect of that, even in terms of mortgage mortgage bonds that the level their interest rate level that you're able to achieve is much lower than if you were to take, you know, a bank loan directly as a private individual. Now obviously, mortgage bond is collateralized with the with the value of the house and, and, for corporations depending on what is what is behind the bond, and what kind of security there is. It could be obviously better or worse than then housing but, but obviously large corporations have potential to, to, to create a bond issuance that is of a large enough size that is interesting for the market and if the market knows the company or or feels the company has a credit quality that is very high, then that will drive the interest rates down for for that interest rate that they have to pay on the bond. And, and that's obviously very attractive for for companies of all types, and it doesn't matter whether it's an energy company or it's, it's Apple or it's a supermarket, I mean if they are big enough and they can do it, then the financing, cheap rates in the market are, are very attractive now, like any other company, you always want to keep your debt levels at a certain level, you don't want to, you know, borrow beyond what the market feels is comfortable, because then people aren't too much then your creditworthiness suddenly apart, you've borrowed so much money that nobody wants to lend you anymore because how are you going to pay it back right. But where you have potential to borrow. They will obviously want to finance themselves as much as, as they can because most companies will have an internal sort of rate of of return on capital requirement that is probably much greater than the interest rates that they can finance themselves out in the bond market. So, you know, take, take a bank. Like, I don't know they are Danske Bank or someone else. They might have returns on capital that are 10

all the sort of environmentally environmentally friendly aspects of of investing that you can get into. And I'm sure you've probably read numerous articles in the media about, you know how pension fund so looking more at ESG investments and everybody wants to make sure that they're investing in the right things and it's not just environmental things it's also, we don't want to buy weapons we don't want to buy cigarette producers we don't want to this and that and the other so you know, If you only look at things from a return perspective, of course there will be some things that are more efficient than others, but once you put in, kind of more moral aspects into investing than then it'd be you know you probably cutting off certain things that that might have a higher return but I'm not attractive from from that point of view, and that's completely understandable.

Edoardo 12:59 Yes, I think this is the old concept that since we are in the this Greenium

that some bonds are showing. The question will be like. Do you do you think that issues should be rewarded by Greenium if they're issuing green bond?

J.S. 13:23 The market will determine whether issuers deserve a Greenium. Given how the market is right now. The answer is probably yes. Because there is a demand for those kinds of bonds, there is a demand. There's a lot of funds that are you know want to create good returns on on ESG cases. So, it's, I mean, pure economics demanded some, you know, supply and demand, if, if the demand is out there for ESG products and green bonds, then that will drive the interest rates on those down and they will category him. So, you know it's not a, you know, the markets are never a question of what's fair and what's not fair. Investors decide the price at the end of the day and you'll get the Greenium if it's there and if you don't, it's not there then it's not there, but then I think one of your other questions was, you know, if, if, if after adjusting for issuing costs, the Greemium is zero, why would you still want to do it? Well, I mean, maybe you'll get the green Ium later, I mean if you have a successful bond. Now, maybe it's an investment for the future. It can also be other things, it might be the regulation requires you to do and you don't have a choice or maybe, you know, the company has certain governance policies that says we have to do this and we want to do this because it's the right thing to do and, but, But the future potential has to be included in the fact that you're starting down this path, and maybe it's your first time making a green bond, and the market is saying let's have a look at, if these guys are good or not, then maybe there's no premium. That means that the market is getting, you know agreed a good yield on your bond, compared to other bond green bonds that don't have agreement. So the investors are happy next time there might be more of a fight for your bonds and then maybe there'll be much more of a premium. So, you know, it's like anything else you know sometimes you start a business and, and you don't make a lot of profit on your first sales but you're getting customers right can think of it in the same way,

Esben 15:38 relating to your, your answer just on the cranium juice is so with the EU sort of introducing more sort of set frameworks so here I'm thinking of the green bond, standard the EU game run standard essentially creating regulations around green bonds, and thereby creating more transaction costs and relating back to what you said earlier, so mostly big firms issue green bonds, I have the, the most benefit of issuing these. Now, if you think about small and medium enterprises that perhaps have technology that's more that drives the green energy transition to a bigger extent do they perhaps have a harder time financing these technologies through green bonds because of these transaction costs,

as well as just the. Yeah. The scale Yeah,

J.S. 16:49 I mean, I'm obviously not. As I mentioned that an expert on what the exact requirements are and the costs involved are, I guess if you're a smaller company and you're kind of at the point where you say well I can if I go for a green bond is going to cost me this much. I can also finance myself this other way and it's gonna cost me that much, you will kind of make a cost benefit analysis of, you know which way do I want to go, and, and do the one that's best for you. All things considered, now. So yeah, I mean the, I think that he you, I mean, you know the term green bond shouldn't be thrown around, just so that everybody can use it and nothing is actually any different from a normal bond, There has to be some kind of reason for why it's green, and that people can feel that it's, it's, it's legit. I mean I just watched the documentary yesterday called see spirits on Netflix, I don't know you've seen it, But, you know opens your eyes about how fake a lot of these labelings can be regarding things that you buy and that you think are are good and they're not, you know. So green bonds, you know, no different. I mean, you're selling, you're getting Agrium for for something and not for nothing. And, and therefore it needs to be, it needs to be monitored and needs to be regulated and hopefully that regulation and everything around it is, is, is fair and justified so that green bonds that deserve to be green bonds are called green bonds and those that are not Don't, don't, don't get that label. I'm sure that cost something extra because there will be people involved to be able to allow that. Otherwise everybody will just call them, they're the bonds green bonds and then try to get the premium right. So so the smaller companies yeah they will struggle maybe with those additional costs, whether they can find other ways of putting themselves together, or doing, doing it in some other way, or getting subsidies, or I don't know, I mean, it's it's obviously a shame that those costs have to be there, if that's the best way of financing, but there's also other ways of financing, I mean, the thing is, if the company is green. It doesn't matter whether they make the green bond or not they'll still be a green company, right, and if they're successful, then later on there will be big enough and then they can try to do green bonds, and the people that have kind of say a look through, because investors will sometimes make a look through and they will say, this company is very involved in, you know, clean energy and everything else. They're too small to issue green bonds, but we have financing with them and we classified maybe as a green bond or, you know, you know, a company that is in sort of our ESG space, or whatever it is. So I guess there's different ways you can look at it. But if you want the official green bond label the way that it has to be then yeah, you need to pay for it.

Esben 20:08 If I could just ask you to comment on. So, on one thing, China issues, these green bonds that on the Luxembourg Stock Exchange, that effectively fund coal projects. So green call objectively, as an investor, how would you how would you view that would you view that as greenwashing or is that you have to think about it in the context of China's development stage, in essence.

J.S. 20:46 Yeah, I mean, obviously, I without knowing the bonds or the circumstances well enough and what they classify and who was involved in, in determining it determining whether it's green or not, it's hard for me to comment that, that exactly on something like that I mean, I think you said it yourself. I mean, it's probably an area where you need to make sure that it deserves that kind of recognition, and make sure that the players involved are doing what is supposed to be done for something to be a green bond. Again, you know you'll always have that look through. Generally for many investors I mean sometimes things just get thrown into a big bunch of us, you know, I mean, as we saw on the financial crisis, sometimes with credit ratings and things like that are just it has AAA and can just get thrown into something else, and then it shows, shows up to be something that's much worse rated in real life. And when, When there's a lot of stuff in the market, and people just are looking at improving returns you know if you have a lot of funds, competing to be the ESG fund or the you know green bond fund that gets the best return you you will probably have some that are less discerning in terms of, you know, what am I actually buying here is it a Chinese green bond and, you know, been greenwashed like you call it potentially or not, I don't know I mean, who knows but but there will be some that buy it and there'll be some that question it. And at the end of the day the regulators that are giving those labels have to be, you know, have to stand up for what they're they're giving the labels for. But yeah, I think, I think the main takeaway from that, from that point I think that you've made is that you have to be careful, you know, what are you giving this to. It shouldn't be shouldn't be thrown around too easily.

Esben 22:58 Now the, just to clarify the definitions of green are given by the People's Bank of China, the central bank. So, yeah, now that you you mentioned the financial crisis. Can you draw any parallels in terms of bubbles or frothiness of green versus triple A rating on bonds,

J.S. 23:24 I think, I think the financial crisis, taught us a lot in terms of giving too much power to certain agencies, and to monitor what those agencies do and how they do it. I mean, back then, there were many stories about how a lot of the credit agencies were basically bought indirectly. In terms of giving certain credit ratings for things that

probably shouldn't have had those credit ratings, not doing enough work to monitor them or to you know judge them and having pressure put on them to, to make sure that those credit ratings didn't go down and since then, there was obviously a lot of stick that we learned from those history lessons. When it comes to the next type of thing where there's, for example, green bonds or something else that we classify who classifies it. Are they being bought again reminds me of the CeCe faricy documentary how those, you know, more linked on the, on the cans of tuna with dolphin friendly dolphin friendly were just being bought, you know, and they were killing dolphins at the same time, you know, so, so how do we make sure that that doesn't happen in other areas like green bonds. It's it's a it's a question that does need to be tackled and I think it's it's something that the regulators and the governments have to make sure. But, but, yeah, I don't, I don't have the answer to that.

Edoardo 25:04 Yeah, so now it's been 24 minutes, and if you want, we could. And then know how you feel about.

J.S. 25:17 I can do another 10 minutes or so I do have to have my wife with some dinner because she's not feeling too well today so I promised her I wouldn't take too long.

Edoardo 25:26 Yes. We'll promise the same then I just share the example, a case study from the Transport for London. And my question was about like how does the company benefit from having a diverse diversified investment base in European because their, their strategy was to use a green bond to diversify their investment base, and I was, I was interested about like your.

