CARBON YIELD METHODOLOGY

Assessing the Climate Mitigation Impact of Green Bonds

THE CARBON YIELD METHODOLOGY

This methodology, funded by the Rockefeller Foundation, was produced as a collaboration between Lion's Head Global Partners (LHGP), a specialist Merchant Bank and Asset Manager; South Pole Group (SPG), a Climate Change Specialist and Advisor on sustainability-related investment portfolio risks; and Affirmative Investment Management (AIM), a specialised dedicated Green and Social Bond fund management company. The three parties will take the methodology forward through their respective practices: LHGP through their advisory business and investment activities, South Pole as third party implementers of the methodology for issuers and investors, and AIM through their Green Bond investment activities and as the first investor to use the Carbon Yield methodology as part of their impact reporting commitments.

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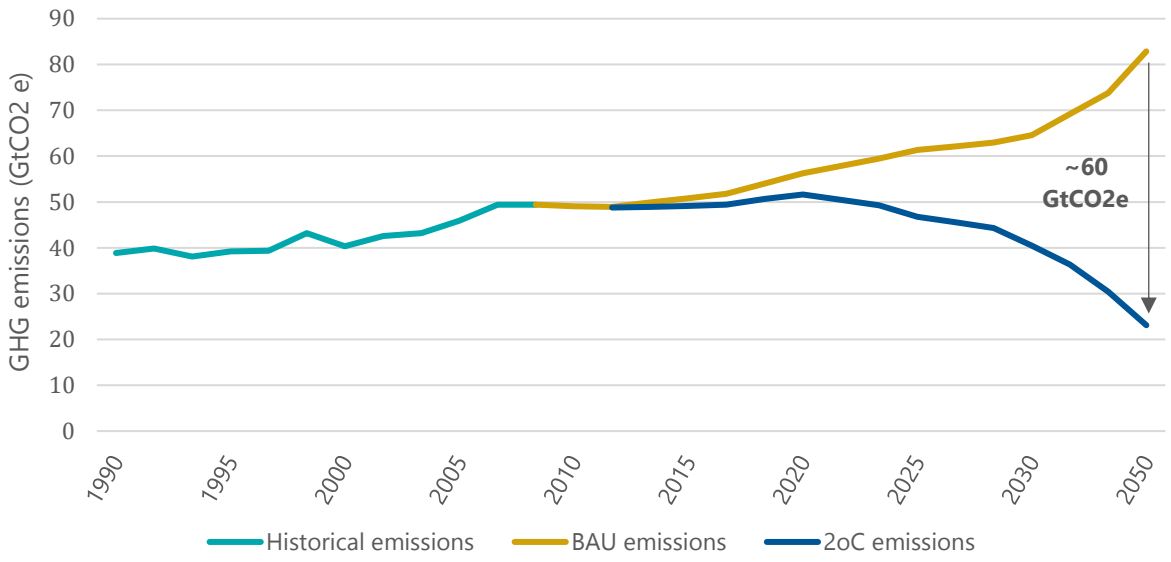
1 Introduction and Motivation

1.1 Green Bonds and Climate Change Mitigation

Estimating the impact of green investment in terms of greenhouse gases emissions avoided is important in the effort to curb climate change. In accordance with the 2016 UN COP 21 Paris Agreement ratified by 139 countries[1] to keep global warming to below 2°C we must substantially reduce absolute emissions of greenhouse gases (GHG) into the atmosphere. To do so, a globally concerted effort to transition to low carbon economies is required to reduce emissions by approximately 25 billion tonnes of carbon dioxide equivalents (CO_2e) per annum (25GtCO_2e per annum) versus Business as Usual (BAU) by 2030 and by 60GtCO_2e versus BAU by 2050. Estimates vary for the capital cost of such a transition but include a cumulative investment of $53tn by 2035 in the energy sector alone[2], and $93tn by 2030 across the global economy[3].

Figure 1 GHG Emission pathways to 2050



Source: UNEP

Notes: please note that the above graph is for illustrative purposes and does not look to provide an accurate representation of the BAU and 2°C pathways.

[1] United Nations Framework Convention on Climate Change, count as of 5th October 2016.

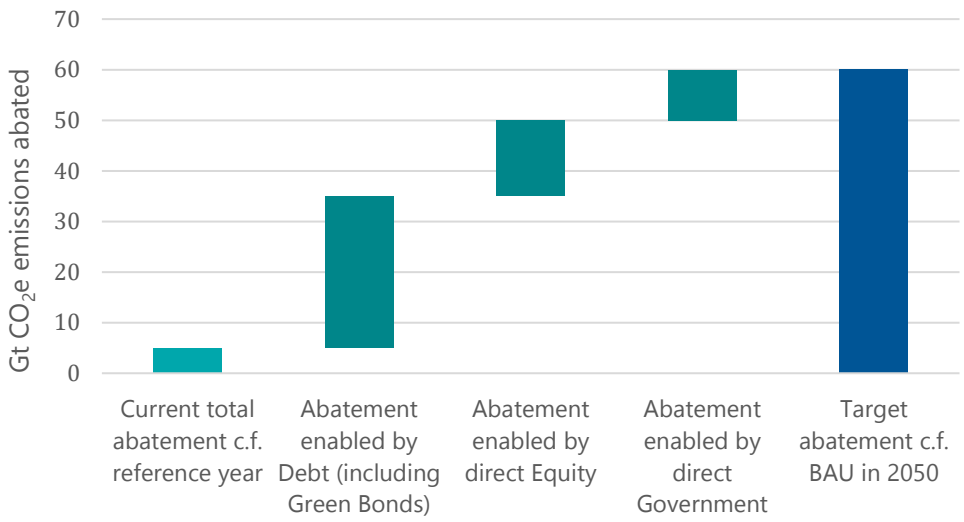
[2] "World Energy Investment Outlook" *International Energy Agency* (2014)

[3] "Better Growth, Better Climate" *New Climate Economy* (2014)

For 2030, the New Climate Economy estimates that there is a capital investment need of $6 tn per annum over the 15 years from 2015-2030, equivalent to 8% of global annual GDP in 2015. This investment is required to finance projects with an abatement value of approximately 1.5GtCO_2e per annum, implying a cost of US$4,000 per tonne of CO_2e abated. For the sake of comparison, if the carbon abatement efficiency of capital invested were instead 1 tonne of CO_2e per $1,000, the necessary amount of capital required to decarbonise the global economy would be a quarter of that currently estimated.

The global fixed income market, as the world's largest asset class, has a critical role to play in financing the transition to a Green Economy. Historically this role has been under-recognized, however the Green Bond market has been an important development in unlocking its potential. Without participation from debt investors, it will be impossible to achieve the necessary capital flows to tackle climate change. The potential role of the debt capital markets in the attainment of a 2°C world is illustrated in Figure 2 below.

