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Trajectory Monitoring in Portfolio Management and Issuer Intentionality Scoring

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Abstract

2°C alignment has become a major issue for climate-aware portfolio management. There are sophisticated initiatives aiming to predict corporate emission intensities from 2030 up to 2100. In this paper, we focus on the significance of the 'current policy scenario', where corporates would simply stay on their current trajectories for their emission intensities. The United Nations Environment Programme has illustrated how far the global current policy scenario is from a global 2°C scenario. We want to understand this 'current policy scenario', broken down asset-by-asset within the significant emission sectors and from a global index point of view. We will address choices of emission intensity metrics and of weighting schemes. Enabling the low-carbon transition while maintaining a long-term focus in investment decision-making is a relevant approach. In this paper we intend to illustrate the virtue of the long-term choice with a simple three-year observation gap in the power generation sector's intensities. To complement our 'current policy', which focuses on the emissions track-record of firms, we illustrate a mosaic theory approach to quantifying the intentionality of a firm to green itself. Anticipating positive impacts requires that investors have identified their key questions for firm's intentions.

Keywords: Climate change, scenarios, trajectory, intentionality, decision tree

JEL classification: G11, Q54, Q56

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Key takeaways

- Climate change raises questions both about '*climate risks*' and actors' '*intentionality*' to go in the right direction. If these two are intimately linked – if we admit that wrong intentions are more likely to be penalized by the market and therefore pose a risk – it is oversimplifying and often false to address them simultaneously.

- A mapping exercise is required to link each emissions sector (SDA, for instance) projected by models to the existing business sector (GICS[1], for instance) breakdown.

- This paper focuses on the observation of issuers' emissions-intensity trajectories and on measuring their intentions to improve them.

- To avoid opacity issues on labelling methodologies, we distinguish two metrics:

  - An informative temperature tag measuring issuers' alignment. This tag is defined at the issuer level and characterizes its trajectory.
  - An intentionality score measuring to what extent the investment participated in improving climatic conditions at a security level.

- '*Alignment*' is a relative notion expressing a distance between an individual or a group of individuals and a reference. An aligned individual is an individual whose trajectory answers the reference requirements.

- An '*aligned portfolio*' can either be the remaining universe filtered by misaligned individuals (exclusive) or any portfolio, whose aggregated trajectory answers the reference expectations (inclusive). In this paper, we discuss:

  - A systematic exclusion of misaligned individuals would allow us to select the aligned individuals only (an exclusive alignment). It might not be financially efficient and leaves no room for intentionality.
  - An aggregated portfolio meeting the conditions of the reference scenario could contain issuers that are not aligned themselves (an inclusive alignment). This allows us to extend the universe with an '*alignment buffer*', increasing the robustness to outliers, and accounts for the intentionality of misaligned issuers.

- Intensities make sense when the comparison remains intra-sector (e.g., when we compare comparable businesses).

- Projecting trends requires defining a fitting period. Fitting a model on historical data is sensitive to the period definition.

[1] The Global Industry Classification Standard (GICS) is an four-level industry classification developed by MSCI and S&P in the late 1990s and is commonly used by fund managers for the sector, industry group, industry and sub-industry mapping of securities and corporates by their business activity.

- A portfolio trajectory depends on the weighting scheme. Assuming that our portfolio trajectory is the weighted sum of individual trajectories, we show that it is feasible to obtain, and to justify, trajectories for sectoral intensities that globally answer the science-based target (SBT) requirements. We use varying illustrative weighting schemes.

- Defining the emissions-intensity trajectory has no reason to follow the portfolio weighting scheme. Consequently, we propose varying ways to project the trends, emphasizing varying individuals to understand the dynamics of the intensive and non-intensive actors within the portfolio.

- Power generation (our third case study) is the only SDA sector where the trajectories of market-cap-weighted and constructions equally weighted over the entire sector allow us to reduce effectively intensities.

- Power generation's 2030 projections as of 2014 and as of 2017 have improved drastically. This visible improvement with only a 3-year gap validates the relevance of a trajectory monitoring with the simple '*current policy scenario*' approach.

- We propose a '*intensity-unit-homogeneous*' framework, where we use emissions per GDP for temperature scenarios and emissions per contribution to GDP for corporates.

  Unsurprisingly the intensity projection of MSCI World with temperature scenarios indicate that the track-record of corporates taken in their entirety is unlikely to achieve a 2 °C scenario.

- Talking about intentionality can often raise questions around the very qualitative notion of '*fairness*'. It can refer to emissions scale (size effect) or regional discrepancies (country effect). The two can be respectively corrected by playing on the weighting scheme or thanks to different target requirements for emerging countries.

- We pose the definition of a new conditional scoring framework, to track intentionality at a security level. The structure is malleable but makes it possible to apply the same methodology systematically to each issuer within the reference universe.

- Similarly as the TCFD posed a set of yes/no question to assess the disclosure of climate relevant information, we asked a set of questions to label the securities. The process is a conditional questionnaire following a bottom-up decision tree structure. Most information to track intentionality is available and that such a process, eventually completed with natural language processing is both feasible and recommended to properly assess the intentions behind the investment.

1 Introduction

The 2018 IPCC report, Global Warming of 1.5 °C, acknowledges that limiting global warming '*well-below*' 2 °C will require global and rapid transition in the entire economy. More recently, the UNEP emission gap report 2019 indicates that GHG[2] emissions continue to rise despite warnings by scientists and political commitments.

The Paris Climate Agreement has set the ground of the discussion around the 2 °C objective. This has led to an increase in demand for an implicit temperature indicator, making it possible to rank issuers, portfolios or investment strategies according to their environmental impact. From an investor's perspective, this translates into a strategic asset allocation problem and into stock or bond picking in the context of climate change, as investors have clearly started caring about the impact they can have on climate change. They need an efficient tool to measure their impact. If the '*temperature*' unit is debatable, a '*label representative of the impact a security has on climate change*' is both feasible and meaningful for the financial community. In this paper, we provide an issuer-level temperature label and also introduce the concept of a decision-tree process, accounting for intentionality scores at every possible level (sector, issuer, and security). The purpose of this publication is also to offer more visibility on a subject that has been opacified by its own popularity, which is not helping given the state of emergency.

One could definitely say that climate change has become an increasingly trendy topic, raising interest and generating discussion in the society, literature and more recently, in the markets. However, despite its popularity, the topic is far from being resolved, due to the diverse and often divergent analysis on the importance and emergency of the climate change. Such a non-common sense, non-common strategy on the matter has generated some skepticism about it. In finance, the subject was long perceived by some as nothing other than a marketing argument as the subjects' value-added to the financial processes was observed as being mostly noise. As long as no consensus is found, or at least a referring majority established, this is likely to remain partly true. However, Bennani *et al.* (2019) and Ben Slimane *et al.* (2020) respectively, showed that equity and bond markets are increasingly pricing ESG, including the environmental criteria, which shows that, despite the absence of commonly accepted references, the market is progressively processing climate-relevant information. To go further in answering the gain in popularity of climate change in particular, both academics and professionals are researching and publishing alignment methodologies. The most famous initiative is the sectoral decarbonization approach (SDA), providing optimal intensity reducing pathways, with respect to activity projections, for some intensive sectors. This method is introduced in the context of the Science-Based Target initiative (2015). However, no consensus on measurements and course of action has emerged despite the growing number of allusions to climate change. Therefore, before addressing this subject once again, it is important to properly distinguish concepts associated with climate change not to add further confusion.

Climate issues in the field of finance are indeed multifaceted. The famous question about '*climate and transition risks*' – that can be caused by changes in economic intermediary variables or in the regulatory environment, or by the interconnectedness of financial and physical systems

[2] '*A greenhouse gas (or GHG for short) is any gas in the atmosphere that absorbs and re-emits heat, and thereby keeps the planet's atmosphere warmer than it otherwise would be. The main GHGs in the Earth's atmosphere are water vapour, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and ozone* (Brander, 2012).

and also the increasing likelihood of natural disasters – is by essence of high complexity. Many introduce hypothetical damage functions affecting capital, which practically equates to fixing the amount of losses beforehand. The '*accounting methodology*', followed by the computation of representative footprints, is an issue in itself. This problem is becoming an operational challenge for asset managers who must ensure a monitoring of the actors involved. Finally, there is a '2 °C *investing*' subject that focuses on forward looking trajectories and intentionality assessment. This paper focuses on the latter, and there will be no risk dimensions nor questioning of how the carbon intensities are computed. Indeed, if '*climate risks*' and actors' '*intentionality*' to go in the right direction with respect to their current trajectories are intimately linked – if we admit that wrong intentions are more likely to be penalized by the market and therefore pose a reputational risk – it is oversimplifying and often false to address them simultaneously. In other words, this paper is a quantitative analysis to help automatize forward-looking reporting and allow managers to filter, if they wish to, issuers in the wrong slope and/or to select securities on the right direction. First, we compare the reduction trajectories required in the literature and the trajectories we can observe in real data. We also introduce a portfolio or benchmark labelling scheme based on an average intensity pathway. The last section part introduces a more advanced hybrid system to rank intentionality at a security level but still with no risk dimension or real questioning of the input data.

In a previous working paper (Le Guenedal, 2019), we reviewed the functioning of Integrated Assessment Models, to understand the '*scenario generation*' dimension of the climate change subject. These are mathematic frameworks, that make it possible to set optimal trajectories based on optimal capital allocation. To some extent the models are searching for the trade-off to allocate funds on adaptation or mitigation-preserving consumption and growth. Economic activity generates emissions often called '*induced emissions*'. These are what we measure with the carbon Scopes 1, 2 and 3, in order to compute footprints at a granular level. In particular, the Scope 3 downstream, which represents in some cases 90% of the environmental stake for the actors concerned, is often quite roughly estimated. The dynamic integrated climate economy model and others generally introduce a mitigation ratio, which is the percentage of green house gases that we are not emitting in the atmosphere if we pay the corresponding abatement costs. In the past we kept no track of these '*avoided emissions*', but data providers are actively working on the disclosure on such information of prior importance if we wish to implement alignment strategies. Once these measurement systems are developed, and with an efficient capital expenditure tracking, allocation strategies should be able to embed an assessment model module to optimally manage capital flows over time, considering the natural capital. The emergency dimension of the problem remains. Indeed, a 1.5 °C increase would be enough to start the melting of the permafrost, a condition under which the society as we know it might be at risk[3]. Consequently, it is important to start selecting issuers that are in line with the requirements to meet the 2 °C and ideally 1.5 °C without waiting 2030 for the new metrics to be integrated into allocation processes. We therefore need to implement alignment screens in the best way we can, as soon as we can, despite the reluctance of skeptics.

[3]The COVID-19 impact on the market and human society is still to be assessed. The scientific community has warned that climate change increases the likelihood that similar new viruses will appear and/or mutate faster. The global health crisis caused by the coronavirus could be the first of a series if nothing is done to preserve the environment and stabilize the climate.

Labelling methodologies are often black boxes mixing fitted trajectories, company targets from annual reports, analyst intuitions, sometimes news and announcements, among other potential sources. The resulting metrics therefore lack transparency. In this paper, to avoid opacity issues, we distinguish the metrics. First, we define an informative temperature tag measuring issuers' alignment. This tag is defined at the issuer level to characterize its emissions trajectory. We then introduce a new intentionality scoring process based on '*yes or no questions*' to better approach transition investing at a security level. This intentionality score measures to what extent the investment participates in improving the climatic condition. Projection of past trends lead to inconsistent trajectories that end up on aggregated representative intensities highly sensitive to the weighting scheme. The wise portfolio manager would therefore prefer to rely on advanced security picking that can be supported by a conditional scoring algorithm. If one's goal is to act to preserve the environment, it makes sense to give the way to a certain amount of activism in the decision-making process with or without – sometimes unnecessarily complicated – quantitative scoring processes.

2 Trajectory tracking and temperature labelling

The projections used by science-based targets (SBT) initiatives for their trajectories reflect varying plausible paths for the carbon intensity reduction. They are based on strong convergence and economic activity assumptions and are subject to varying modeling uncertainties. Additionally, measuring the temperature associated to an activity or a project is rather complex as there is not only one way to define an actor's '*alignment*' with respect to what everyone else is doing simultaneously.

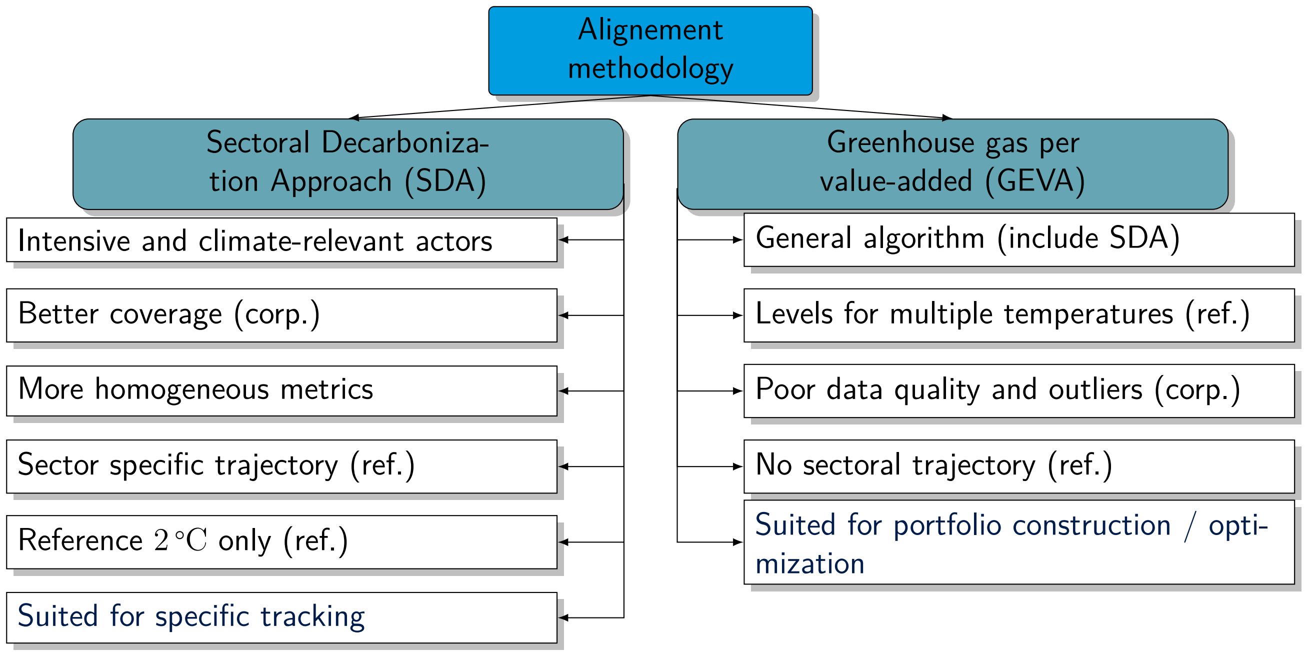
2.1 Methodology specifications

In this section, we present our main methodological choices to track company emissions and compare their trajectories to a reference. The methodology presented is a general and naive approach for trajectory tracking. The main principle and methodological concepts are shared with the data provider Trucost, part of S&P Global.