J.S. 25:55 Yeah, I thought it was a very good question. I have to think about that one actually. I mean, it's the best answer I could come up with is that, you know, your, your investor base are kind of like your, your customers in the bond market right. Imagine you're a little Danish company and, and you're only selling your bonds to two Danish banks. And suddenly, you're able to get people buying your bonds in the States and Japan and Russia, everything else. Well, the more people that know about your bond, and that are investing in your bond. The more demand that will be for your bond. Next time, then maybe you know, they have some investors in the Middle East and in Asia and they look at their own competitors and they say oh this guy he bought the green bonds from this company and it did very well. Next time there's an assurance we want to be involved. And then you get these over subscriptions, which are which are fantastic for issuers because they push the rates down. So, you know, the more you get your bonds

around. Hopefully, the more oversubscribed, these, these bonds will be next time around. I think that's why because other than that I mean as long as they, as long as they finance their the bond in a good level they should be happy. And whether it's, you know, sold in the States or Asia wherever it shouldn't matter. But you know it's a benefit that they're not.

Edoardo 27:35 Right, yeah, it seemed that using a green bond they were able to access, like, more international market.

J.S. 27:43 Yeah, again, supply and demand right i mean if, if you're having a lot of funds around the world looking for good green bonds and there's a good issue from TfL. I can understand that yeah they they probably like well let's let's look at that, you know that's a new one and it's got a good yield or whatever it is and then they put it into the portfolio and then they keep an eye on for next time. And then they might also, I don't know, depending on what kind of funds they are. They might also buy other issuances that they make maybe that aren't green

Edoardo 28:16 yet, so we said that factors that bring funds, thinking consideration are like yields about so greps long term like long term or would you say that, like green funds, like a different point that he phrased important from a normal Fund is a lot more longer, for example, in their investment strategy.

J.S. 28:39 I think you would definitely think about the long term consequences of that yeah and that it's you know that would benefit you, over a longer run, that you have all this, all these investors from all over the world, for sure. Yes.

Edoardo 28:55 And last question perhaps like, how do you feel about talking about climate action, and environmental sustainability within the context of the life insurance,

J.S. 29:09 he's not it's a very it's a very good question. I think, you know, I mean I watched that documentary yesterday and it still gets in my head, you know like, even the day after it's like that with some something that you watch but, but, you know, you, you watch something like that and you think, you know, I can just stop eating fish but, you know in reality that doesn't really change things very much in the grand scheme of things. You need to change things where, you know, regulation is where the money is, and so on. Now, I don't have the answer for the fishing industry but when I look for, for things that you know the life insurance business could do when, and to some extent already are doing, because you do see a greater interest, and and a lot of media coverage in terms of

how pension funds are looking at investing and in green ways I know our pension fund norley pension. We have an ESG strategy as well and in terms of making sure that certain things don't go into the portfolio that we don't, we don't like. But I don't know how familiar you are with with life insurance regulation but, but there is in 2016, something called solvency two was introduced into life, the life insurance and pension industry, which in essence was very much about the the capitalization and the capital requirements of of pension funds. And this you could also, you could also put it over to banks and others that have like basil. Basil rules you know so. But what you could do and then obviously depends on the regulator and how they look at these things is similar to how a lot, you see a lot of pension funds are very interested in infrastructure projects because they get good returns on them and they have beneficial capital requirements so they, they have to hold less capital for those kinds of investments because they're kind of given special treatment versus other types of investments like equities, You have to hold a lot of capital for because it's very volatile it's very risky you can lose your money. But infrastructure projects or long term projects that should generally if the, the underlying counterparties is a safe. Safe investor then you can you can expect to get your money back and it's an it gets this kind of benefits so that it pushes all this money because there's probably, I mean there is absolutely huge sums of money in the pension industry. If you take the total au M and the whole, whole world and you look at how much is in in pension in life. It will be a huge percentage, and if that money can be siphoned off into more clean energy projects, because they give, they make financial sense from a capital requirement and a year perspective, you can very quickly get some amazing results I reckon if, if, you know, you could also create a bubble. And that's obviously what you have to be careful about because if you make it too attractive, then you suddenly have all kinds of people making project saying that it's you know I'm making clean energy and they're actually doing nothing. You know, so you have to be careful about that too but, but in practice. There is a huge, huge sum of money that's willing and able to invest in these kinds of things, under the right context, and an all it requires is, is the right regulation and and I can remember how it is with depending on how it is structured, certain things, if it's infrastructure projects I know, for example, they will get capital, you know, Call relief but but they will give given, they'll be given more beneficial capital requirements, but a green bond per se I don't know I don't think it gets a special treatment over a normal bond. But maybe there's something there that can be done so that they may or might not be as, as, as punished in from a capital requirement perspective,

Edoardo 33:44 there is a huge gap in what is stands between the transition financing gap,

the IRENA says that there are 110 billion gap between the edge infrastructure. And do you think, like, how would like the capital market in general but perhaps the pension fund business help filling this green transition financing gap.

J.S. 34:17 I think that huge potential filling up that gap. Huge. If it's done in the right way and regulation is on their side. I think it can be done. I mean, it's just a question of looking I mean, you look at look at the day, I mean, look at the Danish mortgage bond market. I mean, almost the entire pension fund industry in Denmark holds almost all the mortgage bonds. In Denmark, I mean, Of course, there's also international buyers of it but, but if all the Danish pension funds stopped buying Danish mortgage bonds I mean interest rates on mortgages would be, you know, vastly higher. So, similarly in the rest of the world, given the focus on, on the environment and green bonds with the right regulation from AOPA and other regulators, you could easily get a huge impact. I mean, I mean 110 trillion I mean, what is what is the use of all the assets in all the pension funds in the world I mean multiples of that right,

Edoardo 35:29 yes. So would you say that the pension fund industry is the, the sector that will have the most impact

J.S. 35:40 could be. I mean that's savings. It's, I mean it's a savings industry right warehouse, I mean otherwise it's people that are looking to, to, you know, private investors looking to just make it, you know, high return they, you know, you'll see some that buy green bonds and you'll have some funds that you know do like a mixed strategy or like a ESG strategy and then put some green bonds in and so on. But the pension funds given the right incentives, you know, they could buy huge amounts of this stuff. And then obviously, there'll be the main buyers of those funds in the first place. So, so if you're looking at where is your real market for putting these green bonds. I would say it's in the pension and the life and pension industry

Esben 36:32 is that because there's a match between investment horizons, in particular,

J.S. 36:38 there is a matching investment horizons, because people obviously have a long term investment horizon, when they when they're going on pension but also I think in terms of the story I think the story is something that appeals, you know, as you can see I mean, you probably if you did like if you Googled how many pension funds are writing about green bonds and ESG investing and environmentally friendly solutions to investing. I reckon you find 1000s of pension funds that are looking into that. And, and they'd be

key, because the story is great for them that you want to write out to all your pension members and say we're, we're taking care of the environment by investing in friendly things we're thinking about the future of your children and your grandchildren.

Edoardo 37:35 Right, by their consumer demand for.

J.S. 37:39 Because how do they sell themselves, you know, of course returns are great but at the moment, there's not a lot of return. so, you know, yields are not high. People obviously want to have a good retirement but you still need to buy bonds you still need to buy I mean you're going to have a diversified portfolio anyway. You're not just going to pile everything into equities. So, so there won't be a need for bonds and there will be a need for infrastructure and other things like that and the more you look at the asset allocation of pension funds nowadays is there's a lot of alternatives and illiquid assets and things like that because it makes sense I mean illiquid assets are things that, that the pension funds are our primary buyers are because of their investment horizon, and green bonds, long dated long dated government bonds, I mean, you look at all the sort of long dated government bonds in Europe are being bought by the pension funds because they have long dated liabilities. So they actually liabilities work like really well in Norway for example you don't have government bonds longer than 10 years they would love to have longer ones. There's no market for it. So many other places you know it's just because you don't have you don't have enough issuers of those long dated types of bonds so. So yeah, for sure. I think that life, life insurance industry is a primary candidate for those kinds of investments.

Edoardo 39:14 Yes, that's. So we all hope that regulation will move fast. Yeah. Yeah. All right. All right,

Esben 39:28 we want to wrap it up, and not take up any more of your time and let you get back to your duties.

J.S. 39:40 That's fine, thank you very much guys, thank you so much. Yeah, and when you're finished with with the, I would love to have a read if I am allowed. At some point.

Esben 39:49 Of course, of course,

J.S. 39:53 Good luck

Esben 39:54 to thank you very much. Have a nice evening.

J.S. 39:57 Bye Bye

Edoardo 39:58 Bye

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10.3.1 Semi-structured Interview Questions

Interview outline

Introductory questions

Could you summarize your experience in the fixed income market?

Could you elaborate on how you work with bonds?

Corporate Bond Issuance. Parallel with Energy Sector.

In your opinion,

What is the best and worst characteristic of bonds?

Why would a company choose to issue a bond instead of borrowing money from a credit institute? Does this answer change when you think about energy companies? Here I am thinking about wind power company (Ørsted) for example.

What motivations of issuing bonds? Again, does the answer change for the energy sector context?

SME – higher risk – less likely to benefit from green bonds? - but more innovative tech perhaps needed for green energy transition? Feel free to interrupt ill ask this

What type of company benefit the most from issuing bonds? Any difference in the answer when thinking about energy companies?

Green bonds are oversubscribed (TfL's green bond was a massive success with investors. The bond was oversubscribed by 50%, with the £400m offering receiving orders for £600m.)

What happens when a bond is oversubscribed?

How does this affect green bonds effectiveness in financing a greener energy sector?

Theories that we would like to discuss:

We research whether green bonds are an effective tool for financing the green energy transition. Therefore, we investigate financial and non-financial performance of energy companies which issue green bonds.

From a capital market theory perspective,

should issuers be rewarded with a bond premium for facing more issuing costs (second party opinion, certification, reporting) than a normal vanilla bond issuance? IS GREENIUM FAIR

After adjusting the calculations for issuing costs, there Greenium is 0.

What other reasons for issuing green bonds?

Might a company want to signalize that it is committing to energy transition?

In theory, would be reasonable to think that the issuance of a green bond determines the increase of stock price of the same issuer company?

Can other cofounding events have determined the increase? Here I am thinking about the announcement of equity issues, (regular) bond issues, or quarterly earnings

Type of investors buying into Green Bond

What type of institutional investors buy into bonds? Would the answer change if we refer to green bonds? Here I am thinking about green fund

From an institutional investor perspective, what factor are taken in exam when investing in bonds? Is the long-term horizon one of those?