Figure 2 Potential Contribution of Green Bonds to GHG Abatement Effort

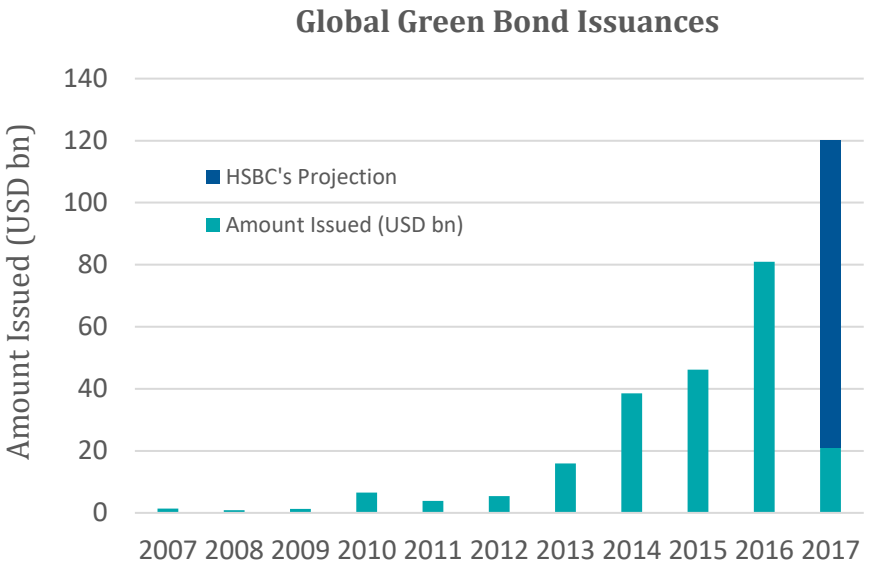


Source: LHGP (share reflective of current capital structure allocation between debt, equity and government regulation)

Despite there being no additional economic benefit for Green Bond investors, demand has been growing annually. Institutional investors increasingly make the case that their end investors care about the impact of their investments as well as the financial returns, which has contributed to growing demand for Green Bonds. Of all the impact sectors, the environmental

one is the largest and most developed. From first launch of the concept in 2007 and 2008[4], the Green Bond Market is now anticipated to breach $100bn of issuance in 2017.

Figure 3 Green Bond Issuances – historical and projected



Source: CBI, HSBC

While the pace of issuance is important, bonds mature and as such it is important to know the absolute value of bonds outstanding at any point in time and the volume of bonds maturing, so as to provide an indication of the amount of net new investment into the green economy annually. Currently we estimate that the outstanding balance of Green Bonds in the market is $150bn[5].

Despite knowing the size and composition of the Green Bond market, we currently have limited ability to assess and compare the contribution these investments are making to the global climate change mitigation targets described above as no universal quantitative impact metric has been applied to these instruments. Without such information, it is impossible for investors, policy makers, project developers or the wider climate change and investment communities to estimate progress towards reducing emissions.

As the Green Bond market evolves, there has been growing demand from investors to be able to quantify the impact of their investments. Green Bond Principles (GBP) and the Climate Bonds (CBI) Standards guidance include impact assessment and reporting. A number of issuers

[4]The World Bank Green Bond (2008), an early version of the EIB Climate Awareness Bond (2007), formed the generally accepted Green Bond Use of Proceeds template. The 2007 EIB Climate Awareness Bond, sized at EUR600mn and maturing in 2012, is generally accepted to have been the first climate targeted bond. The World Bank launched with SEB its own green bond a year later in 2008, totalling SEK3.35bn and maturing in 2014 (Climate Bonds Initiative 2017)

[5] Source LHGP analysis of CBI data: March 31st 2017

are beginning to provide information on the estimated impact of their Green Bond programmes. The current format of the information provided by issuers, however, is not easy to use for investors: as each Green Bond can finance multiple projects across different geographies and in different currencies, comparison across issuances is difficult. As a result, impact assessments are challenging. In 2015 a coalition of 11 Development Finance Institutions (DFIs) and development banks collaborated to develop a harmonised framework for reporting, looking to increase comparability of different issuers' Green Bond Programmes[6]. Though not yet widely in use this crucial first step in creating a universal approach to impact reporting, including the climate mitigation impact in terms of GHG emissions abatement, is what this initiative looks to build on. Where the harmonised framework looks to standardise ex-post annual reporting, we propose to introduce an ex-ante estimate of Green Bond's impact, thus increasing transparency at issuance.

Understanding the impact of Green Bonds is valuable and can incentivise allocation of capital to Green Bonds in general. While there are multiple factors that influence an investor's decisions to invest in one bond versus another, by increasing transparency around the decarbonising impact of investments, the contribution of capital markets can be better understood and tracked, facilitating investors in making informed choices. Although we recognise that there are many important broader impacts associated with Green Bonds than GHG abatement, such as increasing climate resilience, the attempts to measure GHG abatement are currently the most advanced in the market and therefore the initial focus of this methodology.

It is important to note that the concept of GHG abatement impact has a high degree of geographical specificity: the absolute amount of emissions displaced depends on the baseline emissions in the given area and the local context (climate, industry and landscape). However, the impact of a tonne of CO_2 is global, so tonnes saved in one geography has value to society as a whole, and indeed to an investor, regardless of home geography.

Meeting climate mitigation targets requires a tenfold increase in the volume of green financing. We do not believe that this can be achieved without a simplified system to estimate impact. To address this issue, we propose the establishment of a quantitative GHG impact metric for Green Bonds: **The Carbon Yield** (C_Y). Under the Carbon Yield methodology, the annual carbon equivalent abatement potential of a Green Bond can be transparently calculated by issuers and independent third parties, and used by investors. This is different from what is currently offered by the market which are primarily qualitative assessments of Green Bonds.

[6] "Joint Communication on a Revised Proposal for Green Bond Impact Reporting Harmonization" *European Investment Bank* (2015)

1.2 The Carbon Yield

The Carbon Yield is a new metric looking to quantify the environmental impact of a Green Bond in terms of GHG emissions avoided through the financed activities. The impact is expressed in Potential Avoided Emissions (PAE) enabled by the use of proceeds of the bond in terms of tCO_2e /unit of capital/year, i.e. how many tonnes of carbon dioxide equivalents (tCO_2e) are expected to be avoided per unit of investment per year[7].

e.g. Company Corp. €500 million 02/2025 3.5% **0.735(C_Y)**

(C_Y) = tCO_2e/€1,000 /year

An investor holding €1,000 of this bond for a year, would have enabled 0.735 tCO_2e of potential abatement[8]. Similar to traditional coupons, partial year holdings can be calculated on an act/365 basis, by multiplying the yield by the number of days held divided by 365. Although, unlike a coupon, the carbon yield has no intrinsic monetary value. This metric allows investors to compare the climate change mitigation impact of Green Bonds, and simplifies impact reporting for both issuers and investors.

Investors can aggregate the Carbon Yields of different bonds in their investment portfolios to obtain a portfolio level Carbon Yield. This can then be communicated to their own investors as part of their impact reporting. By using the Carbon Yield investors can ensure that the mitigation impacts of their Green Bonds holdings are being calculated consistently.

The Carbon Yield (C_Y) of each bond is calculated at the issuer's Green Bond Framework[9] level, and thus is a weighted average of the carbon yield of each project within that Framework. As such the Carbon Yield of bonds issued under one framework will be the same (avoiding issuance arbitrage).

Capital Raised under Framework (€mm)	Potential avoided emissions (PAE) financed through projects committed to under Framework (tCO_2/year)	Carbon Yield - applicable to all bonds in Framework (tCO_2e/ €1,000/ year)
500	367,500	0.735

[7] The lifetime GHG abatement of a project is annualised over its operational lifetime and construction period (where relevant).

[8] This will be the potential impact enabled through the debt; the Carbon Yield does not give legal ownership.