We implement an effective emissions track-record based on the belief that observation is not neutral. A more efficient tracking by the financial industry and media is likely to act in favor of the less gloomy climate scenario. We present two specifications. A specific trajectory tracking for intensive or *climate-relevant* actors, and a systematic labelling process for broad portfolio construction. This distinction must be made because of the non-availability of a set of reference trajectories for specifically labelling each sectors. Figure 1 shows the distinction and comparison between the specific sectoral methodology, and the more general one based on emissions per value-added, i.e. each company's participation in GDP. In this comparison, some criteria relate to corporate data (corp.), others to the reference (ref.).

All in all, these sectoral and general methodologies are defined and integrated into an in-house visualization platform allowing analysts to compare issuers on each universe and sector. In this presentation, we reiterate the definition of the carbon scopes, provide some details on the reference and corporate data, and explain the main choices that have to be made, and the challenges in

Figure 1: Sectoral vs. general alignment methodologies



defining and aggregating trajectories.

Carbon scopes definitions We briefly reiterate the definitions of the emission scopes for companies.

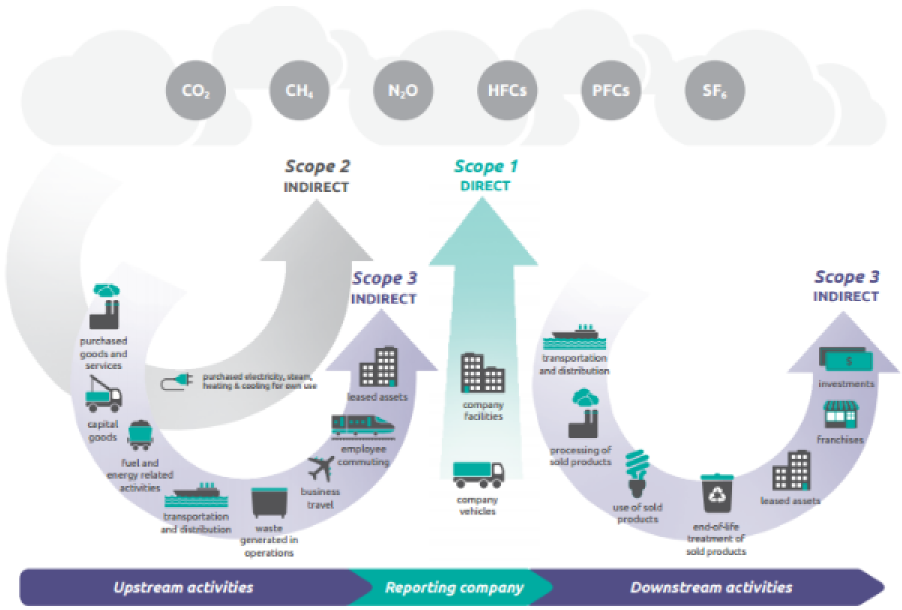
- Scope 1 corresponds to direct GHG emissions emitted by the company. This scope contains only the emissions from sources directly owned by the company. For example, fuel that is consumed on-site.

- Scope 2 corresponds to indirect GHG emissions from the direct suppliers of electricity, heat and steam. To some extent, it is related to the energy mix of the location/market of the company. For example, a company settled in France, should have a lower scope 2 because of the nuclear predominance, than a company settled in Germany for the exact same activity.

- Finally, Scope 3 gathers all other indirect GHG emissions, from the supply chain (upstream of the value chain) and products and services (downstream of the value chain). For the food sector, upstream emissions can account for approx. 80% of the GHG emissions. For the automobiles sector, downstream emissions can account for approximatively 80% of the GHG emissions.

One can notice that, depending on the given definitions of carbon scopes, that most companies' Scope 2 is power generation's Scope 1, while, more generally a company's Scope 3 – upstream or downstream – is either counted somewhere else or depends on the final consumer only. It is therefore often impossible to reasonably work with absolute carbon budgets. In parallel to this major aggregating issue, there are arguments on methodological issues. Indeed, on which scope should we focus? Should we use a relative value of tCO_2 emitted compared to industry

Figure 2: GHG Scopes illustration



Source: Greenhouse Gas Protocol (2016)–
https://ghgprotocol.org/blog/you-too-can-master-value-chain-emissions

peers? An intensity is the division of the emissions by a related metric. A very popular financial metric was to consider the top-line of the companies' income statement (i.e. revenue). We can also use the invested amount by a portfolio or a mutual fund (tCO_2/mUSD\$). More recently measures of intensity per unit of production have become popular as they make it possible to better compare the efficiency of individual companies in the same industry[4] (e.g. tCO_2/MWh for power generation, tCO_2/passenger km for air transportation etc). Formally, it means that we can use at least four metrics to compare the same emission scope i for a company:

$$\begin{aligned}
\mathrm{Scope_i}(j) &= \text{Absolute emmissions (in tCO}_2\text{e)}, \\
\mathrm{CI}_{i,\mathrm{Rev}}(j) &= \frac{\mathrm{Scope_i}(j)}{\mathrm{Rev}(j)}, \text{ where Rev}(j) \text{ is company } j \text{ revenues}, \\
\mathrm{CI}_{i,\mathrm{Prod}}(j) &= \frac{\mathrm{Scope_i}(j)}{\mathrm{Prod}(j)}, \text{ where Prod}(j) \text{ is given in a unit relevant at the industry level}, \\
\mathrm{CI}_{i,\mathrm{VA}}(j) &= \frac{\mathrm{Scope_i(j)}}{\mathrm{VA}(j)}, \text{where VA}(j) \text{ is the company } j \text{ value-added to GDP.}
\end{aligned}$$

Most of these questions are in fact accounting issues. This is why we need to develop forward-

[4] At a second stage, issues with the expression intentionality also appear. As for the the target horizon, should we consider five, ten or fifty years? How does moral hazard (defined in this context as the credit we give to the company's reported target) increase with it? How do we compare 10-year vs. 50-year targets? Regarding the reference or baseline scenario, are the International Energy Agency (IEA) scenarios a relevant base of comparison? How do we compare issuers' emissions to the global world trajectory in terms of tCO_2?

looking processes that can run with different parameters and input data.

Corporate data The methodology is *a priori* agnostic about both corporate-level data and the reference scenario providers[5]. The intensities (per revenues, per value-added or production) are gathered and homogenized by Trucost, and provided on an annual basis. Latency remains an issue and the latest registered intensities are lagged (we use data from 2017) and more generally every issuer provides updates in annual reports only. Both the frequency and latency should be improved if this tool is to be more effectively implemented and used in investment processes. To be in line with emerging regulations, we follow the September 2019 technical advice on the calculation of carbon intensity provided by the EU technical expert group on sustainable finance (2019) by choosing to illustrate our calculations for systematic temperature labelling with Scope 1 + Scope 2 emissions[6] (per revenue).

The fitting period for issuer specific trajectories goes from 2012 to 2017. The results are very sensitive to this fitting period. In practice, it can appear '*unfair*' to ask a company that already has a low carbon intensity to reduce it even more. This question can however be partly solved with an appropriate weighing scheme[7]. Nevertheless, in most SDA sectors – except power generation – mild intensity reductions[8] are required. Even if low carbon intensive companies should be less penalized – in case of a slight but sustained intensity increase – these companies would still appear on the wrong slope to meet the 2 °C objective. We will explore multi-conditional selection and intentionality scoring to overcome this issue in the last section.

Reference scenario(s) For climate-relevant sectors, we use the sectoral decarbonization approach (SDA) trajectory published by science-based target for 2 °C reference pathways. These reference scenarios – partially *outdated* (2015) – are subject to criticism (2Dii, 2020). However, they are still the only explicit sectoral *trajectory* reference available on the market place. The communicated trajectories are in emissions per production unit. The issue here is that investors and corporates are used to intensities expressed per million of revenue. This issue can be more easily overcome for some sector than others. For instance, for iron and steel, the quantity can be approximated using the revenues and the price of the commodity.

In the general case of a diversified portfolio containing securities from every sector, this exercise becomes extremely complex. The reference scenarios in this case are set by the representative concentration pathways (RCPs). In this context, we must prioritize the homogeneity of the intensity data. Although CO_2e per unit of production is relevant for intra-sector comparisons, we will have difficulties to aggregate data in CO_2e/MWh for power generation stocks, CO_2e/passenger/km in air transport, with the intensity of service or financial companies. Therefore, in partnership with Trucost, we introduced the intensity variations in CO_2e/GDP for the RCPs adopted by the IPCC for its fifth Assessment Report (AR5) (Moss *et al.*, 2010). To remain homogeneous with the

[5]To some extent, it can also be used to reduce any negative externalities. Scopes 1, 2 and 3.

[6]We acknowledge that it implies counting the power generation sector's trajectory twice, which is reflected in Scope 2 of companies from other sectors. However, as we analyze SDA sectors separately, we can make the assumption that the double-counting issue is an externality. Moreover, including Scope 2 implies taking energy consumption into account, which, in the case of most service industries, is the main source of emissions.

[7]For example, an *intensity weighting scheme with memory of past efforts* can be developed.

[8]According to the science-based target initiative sectoral decarbonization approach.

CO_2e/GDP intensity metric of the scenarios in Table 1, Trucost proposes to introduce corporate intensities in CO_2e per unit of contribution to GDP for the universe of issuers, including the issuers in the SDA sectors. This denominator in the intensity metric is the corporate *value-added* (Randers, 2012). This way, we can place an informative temperature tag on each issuer. This tag must be reassessed as often as the frequency of corporate intensity metrics disclosure allows it.

An advantage of the carbon intensity contraction approach versus others, including approaches that compare absolute levels of company emissions against global climate scenario outcomes, is that the intensity approach provides flexibility given the propensity for many individual companies to grow by M&A or other corporate activity while others contract. A company with significant growth in its operations and consequent growth in emissions profile may be assessed as consistent with the 2 °C outcome by significantly reducing its emissions intensity, measured as a ratio of GHG to a company financial indicator like company value added or revenue, despite its absolute emissions rising.

Another advantage of this approach is the fact that it is already being used by some companies already. For example, Oil & Gas Equipment & Services company Core Labs (2019) has set their carbon emissions targets based on the above-mentioned approach.

Table 1: Annual percentage changes required to achieve climate scenario outcomes

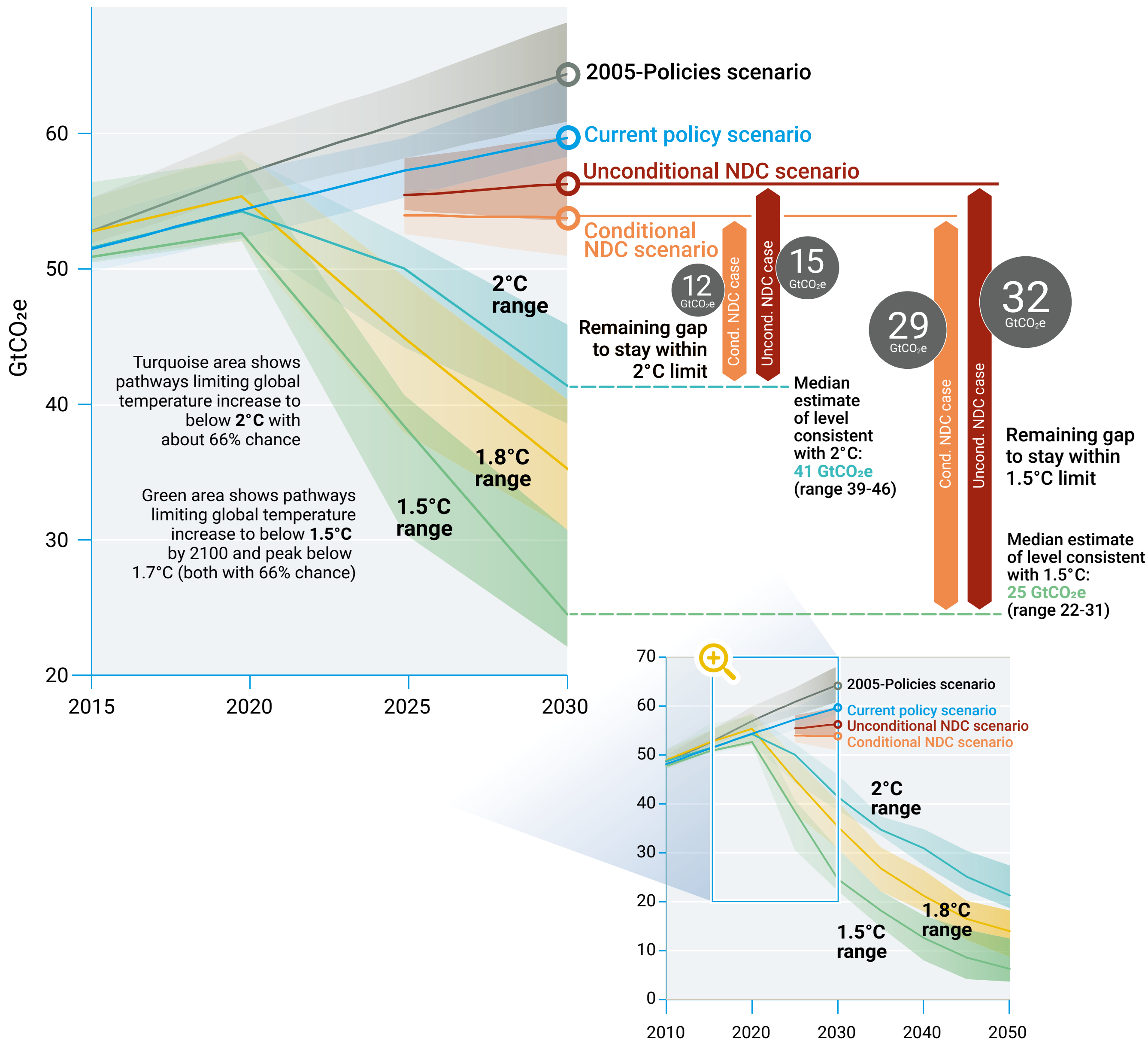
		Absolute change CO_2e		Intensity change CO_2e/GDP	
		2011-2020	2021-2030	2011-2020	2021-2030
2 °C	RCP 2.6 W/m^2	-0,6%	-1,7%	-3,2%	-4,2%
3 °C	RCP 4.5 W/m^2	1,3%	0,4%	-1,5%	-2,3%
4 °C	RCP 6.0 W/m^2	1,8%	0,9%	-1,0%	-1,8%
5 °C	RCP 8.5 W/m^2	2,0%	1,4%	-0,8%	-1,4%

Source: IPCC AR5 Scenario Database, IIASA – Calculations by Trucost

***Trust what you can see*: track-record only** The future intensity of issuers can be estimated using their communicated targets, their future production plans (from asset-level data) and the observed trends of their intensities. For the GHG emissions for the World, we can see in Figure 3 that UNEP uses as a reference the '*current policy scenario*', which corresponds to the situation where all policies now in place are taken into account while assuming that no additional measures are taken. We propose to extend the trend of past intensities for corporates, which is similar to UNEP's '*No change*' approach applied to intensities with a higher granularity.