Would be reasonable to think that the issuance of green bonds helps attract specific equity investor clienteles? "Sustainable investors"

Life insurance business and Decarbonization

Briefly, how do you work with the life insurance business?

What role does the fixed income market plays in this industry?

Does climate action and environmental sustainability mean anything to you in the context

of the life insurance business?

Is climate risk a relevant topic or KPI?

If you were to address one climate action that society should undertake to prevent the energy sector from causing further global warming, would you say that decarbonization is the most important?

Here I am thinking in the context that the energy sector accounts for most CO2 emissions globally.

Regarding decarbonization, what role could the life insurance industry play in driving this goal for the energy market?

Closing the green transition financing gap

We found various estimates on the financing gap that stands in the way of greening the energy sector: An estimated total $110tn gap stands in the way of greening global energy infrastructure by 2050, averaging around $305bn every year. (IRENA, 2020).

How could capital markets help to fill the green transition financing gap?

Which capital market player would have the most impact in filling the gap and why?

Noting large renewable energy fund of Blackrock ($4.8bn) and green fund of CIP (EUR 13.4bn)

Further discussion

Investment banking business

Could you tell us briefly what your background is and what you did while working in London?

Bond Structuring side (option)

Which parties are involved in the structuring phase of a bond?

Based on your experience, what are the main transaction costs that an issuer faces when issuing?

Have you also worked with the ICMA standards while structuring bonds? If yes, how

was your experience with the organization? Do you think that the role of the ICMA is fundamental for the fixed income issuance?

Bond Sales side (option)

In your opinion, what are the most important information that a bond salesman needs to provide the prospective clients?

Is the use of proceeds an important variable for prospective clients?

10.4 Appendix - Emrah Öztunc

Emrah Öztunc - Energy Sector Commerical Councillor in the Trade Council at the Royal Danish Embassy in Beijing.

Esben 0:50 I'm here with Mr. Oz change the energy sector counselor at the Royal Danish Embassy in Beijing. Thank you for being here, and I'll start with introducing our pieces, research question. So the, the project addresses the financing gap that stands in the way of global green energy transition. And by looking at the key emitter countries, the US the EU and China. We basically investigate green bond effectiveness in closing this gap. Our research question is, our green bonds, an effective tool for funding, an energy transition. And here we do a multi level impact assessment, our papers discusses whether green bonds are truly being used in the intended in the intended way. And also, whether they're able to enable the capital flows into the right areas and right industries. And our, our, our, our KPI is basically decarbonisation, that's what we're looking for. And that's what we consider positive environmental impact. And that's one of the, the sort of requirements of a green bond that it had needs to have a positive environmental impact, and we judge that in the energy sector as decarbonisation. So for this interview, we hope to gain some insight into what motivates certain industries to seek a green bond financing in order to finance their green transition. So I'll start with some general energy sector questions. So without going into detail on the current energy mix of China. How would you describe the current state of development of China's green energy transition on the ground. So here I'm thinking which sectors are receiving the most attention and whether it's positive or negative by stakeholders such as government regulators and society at large.

Emrah 3:07 Okay so first of all we can say that the current government, China has just launched his new 14th 5 year plan. And within this, it has some developments, specifically

sectors, including the energy sector. This also includes the main energy sectors, such as coal, but also the renewable energy sectors, such as the offshore audience or the wind industry, and solar etc. And in order to answer your question, how would you describe the current state of the China's green energy transition on the ground. Well you can say that China is of course, trying to achieve its screen transitions, without straining or without creating more burden for the economy. So that means that at least to achieve great transition, while still maintaining a high level of GDP, and also maintain the jobs, this is one of the biggest issues, Simon often faces. And in terms of the question they would say those are receiving the most positive and negative attention by stakeholders, such as the government and regulators say of course the coal sector SPPC attention, both positive, but also the negative side. And this is because that still many provinces, but also in general, China is quite dependent on the coal industry, because it creates a lot of job, but also something that provides fuel for the heavy industry in China. And, of course, they think the government is aware of the negative influence of China. So of course the pollution levels, local production levels, but also China's ambition in delivering into the Paris agreement with the Global Climate Initiative. So China is very focused on finding ways to make it, make its coal industry more green. And I think last time we also talked about carbon capture storage and utilization, this is still something that is going on technology. China's trying to do, but also through using the the clean coal industries. And I think this is kind of a way to prolong the office of the coal but nonetheless. You can also say that recently in the leaders site where Joe Biden invited all the international leaders to discuss the climate ambitions, Xi Jinping actually says that China will start reducing its scope of the 45 year plan. So what does this mean is that after 2025. China will start bringing down its usage of coal and development of coal based facilities. This is of course a great development. But of course, this is five years ahead so there's no five years, I love wherever can still be built. Does this answer your question, your first question.

Esben 6:43 Yes, definitely, definitely. Since you mentioned, in our last talk together. One of the main hindrances, you mentioned was the lack of electricity grid to support renewable energy, how has this developed since?

Emrah 7:03 I think it's still an issue that still maintains to be a problem. China, because, well, we can say that in the last year in 2020, the offshore wind industry has been developed significantly and actually decreased now jiko was in capacity. And we can also say that. Still, there will be developed a lot of offshore wind, but after this year 2022 and onwards,

the subsidies for offshore wind development will disappear. This is of course a challenge, but the provinces have been asked to create a whole subsidy schemes in order to do it to to emphasize or to utilize and more offshore wind farms across the provinces. If they do it correctly, equilibrium become better than the national resources.

Esben 8:04 It's funny. It's good that you mentioned subsidies and this is where the green finance aspect, now comes in because, so it is very much that China's moving away from subsidies, but towards incentives, this is also what China's trying to do in terms of their supply side reforms in that, for example the PBOC provides cheap loans or cheaper loans compared to regular loans to banks, which then only can use this, these, this capital to fund, renewables, or green projects, and coal was recently removed from the PBO CS Green Project eligibility catalog. So this year, only a few days ago. So that means that it would you say that this is an indication of kind of moving in the right direction. Because us You mentioned in the last interview that removing subsidies, could be a sign that China is moving in the wrong direction in terms of green energy transition.

Emrah 9:11 It's always the thing is that China, the reason why China has moved the subsidy scheme is that the money has been used in some parts of China in a negative way or not negative but maybe not as efficient as the central experiment. But this, of course, doesn't mean that China will not use this money elsewhere, into the coal industry, for example, Of course, our research and development is still going on. And there was also huge development of further hydro energy and solar energy, etc. So these are the technologies that China is heavily focused on. And you can see that everything is compared to the price of the illusion from code. That was the, the benchmark price in order to measure the efficiency of renewables. So it's I think definitely China is expecting that. A measure of maturity of the industry will achieve PhDs. Normally, when for example one of the coastal provinces have achieved a sufficient amount of industrial maturity, then it will spread to the other provinces. Because of the knowledge that has been created, that particular province tops I think overall in the next five years we would like to see a more robust and more mature industry. Track.

Esben 10:48 Alright, thank you for that. Now I'll move a little bit more into the green bond universe. So in our, in our research we identified three main motivations for companies to issue a green bond. One would be the, it's sort of a signaling signaling or marketing tool to indicate to the market, that they are moving in the right the right direction. The second is taking genuine action towards greening and changing their long term business plan and business model. Interest restructuring or otherwise. And the third final one is

simply to be able to prolong their co2 emissions co2 heavy emissions models, as, as, as the case or arguably as as the case with green coal. So, in your opinion, what do you think are what motivations do do fossil fuel energy producers have to issue, green bonds in China.

Emrah 11:55 Yeah that's a good question. Well, the fossil fuel energy producers, by that particular You mean the energy companies,

Esben 12:02 yeah, yeah,

Emrah 12:03 of course, the thing is that the energy companies in China are regarded as basically is the state owned enterprise. So this is a part of the local municipality or the local province provincial ownership. In some cases, but the whole thing is that the motivation comes from the fact that the governors or the local governments, has the governors, the governor has a kind of some particular KPIs key performance indicators which they have to be there. And some of those are economical KPIs, such as GDP, and also job creation, results. Number four local growth. But another thing is of course the local pollution levels, and I think China is also moving towards measuring more of its emissions, both from particles, but also carbon emissions. And this is also what you see that some of the larger companies have been motivated towards using more green resources in order to bring down emission levels. So if they cannot compensate for the amount of emissions that they, they send out in the atmosphere, they have to find that our emissions elsewhere, create more green jobs or credits or more green products in order to balance the amount of emissions. Yeah. So this kind of say that the the the companies or the energy companies are forced to deliver on.

Esben 14:01 Yeah. So, with the PBOC sort of excluding fossil fuel or coal and other fossil fuels as green bond eligible projects on the ground, it doesn't really have a the intended effect, because they are SMEs and they don't. They aren't affected the same way, privately owned enterprises.

Emrah 14:28 You can say that they have to deliver some, some, some specific goals and targets, and I think each, each company is being tested and checked upon in terms of the economy, and also the rest and so I think China is becoming more and more strict towards its authorities. The energy agencies, but also the energy companies in the industries which are already heavy emitting carbon particles will see some, some benefits if they can live up to these goals. This is the most motivating factor.

Esben 15:14 Yeah, okay. So now when I ask a question, but it doesn't matter, it doesn't.

It's, it's fine if you can't answer specifically, but which energies industry sectors benefit most from issuing targetlink bonds, a green bonds that have these Use of Proceeds requirements, such as climate change mitigation or adaptation, do not suffer can signal, do no significant harm and decarbonisation. Here I'm specifically interested in. Operating. Operating expenditure heavy versus capital expenditure, heavy market players.

Emrah 16:00 Not sure if I understand your question correctly, I mean, would you like to know which industries issue most conditions I believe bonds, such as the green bonds.