[9] The issuer's Green Bond Framework is a document which, in accordance with the Green Bond Principles, outlines: the intended use of proceeds from the issuance, a process for determining and evaluating projects eligible for financing under the Framework, how the proceeds will be managed, and the reporting the issuer intends to carry out on the use of proceeds and impacts.

By providing a simple, globally recognisable, and quantified impact metric upfront, the Carbon Yield (C_Y) provides significant benefits. The C_Y will enable portfolio managers to simply calculate the abatement impact of their holdings and issuers to more easily report their GHG impacts at year end. This impact metric is intended to assist investors by increasing the amount of information available to them, and to encourage additional capital to flow into the Green Economy. The quantitative nature of the metric allows for cross-issuer comparison of estimated abatement at framework level, such that those investors interested in the mitigation impact of their investments can use this to compare issuances. On a market level, the aggregate yields will provide an estimate of the potential GHG abatement that the Green Bond market is contributing to the effort to curb climate change to below 2°C global warming.

Investors will "accrue" abatement impact in the same way that they accrue coupons. The relevant proportion of annualised GHG abatement impact will accrue to the investor by holding a position in the security over a period of time. It is important to stress that the PAEs apportioned to the debt holders are a non-tradable metric, without an explicit monetary value and not usable as an offset or part of any traded carbon credit system. The system's sole purpose is to enable investors to compare and report the environmental value enabled via their investment.

Green Bonds may finance projects which benefit from incentive schemes, such as the UN Clean Development Mechanism (CDM) or Verified Carbon Standard (VCS) systems. In these cases, the carbon yield of the project should match the value being reported under the CDM or VCS, but they are used for different purposes. The carbon credit is a tradable asset, while the carbon yield is simply a reporting metric. In this context, the metric works equally well with assets that are outside a standard Carbon trading system.

This methodology is for the first iteration of an impact metric that will evolve over time to consider impacts beyond those of GHG emissions alone, such as water efficiency, biodiversity and resilience, thereby more broadly representing the "green" impact of Green Bonds. The accuracy of the impact calculations will improve as data availability increases, and the investment community continues to demand increasing transparency. The methodology will be adapted as appropriate in conjunction with the evolution of the green bond market and industry guidelines.

2 The Methodology

The methodology looks to create a simple metric which **quantifies** the potential GHG abatement enabled by Green Bonds. Such a metric will allow investors and issuers to understand the impact of their investments, and the wider community to quantify the aggregate impact of the Green Bond market on global emissions, and thus track progress towards achieving a 2°C scenario.

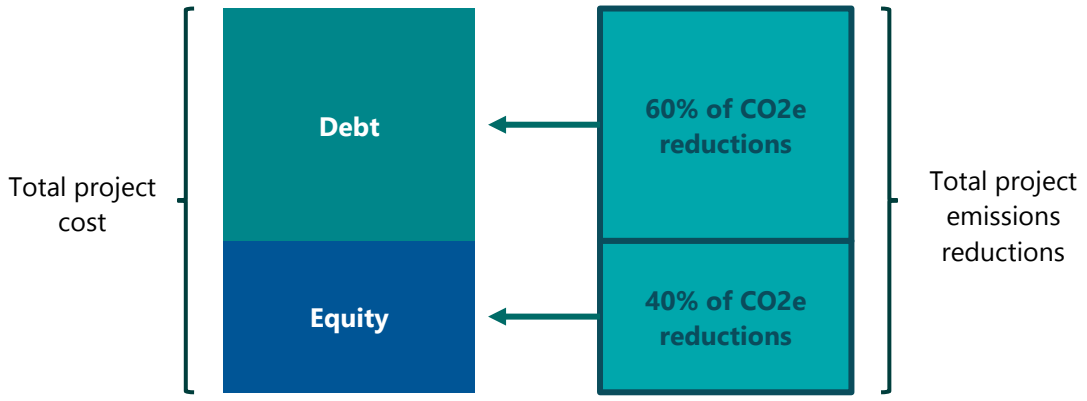
No standardised, quantitative metric and associated guidance, is currently widely used in the market. The Carbon Yield associated with a particular Green Bond Framework will be the same for all bonds issued under that framework, and will be updated annually – as the underlying portfolio and amount of bonds issued changes. Having this metric associated with each issuer's Green Framework allows immediate comparability of assets and easy aggregation of impact for investors.

2.1 Conceptual framework

Under this methodology, we propose a structure for conducting an evaluation of the GHG abatement potential of Green Bond frameworks, which is then summarised in the Carbon Yield. The aim is to assess the "potential avoided emissions" (PAE) of greenhouse gases achievable through a Green Bond framework and convert it into a per 1,000 $/€ (or any other currency)/year metric. Avoided emissions are defined as anthropogenic emissions of greenhouse gases (GHG) that would not have occurred if an activity had not taken place.

In our approach, we assume that GHG emissions reductions are apportioned equally across the capital structure of a project: if a project is financed with 60% debt and 40% equity then equity investors are allocated 40% of overall emissions reductions and debt investors the remaining 60%[10]. This is illustrated below:

Figure 4: Allocation of Carbon Abatement under the Carbon Yield

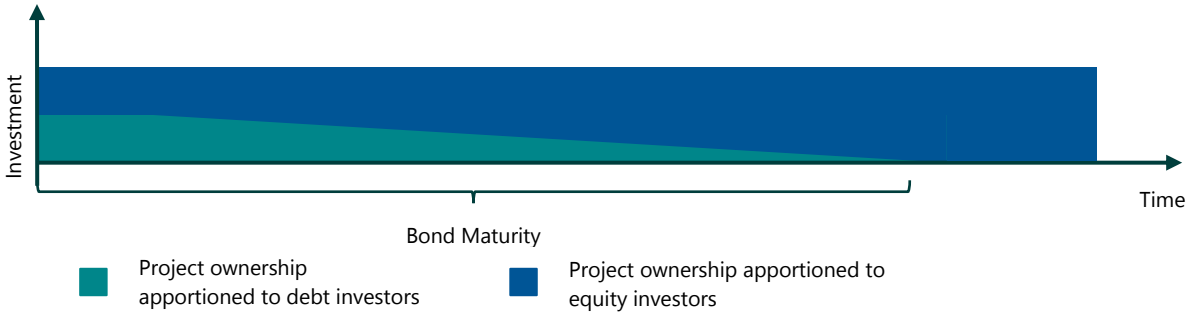


This concept can be extended to the lifetime of the project: by calculating the carbon yield on the basis of the unit capital invested, the model works across the life span of a project. While the capital structure of a project may change over time, under this methodology the carbon yield of a unit of invested capital remains constant.

It will be observed that this methodology can enable non-debt investors to calculate the Carbon Yield of their holdings as well.