However, mixing targets ('*what issuers promise*') and trends ('*track-record of issuers*') in the same process would lead us to an opaque metric, potentially lacking transparency for portfolio managers. Thus, in this section we focus on projected trends only. To be forced to define our so-called forward-looking metric from a past historical track-record is both contradictory and disappointing. Moreover, one must be aware that it might not be representative of the disruptive changes that can potentially occur in the future. For instance, a power generation company building renewable energy facilities might display a progressively increasing intensity if the price

Figure 3: Global GHG emissions under different scenarios and the emissions gap by 2030



Source: UNEP (2019) – https://www.unenvironment.org/resources/emissions-gap-report-2019

of energy changes. This would affect its revenues – or the demand – and in-turn also have an impact on Scope 1 emissions – while this same company might abruptly reduce its emissions once the project is done. This is why, in most forward-looking assessments, the notion of intentionality which will be further developed in the last section, is generally included. Finance for Tomorrow (2019) provides a methodology map for physical and climate risk. We believe that it is eye-opening to analyze both the track-record of corporates' emissions intensity and their reduction target intentions.

Sectoral mapping and reference trajectory, a matter of choice? An additional constraint posed by a choice of a reference scenario is the need to validate the mapping between the GICS sector taxonomy[9], which is geared towards a business logic and reference sectors geared towards emission sources. Reference sectors can be different from one projection model to another according to the modeling structure. A mapping exercise is required to link each sector projected by models to the existing GICS breakdown. This exercise must be performed with care and existing reports sometimes account for multiple occurrence or missing sectors. This exercise could be performed with additional business structures, such as the statistical classification of economic activities in the European Community (NACE) approach. Trucost actually uses a taxonomy of 464 sectors. The 464 sectors account for all the sector of an economy. The sectors used by Trucost are based on the North American Industry Classification System (NAICS), which is in turn very similar to NACE. Table 2 shows the link between GICS and Trucost Sector revenue for some cement companies. The Cement Manufacturing Trucost Sector (highlighted in blue) tends to be the primary Trucost Sector for most companies in the Construction Materials GICS Sub-Industry. Ready-mix concrete manufacturing or other concrete product manufacturing are examples of other Trucost Sectors.

Table 2: Sample of Trucost Sector Revenue (2019)

Company	***GICS Sub Industry***	***Trucost Sector Name***	***Trucost Sector Revenue (USD mn)***	***Trucost Sector Revenue Percentage (%)***
Sumitomo Osaka Cement Co., Ltd.	Construction Materials	**Cement manufacturing**	**1,746.60**	**77.14**
Sumitomo Osaka Cement Co., Ltd.	Construction Materials	Other concrete product manufacturing	166.53	7.35
Sumitomo Osaka Cement Co., Ltd.	Construction Materials	Stone mining and quarrying	115.62	5.11
Sumitomo Osaka Cement Co., Ltd.	Construction Materials	All other basic inorganic chemical manufacturing	108.27	4.78
Sumitomo Osaka Cement Co., Ltd.	Construction Materials	Real estate	58.46	2.58
Sumitomo Osaka Cement Co., Ltd.	Construction Materials	Broadcast and wireless communications equipment	51.92	2.29
Sumitomo Osaka Cement Co., Ltd.	Construction Materials	Other electronic component manufacturing	16.9	0.75
Taiheiyo Cement Corporation	Construction Materials	**Cement manufacturing**	**5,739.61**	**69.47**
Taiheiyo Cement Corporation	Construction Materials	Waste management and remediation services	767.35	9.29
Taiheiyo Cement Corporation	Construction Materials	Other concrete product manufacturing	702.95	8.51
Taiheiyo Cement Corporation	Construction Materials	Sand, gravel, clay, and ceramic and refractory minerals mining and quarrying	535.74	6.48
Taiheiyo Cement Corporation	Construction Materials	Real estate	516.46	6.25
Konya Cimento	Construction Materials	**Cement manufacturing**	34.73	62.55
Konya Cimento	Construction Materials	Ready-mix concrete manufacturing	20.79	37.45
HeidelbergCement India Limited	Construction Materials	**Cement manufacturing**	305.24	100
Fauji Cement Company Ltd.	Construction Materials	**Cement manufacturing**	152.89	100

[9] Or any other sectoral taxonomy used by portfolio managers.

We call *SDA sectors* the intensive sectors for which the intensity reduction trajectories are provided by the science-based target initiative. Despite comments on the effective impact represented by these reduction pathways (2Dii, 2020), it remains important for asset owners to be able to screen the universe per '*climate-relevant*[10]' sector, to detect miss-aligned issuers and engage with them when necessary.

An overview of the mapping to link SDA sectors to GICS sub-industries is given in Table 3 and the full table is provided on page 51. Following this mapping gives a representative idea of the weights[11] and the distribution of the emissions of the MSCI World Index given in Table 4 on page 20. In terms of market capitalization, the SDA sectors cover 85.3 % of the MSCI World Index, but it is remarkable that the Scope 1, Scope 2, direct and first-tier indirect emissions mostly comes from few sectors. We can see in Table 4 that Scope 1 is predominantly attributed to power generation (utilities sector) with 37.8% of the emissions, while for Scope 2, other industry (28.7%) or services[12] (22.4%) stand out. Some sectors are not covered by the methods and others, not among the most emitting are missing. Most of the GICS sectors are assigned to other industry or services and commercial buildings, which is one of the downsides of this mapping. The SDA grouping can indeed appear over simplifying. On the other hand, IEA trajectories are less granular in their mapping and project in fact only four categories: (i) power generation – similarly as SDA – (ii) industry – gathering cement, chemicals and petrochemicals industry, aluminum, pulp and paper and other industry – (iii) transport services – light and heavy road, rail aviation and others – and (iv) services.

We reiterate dilemma from Figure 1, forcing us to choose between a better concentration and temperature granularity (RCP 1.9, 2.6, 3.4, 4.5, 6 and 8.5 $W.m^{-2}$) on the one hand, and a better sectoral granularity on the other. Indeed, if we need a temperature tag, we must use the RCP trajectories with RCPs granularity, which is given at an aggregated level. Consequently, we lose the sectoral specific dimension[13]. This is why we kept monitoring more closely specific carbon intensive sector in this study.

Portfolio alignment, what does it mean? To set a general definition for alignment, one can say it is a relative notion expressing a distance – or deviation – between an individual or a group of individuals and a reference. Therefore, it requires a reference scenario, or trajectory. Once this reference is provided, it becomes an absolute condition and the issuer behind the security can be aligned or not. From the aggregated standpoint, we can allow – or not – some misaligned individuals in our portfolio as long as the weighting sum respects all the total sectoral carbon budgets. In other words, an aligned individual is an individual whose trajectory answers

[10]This term was first introduced by Battiston *et al.* (2017), to identify the main transition risks for the financial system. They develop a new taxonomy, which regroups sectors from NACE classification, into groups that are relevant for climate analysis. From a prospective standpoint, as no required reference trajectories were published for these '*climate-relevant'* sectors, we therefore use SDA and GICS sectors in our analysis.

[11]As of the end of January 2020.

[12]These two are in fact the same emissions counted twice.

[13]There is another choice to make: between sectoral decarbonization with the finest sectoral mapping, and a country-oriented split, with decarbonization requirements that can strongly vary between regions but in which we can use the four IEA referring trajectories. Indeed, even if the trajectories could be provided for each SDA in each region, the theoretical clusters might not find sufficient real-data trajectories to be able to construct a robust tracking algorithm.

Table 3: Sectoral Mapping SDA sector vs. GICS

SDA Sector	GICS Sub-Industry	Code
Iron and Steel	Steel	[15104050]
Aluminum	Aluminum	[15104010]
Cement	Construction Materials	[15102010]
Chemicals and petrochemicals	Commodity Chemicals	[15101010]
	Diversified Chemicals	[15101030]
	Fertilizers and Agricultural Chemicals	[15101030]
	Industrial Gases	[15101040]
	Specialty Chemicals	[15101050]
Pulp and Paper	Paper Products	[15105020]
Power Generation	Electric utilities	[55101010]
	Multi-Utilities	[55103010]
	Independent power producers and energy traders	[55105010]
	Renewable electricity	[55105020]
Other Industry	Diversified Metals and Mining	[15104020]
	Gold	[15104040]
	etc... (+40 other sub sectors)	
Light-duty road passenger transport	Trucking	[20304020]
Heavy-duty road passenger transport	Trucking	[20304020]
Rail passenger transport	Railroads	[20304010]
Aviation passenger transport	Airlines	[20302010]
Other transport	Air Freight and Logistics	[20301010]
	Marine	[20303010]
	Trucking	[20304020]
Services / Commercial Buildings	Gather 73 GICS-sub industries	
Sectors and activities not covered by the method	Coal and consumable fuel	[10102050]
	Integrated oil and gas	[10102010]
	Oil and gas refining and marketing	[10102030]
	Agriculture products	[30202020]

Source: Science based target initiative – https://sciencebasedtargets.org/.

the reference requirements. An aligned portfolio can either be the remaining universe filtered by misaligned individuals (exclusive) or any portfolio whose aggregated trajectory answers the reference expectations (inclusive). If there are rising questions in multi-asset strategies about how to pick securities '*that really matter*', and to maximize the marginal impact of the portfolio, the question of alignment can first be approached by a simple extension of decarbonization strategies, but this time, using forward-looking metrics. This type of methodology can be applied on both corporate, compared to the IEA, to the Intergovernmental Panel on Climate Change (IPCC) or other scenarios, and on sovereign tracking the surplus carbon budget emitted in the past and estimation for the coming years. The sovereign case is however not treated in this article.

In this paper, we used the following representative construction to track the trajectory of a portfolio. We therefore constructed the trajectories for the aggregated portfolio with five different illustrative weighting schemes[14]. We note TCI$[d_1, d_2]$ the vector representing the trajectory of

[14] These weighting schemes are illustrative to provide an idea of varying scales only. Moreover, they are fixed.

Table 4: Mapping coverage MSCI World Index

SDA-Sector	Scope 1(%)	Scope 2 (%)	Direct and First Tier Indirect (%)	MSCI World Weight (%)
Aluminum	1.21%	2.10%	1.16%	0.02%
Aviation passenger transport	3.91%	0.12%	2.81%	0.11%
Cement	6.78%	5.80%	5.78%	0.27%
Chemicals and petrochemicals	4.11%	10.81%	4.72%	2.07%
Iron and Steel	10.18%	6.05%	9.08%	0.18%
Other Industry	5.17%	28.66%	13.44%	32.89%
Other transport	1.62%	0.45%	1.26%	0.53%
Power Generation	37.78%	4.37%	28.30%	3.28%
Pulp and Paper	0.46%	0.75%	0.95%	0.09%
Rail passenger transport	0.33%	0.58%	0.32%	1.15%
Services / Commercial Buildings	3.01%	22.37%	5.77%	44.72%
Total	74.58%	82.07%	73.60%	85.30%
Missing	6.09%	8.63%	7.67%	12.02%
Sectors and activities not covered by the method	19.34%	9.30%	18.73%	2.68%

Source: BarraOne and Trucost

Benchmark data as of january 2020 and Emission data for the year 2017

carbon intensity between d_1 and d_2[15]. The different representative weighing schemes we use in this paper are the following:

- The *enterprise value or market capitalization weighted* is the trajectory of reduction is scaled by size, larger companies (measured by total enterprise value or market capitalization) reduction or increase have more impact[16]:

$$\mathrm{TCI}_t[P,H]_{\mathrm{MCW}} = \sum_{i=0}^{N} w_{i,t}\mathrm{CI}_{i,t}[P,H]$$

  where $\mathrm{CI}_t[P,H]$ is a vector representing the aggregated trajectory of investment between P and H based on information available at t; $w_{i,t}$ is the weight in the portfolio of Asset i at t and $\mathrm{CI}_{i,t}[P,H]$ is the individual intensity trajectory of Asset i based on information available at t. N is the number of assets in portfolio.

- The *equally weighted* scheme gives each trajectory the same weight in the aggregated trajectory:

$$\mathrm{TCI}_t[P,H]_{\mathrm{EQW}} = \sum_{i=0}^{N} \frac{1}{N}\mathrm{CI}_{i,t}[P,H]$$

The market cap is based on the weight on the measure date and the intensity weight on the average over the observation period.

[15] The carbon intensities are rebased to 1 for d_1 in this article.

[16] Even if they pollute less/more.

- An *aligned portfolio* (exclusive), obtained selecting only the stock on the *right* reduction slope:
$$\mathrm{TCI}_t[P,H]_{\mathrm{AEW}} = \sum_{i=0}^{M} \frac{1}{M} \mathrm{CI}_{i,t}[P,H] \times \mathbb{1}_{[\mathrm{CI}_{i,2030} < \mathrm{CI}_{\mathrm{ref},2030}]}$$
where M is the number of aligned individuals in the portfolio, $\mathrm{CI}_{\mathrm{ref},2030}$ is the required intensity in 2030[17].

- The *Intensity weighted*, where the weight of each actor is determined from its average intensity on the past historical. This way we can consider both absolute and relative trends[18]. The representative intensity weighted (IW) scheme gives more importance to most intensive actors:
$$\mathrm{TCI}_t[P,H]_{\mathrm{IW}} = \sum_{i=0}^{N} \frac{\mu(\mathrm{CI}_i[t_c,t])}{\sum_{i=0}^{N} \mu(\mathrm{CI}_i[t_c,t])} \mathrm{CI}_{i,t}[P,H]$$
where $\mu(\mathrm{CI}_i[t_c,t])$ is the average carbon intensity of Company i between t_c and t. Indeed, to stabilize the results intensities used in weighting scheme are consolidated by averaging at least two years. We point out that this weighting scheme is not stable and purely informative of the effective reduction of the most intensive actors in the portfolio.

- An *inverse intensity weighted*, where we emphasize the trajectory of the issuers that were the less intensive on the historical. Inverse intensity Weighted (IIW) emphasizes less intensive actors:
$$\mathrm{TCI}_t[P,H]_{\mathrm{IIW}} = \sum_{i=0}^{N} \frac{\sum_{i=0}^{N} \mu(\mathrm{CI}_i[t_c,t])}{\mu(\mathrm{CI}_i[t_c,t])} \mathrm{CI}_{i,t}[P,H]$$
Similarly, this weighting scheme is informative and not representative of any financial strategy. It shows the effort produced by less intensive companies and reproduce the trajectory of a decarbonization tilt (drifting toward less intensive actors).