Esben 16:17 So some, some, some industries will have a higher upfront costs in terms of developing a project, as opposed to, for example, gridlines, that only have operating costs. So, when they issue a green bond. I know it's quite technical if you don't know green bonds, it's sort of difficult for you to answer but I was wondering if you could give some insight into what what motivates companies in general to seek funding, external funding work when you're OPEX heavy or capex heavy

Emrah 17:00 motivation comes from the business. Well, first of all, because, in any case with capex and opex a business model is very important so I think the first one is to show a case study or a business model that has the lowest amount of CapEx and also the lowest environmental impact. This is also something that's very important in China. Maybe this is one of the criterias that the image companies need to be presenting before they can be eligible to get any kind of funding, okay suppose is the, the utility. Utility economy. So this is the ongoing expense. And I think this is also something that will be looked upon in terms of the amount of the break even point you know the the payback time of the business case, which makes any business case a great deal if they have short term payments. But again, I think also the graduate, environmental impacts will also be measured with it with a or a parallel to the holidays because I think this is where the motivation factor comes into picture, that every year the company's mission is based on DISAPPEA emission targets and emission measures along with operational expenses.

Esben 18:27 Okay, thank you. Now we'll move on to the coal in China. So we've already talked about coal fired a lot, but how realistic, do you see China's ambition to make coal fired power plants, obsolete by 2060. And this, keeping in mind that China in 2020 added 38.4 gigawatts of add capacity.

Emrah 18:55 Yeah, this is a question, because frankly I don't have a class for that I can look into. And my heart says,and wishes that, that this is something that China can

realize, both for the global society and also for China. But of course it is also mentioned code is very cheap and is economically, something that is very patient. Why, because all the long term effects in terms of environments and also the human life. Likelihood health implications might be itself a good reason to move away from coal. This is objectively true and but I will say that even though China is constructing a new coal fired power plants. For example, to this year. In the beginning of this year, the Ministry of Environment and ecology or Ministry of Ecology and environment in IE, you cannot actually make the kind of a hearing, or they have been investigating the National Energy Administration, but the amount of new lithium coal fired power plants, and whether any has been living up to the restrictions that appear of that a crude, or didn't feel awesome. And they actually didn't restrict the amount of coal fired power that will be built. So they actually asked me to work to come up with an explanation to the city council. And this is something new in Chinese and the main streets, start bashing all of originalism, the energy companies, or the industry, in order to make an awareness of the stop the recording industry so I think this is a nutrient that we will see more and more. And this is also one of the reasons why he is existing today is a new mainstream China.

Esben 21:07 China has been issuing green bonds since 2016 to fund coal specifically. And now in our paper and also I noticed that you're wearing the SDG pin that our respondents from Nordea, the EIB say have noted that green doesn't shouldn't just be about environmental impact, it should also consider the context and in China, the context is as you say, employment, jobs that that also have to be created in the code when considering funding or financing, green projects. So, in the long run. No, sorry, forgot. No, yeah. So, could you put coal in the perspective of long like long term viability. Visa-a-vis we like the ecological civilization that Xi Jinping talks about.

Emrah 22:18 Yeah. I think the initial plan was to go back in time. The premise was to make coal, green, and make it a part of the Chinese society in terms of the industry because many cities in China is also being built upon coal mining and coal manufacturing, but we can say that. I think this this ideology has changed a bit. Also with ecological civilization because it's not, it's, it's rather impossible to make something green. I think also that this is something that China is realizing slowly. Also with the current announcement by Xi Jinping that they will start from the Commission stock, the socialization extension of coal fired power. This is a new trend, a new signal a new path will be taking. I think this is the kind of move that it has been proven that cobalt cannot be made green, because even though you're putting in our filters and carbon capture etc from steel to coal mining

the coal is laying piles outside it releases a lot of co2. You cannot avoid that. That's one of the evidences from from from the real world, you can say. Yeah.

Esben 23:51 But, so the statistic I mentioned before with China's capacity building in 2020, being around 38 gigawatts, that also include decommissioning, so is that maybe a sign that China is increasing efficiency, energy efficiency of coal plants, and thereby justifying the greenness aspect because what is defined as green is basically just decarbonisation. So,

Emrah 24:24 if we separate those two things. One of them is the green sources either one is energy efficiency, I think, for the whole sector. Energy efficiency is all necessary. So, if you can do things more energy efficient means that you get more energy for amount of fuel that you're burning. That doesn't mean it's becoming green, it's just becoming more efficient. But with the the the green ideology ideology. It actually means that you remove the sources that, that, that takes to to out from the ground and puts it into the atmosphere, but it is a global, global warming of nations, greenhouse gases, etc. So I think there's a huge distinction between that I think, even though I think the energy efficiency work being done in China will be done. Also in the future, it's not a greenwashing. I think there will still be working on doing the energy efficiency part, but of course, making anything biopolymers more energy efficient, makes them more competitive. That's a lot. So you can say in that context. Well you can say that, in order to expand a lot of people have goals I promise they will make them more efficient, because also, some of the coal fired power plants cannot be decommissioned by the way, this will have payback period to the nodes economical.

Esben 26:08 So there are sort of co2 emissions locked in for the next decade or so.

Emrah 26:15 I would say so. Because the argument is also Mr. Xi Jinping relations. The President mentioned that, after 2025 We'll start building new, new coal fired power plants. So in the next five minutes there will still be building, in fact, to a small extent, but those will not be equal conditions,

Esben 26:33 immediately. Yeah, of course, another. So the nearing the end. Thank you for staying over, over time, regarding natural gas. So, in the, I don't know if you've heard about the EU taxonomy on sustainability, sustainable economy. Yes, well they recently excluded or it's in, they're discussing whether or not they should exclude natural gas as being able to be labeled green. So at the moment it's it's it's not set yet. But could this

potentially be China's next hurdle, sort of, because now in Europe. Coal is sort of labeled Brown. And if we now start labeling, natural gas as brown. Will this be another burden for China going forward, because they are in the top 10 of natural gas, they have top 10 natural gas reserves, I think,

Emrah 27:42 I think, I don't think that China, at least not in the next many years will go the same way as Europe was because the thing is, Europe is, or maybe the European countries in general is 10 2030 years ahead. Some countries are having China, economically, we had plenty of time to mature, our industry, to go from coal, biomass natural gas and other sources and now you're moving towards renewable energy sources really moving away from biomass in Denmark. You know, for China to do the same thing to go through that phase as well, that otherwise, that will mean, they're actually dropping stuff. And they will never be able to do that, this transition period. So there's kind of a level of inequality, and this is a process. So for now, China will look upon natural gas as something that is green, definitely agree in complex code, and gradually maybe in the future, somewhere in future, but I think they will be investing heavily in the importance of natural gas from Southeast Asia, from Russia, etc, building more pipelines gas pipelines, this, this is also something that will boost the local economy but also something that will replace the coal, otherwise it will have nothing else to do based on how big an industry and the energy demand of China is, then you cannot go ahead and remove coal and natural gas seam cheese

Esben 29:35 is your the maturity of development should should be incorporated into what we can determine is green, that is basically our argument as well. So now for a concluding question. What do you think is the most important and or effective tool in accelerating and ultimately achieving a green energy transition. Here I'm thinking of government, led efforts such as policy setting regulations market mechanisms such as supply side reform, private investors and society in general

Emrah 30:18 public government pass, they have to keep on researching or supporting the financing research and development. This is extremely important. So sometimes they need to have the political setup where research and development both in China, but also incorporated in other countries can further be developed. They also need to establish regulations that supports the agreement gender. This means that, making specific events benchmark, careers, but the initial pricing that supports the green resources, but also puts more taxation on the more immediately more polluting sources. And also I think it will be beneficial if China opens up more towards the Korean companies can come work cooperate

with the Chinese energy companies, in order to develop more green projects together. And also, that also goes, the external financing into China, because if the foreign companies can operate more freely in China, cooperate more with the developers, then of course the national investment banks or pension banks, etc ATF etc, will be more willing to to put their money where it matters. In China, and I think this is the way, a very important aspect as well. Regarding the Society of course, there needs to be a culturally cultural understanding of the importance of not using coal because coal is something that is only being used by the energy companies in the power plants and industries. Coal is something also be used in rural areas for example in China. So overall I think it's the government and society's responsibility to work together. Of course the government's role here is to educate the future generations to understand why is it important to have a proper climate agenda and to deliver upon it. And together, even though it might be more expensive.

Esben 32:52 Thank you very much. All right. Sorry for going over time. Regarding your comment on letting more international players onto the Chinese market. For the Foreign Ministry sake, I hope that's possible, but when you think about China's emphasis on these in your 14 Five Year Plan Danish embassy report. Think there's those three key things that China sorts sort of values most and one of them is energy security. I know it's hard for me to imagine that they would allow foreign, foreign forces into that key industry, but let's see

Emrah 33:46 if they cooperate in a joint ventures, where, for example Danish companies and Chinese companies can work together to deliver upon the single agenda. Then I don't see that as a troubling question in fact there are many wonderful things in China. They have the bigger companies and universities, but also if you look at hiring for example, you have to be away from from France that is operated industry distributed systems. And I don't think the energy security is something that, that will be damaged by this. The fact is that this security, which Chinese prefers is to have enough energy, preserving and heating, when there is a need for it. But I think that it should also be solved with the help of foreign companies such as making properties. And also making it possible to have proper trading scheme. So in this economy transfer, transfer from from province to province, without much difficulty, kind of intellectual property agreements. Purchase Agreements. So those are the parts of the past and the companies that work together.

Esben 35:08 All right, I'll stop it here, and of course thank you very much for your time.

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10.4.1 Semi-structured Interview Questions

Interview outline Notes

Green Energy Transition vs. The Energy Infrastructure Financing Gap

Thesis introduction and research questions

The project addresses the financing gap that stands in the way of a global green energy transition. By looking at the key emitters, USA, EU and China, we investigate green bond effectiveness in closing this gap in financing compared to other types of funding methods.

Our research question is: Are Green Bonds an effective tool for funding the Energy Transition? A Multi-Level Impact Assessment of Green Bonds.

Our paper discusses whether green bonds are truly being used to enable large amounts of capital to flow in the right (green) direction: decarbonisation targets in line with the Paris climate goals. The paper also discusses greenwashing of green bonds in terms of the use of proceeds clause and, here China is an interesting case regarding 'green coal'.