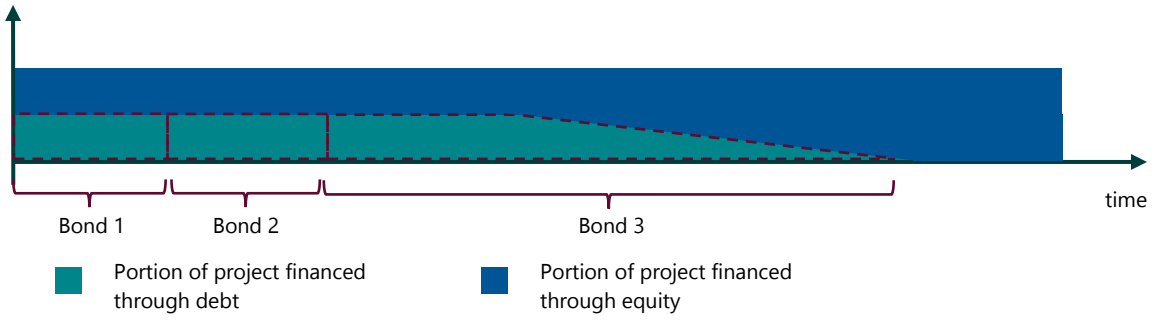
[10] Please note that the capital structure given here is an example, different projects will be financed using different sources of capital in differing proportions.

Figure 5: Illustrative Project Capitalisation

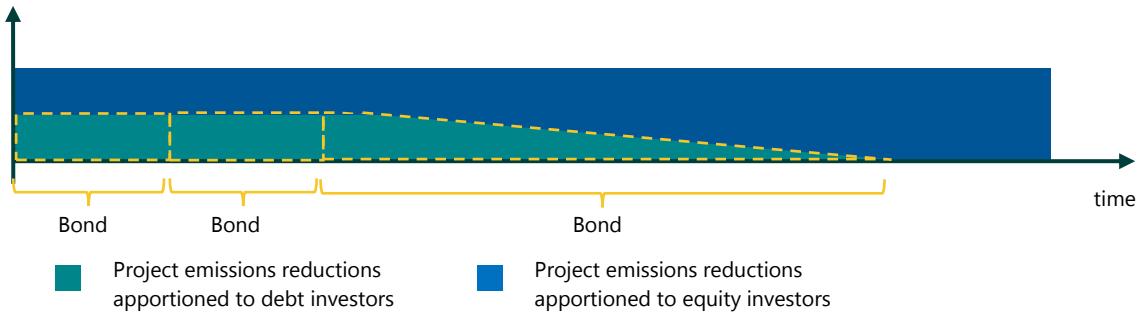


This methodology avoids double counting within the same project by allocating enabled emissions reductions to stakeholders per the capital structure. As the graphs in figure 6 below illustrate, the total emissions to be allocated does not change and the Carbon Yield of a unit of invested capital does not change. However, as Bond 3 in figure 6 amortises, the amount of CO2e that the debt investor can claim declines as the invested debt notional declines.

Figure 6: Example of an Amortising Project Debt Structure with Refinancing



The associated allocation of enabled emissions reductions:



Double Counting is further discussed in Section 2.3.1.

Whilst we go through the methodology for calculating the Carbon Yield in detail in Section 2.4, it can be summarised by the steps given below:

1. First, projects and activities funded through the issuer's Green Bond Framework are identified and categorised according to sector and sub-sector[11].
2. Second, relevant baselines for each project/activity type must be identified. To calculate the abatement potential of an activity, a reference emissions baseline is needed.
3. Then for each project (and/or activity/sub-sector) the potential annual GHG abatement is calculated. This metric is defined as the average GHG abatement for the underlying project's expected lifetime, or the operating GHG abatement[12], adjusted for the construction years (where relevant). Under our initial proposal, we do not adjust the Carbon Yield for GHG emissions *created* during the construction phase, although in time and as disclosure improves, the market may move to demand such an adjustment. The number of construction years is accounted for within the total project lifetime however, such that the average abatement is an average over the whole project lifetime including construction.
4. Second, the capital cost of the project is inputted. Where the full capital cost is not known, it can be imputed from technology benchmarks, published by entities such as the International Renewable Energy Agency and other industry organisations[13].
5. By combining the annual abatement potential with the capital cost of the project, the annual potential GHG abatement per unit of invested capital can be derived.
6. Once the annual potential GHG abatement per unit of invested capital is known, an issuer can allocate that potential abatement to the quantum of capital that they have invested in or committed to the project.
7. By taking a weighted average of the potential abatement impact per capital invested for each activity in the Framework, the issuer can calculate a Carbon Yield per unit of invested capital of their Green Bond Framework, i.e.- the Carbon Yield of the Green Bonds issued under such a framework. Alternatively, if the issuer does not provide a Carbon Yield for their security, the investor can still use this approach to calculate the Carbon Yield as long as certain base information regarding the use of proceeds is provided (through the Green Bond Framework).

The steps above are laid out in more detail in Section 2.4, Steps 3 – 7 in the above are under Step 3 in Section 2.4.3.

This metric is simple to use, can be independently verified or calculated by third parties and provides clarity to investors.

[11] What we refer to as sub-sector in this document some market participants call "technology"

[12] The abatement achieved during operational years of the project, i.e. from project completion to decommissioning, excluding construction.

[13] The relative availability of such benchmarks depends on the sector addressed, these are widely available for certain activities, such as renewable energy generation. For other sectors however, additional research may be required to generate useful benchmarks.

2.2 Intended users for this methodology

The Carbon Yield methodology is intended for use by all market participants: issuers, investors and analysts of Green Bonds. Though the methodology will be the same for use across these groups, the information available will differ. Issuers will use a primary methodology and investors will use an adapted methodology, with an accompanying Transparency Metric (Section 2.5), reflecting the differences in access to data.

- Issuers - When this methodology is being used by an issuer, or a third party charged by the issuer with the calculation, it is assumed that full disclosure of use of proceeds and other relevant detail will be provided for the calculation of the Carbon Yield. Bond underwriters will want to ensure that the issuer has provided the necessary data to support the reported Carbon Yield on a bond at the point of issuance (guidance given below). This process will likely require bond underwriters to request an opinion from the issuer of the validity of the calculation. For this reason, we anticipate that most issuers will request a specialist advisor to perform and verify the calculation. The data may not necessarily be publicly disclosed, but will be available internally to the issuer and to the third-party provider.

- Investors and analysts - Importantly, investors or asset managers can also use this methodology to estimate the Carbon Yield of any Green Bond including those issued without a public carbon yield. However, in this instance, investors will also need to consider the quality of data available as they may not have access to the same level of disclosure as the issuers or their third-party verifiers. Such calculations will rely on publicly available information, which may affect the accuracy of the result. Therefore, if a stakeholder, e.g. an investor, uses the methodology without direct access to framework specific information about the use of proceeds, we propose that the transparency of the communication surrounding the bond should be evaluated. For example, investors would consider how well the issuer communicates the impact goals of the bond through their own reporting, a "Second opinion" or other available data. This is accounted for in the adapted methodology through an accompanying **Transparency Metric (Section 2.5)**.

2.3 Technical Considerations

GHG Emissions

Currently, the Carbon Yield methodology does not include the implicit GHGs *emitted* by activities financed via the Green Bonds assessed, such as during construction. However, we encourage all relevant parties to conduct full GHG inventories of the activities financed. We anticipate that over time, such negative externalities may be included in a future generation of Carbon Yield.

Currency Considerations

For the majority of currencies, we propose the calculation is performed per 1,000 of the unit of capital e.g. per $1,000, €1,000, £1,000 or CNY1,000 (which will be the form used in this methodology going forward). For currencies with an exchange rate of over 10 to the USD, we propose that the unit is changed. For example, for Japanese Yen or Indian Rupee denominated Green Bonds a multiple per 100,000 of invested capital would be more appropriate.