Systematic labelling process The objective is to set a systematic methodology, labelling issuers with respect to the reference trajectory. Thus, we first define an algorithm taking as inputs the trends for past carbon intensity from 2012 to 2017. Each actor belongs to a different cluster sector/country, and each cluster is set to follow its own reduction path. We therefore need: (i) to project each individual trajectory[19], (ii) to compare it to the reference of required reduction for the cluster and (iii) to determine the scenario favored by the actor[20] behind the security. In the first step, we must omit companies with inconsistencies in intensity data to avoid producing diverging signals. In a complementary illustrative step, we combine the individual projections

[17]We used rebased intensity i.e., at date P all asset intensities are set to 1 and we track and project changes from then. Therefore, we can reasonably set $\mathrm{CI}_{\mathrm{ref},2030} = 0.7$ for instance, and we obtain the portfolio of the assets for which current effort are in line with a 30% reduction in 2030. In this example, we used 1, which means that we allow in the portfolio any company that has significantly reduced its emissions along the fitting period (2012-2017).

[18]Most intense sector trajectories are overweighted while a decarbonization strategy would do the exact opposite. The purpose of this weighting scheme is to focus on intensive companies' reductions, to emphasize marginal reduction trajectories. Said differently, we insist on intensive companies' reduction. The inverse intensity is more relevant to understanding the projected trajectories of low intensive actors – decarbonization strategy trajectories.

[19]For simplicity's sake here, we use a linear model to extrapolate future values.

[20]Note that this algorithm provides issuer-level labels and not security-level ones.

obtained following the varying aggregation methods presented above. This way we approach both exclusive and inclusive constructions for portfolio alignment.

Algorithm 1: Scope 1 + 2 intensity trajectory labelling

Input:
– Asset universe (or index for which we have): Scope 1 + 2 historical intensities data
– N different reference scenarios,
– Parameters: Historical considered P (default = 2012), Horizon considered H (default = 5 years), Extrapolation function (default = linear).

for *Sector s in 'Sectors'* **do**

  for *Company i in sector* **do**

    Filter inconsistent intensity data

    Get and project:

$$\begin{aligned} CI_{i,past} &= [CI_i(P), \ldots, CI_i(t)] \\ CI_{i,proj} &= [CI_i(t), \ldots, CI_i(t+H)] \\ CI_i &= [CI_i(P), \ldots, CI_i(t+H)] \end{aligned}$$

    Also get company Region r – facultative and depends on data avalability.

    Get:

$$CI_{S,r,s} = [CI_{S,r,s}(P), \ldots, CI_{S,r}(t+H)]$$

    where S is a reference scenario. At this stage it is required to rebase the trajectory to obtain the slope of the curve on the same base. Once it is done we can deduce the extra carbon budget.

$$\Delta CI_{\text{Budjet}}(S) = \sum_{i=P}^{t+H} CI_i[i] - CI_{S,r,s}[i]$$

    if

$$\Delta CI_{Budjet} >> K$$

    where K is the exclusion threshold. It can also be calibrated to fitler a certain percentage of the issuers. **then**

      The company trajectory is environmentally harmful! Consider engaging.

    for i *in* $[1, N]$ **do**

$$\begin{aligned} \text{closer scenario} &= \text{argmin}\left\{\Delta CI_{(Budjet)}(i)\right\} \\ \text{Label} &= \text{Temperature of the closer scenario} \end{aligned}$$

Result: Labeled universe

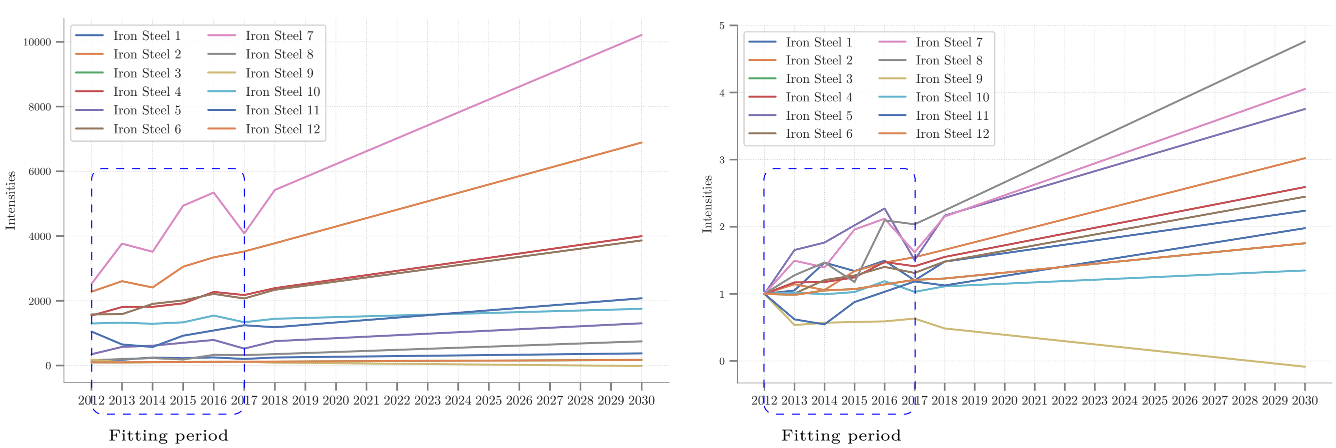
The algorithm 1 is not specific to carbon. It can be used similarly with any scope or any metric to track a trajectory – as long as the metric can be transposed to a variable provided in the scenario. Note that using absolute Scopes 1 + 2 directly focuses on the environmental dimension only, without any consideration of the revenue implied by the activity. The choice is made here to use intensity, as this quantity is generally required to decrease, no matter the modeled projected activity for the sector. It allows us to discriminate more comfortably between better and worse aligned issuers.

We present the next algorithm 1 through a few case studies to understand the main functioning of this analysis. We also aim to identify the limits and the control processes required and sometimes question the feasibility of the labelling based on the data available. These case studies will be picked among SDA sectors in a world universe – ignoring country reduction target discrepancies – to unveil the construction of an alignment strategy with real data and make the connection between the literature on decarbonization with one of the most commonly used financial index.

2.2 Sectoral decarbonization case studies

Iron and steel Let us follow and describe analytically the process for the iron and steel sector. The first step consists in fitting the historical trajectory between 2012 and 2017 (for the default parameters P and H) and exploring the projected trends. The GICS sub-industry steel is directly an *SDA sector* for which we have a required trajectory obtained by sectoral decarbonization approach. Figure 4 shows that most companies display quite robust trends after filtering for inconsistent data. We can observe a reduction of intensities on the last observation year of 2017. The emissions gap report 2019 (UNEP, 2019) identifies a brief stabilization of total GHG emissions between 2014 and 2016. Issuers 2 and 7 present levels that must be carefully monitored. Unfortunately, reasoning in absolute does not lead anywhere as there is a well-known mismatch between bottom-up aggregated data and global trend estimation, mainly caused by accounting issues and poor transparency. Consequently, to construct an exclusive 2 °C aligned investable universe, we need to reason in relative terms and look for the companies' slope of intensity reduction. To compare these trajectories in terms of percentage reduction, we must re-base the intensities observed and projected. There is in fact no need to compute the excess carbon budget, or overrunning intensity, of each company to see that only the Issuer 9 can belong on its past track-record to an asset universe 2 °C compatible, because it has been reducing its intensity based on the fitting[21] period of this example.

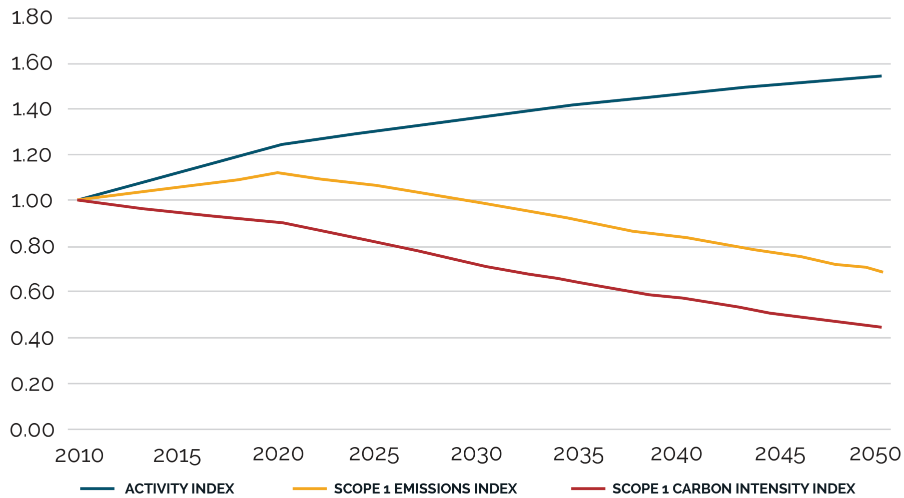
Figure 4: Iron and steel observed and projected trajectories



(a) Absolute (b) Relative (% change)

[21] We keep in mind that the results are sensitive to the fitting period.

Figure 5: Iron and steel reference trajectories



Source: Sectoral decarbonitization approach (2015)– `https://sciencebasedtargets.org`

The second step – which is not necessary in this case but is provided for illustrative purpose – consists in considering the required reduction trajectory for this sector. The 2015 report presenting the sectoral decarbonization approach (SDA) in the context of the science-based target initiative[22] gives the trajectories for activity absolute emissions and intensity in Figure 5. The shapes are justified as follows: "*iron and steel sector emissions will increase slightly because of growth in this activity, but the total emissions need to decrease by 31 percent and intensity by 55 percent by 2050*". The trajectory is provided for Scope 1 only. We do not question the growth hypothesis made in the IEA scenario nor the science-based target initiative. We reiterate that the process can be based on any provided reference. This step remains, however, important as one must keep in mind that a 2 °C universe might require an increased production of steel in short-term and consequently of the emissions of this particular sector.

Scope 1 intensity is required to decline by more than 20% by 2025 in this sector according to this reference scenario. We see that its absolute emissions are allowed to grow, as a 2 °C scenario requires an increase of steal production. We also note that the slope of the intensity curve is not steep, we therefore consider acceptable any company that does not increase its intensity. It is a general observation that can be made in almost every sector, which also bring another answer to the question of *fairness* of this system. In simple terms, we consider here that no company should increase its emissions for constant or decreasing revenues – in such time of emergency – no matter the relative scale of its emissions compared to its industry peers. The fragility of this proposal lies in particular in the absence of any real control over product prices and/or external crisis. The knowledge of these prices makes it possible to move roughly from the required activity (demand projected by the IEA) to the income of companies (revenues), and thus, by introducing intensity trajectories, to Scope 1 direct emissions. Considering that external effects on prices affects companies similarly within the SDA grouping, we can consider that this comparison

[22] Referring to the IEA (2014) report.

makes sense when it is done within the same sector[23]. Examples from other sectors demonstrate that this thinking is sometimes limited. Gas companies have for instance to dig deeper and go further off shore – for security and resources availability reasons – and so potentially increase their insensitivity. These sectors are not covered by the SDA method but sectors that are required to converge are subject to the same market mechanisms possibly limiting their reduction efforts.

Figure 6: Steel sector portfolios intensity trajectories

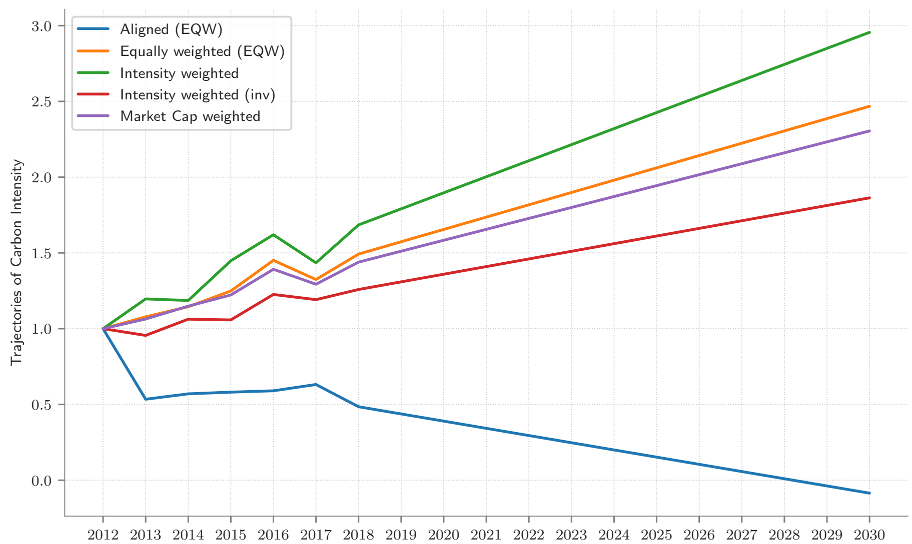


Figure 6 illustrates the intuition that the projected intensity based on recent track-record is better for low-intensity iron and steel issuers than high-intensity issuers (*intensity weighted (inv)* line below the *intensity weighted* line). The trends are dependent on the observation period.

Cement The cement sector – or GICS sub-industry construction materials, which is in the top five of most emitting sectors – has also its own decarbonization trajectory set by the method. In terms of emissions, we reiterate that the construction sector is among the most intensive. We first plot the corporate realized and projected trajectories in Figure 7.

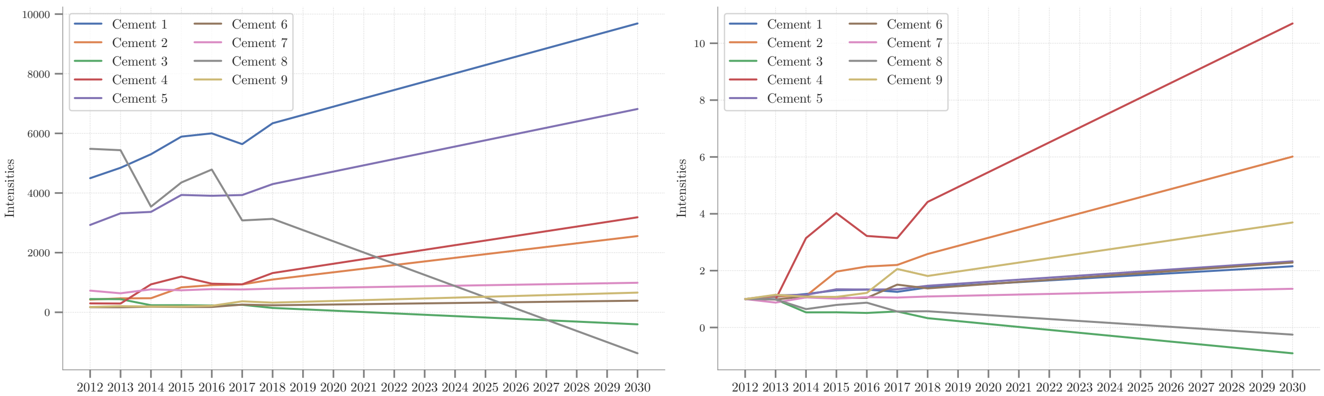
This sector is required to reduce intensity gradually whereas its activity must rise until 2020 when the peak should be reached (according to the projections made in 2015). The SDA convergence target imposes a 20% target between 2010 and 2050. The trajectory for activity, emission and intensity are given in Figure 8 below. The variation trend for intensities must be stagnant if not decreasing between 2010 and 2025. Therefore, any actor demonstrating a robust increasing trend in terms of intensity must be engaged or excluded from a 2 °C universe.