From this interview, we hope to gain insight into what motivates certain industries to seek green bond financing in order to achieve a green transition.

General Energy Sector Questions

Without going into detail on the current energy mix specifics, how would you describe the current state of development of China's green energy transition on the ground?

Which sectors are receiving the most positive/negative attention by stakeholders such as government, regulators, and society at large? - Here I am looking to coal caps, incentives, policy goals etc.

How is the electric energy grid system developing?

In our last interview, you stated that getting rid of subsidies for offshore could indicate China isn't going the right way? Is this still your view?

Green finance emerging – the PBOC provides cheap loans to banks for financing of green projects - essentially switching from subsidies to incentives and more in line with China's ambitions in supply-side reform

In our research we have identified three motivations for green bond issuance:

Green bond issuance as a corporate signaling/marketing tool indicating a genuine move towards a green transition

Taking genuine climate action towards greening and changing long term business model through restructuring

Prolonging CO2-emission-heavy business model through, essentially, greenwashing key business activities

What motivations do fossil fuel energy producers have to issue green bonds?

Which energy industry sectors benefit most from issuing target linked bonds such as green bonds (Use of proceeds requirements: climate change mitigation/adaptation, do no significant harm, positive impact on climate)

Here I am specifically interested in OPEX vs. CAPEX market players.

Coal in China – An obsolete industry?

How realistic is China's ambition to make coal-fired power plants obsolete by 2060 when China is still constructing new coal plants? (38.4 GW added capacity in 2020 alone)

Can you put this in the perspective of increasing energy needs alongside rising GDP and energy security needs vis-à-vis "Ecological Civilization" ideals?

Many green bonds have been issued to finance coal power since 2016 - The abovementioned statistic on the capacity increase also includes decommissions – Could this mean inefficient coal power plants are being replaced by less polluting ones or is that pure speculation?

China has issued green bonds to fund coal power efficiency increases and emission reductions, yet it was just taken off the PBOCs Green Bond Endorsed Project Catalogue? How does this actually affect China's largest coal power companies?

Will a reduction in funding availability meaningfully reduce CO2 emissions by 2030?

In the long run – 2060?

Does your answer change when addressing POEs vs SOEs?

Our interview findings with EIB/Nordea show that the term "green" must be viewed by

incorporating economic development and social context in the discussion.

When addressing the issue of greenwashing in terms of green coal, how would you go about this issue?

You previously stated "coal is the foundation of the Chinese society so I have to say, for them to get rid of the coal is actually a huge burden. It will be something like cutting off your legs and try to run...employment is heavily reliant on coal".

Natural Gas

Context: The European Commission has adopted its final screening criteria under the EU taxonomy, a framework for classifying green investments i.e green bonds. A key battleground has been the energy criteria, with various industry bodies and member states lobbying for the inclusion of certain technologies, such as natural gas. Amid the uproar, the Commission chose to delay its decision on whether to include the controversial technologies such as natural gas.

The EU is showing signs of slowly moving away from viewing natural gas as "green" in order to achieve a green energy transition after almost completely cutting out coal and labelling it "brown".

Does this trend put further pressure on China's green energy transition?

Concluding Question

What do you think is the most important and/or effective tool in accelerating and ultimately achieving the green energy transition? Government led efforts; policy setting, regulations? Or market mechanisms; private investors, society? Both?

Areas of expertise

Offshore and onshore wind

District Heating and cooling

Sustainable Cities Buildings

Green energy solutions (hydrogen, biofuel, biomass, solar)

Energy efficient power production

Maritime technologies

In order to save time and allow for more in depth questions, ask for permissions to use past interview transcript in Master thesis project.

In depth knowledge of political framework (PESTEL) - PBOC/NDRC newly released green project catalogue (no coal) what consequences this has on China's energy mix?

OPEX vs CAPEX

Energy sector – China specific: motivations for issuing a green bond/signaling corporate move towards a green transition/taking action towards greening depending on industry?

A green transition of the Chinese economy and society: "Ecological Civilization"

BRI: exporting fossil fuel and emission-heavy industry to countries along the road.

The 14th FYP: "Adhere to the concept that lucid waters and lush mountains are invaluable assets. Adhere to respect, follow and protect nature. Adhere to the priorities of resource conservation, environmental protection and restoration of nature. Implement sustainable development Strategies. Improve the overall coordination mechanism in the field of ecological civilization, and build an ecological civilization system. Promote a comprehensive green transition of economic and social development, and build a beautiful China."

ENERGY: "Resolutely curb the blind development of high energy-consuming and high-emission projects, and promote green transformation to achieve positive development. Expand in sectors such as energy saving, clean production, clean energy, ecology and environment, green upgrading of infrastructures, green services etc."

"Chinas overarching ambition is to establish a modern, clean, low carbon, safe and efficient energy sector. This is to be ensured by having 20% non-fossil fuel in total energy consumption by 2025, 25% by 2030 with total 1200 GW of installed capacity of wind power and solar power by 2030.

In the new 14th Five-Year Plan China is aiming to ramp up its ambitions in developing its energy sector in order to include more green energy sources and peak its carbon emission by 2030. This entails including more renewable energy sources in the provincial energy mix and development of plans to mitigate the environmental impact of the energy and industrial sector. As an overall target, China aims to increase its proportion of non-fossil energy sources to about 20%, which primarily will be based on offshore wind, solar, hydro

and nuclear."

Energy Security Energy security is identified as one of three predominant security risks to China's economic and social development in the 2021-2025 period alongside food and financial security. In order to maintain energy and resource security, China aim to improve the distribution and structure of coal production to ensure supply, while the plan also calls for a steady increase in oil and gas. The 14th Five-Year Plan also contains a target for non-fossil fuels, which includes nuclear and hydropower, to make up around 20% of China's energy mix by 2025.

Renewable Energy Offshore Wind The future renewable energy development in China includes both centralized and distributed systems according to the provincial setup, which involves population intensity and space availability. The development of offshore wind in the coastal provinces is expected to continue to develop in an orderly manner and large-scale power bases will be established in provinces with large offshore wind potential such as Guangdong, Fujian, Zhejiang, Jiangsu, and Shandong. As a measure to boost the offshore wind development, the National Energy Administration (NEA) will in 2021 issue a planning and management measures for development of deep-sea and offshore wind power, and furthermore launch deep-sea offshore wind power demonstration projects. Meanwhile, NEA urges local authorities to actively introduce their own incentives and subsidy policies in order to support a sustained offshore wind development.

Need for More Energy Storage and P2X-Hydrogen For the first time, the 14th Five-Year Plan sets hydrogen and energy storage as cutting-edge technologies. The government will organize and implement plans for future industry incubation and acceleration. In order to utilize the full potential of renewable energy sources, especially when establishing offshore wind in the coastal provinces, it is necessary to decrease the high wind curtailment levels due to imbalance of energy consumption and production. Therefore, China plans to develop more hydrogen based P2X facilities in order to store surplus energy from wind, solar and hydropower in order to produce green hydrogen.

Energy Efficiency Under the theme of green development, China is resolved to promote energy efficiency. That applies to multiple areas, but an emerging area such as data centres is specifically mentioned. The 14th Five-Year Plan also states an intent to optimize China's energy system and implement an energy saving technology transformation. In relation to smart energy, which refers mainly to intelligent upgrading of power plants, an energy efficiency analysis will be conducted in the coming years.

BIODIVERSITY: According to the 14th Five-Year Plan pollution prevention and control has high priority and environmental governance system will be improved within the next five years. According to the Five-Year Plan, formulation of a three-year plan for establishment of a modern environmental governance system will be implemented. This will among other things include building a system for oversight of fixed pollution sources based on emission permits.

Previous interview statements:

Question regarding the neccessity to include social aspects when planning a green energy transition: "the current state of the energy industry, as I said, the, the, the coal is the foundation of the Chinese society so I have to say, for them to get rid of the coal is actually a huge burden. It will be something like cutting off your legs and try to run. Because most of the developments and the economy and villages and municipalities townships etc. are based on coal manufacturing coal mining and also employment is heavily reliant on the coal industry."

10.5 Appendix - Emrah Öztunc(2)

Emrah Öztunc - Energy Sector Commerical Councillor in the Trade Council at the Royal Danish Embassy in Beijing.

Emrah 0:05 Yes, but let's switch to English.

Esben 1:04 All right. Well, um, if you could briefly introduce yourself and tell us a little bit about what your experience is related to working with the energy industry in China.

Emrah 1:16 Sure. Well my name is Emrah Oztunc. I have an engineering background as a construction engineer, I've been working in the field of engineering for more than 10 years now, and I'm working as a sector counselor here at the Royal Danish embassy in Beijing, where I'm in charge of the SSE programs for district heating and clean heating program and the quality of offshore wind, so this is the, the two SSE programs that are strictly energy related here in in China. This is a cooperation between the Danish authorities mainly Danish Energy Agency and the climate energy and utilities ministry, and the Chinese authorities. The National Energy administration and China renewable energy Engineering Institute. Yeah, so, cooperation between the countries where we are working on a political level, and also on the government to government level agenda points.

Esben 2:24 Alright, thank you. Now I'd like to go into some more industry related questions so how would you describe the current state of China's energy industry. So in terms of its energy mix and its development, trajectory.