We propose that the Carbon Yield is not adjusted to a common currency, consistent with the coupon of a standard bond. Instead, Carbon Yield refers to a unit of capital invested in the currency of the bond. To compare projects, investors will adjust the Carbon Yield for the invested currency. For example, an identical project with a capital cost of £200mm is financed with a £100mm Green Bond in Sterling and a $125mm Green Bond in USD and the stated Carbon Yield of the two bonds will be different in their respective currencies. However, when translated back into a common currency (£) they will be identical, as long as the exchange rate between GBP and USD has remained constant at 1.25.

Definition of Green Bonds

The purpose of Green Bonds is to raise funds for new or existing projects which aim to achieve environmental benefits. Green Bonds are generally self-labelled and there is currently no universal industry definition of what constitutes a Green Bond or a standardised approach to measuring its impact. Issuers, external reviewers and other stakeholders have different approaches to Green Bonds. Increasingly, the market recognises the Green Bond Principles (GBP) and the Climate Bond Initiative Standards (CBI) as the preponderant guidance[14].

The Carbon Yield methodology adopts concepts from the GBP and the CBI to define the Green Bond subcategories.

Climate Aligned Bonds

Climate Aligned Bond (CAB) or Green Bond where there is not a specified use of proceeds is a type of corporate bond where proceeds do not fund a pre-defined green activity, for example, through a general corporate purpose bond. The universe of CABs is thought to be far larger than that of Labelled Green Bonds, in part due to the significantly lighter reporting required (i.e. no use of proceeds reporting is necessary). While CABs may ultimately lead to positive environmental impact, these bonds are not required to produce a Framework, thus there is little transparency and disclosure on the actual use of proceeds. As such, we propose that the Carbon Yield methodology will not be applied to these bonds.

The Carbon Yield methodology can only be applied to Green Bonds which comply with the levels of disclosure advocated by the GBPs and CBI Standards. In particular, the methodology requires a Green Bond Framework and adequate annual reporting on allocation of bond

[14] www.climatebond.org

proceeds to projects. The need for a Framework arises from the need for project details to calculate the Yield. Therefore, a bond issued without any indication as to its purpose will not be suitable for a Carbon Yield calculation.

Additionality

When presenting the effects of a project or an investment, it is important to discuss the concept of "additionality", a term that is often used in relation to Clean Development Mechanism projects as defined under the Kyoto Protocol. A project is *additional* if it can be proven that its effects would not have occurred in absence of the project activity. Green Bond frameworks are instruments subject to market demand without set criteria and therefore, additionality for the projects financed via the framework is rarely established. This issue should be taken into consideration when discussing the potential benefits of a bond. Consequently, we have chosen to use the term 'potential avoided emissions' (PAE) when communicating the climate benefits of a framework or project.

2.3.1 Double Counting in Carbon Accounting

It is important to highlight the risk of double counting. Two main types of double counting can occur when apportioning emissions reductions to financial securities such as bonds and equity: 1) double counting vertically across the value chain, and 2) double counting within a project. Note that as the Carbon Yield does not give legal ownership of the avoided emissions, but rather seeks to apportion *enabled* emissions, therefore any double counting will not distort an existing trading or offset system.

1. <u>Value chain double counting</u>:
   Value chain double counting refers to double counting of emissions reductions along the value chain of a project. For example, in the construction of a wind farm, the wind-turbine manufacturer might issue a bond (potentially a Green Bond) to finance their research & development costs or working capital for inventory and internally allocate some or all expected future emissions reductions from their turbines to the bond, as the products they produce eventually lead to emissions reduction activities.
   The developer of the wind-farm may also issue a Green Bond, referencing these same emissions reductions. Under our proposed methodology, the value chain participants could be included in the Carbon Yield of the project for inventory that they hold prior to sale, assuming that they can provide data on the projects where the assets will be deployed. This is consistent with allocating a yield during the construction phase of a project, as the manufacturer is using debt to finance working capital it uses to hold inventory for a project. However, after transfer of the assets to the project via a sale, under this methodology, the potential carbon abatement impact will transfer to the project as well. As the manufacturer has no outstanding credit to the project. In the case where the turbine manufacturer was to provide capital goods to the project in lieu of investment, then the manufacturer would qualify under the Carbon Yield methodology. It should be noted that value chain double counting will always be a complicated issue that can never be perfectly defined, but will require a case-by-case assessment.

2. Overlap double counting:
   One of the main uses of Green Bonds currently is to refinance existing projects. Double counting would only occur if a new Green Bond with a Carbon Yield is issued to refinance another maturing Green Bond that also has a Carbon Yield, but before the original bond matures. We call this overlap double counting. As issuers face a negative carry from such pre-financing, there is a disincentive for excessive pre-financing, therefore we propose that this challenge is acknowledged, but cannot be perfectly eliminated.

2.4 Calculating the Carbon Yield

2.4.1 Step 1 – Assessment of the framework projects: do they qualify as Green? Do they count towards GHG abatement?

To assess the PAE of a Green Bond framework, the impact of projects in the frameworks' project pool must be catalogued and aggregated. For example, if an issuer's project pool consists of twenty projects, ten may be selected to be financed via the bonds issued under the Green Bond framework. The PAE enabled by those ten projects will be estimated and allotted to the total amount of capital raised under the framework. Sufficient information about the projects must be available to estimate the GHG impact of these, and eventually the Carbon Yield of the bond framework.

It is important to note that a framework can also contain projects that are environmentally beneficial and vital for a climate smart economy but can't be identified as materially reducing GHG emissions (e.g. some water or adaptation focussed project), these projects will be excluded from the Carbon Yield assessment.

The below table shows a suggestion of categories for the types of projects that can be financed via the frameworks which would be eligible for a Carbon Yield. Projects outside of these categories are also accepted if a GHG abatement outcome can be proven, including, for example, projects with an adaptation focus containing an abatement component.

Primary Categories	Example project activities	
Renewable energy	*Energy generation*	*Wind*
		Solar
		Geothermal
		Bioenergy
		Hydro

Energy efficiency	*Eco-efficient products: Products increasing energy efficiency* *Retrofit/Upgrade of buildings*
Pollution prevention and control	*Waste to energy*
Construction	*Green Real Estate, Low emission construction material usage*
Clean transportation	*Rail and mass transit*
Sustainable waste and water management	*Distribution, treatment, capture and storage infrastructure*
Sustainable agriculture and forestry	*Agricultural, forestry and wetland activities* *Sustainable management of living natural resources*
Conservation and appropriate[15] Adaptation activities	*Aquatic and terrestrial biodiversity conservation, adaptation activities (as appropriate)*

2.4.2 Step 2 – Establishing Baselines

A baseline is needed in order to quantify the amount of potential avoided emissions generated by the project. The baseline describes what would have occurred under a Business as Usual Scenario; in energy, for example, this would mean generating the same amount of energy using the current energy generation mix of the grid, in the case of a project financing electric transport it would be the transport system fuel mix currently in use. The PAE are calculated as the difference in GHG emissions between the baseline level emissions and the scenario where the project occurs (project scenario). The project scenario provides an ex-ante estimate of the projects' GHG outcomes.