Figure 7 shows that Companies 3 and 8 only are on a reduction path. Another dimension highlighted by this case study is the possibility of negative intensities (if linearly projecting the trend). Even if the carbon capture and storage technology can appear - on a 2050 horizon (Naimoli and Ladislaw, 2020) - it is unlikely to lead to a negative Scope 1 in most sectors[24].

[23]Some factors must be controlled (size and country mostly).

[24]Scope 1 represents the direct emissions process. A negative Scope 1 for construction material would mean that, for instance Company 3, will discover how to make cement from and/or absorbing the carbon dioxide in the atmosphere in the process.

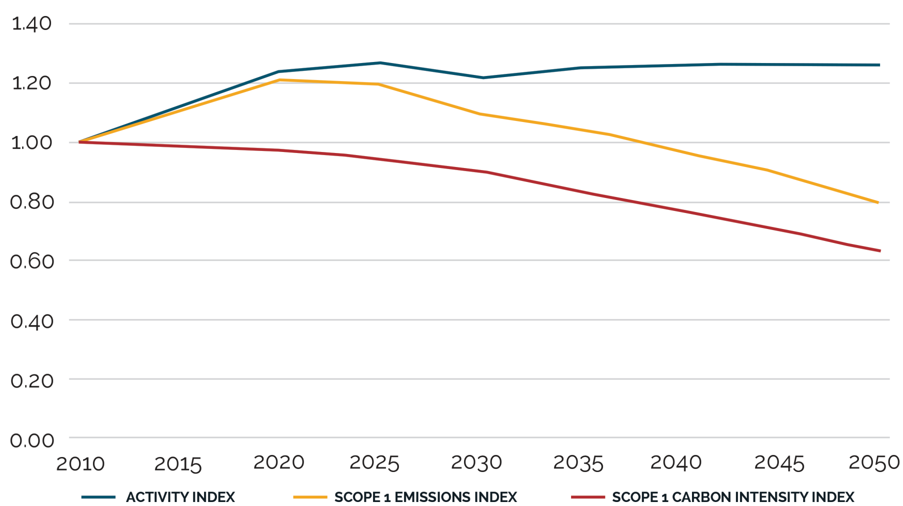
Figure 7: Absolute and relative cement trajectories



Left: Absolute observed and projected intensity trajectories

Right: Relative observed and projected intensity trajectories (% change)

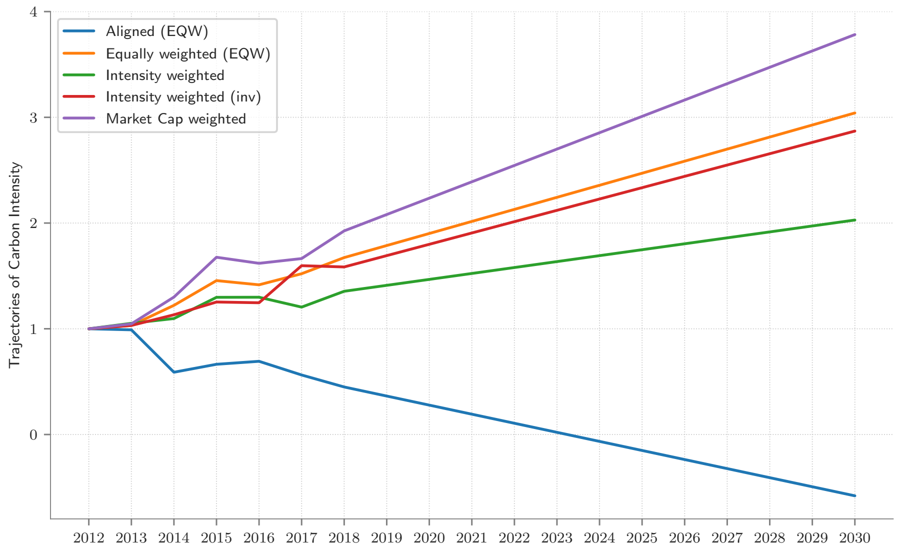
Figure 8: Cement reference trajectories



Source: Sectoral decarbonitization approach (2015)– https://sciencebasedtargets.org

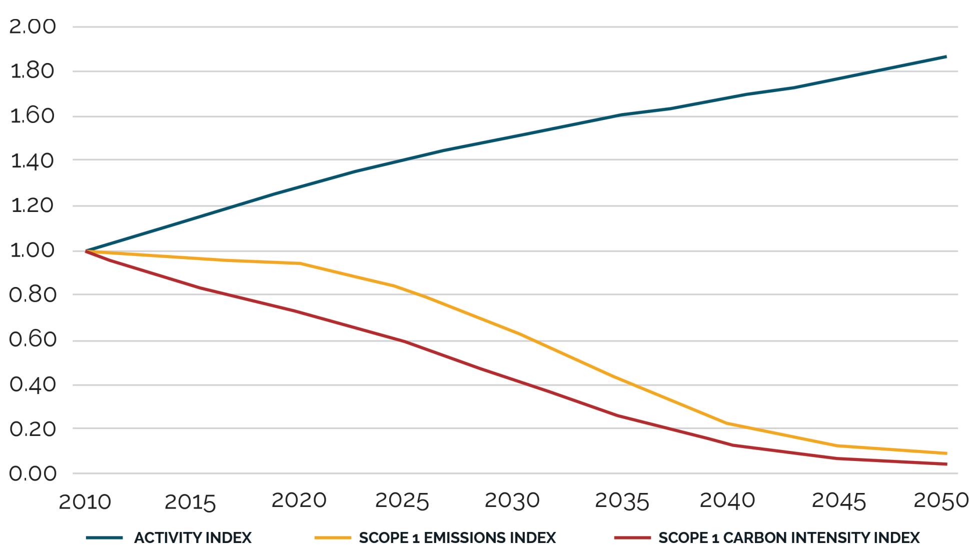
The construction of varying portfolios within this sector is possible. With a reduced sample size, the possibilities are straightforward. If we maintain the credibility of the continuation of the aggressive reduction for the company 8, which was the most intense in 2012, we will see that the intensity-weighted portfolio will have a lower projected intensity in 2030 than the other proposed schemes. This case study highlights the special situation of this company and raises the question of the possibility that other large intensity companies might follow suit.

Figure 9: Cement sector portfolios intensity trajectories



Power generation Power generation is the aggregation of the sub-sectors: electric utilities, multi-utilities, independent power producers & energy traders and renewable electricity. These sectors are all among the most emitting and are clearly the most concerned by Scope 1. Every other sector Scope 2 can be attributed to their direct emissions, it is therefore particularly important to track the effort made in this cluster. Moreover, demand for energy is bounded to keep increasing with growth – we can read on Figure 10 that it is projected to almost double by 2050. For these sub-sectors, the required convergence is abrupt.

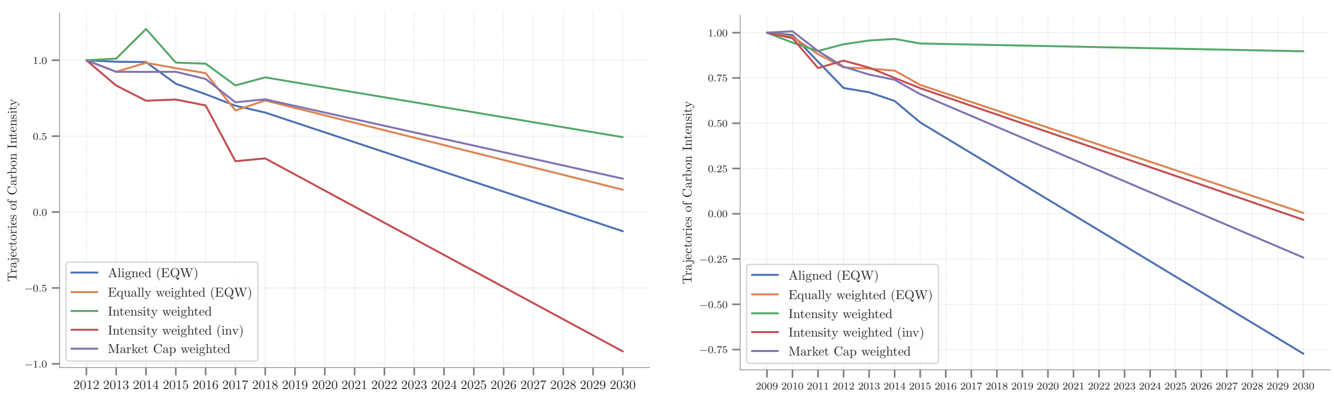
Figure 10: Power generation projected trajectories



Source: Sectoral decarbonitization approach

The projected trajectory of the portfolios constructed with the multiple weighting schemes are presented in Figure 11. If we focus on the portfolios projected from the 2012–2017 period, most of the portfolio construction strategies are in line with a 50% reduction on the 2030 horizon (close to the 60% required by SDA), which is remarkable. If we run the exact same exercise with a projection from the 2009–2013 period, we find that the intensity-weighted portfolio was on a 10% reduction trend for 2030. This raises the fundamental question of how the investors or managers perceive and maximize their environmental impact. Do they wish to minimize their footprint with a lower intensity exposure? Or do they prefer to maximize their marginal positive impact (in avoided carbon per million invested for instance)? In addition, is there a necessary intensive step in a company's life before greening their activity? These questions can be transposed in terms of risks and premium, as more-intensive companies, exposed to higher taxation, might become riskier – not necessarily in fact, but be considered most as risky can make it true – than their peers – all things considered equal. Therefore, these companies will soon be asked to pay higher premium to access funding through bond markets. Indeed, Ben Slimane *et al.* (2019) indicate that already good vs. bad ESG issuers see differences in cost of capital. Consequently, offering them funding – subject to the presentation of a decarbonization project of course – might both maximize marginal effectiveness of the investment (in avoided CO_2/USD mn) and return because of the premium, while decarbonization of a portfolio for the simple sake of lowering intensity might reduce investors premium and GDP.

Figure 11: Power generation portfolio on varying fitting period



Trend fitted on 2012-2017

Trend fitted on 2009-2014

Toward a reward and punishment system? To conclude with this presentation of the intensity track-record algorithm, we reiterate some key findings of this section. The implicit trajectories are sensitive to the fitting period and carbon Scope 1 and 2 intensities require some level of data quality filtering. There is a fundamental question behind 2 °C or more generally impact investing that must be answered. If we think of the 2 °C allocation process from a reward and punishment standpoint, we can simply '*reward*' – overweight – companies that have respected the annualized reduction the year before and '*punish*' – underweight or short – issuers that did not. In practice, reduction do not occur annually and cutting access to capital to companies before they effectively reduce emissions may not be the best thing to do. Quantitatively, stock picking based on intensity reports was said to be an operational puzzle as long as no automatized and reliable tracking was provided as an input. One can wonder if the required quality control of corporates' intensity over the recent historical observed in this section was not facilitated by the very absence of proper tracking from investors, asset owners or media. Said differently, the observation is not neutral, all scenarios currently exist simultaneously and will continue to as long as carbon intensity variations are not properly tracked. This would imply that once this tracking established, we might observe a stabilization and less erratic trends, which might also act in favor of a less gloomy scenario.

Other fundamental questions could be asked. Is the objective really to reduce exposure to intensive activities or issuers (a smaller footprint)? If so, how do we do it without risking reducing global GDP? Or is the objective to maximize marginal impact of the investment made and thus, to help the brownest to go greener? In fact, the two objectives are not totally contradictory, they just do not arise at the same reflection level. In the last part, we will explore the possibility of a bottom-up process labelling investment possibilities at a securities level. We see that the question of brown or green can be answered by combing information at every levels.

2.3 Labelling a portfolio or a benchmark

In the algorithm 1, we described Scope 1+2 trajectory labelling for SDA sectors. In fact, the same process can apply to any sector as long as we can match the intensity trajectories with a reference scenario. If we want to adjust this algorithm to a cross-sector portfolio such as MSCI World Index, our choice of intensity measure will have to match the following additional conditions:

(*i*) A homogeneous intensity metric (and unit) across heterogeneous sectors,

(*ii*) A metric for intensity compatible with additivity across the universe,

(*iii*) The availability of a set of scenarios projected for this intensity measure with matching temperatures.

Homogeneity is absolutely crucial. This is a key success factor that one should have in mind when tackling the issue of climate trajectories. Additionally, in the context of a cross-sector approach, the distribution of intensity data becomes wide. We lose the advantage of analysis by SDA sectors which brings together comparable businesses in emissions and intensities. As displayed in Figure 12, there is a high density between the 10^{th} and the 70^{th} percentiles while higher percentiles have significantly higher intensities. We can use a portfolio weight aggregation[25], but this scheme assumes that the investments are proportional to the intensities weighted by portfolio weights. We end up with a high dependence of our aggregation scheme on higher-intensity issuers. We can reason on this climate metric in a similar fashion as we address financial ratios (Agrrawal *et al.*, 2010) to better capture the central tendency for the intensities of the portfolio. To keep a control of outlier data, for each year we bring values of intensities under the 5^{th} percentile to the 5^{th} percentile value and the values over the 95^{th} percentile to the 95^{th} percentile value.