Emrah 2:43 Good question. As you well know, China is world's largest polluter in terms of the carbon emissions and but also for for local pollution levels, so that by with that of course we mean that it would blow up air pollution levels is mainly dust. Peel two and a half. NOx SOx, etc. So those kind of pollution levels that you will usually see from countries heavily dependent on coal. China is a real primary example of that because they heavily rely on on coal for both their energy sector, but also on their industry. That's very important because China is known to be the factory of the world, all the many of the manufacturers of steel, cement for concrete and also chemicals are located in China, so that's like the world's largest manufacturers of these kind of products. And, well, how would I describe the current state of the energy industry, as I said, the, the, the coal is the foundation of the Chinese society so I have to say, for them to get rid of the coal is actually a huge burden. It will be something like cutting off your legs and try to run. Because most of the developments and the economy and villages and municipalities townships etc. are based on coal manufacturing coal mining and also employment is heavily reliant on the coal industry. So, mining, and transportation. Construction of power plants utilization of coal fired power plants and industries are heavily reliant on on coal, but luckily, they're actually taking a huge step towards becoming a carbon free carbon neutral society. With that, of course, I mean, that they are trying to to establish many more wind facilities, both onland and offshore, solar PV is also developing very very fast, while China is really far ahead with hydro power. They have the world's largest hydro dam. The Three Gorges Dam, which is located in China, and they have even much more of a big capacity for evolving or hydropower so that's something that really should be developed even further. And lastly, and this is also something that we have not as Denmark able to support, but that's the nuclear industry, which is in some countries perceived as a scheme, a sole source of fuel, or energy, but of course you have the whole issue with with with with the radioactive waste so so, yeah, there are some issues there, but but but largely they're taking shifts towards that. And also they are part of the Paris agreements. So, look at some of the other countries, large countries such as America, United States. They signed out of the Paris agreements, and the government the Trump administration, and hopefully with the new Biden administration you're coming back into the agreement again, but but China has never signed off, and China has always been part of the Paris Agreement, even though they know that it could have some consequences for their economy. So that actually proves

that they are willing to let go of their fossil dependency and the carbon burden they have, and also seek alternative ways of manufacturing and also the energy production.

Esben 7:12 Looking at this sort of the energy industry but taking with regards to government support. What the What direction is the government taking in terms of supporting the industry to meet its 2060 co2 neutrality pledge. Yes. Yeah,

Emrah 7:34 I know that's the second question you're asking for now. The 2060 carbon neutrality pledge is something that has, like appeared to miss you so it's quite a new policy. And then, and China has not revealed exactly what kind of policies they will develop in terms of this new decision made from Mr Xi Jinping though is at the moment is unclear how they will shift their industry and the energy sector towards carbon neutrality until then. But we know that at the moment, the Chinese government is developing their 14 five year plan. So the finding patterns, basically is there. The government plans on how to develop. Each of the sectors in the country, and the 13 five year plan is about to expire, is actually expiring this year, and in spring next year. The new 14 five year plan will emerge. So that will reveal how the government's plan to go out with the new 2035 and 2060 goals.

Esben 8:59 Yeah, we we've used a in our project we've used this report or a plan or proposed plan by conducted by TsingHua University for ecology and environment together with a ministry body that predicts the complete phase out of coal, and an increase 580% increase in solar investments in in offshore wind and onshore wind is also around like 300% increase. That's sort of the plan that we've used as our as the most likely plan going forward for China. But, of course, like you say there's a lot of unknowns, especially with regards to achieving 2060 goals. So my next question would be, is there a match, do you see a match in terms of climate action efforts by the energy industry in relation to make the industry align with the 2060 goals, and the needed trajectory for the greening of the industry that has to be taken in order to meet these goals.

Emrah 10:23 We don't know the 2060 goals, or how they will achieve that. For now, but but basically based on my own experiences. There are some things that need to be in place in China. If they want to reach carbon neutrality because, as I also started saying started by saying, then the coal dependency or the dependence on fossil fuels, is a huge burden. And in order to get out of this. Get away from this burden. And they really need to change some core infrastructure parts in the society. And of course, a carbon capture and storage is something that can help decrease the carbon emissions, and even help the

global. The global emission conditions, but also also by the need to develop market for more renewable energy, and also find ways to store all this renewable energy because one of the things that they're suffering largely from is curtailment in the industry. Do you know what I mean by

Esben 11:40 curtailment, I'm not entirely sure no.

Emrah 11:44 While For example, one of the issues that has occurred in China is for example when they have a lot of wind windmills, and wind farming and the wind is there. The wind is blowing, so there's a nice real resource, and they couldn't actually just start the windows right. And since they don't have the, the necessary infrastructure to supply the electricity to the largest cities such as Beijing, Shanghai Guangdong, etc. And the electricity is not able to be to be transmitted. And they don't have any means to store that huge amount of electricity. So the only thing you can do is to curtail away that wind. So that means that you don't start the generators, and there is no electricity being produced, even though there was a lot of wins. So, they don't have like batteries. They don't have the facilities to store all the electricity. One thing that China is reliant on something called hydro storage. And so that's well basically if you think about a hydro dam, or a kind of a reservoir up in a mountain, what it's about is that you pump the water populates this. That's like pumping the water uphill, to create potential energy, and that will be stored in the reservoir. And when you need energy you can have that water to come through the generators are so efficient, that you lose a lot of energy in that process. And what about but that's what they have at the moment and batteries are very expensive and environmentally polluting and and hydrogen. Technology is not developed yet. So power to X is not something that they can use already by now. So there's still things going on on on on the research and development side when it comes to energy storage and hydrogen etc. Those are the things coming back to our subject. And the question. Those are the things that we need to develop more on, especially in storage facilities.

Esben 14:16 So, now, towards ccus. Do you think coal free China is possible. I mean, what, what, how would you judge the likely hood of that

Emrah 14:40 China, that's a very interesting question. Of course, I mean, I think everyone will be looking forward for a call from China, but but but when you're looking at into different sectors in the Chinese society. Many things begin from the coal industry. I mean, it is so rooted in the, in the Chinese society and in the communist ideology. That is, it

is a fundamental shift it needs to take in order to let go of that dependency. As I said, they have like cities and villages, built solely for the purpose of coal miners to live there. They have like specific railroad connections and insistence sale routes and, which only transports coal power plants, only built for the purpose of burning coal and producing electricity for the, for the societies, they have the world's largest power plants, based on coal, which is located actually here in Inner Mongolia, and they are also importing all the coal. This is something that many people don't know. And that is not because they don't have enough coal, but that's because the quality of the coal they have in China is very low grade, which means that the quality is not very good. And the reason why I say that is because for example for steel production. Coal is an ingredients when he wants to produce steel. It's an active ingredient in the steel component. So they're actually produce. Sorry. They're actually importing a lot of coal from Australia. So they're actually selling a lot of coal from Australia, and also from some other countries in order to produce good quality steel. So, this just gives a picture on, on how reliant, they are on the, on the, the, the coal industry. And, and then, well, we can say that China will try, in any way to justify the use of coal. And, in any way, to, to, to convince the global population and the global society that you can produce energy and manufacture by the usage of clean coal. This is the term. The China Chinese government has used many times, and inventors, they are the inventors, of the so called Green coal. So, the idea is to produce electricity by emitting as low particle pollution as possible. And then, claiming that the energy is green. But that's not a possibility when you also release a lot of co2 into the atmosphere and contribute contributing to global warming. And that is why the CCUS has actually emerged. And now, because now I know sounds like crazy ideas for that they're actually building some carbon capturing facilities in some cities and consider that you don't have to be an engineer or you don't have to be a scientist to know that if you build a tower that circulates air in the middle of a city with the purpose of capturing carbon. That's not going to work, or I mean co2, that's not going to work because the concentration of carbon emissions of co2 in the air is not as large as in southern Chile, which releases co2 into the atmosphere so now the next thing is, if you really want to use carbon capture, you need to build them inside the heating cloud the power plants or the heat plants for that metric.

Esben 19:01 It's also so energy intensive. I mean, it requires so much energy just to capture the co2 from the, from the atmosphere so it's really. So my next question is where does ccus fit in with regards to the coal industry.

Emrah 19:24 As I said, if you're talking about the coal industry specifically, China, I mean the Chinese coal industry. And of course, ccus is something that we can help promoting promoting the, the continuous usage of coal industry. But of course, I mean, at one point they need to start moving away from from the coal dependency. But of course if, if, if there are no alternatives provided for the Chinese industry in the form of renewable is something that is also useful, that they will start using nuclear. And that's the alternative because China has the world's largest population and the energy demands will not only increase because of increased population, but it also increased because of increased GDP. So what I mean by that is because when the populations becoming richer. Each Capita is using more Giga joules per hour, because they're becoming richer, they will. And also, we are as global society is putting a lot of demand on China, and we want them to have a green transport system transportation system. We want them to invest in electrical cars electrical buses electrical trains etc. But all these things provide more demand for the electrical grid, and at the same time we also asked them to go to codependency without providing them with any alternative. So what is the next thing is either nuclear or more renewable energy. If you don't make a renewable energy more available and cheaper then of course the Chinese society cannot get rid of the codependency. And I think that also as far answers your question on the short term, I think the CC us can really help making the coal industry in China cleaner. And what are the long term. And both the coal industry and the nuclear nuclear dependency has to be removed.

Esben 21:49 So you say there was like a window of opportunity for ccus to be applied in the coal industry. But eventually, it will not make sense to use coal together with ccus. So my next question is, do you see from the Chinese perspective that it makes sense to invest in a very capital high capital requirement technology. When the lifespan of its use is already known to be limited

Emrah 22:25 Lifespan of CCUS or?

Esben 22:27 yeah I mean. So you have to develop ccus, to be able to be implemented on a large scale, but it's not there yet, so that requires a lot of capital investments. But the use you get out of the ccus, as it's applied to a coal plant is limited because the life of coal plants in the energy mix is limited. So does it make sense to invest in rd and technology from China's perspective.