The environmental benefits of a project and the associated project-specific baselines would ideally have been calculated by the issuer when the project was selected for inclusion in the framework, however this is often not the case. If a baseline was not published by the issuer or the one used is deemed insufficient by the third-party service provider charged with calculating the Carbon Yield, a new baseline will need to be developed. It is important to adapt the baseline to the time period the project is active. For example, if the baseline is the grid supply of electricity, it should reflect potential changes in the grid energy mix during the projects lifespan. The baseline(s) should be updated in the yearly revision.

Simplified baselines:

In cases where an investor conducts the Carbon Yield calculations independently from the issuer, it may be necessary for them to apply simplified baselines, i.e. generic baselines for

[15] Activities which will result in quantifiable GHG abatement.

different sub-sectors and regions, depending on the amount of information made available by the issuer. Examples of which can be found in Appendix 1 or via external sources, e.g. through the UN Clean Development Mechanism framework.

2.4.3 Step 3 – Calculating and Aggregating results

In cases where issuers have conducted their own PAE calculations, we would recommend that the results be reviewed by a third party to ensure that they are in accordance with this methodology. This is in line with the recommended use of second opinion providers under the Green Bond Principles and the Climate Bond Standards.

Calculating results

GHG accounting will be conducted where the methodology is being used by the issuer, or by a third party on behalf of the issuer. The service provider will calculate the potential avoided emissions from the project activities. The choice of assumptions and emission factors should follow a conservative approach. In other words, when choosing data points, the value generating the lower amount of PAE should be chosen.

1. Calculate the PAEs of a project, for each project financed through the issuer's Green Bond framework:

   PAE = Lifetime Generation [16]* Baseline Emissions Factor

2. Calculate the yearly PAEs by dividing the Operational Lifetime PAE by the total project lifetime (including construction).

3. For each project the total PAEs are then divided by the project cost in the currency that the Green Bond is issued in, giving PAE/ unit of capital / year.

4. For portfolios of projects, a weighted average PAE for the whole portfolio is then calculated using the amount of capital disbursed to the projects (or the amount of debt issued under the framework) giving the Carbon Yield of the portfolio.

To do this the following type of information will be required:

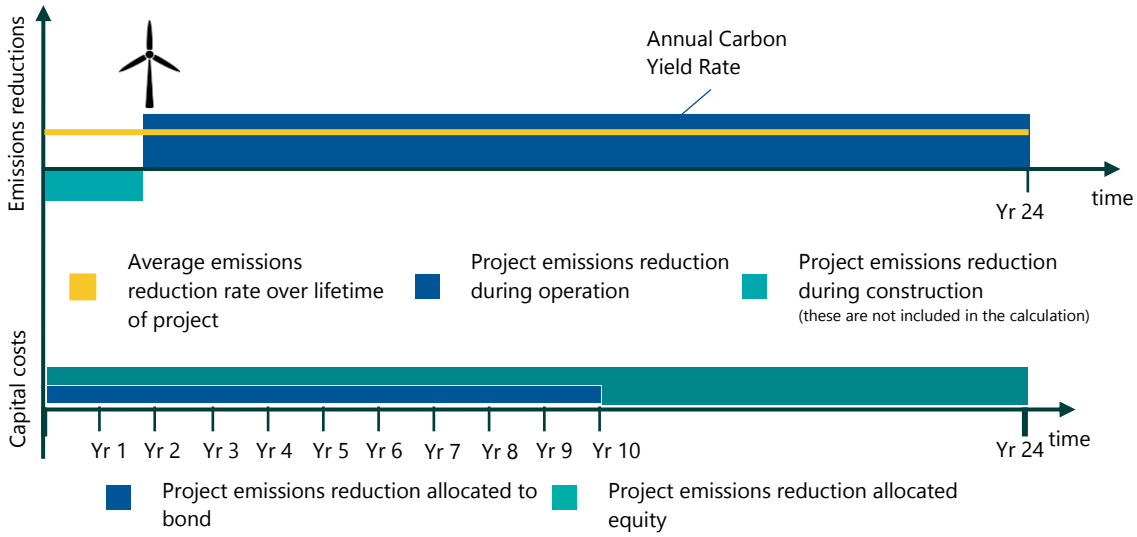
Required Information		Example
1.	Define project category	*Renewable energy*
2.	Define project sub-category	*Wind power*
3.	Specify region	*Europe*
4.	Define operational lifetime of project	*22 years*
5.	Define total lifetime of project	*24 years (including construction)*
6.	Define baseline scenario	*Average grid electricity mix emissions*
7	Identify relevant emission factors	*IEA: World Energy Outlook*
8.	Specify capital cost of project	*E.g. €100 mm or derived from industry benchmarks*

Depending on the type of project, the exact data requirements will differ. Below you will find an example showing how to estimate the avoided emissions from a wind farm project.

[16] Lifetime Generation applies specifically to the electricity and power sector, however equivalent values should be used for other sectors. For example: "activity" in the case of electric vehicles displacing baseline GHG emissions from fuel combustion, or energy savings in the case of efficient housing.

Worked Example of the Carbon Yield Calculation for a single project:

Figure 7: Worked example: Wind farm financed via a €250 mm Green Bond



Step 1: Calculating the projects' total potential emissions reductions:

$$\text{Lifetime generated electricty} = (\text{Installed capacity x capacity factor}) \text{ x } 22 \text{ years}$$

$$(280\ MW\ x\ 22\%\ )\ x\ 8760\ hours\ x\ 22 = 11{,}871{,}552\ MWh$$

$$\text{Lifetime Potential Avoided Emissions} = \text{Generated electricity x baseline grid emission factor}$$

$$11{,}871{,}552\ MWh\ x\ 0.525\ tCO2e\ per\ MWh = 6{,}232{,}565\ tCO2e$$

Step 2: Calculating the project's life time PAE per €1,000

$$\text{Potential Avoided Emissions per €1,000 of Investment} = \frac{\text{Lifetime Potential Avoided Emissions}}{\text{Total Project cost (in units of 1,000)}}$$

$$\frac{6{,}232{,}565\ tCO2e}{250{,}000} = 24.9\ tCO2e/€1000$$

Step 3: Calculating the project's PAE per €1000 per year

$$\text{Annual PAE per 1000 of investment} = \frac{\text{PAE per 1000 of invetsment}}{\text{Total project duration}}$$

$$\frac{24.9\ \text{tCO2e/€1000}}{24} = 1.04\ \text{tCO2e/€1,000 /year}$$

$$= 1.04\ (C_Y)$$

Step 4: Apportioning PAE to the Green Bond issuer's Debt:

In this example, there is only one project, thus each €1000 of project's debt that the issuer holds has a Carbon Yield of 1.04 tCO_2e per year. So, an investor holding a Green Bond referencing solely this project, would accrue 1.04 tCO2e enabled emissions reductions per year for each €1,000 of bond held. If the investor were to hold €50mm for 1 year, the investor would accrue 52,000 tCO2e emissions reductions. Importantly, an equity holder that owns €1,000 of the project has also enables 1.04 tCO2e per year through that investment.

Aggregating Results at Portfolio Level:

Calculation for an issuer portfolio of more than one project and more than one bond:

1. Calculate the annual PAE per 1,000 of investment for each project, as per previous example, to obtain a rate for each one, except in this case the investments are in USD:

   Project 1: Wind 1 has a PAE of 0.87 tCO_2e/$1,000/year

   Project 2: Wind 2 has a PAE of 0.93 tCO_2e/$1,000/year

   Project 3: Solar 1 has a PAE of 0.75 tCO_2e/$1,000/year

   Where a bond is financing projects in different currencies an FX adjustment will be required to ensure that for the portfolio calculation all carbon yields reference the same unit of capital invested.