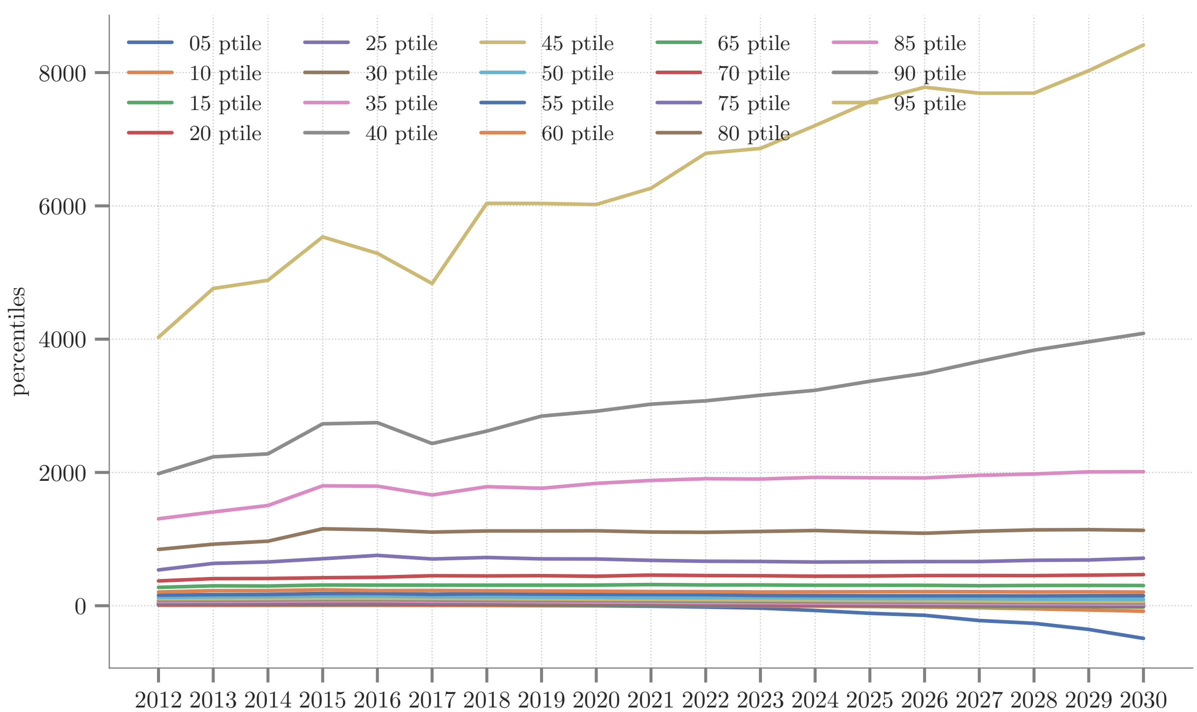
For the MSCI World, we choose to use harmonic weighted average for the 70% of the population with lower values of inverse intensities. Indeed, a separation in two clusters indicates that the segment between zero and twice the lower cluster center value carries between 70% and 75% of the population between the 2012-2017 years (2017 is illustrated with Figure 13). We keep

[25] Equivalent to a market cap aggregation in the case of a market cap-weighted benchmarks.

Algorithm 2: Portfolio intensity trajectory labelling

Input:
– Portfolio or index for which we have historical intensities data in CO_2e per unit of corporate contribution to GDP
– N different reference scenarios,
– Parameters: Historical considered P (default = 2012),
Horizon considered H (default = 5 years), Extrapolation function (default = linear).
for *Company i in portfolio* **do**
  Filter inconsistent intensity data
  Get historical and project $\mathrm{CI}_i[P, H]$ (generalised Algo 1)
  Label individuals with temperature tags
Result: Labeled universe
for $j \in$ {representative weithing schemes} **do**
  Compute $\mathrm{TCI}_j(t)$ for the portfolio
  See representative aggregation schemes definition on page 20
  Harmonic sum the temperature tags for informative portfolio tag
Result: Labeled portfolio

Figure 12: Distribution of CO_2e per unit of corporate contribution to GDP



this threshold through our projection horizon because we need a stability through time in the population which will be averaged. The residual 30% are integrated with a simple arithmetic weighted average.In this section, we could position the intensities of scenarios with temperatures of 2, 3, 4 and 5 °C.

We measured intensities in CO_2e/GDP for these scenarios because we can match this intensity measures with CO_2e/unit of corporate contribution to GDP for issuers. We can then project the weighted trajectory of portfolios or benchmarks, however given the non-homogeneous nature

Figure 13: Distribution of inverse of intensity in CO_2e / unit of corporate contrib. to GDP (2017)

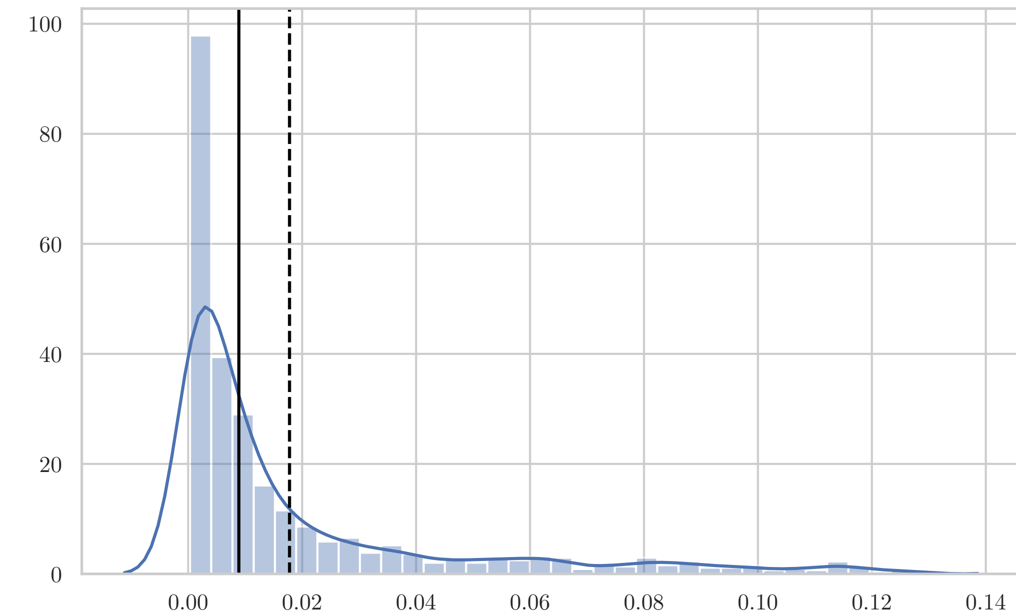
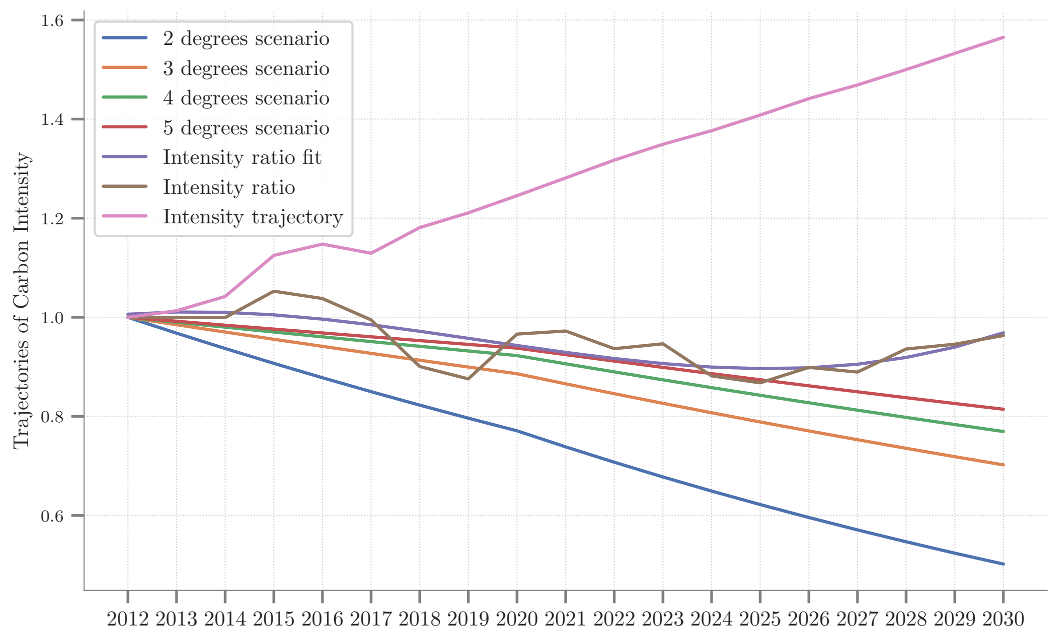


Figure 14: Intensity projection of MSCI World with temperature of scenarios



of the intensity values for a broad universe, we propose an average measure of intensity for the portfolio with a better capture of central tendency. As we can see in Figure 14, if each corporate in MSCI World maintains their current track-record on emissions intensity, the global index is on the track to over-shoot a 5 °C scenario, hence the emergency in action.

We would like to highlight that although the 3, 4 and 5 °C scenarios appear rather close in terms of intensity evolution, the consequences of missing these targets are not linear.

3 Intentionality scoring process

3.1 A bottom-up approach

An intentionality score can be introduced to add information to the trend analysis previously presented. Indeed, we showed that the universe filtered by a 2 °C condition would be rather small – only few issuers that could be outliers except for the power generation sector – which reveals that other metrics must be added to help managers drive capital flows toward responsible projects. Furthermore, this trend-tracking algorithm alone is not particularly suited to credit investors, as there are project-financing bonds that do not reflect the issuer's past and current climate engagement. Building more complex scoring system raises the question of data accessibility. The key takeaways of the TCFD 2018 report[26] revealed that the majority of companies disclosed some climate-relevant "*information aligned with at least one recommended disclosure, usually in sustainability reports*". The impact of climate change, or climate risks, is not directly disclosed by corporates. It therefore has to be assessed by asset owner or asset managers wishing to minimize potential losses. This is a challenge we will not address in this paper dedicated to the evaluation of corporate alignment with the most optimistic scenario. Moreover, the report states that information on strategy resilience under climate-related scenario is limited. Le Guenedal (2019) also noted the lack of visibility implied by the complexity of behavioral modeling, on which resiliency indicators are based. Last but not least, disclosure is unequal and not well centralized. The challenge for large asset managers is therefore to aggregate and filter data from multiple sources. In 2017, the Task Force made the following for recommendations for disclosure[27]:

- Adoptable by all organizations,
- Designed to solicit, decision-useful, forward-looking information on financial impacts,
- Bring the future nature of issues into the present through scenario analysis,
- Strong focus on risk opportunities related to the transition to a lower carbon intensity.

Therefore, to answer these recommendations, most companies' annual or sustainability reports do contain indeed the required information to, at least, have an idea of the reduction target.

First, we pose the following definition:

Definition *$\mathcal{A}_T$ is the set of aggressive targets. Let T be a company target. $T \in \mathcal{A}_T$ if at least one of the following propositions is true:*

(i) Best-in-class: T highest mitigation (times duration) of the sub sector

(ii) T implies reaching 0 emissions by 2030

(iii) T is in line with the Paris Climate Alignment

[26] https://www.fsb-tcfd.org/wp-content/uploads/2018/08/FINAL-2018-TCFD-Status-Report-092518.pdf.

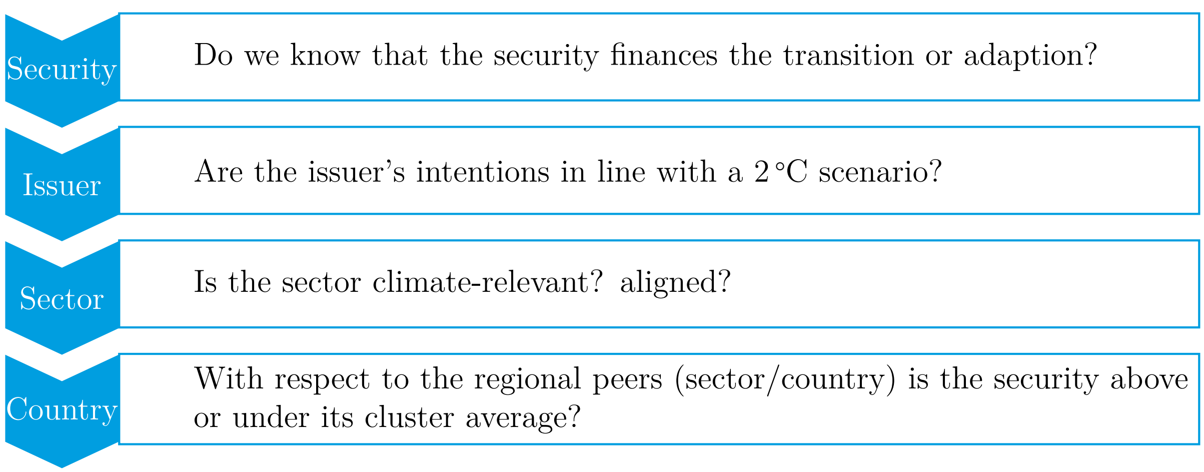
[27] https://www.fsb-tcfd.org/wp-content/uploads/2017/06/FINAL-TCFD-Report-062817.pdf.

Setting this way a set of aggressive targets this way make it possible, if the quantitative algorithm is implemented by managers, to reduce the cost of capital of engaged company (even more).

The intentionality scoring process that we propose is designed to reflect a selection process, which could be the one driven by managers' common sense, but applicable more systematically. It can be represented with a decision tree (see Figure 16). This type of scheme is often associated to '*artificial intelligence*' processes. The scoring algorithm can rely on numerical inputs or natural language processes (NLP) in order to generate information from text reports and news screens for portfolio managers' use. There is no objective function, preferences or substitutions, simply a conditional scoring, and thus no artificial intelligence. A learning process to better classify issuers' credibility can be introduced but it is not central. In general, decision-tree processes are often used in top-down methodologies, however here, we must initiate the process at the security-level data. This means that in the current state of climate emergency, the project is more important than the actor behind it. Secondly, we will consider the issuer objectives, and finally study the sector and possibly country. It is therefore a bottom-up process leading to an intentionality rating.

The main advantages of this additional scoring system lie on its simplicity and transparency. It also provides a rather general framework applicable to diverse scenarios by defining varying thresholds for the binary answers. Consequently, it is adjustable to investors' preferences and highly malleable. The reverse consequence is that we obtain a highly relative score, as it depends on the tree structure.