Emrah 23:02 Definitely. First of all, If China can produce the products themselves. And that can provide a huge benefit for for for your for China. And I say, I would say that

ccus is kind of a bridge technology so this is a technology that will in the beginning, be very useful to justify the use usage of coal in the coal fired power plants, but with time, because we have eateries many many times. China will do best with getting away from from from from the coal industry, also for their own stake, because the emissions does not only occur at the coal fired power plants, but also from the mining industry. Now again, this is also kind of like science. But if you mined coal from the underground and put them in huge piles in the open space. They will also, you know, there will be a lot of gas diffusing from from from that, as well. So, so there you also have emissions coming out, and you also have another emission coming out every time you put a hole into the ground. Because there's a lot of methane, there's a lot of gas, not only carbon, carbon dioxide but also other gases underground that are released in the process so the mining industry, I mean, the beginning. The first point in the industry itself is a lot of pollution so if you have the the mining industry the logistics, the transportation and the power plants. Many people focus only on the power plants, but you also have the mining industry you also have the transportation industry. All of these parts, the whole chain, the you know the the market changing sector chain is the supply chain is polluting. That's why I say that ccus is a bridge technology. It also makes sense for all the existing power plants to be equipped with ccus. But China is also exporting a lot of coal fired power plants through the Belt and Road initiatives and learn about all of these power plants in Cambodia in Sri Lanka. In Africa and in the Arab world you know in the Middle East. Now they're also doing it in Romania and Moldova, Ukraine, etc. They will start doing it in Turkey, and also in the, in the South Central Asian countries. And, I mean, they are waiting for territories to move in. As soon as America and Australia moves out of Afghanistan. China will be there will be a vacuum, where the new superpower will more in as well. If you want to compare, Denmark, with China, you can say that in Denmark equivalent. Now we're talking about rd right. In Denmark equipment is very cheap, but the cost of confining, the man hours is very large, it's very expensive, but because there is a primary manufacturer of components, technology, and this is a technology that we keep very close to ourselves, because this is our life breath. And that's why we can develop many, many things because we are very good at. If you look at China. China is still a developing country. That's why equipment is very expensive. Okay. But, employment in China is very very very cheap. That's why when you're looking at the basic industries, China's can develop themselves very efficiently in the basic industries. That's why we don't have like coal mining they might not have steel manufacturing, Denmark, because those are the kind of basic industries, and although we do have farming but that's with European

government European support. So what I'm trying to say is China will of course benefit a lot from the research and development initiatives and producing their, their own products at all for their own use, but also stop exploiting these things. And one of the examples you can actually take is batteries. China is actually much more far ahead in battery and manufacturing, compared to in Denmark. and I can do the same level as America, which means that they can actually out compete in some areas. Competitors such as Tesla, for example.

Esben 28:05 Yeah. Contemporary apteryx technology limited company that's really making some big moves in the area of batteries, but that's beside the point. So, so I've, we looked at some of some policies that China is using to sort of encourage a greening of the energy industry. And we identified carbon pricing as being a potential tool to to drive to steer the energy industry in the right direction. But with economic development teams so uneven in China. Carbon prices vary so greatly between provinces and areas. So, in 2020, they're supposed to implement a national emissions trading scheme, but do you think that is against the backdrop of this very uneven, development, that it's possible to have a real effect.

Emrah 29:16 In terms of the trading system, and if they successfully finance, a kind of green initiative to the, to the ETS. As you also mentioned the carbon taxation system that will definitely have a peck effect on evolving, the, the, the, the green transition in China.

Esben 29:43 Because you also mentioned competitiveness. So what we, we developed the model sort of showing. Okay, so if the carbon price is 40 yuan per mega tonne of co2 emitted. Then, the cost for a coal fired power plant to develop ccus, in order to reduce its what it has to pay in carbon taxes would make it so much more uncompetitive in relation to renewables because they're able to sell their spare allowances for emissions. So that would make that would put coal fire power plants under so much more pressure, compared to renewables. So do you think that they're actually, they have the necessary capital to invest in ccus technology.

Emrah 30:42 I would say, No, because it is very costly, IF they start burdening their, their life. When I say that again we are coming back to the, the huge dependency on on on the call center. So, if they start a measuring the actual amount of carbon emissions. Now, you have to think of it this way, as co2 or carbon emissions doesn't really hurt China. It hurts the global society. The China is willingly. And with good intentions, staying in this

this corporation global cooperation, but it will be like shooting yourself in the foot. If you start taxing your backbone. Because that's that's what they can rely on. So instead of pushing the the prices for carbon taxation up and punishing the coal coal industry. What the Chinese society will rather want to wait for is decreasing the energy production with renewable sources to get my point. The so called equals to LCOE factor. The levelized cost of energy, you can write it down. LC, are we. So that's kind of the. That's kind of the price, they will cost for a developer or for an energy company to produce one megawatt of electricity from one. When, when farming, Park, so So, depending on on how much it has cost to build that wind farm, how long it might live, it may be live for 2530 years you know provision, and therefore the maintenance and operation. And that's kind of the levelized cost you have for the infinite for the price. The benchmark price. The price you are comparing the ensue IE for solar, wind, and hydro nuclear etc all the renewable energy sources, the benchmark price is cool. So you compare everything in China towards coal. If you start increasing the benchmark price from coal. You also burn the society. Because who is who is going to pay that huge elevated press or electricity. I mean the Chinese population, or the Chinese people are actually not very rich, I know I was talking about the GDP going up, but but but the ordinary Chinese people are not really that rich. I know we teach people love to put in tax and taxes everywhere from cars and for flight tickets and for food, etc. but but that's not how the things are going in China. In China, it's actually the reverse the prices are trying to go down as much as possible so competitiveness is very very important but if, and that's also why we are here in China I mean this our existence. In China, as the embassy but also as the counselors, is how can we bring in Danish companies to China to help bring down the prices for establishment of wind and solar among these kind of things we don't have project, solar, but especially when it's something that we are working on. So in order to answer the question is, China will not understructure start taxing their coal industry because there will be too big of a deal for them, even for small

Esben 34:50 scales. But in the national emissions trading scheme, the initial industries that are being included are coal and gas. So I mean, it doesn't seem to be the case that they don't want to tax their coal. Could this be an indication that they are in fact, stepping up efforts to phase out coal.

Emrah 35:19 You can say that in a way, but also now, for example, for some of the renewable energy development projects in China, the central government has removed the incentives, the incentive schemes for example for the offshore wind, and it's been removed

after 2021, that, that, with that being said. With that being said means that the Chinese government now has more capacity to to close some of the other holes that they have, they have not been maintaining and one of those coal holes is of course the coal industry. So by putting more effort in optimizing the coal and improving the coal sector. China will of course do everything they can to make any kind of an incentive loop incentive means rewarding those coal fired power plants with subsidies, if they can maintain a low co2 emission level, while on the other hand, taxing those coal fired power plants, which has a large amount of co2, but in a way that is all balanced. So the ones that receive the, what gets the, the normal reward from from those who have the penalty. Of course, there has to be some some kind of reward also for the local governments, the local governments in the future in China, or actually as it has always be Nbd will be measurements with with with in terms of their their their their criteria you'll succeed, for how good they are at reducing their emissions. But that's not the only deal. They also have other KPIs, such as job creation. If you close one coal fired power plant in China. You need to make sure that those 500 people, how much, how many people that has been jobless can get a job elsewhere. Now, if you have somebody who has been working in the coal industry for all his life for more than 20 or 30 years, you need to re educate re educate him, and you need to make sure that he can do the same job in another industry that is more green. So that's why there's not there's actually many other hidden agendas, or hidden burdens that we don't talk about. And it sounds very easy to just put some taxes on the on the coal fired power plants and expect that they will pay for it but but if it ends up the coal fired power plants goes bankrupt or they are forced to close down, and that will not only hurt the energy company, but it will also hurt local society. The people, but also the local governments.

Esben 38:23 So you're saying that an emissions trading scheme will likely not cause coal to be phased out rather a slow and controlled phasing out that takes into account. Other, much like you said the layered two issues related to closing these down

Emrah 38:48 will be a slow transition, it will be. So phasing out of the call dependency and that's also why they have those long term visions long term goals, but but the path towards that. 2060 goals is very steep, and they have to take like minor baby steps. Also not to overturn the population. So I think there are things that like there are different strings, being played with here. One is energy efficiency, and also the, the storage, and the hydro, the politics, but also the current capture will make the, the, the burden from the call the ETS less, less impactful to the society.

Esben 39:49 So regarding ccus Is it the, is it a common topic you hear about in your line of work. I'm framing the question with some data for you to keep in mind, we found we looked at a statistic showing the, the amount of papers released by Chinese research institutions, regarding ccus. And what is a, an increase from from about 2002, up until 2017 were it peaked, so we we sort of see the increase go along with the 13 five year plan that mentioned cc us. Specifically, as a tool to sort of green the energy industry. But, in 2019, the amount of cc us research papers, was a fraction of what it was in 2017. So we sort of take this as a, an indication that maybe they've given up on ccus. Well,

Part two

Emrah 0:13 I don't know what that indication might show, but of course it's his theory, that that's one of the ways you can analyze interpreting arguments is also answering questions, and only Chinese context but also from from our other colleagues from the other analyses. Now, we have regular talks with the Indonesian Embassy the British Embassy. The other German industry, etc. It's definitely a hot topic. And the reason why everyone is interested in that is because we all have the common goal of reducing the carbon emissions in China. And the way we can help that is of course. Bye, bye. Mentioning the importance of carbon capture in the recording industry so I don't believe that this is something that's going out and I will forever say that China is still willing to promote CC us. Chinese industry because they can justify their own use. In that context, I was actually several weeks ago, maybe a month ago. We were invited for a coal fired power plant outside of Beijing, and the province, where we went as a kind of a delegation. We went for a delegation visit for our event where a huge group of Chinese workers introduced introduce us and show us around. The funny thing was that they were very keen on showing that they had low, or limited issues from the MLS and that's always been true now that cetera. While they were actually burning coal to produce electricity and heating. But for reducing carbon capture the condenser that when also we were asking for how much carbon emission there. They were not able to answer that, because they will have measured pacifically how much they are not even emission is, like, four minutes or a half an hour. That could be computed or calculated by the amount of food that you're firing and how much you expect will be released into the atmosphere. And that was remarkable because they were very busy talking about the price evaluations, but have no idea how much carbon emissions that were there were something else. So, so in one way. I think the Chinese government's will promote in the next five years. This is subjective theory, they will promote more carbon capture to emphasize because they will

be more pressure on China, and they will be more pressure. Challenges downward trends, being the worst in the world, to move.

Esben 4:00 So what should China's research and development policy look like in order to achieve these 2016 goals?