2. Identify committed capital in the portfolio:

Bond	Notional	Allocated/Committed
Green Bond 1	$100mm	$100mm
Green Bond 2	$100mm	$30mm

   and project level allocation:

Project	Allocated Capital
Wind 1	$50mm
Wind 2	$50mm
Solar 1	$30mm

3. Calculate the Framework Carbon Yield:

$$\boldsymbol{Carbon\ Yield = \frac{\sum_{Framework} Capital\ allocation\ to\ Project * PAE\ of\ that\ Project}{Total\ Debt\ issued\ under\ the\ framework}}$$

$$\boldsymbol{Carbon\ Yield = \frac{(50 * 0.87) + (50 * 0.93) + (30 * 0.75)}{200}}$$

$$\boldsymbol{Carbon\ Yield = 0.563\ tCO2e/\$1,000/year}$$

It is important to note the *"dilution"* effect of having unallocated capital:
If an issuer takes a portfolio approach, providing capital to projects and issuing bonds based on demand, then there may be periods when the volume of Green Bonds issued is in excess of the amount of capital that they have allocated to actual Green Projects. This does not change the Carbon Yield of their projects, but does dilute the Carbon Yield of a Green Bond

issued by that issuer, as the abatement potential is now spread over a larger quantum of Green Bonds.

In the above example, if the total amount of issuance had been equal to the allocation to projects (US$ 130mm) then the Carbon Yield would increase to 0.865 tCO2e/$1,000/year.

If on the other hand, an issuer undersupplies the market, i.e. there are less Green Bonds outstanding than capital that has been allocated to relevant projects, then we would propose that the issuer may either chose to assign their Green Bond proceeds to a set group of projects, or that the Green Bond will be assumed to have been allocated to the highest yielding Green Bond projects.

2.4.4 Step 5 - Presenting results

The finalised result from the calculation should be the framework level Carbon Yield:

Projects in Framework	Allocated Capital	Carbon Yield of Framework tCO2e/$1,000/year
Wind 1	$50mm	**0.563 (C_Y)**
Wind 2	$50mm	
Solar 1	$30mm	

Which is presented alongside the other bond specifics:

Corporation X $200 million 2.5% 01/04/23 0.563 (C_Y)

2.5 Transparency metric

Evaluating transparency (for investors and other external stakeholders)

An investor or other stakeholders using this methodology independently of the issuer will have to rely on publicly available data to calculate the Carbon Yield. As a result, the quality of the Carbon Yield calculated will be affected by the quality of data available to the investor. This leads to a need for the development of a metric or score for the reliability and sufficiency of the information available for the calculation of the Carbon Yield. Examples of aspects to take into consideration are:

- How well defined is the use of proceeds?
- Are the environmental targets and goals clear?
- Has there been/will there be a self-assessment of ongoing and finalized projects?
- Are there second opinions or other external reviews of the issued bonds or frameworks?

The Transparency metric might be used by the investor for internal decision-making, or to be published alongside the portfolio level Carbon Yield in their impact reporting. Investors could disclose, for example, the percentages of the portfolio that fall within each transparency metric band, and/or the overall weighted average transparency of their portfolio. The publication of the portfolio-level Transparency metric will be voluntary during the first few years of existence of the Carbon Yield. As the market develops and data avaiability improves, we would look to change this to a compulsory reporting metric.

Transparency metric

The difference in reliability between results calculated with project specific information and those estimated by a third-party stakeholder with only publicly available data will be communicated to stakeholders via a transparency metric, which is derived from an assessment of issuer disclosure. The metric is a final score between 1 and 5 and gives an indication of the level of transparency the issuer is providing in publically available information.

The points awarded differ between indicators depending on the level of detail of the information required to fulfil them. The lowest score possible (1) requires the fulfilment of the compulsory indicators 1 and 2, each worth 0.5 points. No score is given for partial fulfilment of an indicator. An example of what the Transparency metric might look like alongside a portfolio level Carbon Yield is given below, this is the weighted average of the transparency scores of each underlying bond in the portfolio.

Carbon Yield of Portfolio tCO2e/$1,000/year	Transparency Metric
0.563 (C_Y)	**3.5 out of 5**

The information required to fulfil the indicators can be obtained from a variety of sources depending on how the issuer has chosen to share information surrounding the framework, for example, websites and reports, It is possible that the information required to fulfil all indicators can be found in one single document, for example a report on progress or a second opinion.

The table below shows the seven indicators, the type of information required to fulfil them and the score awarded for completion. We highly recommend that when the Carbon Yield is calculated by an investor or stakeholder the transparency metric is reported alongside the Carbon Yield as an indication of the quality and level of information available to calculate the Carbon Yield.

Indicator		Requirements (type of information required)	Score
Stage 1: Compulsory Indicators to Determine Carbon Yield Eligibility (Maximum Score Available = 1)			
1. *	**Geography: Region**	The regional allocation of proceeds for 100% of the frameworks' raised capital. The regional division to be used is: • Central & Eastern Europe • Central Asia • Developed Europe • East Asia • Latin America & Caribbean • Middle East • North Africa • North America • Oceania • South Asia • Sub-Saharan Africa	**0.5**
2.*	**Sub-sector**	The type of projects financed on a sub-sector level. • For example, for renewable energy projects wind power would be considered a sub-sector.	**0.5**
Stage 2: Determining degree of transparency associated with the Carbon Yield (Maximum Score Available = 5)			
3.	**Established baselines**	The technology or behaviour being displaced by the activities financed via the framework.	**0.5**
4.	**Geography: Country**	The country allocation of proceeds for the frameworks' raised capital.	**0.5**
5.	**External review**	An external review by a third party confirming the GHG abatement benefits covering either: • The framework, • The bonds issued by the framework • The projects financed via the framework	**0.5**
6.	**Reporting on progress** (Can only be completed after	A regular report on progress specifying the GHG abatement benefits covering either: • The framework • The bonds issued by the framework	**1.0**

	fulfilling indicators 1-3)	• The projects financed via the framework	
7.	**Project specific information available** (Can only be completed after fulfilling indicators 1-4)	• Information specifying the inputs and outputs of the projects financed via the framework and showing the environmental benefits of the project implementation.	**1.5**
	Total		**5.0**

*Indicator 1 & 2 are compulsory. Without their fulfilment a framework is not eligible for a transparency score.

3 Disclaimer and further information

This material is for your private information and we are not soliciting any action based upon it. This material is based on information that we consider reliable, but we do not represent that it is accurate or complete and it should not be relied upon as such. We, or persons involved in the preparation or issuance of this material, may from time to time, have long or short positions in, and buy or sell securities futures or options identical with or related to those mentioned herein. No representation or warranty, expressed or implied, is made as to the accuracy or completeness of the information contained in or derived from this methodology and nothing contained in or derived from the methodology is or shall be relied upon as a promise or representation. The methodology does not purport to contain all the information that may be required to analyse debt securities. Lion's Head Global Partners, South Pole Group, Affirmative Investment Management and the Rockefeller Foundation do not assume responsibility for the accuracy or completeness of this valuation tool. Furthermore, you agree that Lion's Head Global Partners, South Pole Group, Affirmative Investment Management and the Rockefeller Foundation will not have any liability to you relating to or resulting from the use of this methodology. This methodology is to be taken as guidance for the calculation of the Carbon Yield, and neither Rockefeller nor any other parties involved in the drafting of the methodology will be responsible for the validity of individual Carbon Yield calculations.