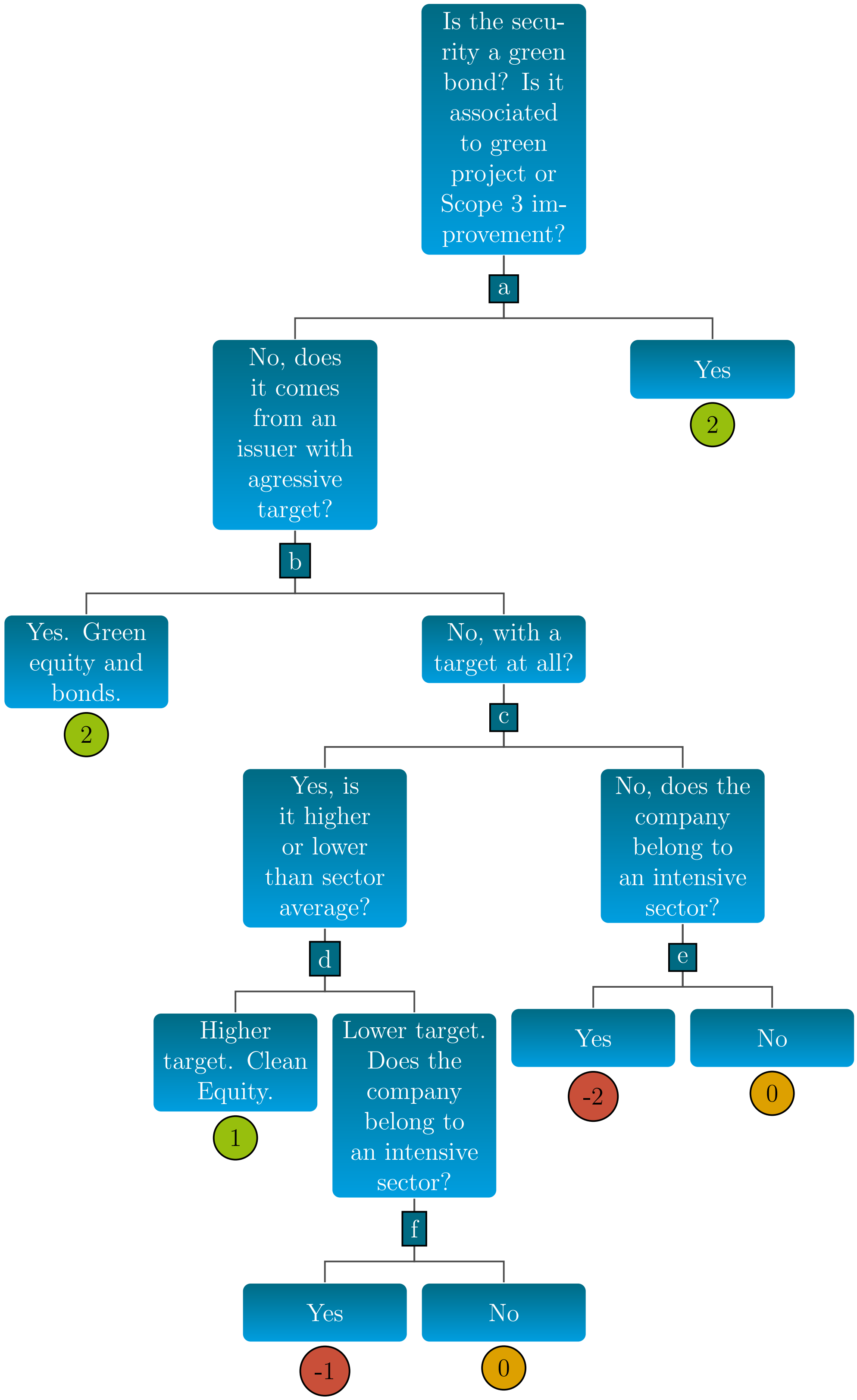
Figure 15: Bottom-up process questions



3.2 A rule-based scoring process

We aim at defining a score, between -3 and +3, focused on the corporate universe. The idea is to sort assets by intentionality to assess which are the securities a portfolio designed to favor the transition should overweight or underweight. Therefore, if we have information about what the security is precisely funding, we must consider this information first. In most of the cases, we do not, and more generally we do not even have access to the details of the capital expenditure information. Some providers are actively working on extending their offer with these information, but the disclosure remains partial. However, some companies have disclosed ambitious targets. If

Figure 16: Example of a naive systematic decision tree scoring system



these targets are considered feasible, these companies should be favored in both equity and bonds areas. Then, we can compare the companies with non-aggressive targets with the sector average and propose a ranking. It is also important to consider the intensity of the activity. Indeed, targets fixed by companies in a sector with a low carbon intensity do not particularly matter to change the current trend. For instance, a company from a very non-intensive sector reducing its emission by 100% in two years does not necessarily deserve the highest score.

The first example of a decision tree provided in Figure 16 is a simple conditional process illustrating the concept. Each node corresponds to a question. We assume that we have already filtered securities that we know to have very positive impacts, step (a) in Figure 16. Filtering companies with aggressive target, we can complete the step (b). For the securities still in the bucket, we consider first the ones issued by an actor that has a target. We can center their target and compare it to the sector average. If the target is higher we can overweight the security in the optimizer, but if it is not, we must assess to what extent the security affects the environment. This process still ignores some cases, and the algorithm 3 allows us to go a little further. It can be applied to define an the intentionality score, as demonstrated in Figure 17.

3.3 A realistic example

The algorithm 3 shows how the system works. This system can use a considerable number of sources for input data. It can be based on existing targets from any providers contracted[28]. We note that most questions can be transformed into a yes-no, in order to simplify the process. In further versions the process can be refined introducing z-scoring methodology. To give a quick overview of the process, Questions 1 and 2 are project based; Question 3 is the improvement of the previous tracking algorithm adding reduction targets; Step 4 raises qualitatively business risk and opportunity questions; step 5 is a feasibility screen; and Questions 6 to 8 makes it possible to differentiate issuers from their peers and neutralize irrelevant information.

[28]To better track the specific intentionality, Natural Language Processing (NLP) is a solution to complete the analysis. Additionally, current Amundi internal process can also be used.

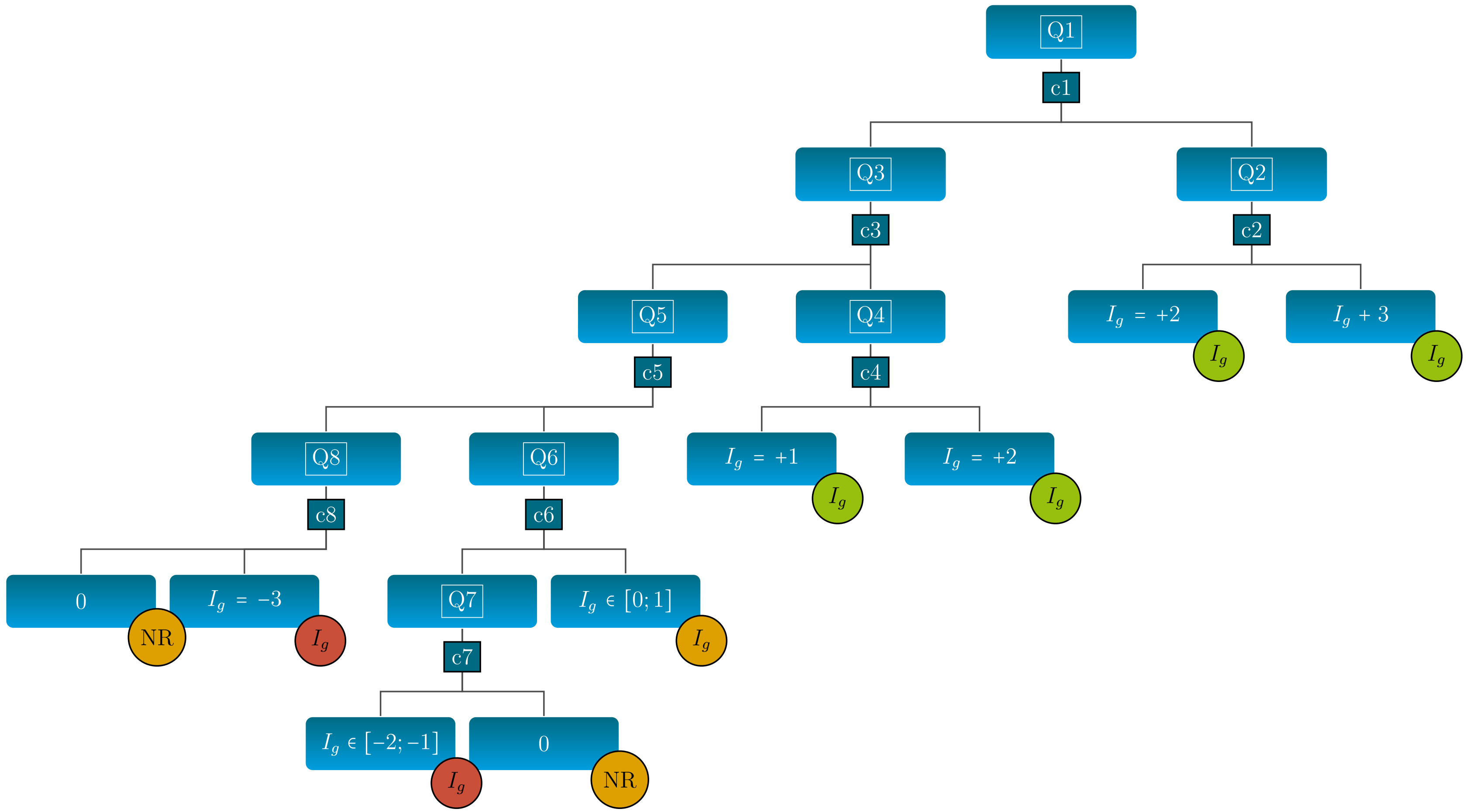
Algorithm 3: Intentionality scoring algorithm

Input:
– Asset universe (or index) for which we have: Targets,
– Avoided emission bases,
– External sources (NLP).

```
if [Q1] Security directly carries green intentionality? = Yes then
    if [Q2] Can we compute avoided emissions? = Yes then
        I_g=3
    else
        I_g=2
else
    if [Q3] Does it come from an issuer with an aggressive target? Or does it come from an issuer
      matching a 2°C scenario requirement (sector/country)? = Yes then
        if [Q4] Does the issuer appear concerned/prepared by the envrionmental stake of its sector
          (Scope 3 reduction/TEE score)?= Yes then
            I_g=2
        else
            I_g=1
    else
        if [Q5] Does the issuer disclose a feasible target? = Yes then
            if [Q6] Is the target above or below the sectoral average?=Above then
                I_g=0 to +1
            else
                if [Q7] Below but does the issuer belong to an intensive/ climate relevant sector? = No
                  then
                    I_g=0
                else
                    I_g=-2 to -1
        else
            if [Q8] Does the issuer belong to an intensive/ climate relevant sector? = Yes then
                I_g=-3
            else
                I_g=0
```

Result: I_g(i)

Figure 17: Intentionality labelling



In this example, we chose to also introduce an intentionality tag that can be informative of the direction favored by the global investment (at a portfolio level). In fact, this tag makes more sense at a security level while the temperature can only be defined at an aggregated level. It is indeed hardly justifiable to say that one security is 2°C while another might be 5°C, especially when the two come from the same issuer. Nevertheless, it is possible to use the questions given in the algorithm 3 to rank securities intentionality. Note that, similarly as the temperature tag of the previous section, this intentionality tag can be questioned and challenged. However, it is to some extent representative as long as we use the same methodology to compare portfolios.

Question 1 The first step is to identify the financial securities for which the '*green intentionality*' is evident. There are therefore three main cases to identify direct green intensity:

- Green intentionality is immediately and explicitly identifiable. Currently, green bonds are the only underlying that meets this criterion. Green bonds used to refund or that cannot be clearly associated to a green project can be excluded from this set of security.
- Intentionality is obvious but remains implicit. These will be traditional bonds issued by companies wishing to reduce their environmental footprint (e.g., manufacturing a more efficient plant), limit the impact of their products (e.g., reducing car emissions, energy efficiency).
- The equity and bonds issued by 'pure players' operating in the field of the environment or energy transition (renewable, water treatment, pollution control, energy efficiency, etc.), developing disruptive technologies, etc.

In keeping with our desire to have a systematic approach, the notion of evidence is essential at this stage. Automatic identification is also essential. For example, it will be a certified green bond flag for the bonds concerned, specific indicators supplied by external data providers, recurring information collected by Natural Language Processing or Reuters data for example.

Table 5: Example green bonds database

ISIN	Mark. Cap	Currency	Issuance	Maturity	Avoided Em.	Avoided Em./ Invest. (tCO_2/M$/y)
Isin 1	932	USD	29/09/2016	31/10/2026	252	0,27
Isin 2	932	USD	29/09/2016	31/10/2046	252	0,27
Isin 3	76	-	04/10/2017	04/10/2022	490	6
Isin 4	300	EUR	14/12/2015	14/12/2022	588	2
Isin 5	100	-	04/10/2017	04/10/2022	644	6

Question 2 If the answer to Q1 is yes, we will look at whether we can estimate the emissions avoided by our investment. In practice, only some green bonds currently provide this information in a simple way (only about 25-30% of green bonds in issue report avoided emissions). At this stage, the use of an external source seems to be the optimal solution for carrying out this screening (Trucost for example). The Table 5 is an example of usable input to answer this question. The idea of valuing projects where the *avoided emissions* are computed is two folds. First, it validates the green content of the project. If emissions are avoided, it is difficult to dispute the fact that the security is actually used for or related to environmental purposes. Second, it encourages disclosure. If information enters the selection process of the assets in the portfolio, then the first step towards pricing is taken. The more we reward such disclosure the more climate relevant information will be disclosed at a project level. Besides, investments in '*pure players*' working in favor of the energy transition and the bonds of companies with a strong environmental ambition will also be valued at this stage.

Question 3 Since the evidence of the green commitment could not be assured, we will seek to verify the relevance of the issuer's objectives in relation to a 2 °C scenario. Are the targets sufficiently ambitious – '*aggressive target*' – to achieve the required emission levels? Are they in line with the IEA reference scenario? The methodology used to evaluate the positioning of an issuer in relation to the trajectories of the 2 °C scenarios is presented in the previous section. In this step, one can use the algorithm 1 to assess the current trajectory. However, we noted in the previous part that this intensity tracking is often not sufficient to efficiently distinguish future tendencies, thus we must improve the process to make it more systematically relevant. In the previous part, the goal was indeed to present the observed and projected trajectories without including targets, so as not to opacify the output. In this process, we acknowledge that the output will be a multidimensional and representative score – the intentionality tag – and thus we include more information. Therefore, this question can be answered in two steps:

1. First, we filter the actors that are aligned according to the algorithm 1, regardless of their announcements for the future[29]. We showed that, even on a universe focused on developed countries and rather large companies, this filtration selects only a few actors except in the power generation sector.

2. Second, we now include the companies' targets. In this paper, we used targets provided by CDP. Again, we can break the process down around target analysis as follow:

   (a) Is the disclosed target aggressive according the definition posed on page 32?

   (b) Is it sufficient to be on the 2 °C path? This step is more complex as it requires

      (*i*) to get the company target – admitting that the targets have been homogenized otherwise it needs to be done,

      (*ii*) to compute annualized reduction and finally

      (*iii*) to compare the cumulative intensity reduction on the chosen horizon with the referring scenario requirement. This way we project a representative trajectory of a smooth reduction between base year and target year.

Despite the appearing complexity, these questions are rather straightforward if the thresholds are high enough (in fact the definition of aggressive targets also directly answer the issue). Indeed, the objective here is to keep only the best-in-class companies in terms of climate alignment and thus carbon intensity reduction.

Question 4 A positive answer to Question 3 will result in a positive tilt for the issuer (between +1 and +2). To refine the level of this tilt, we will try to assess how well this issuer understands the environmental issues of its reference sector. We reiterate that, Question 3 analyses the company prospectively through the projection of its past emissions and its communicated objectives for the future. Here, we seek to identify companies' current practices in terms of energy transition and their vision for a possible change in business model related to climate change. Transparency on Scope 3 or an Energy Transition score maintained in-house in Amundi are the main signals

[29]Indeed, they have appeared so far in line with requirements without expressing the need to advertise about their environmental strategy – through targets and green bonds.

at our disposal. However, in order to more accurately assess the performance of companies, we may use other more specific criteria. This will be, for example, the share of green products in sales, investments in R&D, the percentage of more efficient products in sales, CO2 emissions per passenger, CO2 from vehicles, the percentage of electrified cars sold, life cycle analyses. The best positioned issuers will be at +2, the others will remain at +1 in the discrete process version (V1). Most issuers are still in the left side of the tree after the Question 3.