Emrah 4:09 There shouldn't be. I mean definitely there should be some incentive measures, there should be some motivation for the industry in China to use carbon capture and how they can measure the cut their carbon capture the amount of carbon has been captured. I'm not aware of simple way to do that could be for example, you have the base amount of carbon that they are emitting. That is the test. So that's the kind of taxation equivalent equivalent co2 into the atmosphere. Capture. You can start tracking the amount of carbon. And that will give them a huge stake in the amount of carbon. So that's a very simple formula. But there shouldn't be a kind of balance and they should be kind of incentives for them. And I think the ETS is a key component in that formula actually plays a huge role.

Esben 5:20 So, I spoke yesterday with the director of the Copenhagen school for energy infrastructure. And he mentioned something quite interesting that, because CCS is so energy intensive. It's not carbon neutral technology because even though you're taking co2 out of whatever whether it's applied to a coal plant or whatever it is, you still have to use emit co2 In order to generate the energy that's required to keep the system running. So if it's really the solution to reduce China's co2 is also sort of something we're unsure of. What's your opinion?

Emrah 6:14 technical arguments, exactly the discussion, but as looking at the way the, the energy supply in China is put together, we can say that, of course, I mean CCUS requires a lot of energy to be able to capture the amount of carbon dioxide in the flue gas. In China, is the base load. So, first must produce electricity. And then you have the hydro and then you have the solar, and on the other hand on top you have the ways, something like that. If China can manage to reverse that all the valuable resources. The first and then the coal fired power plants. Then they can solve their problems and also this problem you just mentioned issue is, it takes a lot of energy to start up a coal fired power plant, it can take several days to reach its full capacity. So if, if the coal fired power plant is turned off completely. It will take at least some of these to reach the full capacity or maybe 55% efficiency. In some cases even worse. Some, some of the flexibility of the CO owners in China is very bad. As I mentioned, Fortune child, to be able to turn that trends

and make the renewals, converse and Co. Last among transmission capacity transmission power lines is not good enough. First of all, and secondly, there is a hugely for storage. So you can even increase the amount of renewable energy being used. Now, all these things are possible. There will still be a huge dependency for coal, and for example, China has huge wind resources in the in the ocean. If you look at the whole coastline of China, from, from the province from Beijing, Shanghai, Guangzhou and Shanghai and although to all the rebels who won no problems and. And also, you have so much, and listen carefully you have actually so much resource you can produce so much weight. In order to cover the whole Chinese electricity demand. The whole demand and the population in those areas. So, in order to get rid of that dependency. China also wins, weeks, I think definitely, you can actually also justify that they could remain some coal fired power plants, running efficiently. That shouldn't be a problem.

Esben 9:50 The Chinese strategy going forward is likely to go to offshore renewables.

Emrah 10:00 The recent development that has happened this past year, because it's like a year ago they decided that the subsidies for newly built offshore wind industry offshore winds will disappear. That doesn't show exactly that they are going the right way. So,

Esben 10:29 Do you see limits to the use of CCS, and in case, in case you do, which limits on

Emrah 10:40 technical positions or.

Esben 10:43 So, for the use aspect of it, there's only so many products that you can create through carbon capturing carbon. So, that also means that there's, there's also a limited demand for these very specific products. If you implement it on a large scale. Does it. It has to make sense financially like if you, if you produce a ton of one specific product from a carbon. Carbon utilization, you'll flood the market, and the price will decrease, so you get even less for implementing the CCUS, that sort of one limit we've identified

Emrah 11:30 as one way of, like, talking about, that could be. But as you mentioned as your some of, specifically the application is in this applies in the cities where the concentration of co2 is largest. I can't believe those crazy stories that they're building some of those I'm currently country in the middle of cities and trying to filter co2 out of the air. That's nonsense. I mean, I don't think will ever work for you to resolve the source and secondary issues. The demands for seeing so many industries is awesome. We often use it for over something that hasn't been used for. I think this is why the storage could

come into play. Yeah I think that's also up to the industries to figure out how to further extend the use of that. Before the codependency will be removed. The carbon capture will also be likely all my money to carbon capture and industrial commodities because who knows maybe 1020 years, there will be no need for a steel production and cement production, etc. Wherever illegally for producing some kind of government is not only from coal burning but it also comes from other things, for example, cement production channel, and other things that

Esben 13:39 ties up very nicely with my second to last question. So, emissions in this high emission industries like coal fired energy, cement, like you said, are still become obsolete in terms of how pronounced they are in China's economy in the China's future economy. Do you think it still makes sense for China to invest in and develop CCUS now.

Emrah 14:16 Yes and no. Because, first of all I don't think that I remember still will become obsolete. In the near future, because that's one of the things that families can do in a very cheap way. The US has been pressing China terrorist and trade tariffs, but it's also shared that China can make a lot of money from it and the rest of the world benefits from that.

Of course from from investing in this because Windows, maybe the global society will demand more from China. In my opinion, digital society is expected from China at the moment because it's difficult. So cheap products from China. At the same time demands that they should not put you assess your production to China in order to reduce the price of the goods as cheap as possible, because you know you haven't got your hands dirty, but at the same time you ask them to use less electricity and heat and use this cover. We have an equal share in that in my opinion so chances are we'll promote that. But of course it will also be more costly, because that will require a huge amount of investments to operate all other industries. And also it will be costly in terms of, because there's a lot more. All right, so

Esben 16:26 my last question for this project we're working together with a company called Sustainalytics, they are. Yeah. Have you heard about ESG stands for environmental, Social governance. Okay, well they, they basically are an ESG specialized ratings agency so what they do is that they evaluate companies on three pillars. One environment one social and one governance. So, and then they give a score based on on KPIs. Within these three, three pillars. Do you think that a Chinese company actually cares. What, what an international ratings agency gives them in terms of VST.

Emrah 17:27 And so this is this is a Danish company or Chinese company

Esben 17:31 No, it's It's owned by Morningstar, I believe. So, big international so it's American I guess they try to engage with Chinese companies, specifically, high emission companies to sort of align better with our standards in terms of environmental reporting and governance, really hard for them to engage with Chinese companies and they've had very limited success. They got Petro China to produce a sustainability report, but that's just about it.

Emrah 18:18 Likewise, with is that oftentimes when you try to engage with Chinese government. You have to streamline your points, your arguments, and also the way that you gauge two things in this case, I assume that the environment and social aspects, social impact. Work in China, but there has to be. They have to be extremely clear about what the Chinese government is planning to do, what their focus areas are and how they can streamline their ideas, so it's parallel with the Chinese government is efficient, because if the Chinese government has some plans of how they would like their society to look like. The Chinese. The Chinese society is actually in fact, the guise of intrusion into the society, and they don't want any other cultures, Western culture for that matter, to come in and influence or change the Chinese society. His argument is that they can come and contribute to Chinese society, to provide excellent education for the Chinese, then, then we will know they will be more than willing to, of course, I assume that this is kind of a company that makes money from selling, ideas, and also getting some money from investors because now you also mentioned Morningstar, and they're engaged in how sustainable development in the world. You can kind of buy into that agenda by buying the correct sauce. I think all storage companies and stock registered organizations in the world will be interested to have five stars is that a fee or two stars, I think. I think that's the way to go as the Chinese society.

Esben 20:54 Thank you very much. It was a Pleasure.

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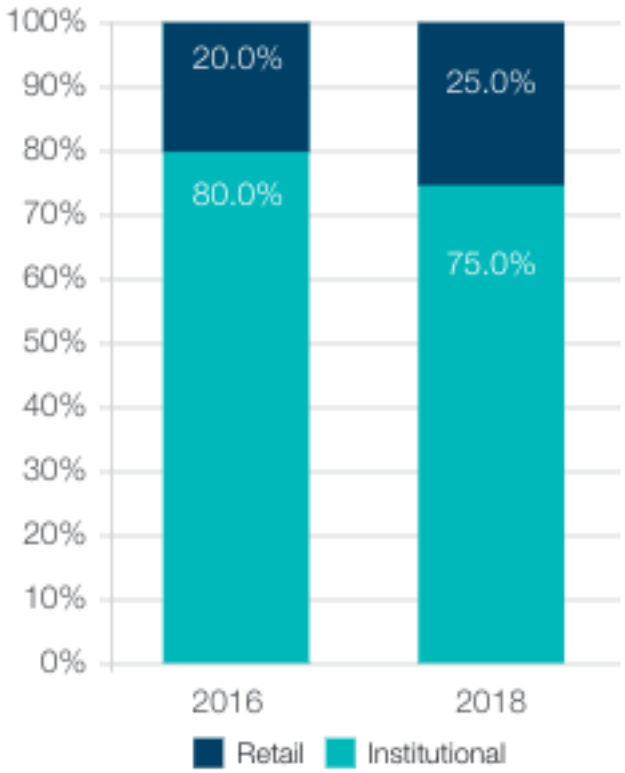
10.6 Appendix - SIC Codes

Coal mining	12
Drilling oil and gas wells	1381
wind turbine manufacture	28110
Refined petroleum pipelines	4613
petroleum and coal products – not elsewhere classified	2999
electric equipment and supplies	3699
Coal mining services	1241
Oil and gas exploration services	1382
turbine drilling services (support activities for petro & nat	9100
Electric – gas – and sanitary services	49
heating equipment except electric	3433
Electric power generation - transmission and distribution	3510
Oil and gas extraction	13
Oil and gas field services – nec	1389
electricity generation by gas turbine	35110
water – sewer and utility line construction	1623
Oil and Gas Field Machinery and Equipment	3533
wood gathering and production for energy	2200
Crude petroleum and natural gas	1311
Electricity generation facility	4911
Pipelines Except Natural Gas	46
ammonia manufacturing	2873
Power - Distribution and Specialty Transformers	3612
petro-chemical industry products (manufacture)	19201
Electricity generation facility	4931
Electricity generation facility	4939
Natural gas liquids	1321
Wind farms	35110
Crude Petroleum Pipelines	4612
petroleum refining	2911
storage batteries	3691
Solar Energy Equipment (manufacturers)	343305

Figure (10.1) reports the list of SIC codes utilized in isolating energy companies that have issued green bonds in the last decade.



Note: Institutional and retail investor data were not collected in Australia/New Zealand.

Figure (10.2) Global shares of institutional and retail sustainable investing assets 2016-2018