As the Carbon Yield is a metric meant for use by the market, we welcome feedback from market participants and stakeholders. The Carbon Yield will evolve as the market does, and we hope to expand it beyond GHG impact alone in the future. Furthermore, the current metric is based on potential expected impact, as the transparency of the market increases and reporting becomes more dynamic, we envision the Carbon Yield becoming more dynamic and precise also. To provide any feedback on the methodology for the Carbon Yield please email us at info@carbonyield.org.

Further information on the methodology can be found at www.carbonyield.org.

3.1 Appendix I – Example baselines

Below is a non-exhaustive list of suggested baselines for common sub-sectors[17] financed via green bond frameworks. The baseline should be adapted to local and/or regional requirements. This list will be updated yearly.

Primary Categories	Example project activities		Example Baselines
Renewable energy	*Energy generation*	*Wind*	• *Grid based electricity generation*
		Solar	• *Grid based electricity generation*
		Geothermal	• *Grid based electricity generation*
		Bioenergy	• *Grid based electricity generation* • *Fossil fuel based heat generation* • *Uncontrolled burning or decay of biomass*
		Hydro	• *Grid based electricity generation*
Energy efficiency	*Retrofit/Upgrade of buildings (low carbon performance)*		• *Reduced use of fossil based energy compared to buildings with a corresponding function* • *Materials with lower life cycle GHG emission*
	Eco-efficient products		• *Products with a corresponding function*
	Products increasing energy efficiency		• *Average use of fossil energy*
	Energy distribution	*Improved grid infrastructure*	• *Energy losses in transmission technology* • *SF6 emissions from leakage*
Pollution prevention and control	*Waste to energy*		• *Uncontrolled burning or decay of biomass*

[17] Please note that some market participants refer to sub-sectors, by which we mean "wind" and "waste to energy" as "technologies".

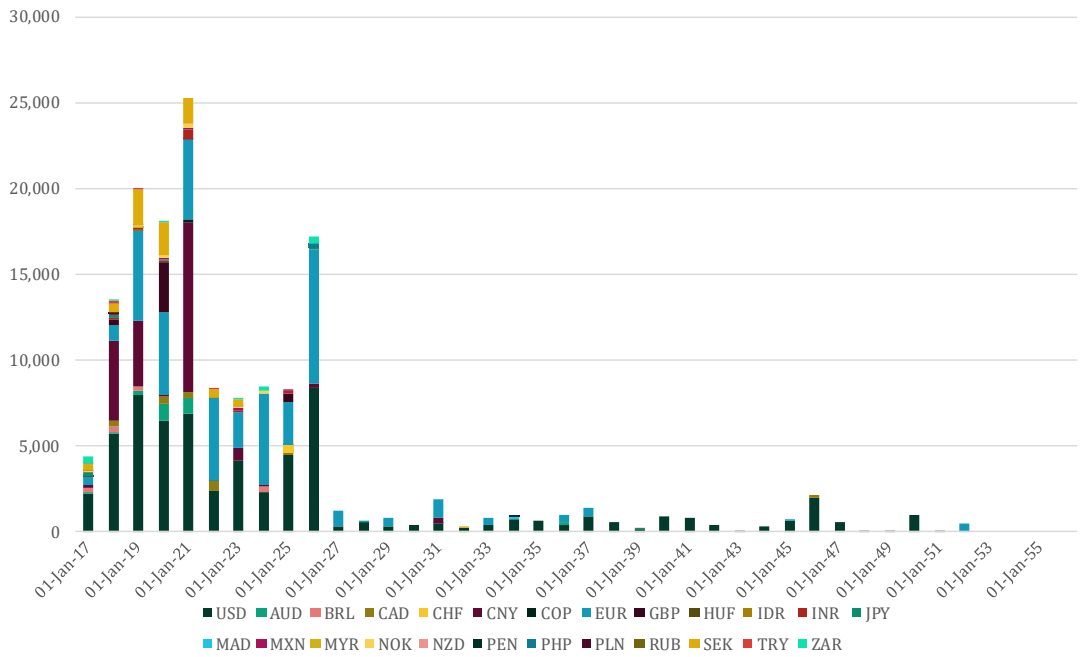
Construction	*Green Real Estate (low carbon performance)*		• *Fossil based energy consumption in buildings with a corresponding function*
	Low emission construction material usage		• *Materials with lower life cycle GHG emission* • *Reduced use of fossil based energy*
Clean transportation	*Infrastructure*	High Speed Rail System	*GHG intensive modes of transport* • *Airplane travel* • *Bus travel* • *Conventional rail* • *Motorcycles* • *Cars*
		Mass Rapid Transit (MRT)	*GHG intensive modes of transport under mixed traffic conditions* • *Bus travel* • *Conventional rail* • *Motorcycles* • *Cars*
		Bus Rapid Transit (BRT)	*GHG intensive modes of transport under mixed traffic conditions* • *Bus travel* • *Conventional rail* • *Motorcycles* • *Cars*
		Modal shift (pipeline)	• *Road transportation (trucks)*
Sustainable waste and water management	*Distribution, treatment, capture and storage infrastructure*		*Municipal solid waste management* • *Landfilling without methane capture*
Sustainable agriculture and forestry	*Agricultural, forestry and wetland activities;* *Sustainable management of living natural resources;*		• *Enteric fermentation: no change in practice* • *Rice cultivation: Flood irrigation*

There are a number of sources that can be used to identify appropriate baselines. This methodology recommends using for example the data sources provided by the UN Clean Development Mechanism framework, the Verified Carbon Standard and the Gold Standard framework as a point of departure when investigating baselines.

3.2 Appendix II – Green Bond Market as of March 31st 2017

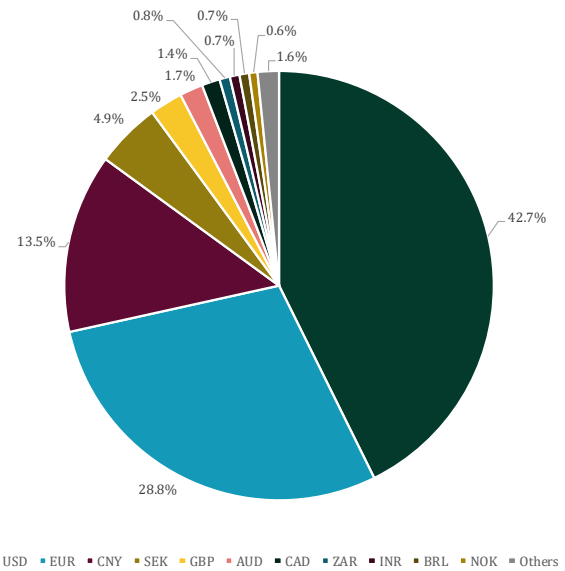
Currently bonds outstanding are denominated in 26 currencies with the majority having maturities of between 5-10 years.

Figure 8: Green Bond Market Amortisation Profile



Source: LHGP, data from CBI

Figure 9: Outstanding Green Bonds by Currency



Source: LHGP, data from CBI

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