Questions 5 and 6 Even if they are not at the expected level set by Question 3, the issuer might still have set a target for itself. It is a yes/no question, which will lead to considering company targets – introduced Question 3 to select to best-in-class – in more depth. The term '*feasible*' represents the whole issue of moral hazard which can only be answered with the help of assiduous monitoring and effective reporting interfaces. This feasibility test can also be replaced by a high-pass filter calibrated on governance scores. For now we will ignore this term and simply consider targets as if they were all equally relevant and easily transposable in a Scope 1+2 intensity reduction percentage. Figure 19 on page 43 shows the underlying complexity in the operational processing of reduction targets. This figure plots the average reduction promised by each SDA-sector over the average horizon defined as the distance between base and target year. Our data focuses on active targets in the sense that we disregard past completed efforts. In the current state of emergency, we would like to see as many bubbles as possible inside the top left quadrant, meaning that companies of the sector represented aim to aggressively reduce their emissions within 10 years or less. Unfortunately, it appears that it is not the case. For instance iron and steel targets are on average set over 20 years. If we transpose these engagements to the iron and steel companies trajectories given in Figure 4 on page 23, we can wonder if we can expect a swift turnaround as has happened in the power generation sector. In general when targets are disclosed, we can start by wondering if these are higher than the sectoral average (Question 6). To answer this question, two methodologies are possible:

- Graphical method: The target is projected in Figure 16. If the issuer appears above and to the left it is because its target is more ambitious compared to its sector (Figure 18).

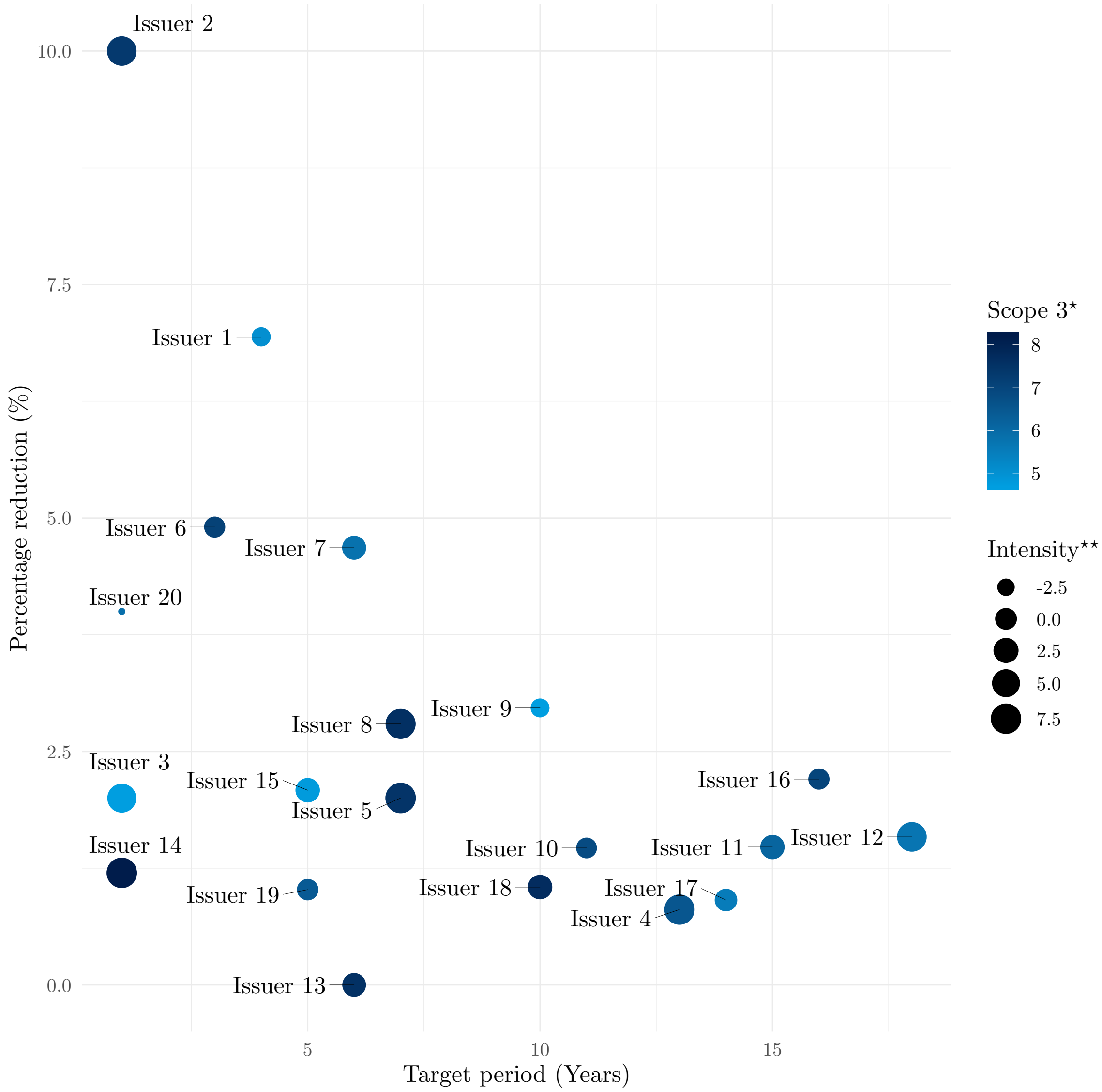
- Numerical method: the target set is standardized annually and a sectoral z-score is constructed. To do so, we can apply the formula for each security i that belong to the sector s:

$$Z_i = \frac{\mu_{i,y} - \mu_{s,y}}{\sigma_{s,y}}$$

  where $\mu_{i,y}$ is the annualized reduction target of the issuer, $\mu_{s,y}$ the sectoral average reduction target and $\sigma_{s,y} = \text{sd}_{i\in s}(\mu_{i,y})$ the standard deviation within the sector. This method is easier to implement however it neutralizes most of the information reducing sharply the dimensionality of the input.

We focus on oil and gas to present the graphical method in Figure 18. We reiterate that oil and gas is a sector for which there is no SDA trajectory and thus no reference to compare each individual. The only data we can use to compare companies is consequently reduction targets. On average, the engagement target is given over 7.7 years and require a 2.7% annual percentage reduction of their Scope 1+2 intensity emissions, which is grossly equivalent to a

Figure 18: Oil and gas target graphical analysis (active target)



* Scope 3 are retrieved from self-reported estimation by companies provided by CDP. We applied log10 transformation.

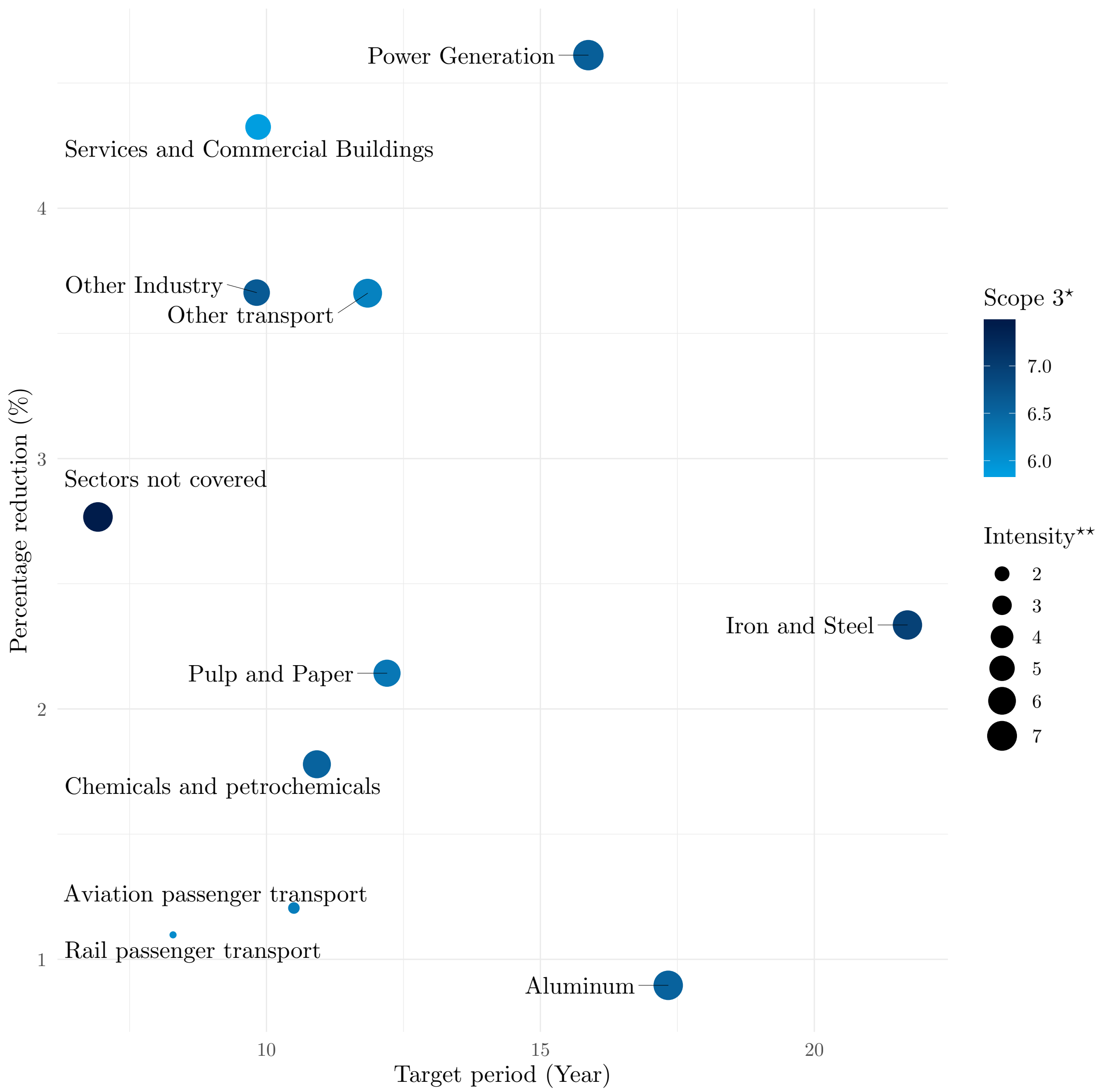
** Intensities are the base year intensity scope 1 + 2 reported by companies to CDP.

20.8% total reduction over the average period. We reiterate that we considered reduction without any corrections in this presentation paper. In this example, Company 5 has the largest base year intensity. Its target of reduction is of 2% annually over a seven-year horizon which is basically the average of the industry. Unfortunately, we do not see large companies with large scope 3 or comparable intensity take the lead in reduction targets. It has therefore not been a surprise to see minority shareholders in Company 18 file a resolution in April 2020 on better specifications for emissions-reduction target, including Scope 3 considerations.Companies with really short-term targets present the advantage to be easily tractable in terms of realization of their engagements. Therefore, if they effectively and implement and sustain their effort, they should have been selected at Question 3. Moreover, the 1-year maturity targets are most likely to become quickly out dated with the passing of the target year. Every company, including the biggest polluter in terms of Scope 1+2, which are below the sector average receive a lower score especially when the maturity exceed the average 7.7 years with lower reduction.

All in all, after this step, we have the corrected trajectories for the issuers including the reduction targets. More importantly, we are able to justify and control our scores with both graphical and numerical analysis. We can calibrate the score in output to be either an implementable z-score in an optimization process, similarly as ESG, or an intentionality factor, allowing the correction of the implicit temperature trajectory.

Questions 7 and 8 These questions can be seen as a neutralization process to avoid inconsistencies in output. Whether the company is in an emissions-intensive sector or not, the impact of its inaction will have a greater or lesser impact on climate change. In other words, in some cases, aqssessing a company's environmental impact makes no sense compared to what must be done on oil and gas steel or energy production companies. A z-score will be calculated to rank the sectors according to their intensity. Companies in intensive sectors with inappropriate practices will be further penalized. In practice, a company that does not have an objective, nor a controlled and decreasing trajectory, in an intensive sector will be heavily penalized (-3 max). Note that this punishment is extremely severe especially since most of the lacking targets can in fact be found in reports and have simply not be reported. On the other hand, if the sector is not intensive, the impact will be neutralized. This way we avoid aberration when not particularly intense actors promise to reduce by 90% their emissions, retrieving a very high intentionally score affecting the weightings in the asset allocation strategy. The same logic will apply to a company with objectives below the sector average. The only difference is that the impact will be more limited than for a company with no objective at all (between -2 and -1 if exposure to an intensive sector; neutral if exposure is low).

Figure 19: SDA sector average target graphical analysis (active target)



* Scope 3 are retrieved from self-reported estimation by companies provided by CDP. We applied log10 transformation.

** Intensities are the base year intensity scope 1 + 2 reported by companies to CDP.

4 Conclusion

Aligning portfolios on 2 °C is a 'hot' question for climate-aware portfolio managers. The general situation on climate is reported by UNEP. Here we provide a basic approach to translate the understanding of '*current policy scenarios*' at the asset-level with a projection of the past track-record of corporates on their emissions intensity.

Emissions-centric approaches have focused on high emission sectors. We propose a mapping of these SDA-sectors to a business oriented industry classification (GICS). We look at weighting schemes within SDA sectors and we realize that within high-emission sectors, only power generation has produced a shift in the recent years. A three-year gap in monitoring is enough to identify this significant change of course. This raises the following question for a portfolio manager: should she/he encourage issuers who have reduced their intensities and who are on a sensible trajectory or should she/he support industries and corporates who will do the transition in the near future. To answer this question we introduce an intentionality scoring to better map the intentions of corporates and thus support the engagement approach of portfolio managers. This scoring also addresses the situation where we have climate-sensible securities by polluting issuers.

To help cut through the complexity and diversity of climate metrics, we have also brought together homogeneous data for corporate intensities and climate scenarios with their associated temperatures. For a global index, it appears with no surprise that '*current policy scenarios*' going unchanged asset-per-asset would lead to a 2030 situation above a 5 °C scenario. We confirm the necessity for asset-owners and investment managers to keep their focus on the climate transition and long-term assessment of corporates' emissions-intensity track-record.

Beyond this confirmation, our recent research (Drei *et al.*, 2019) has highlighted a new development in ESG integration. Indeed ESG investing has shifted towards dynamic forward-looking strategies with anticipation of improving ESG. Regarding the environmental dimension, our body of research – including this paper – reflects our industry's appetite to bring new tools into our arsenal to anticipate the climate risk of corporates. Bouchet and Le Guenedal (2020) use a carbon price threshold to build a new indicator of carbon risk. This indicator has a higher financial sensitivity than a standard intensity measure. We will also be exploring a novel approach to build low-risk carbon sensible portfolios.

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Figure 20: Chemicals and petrochemicals – Absolute observed and projected intensity trajectories

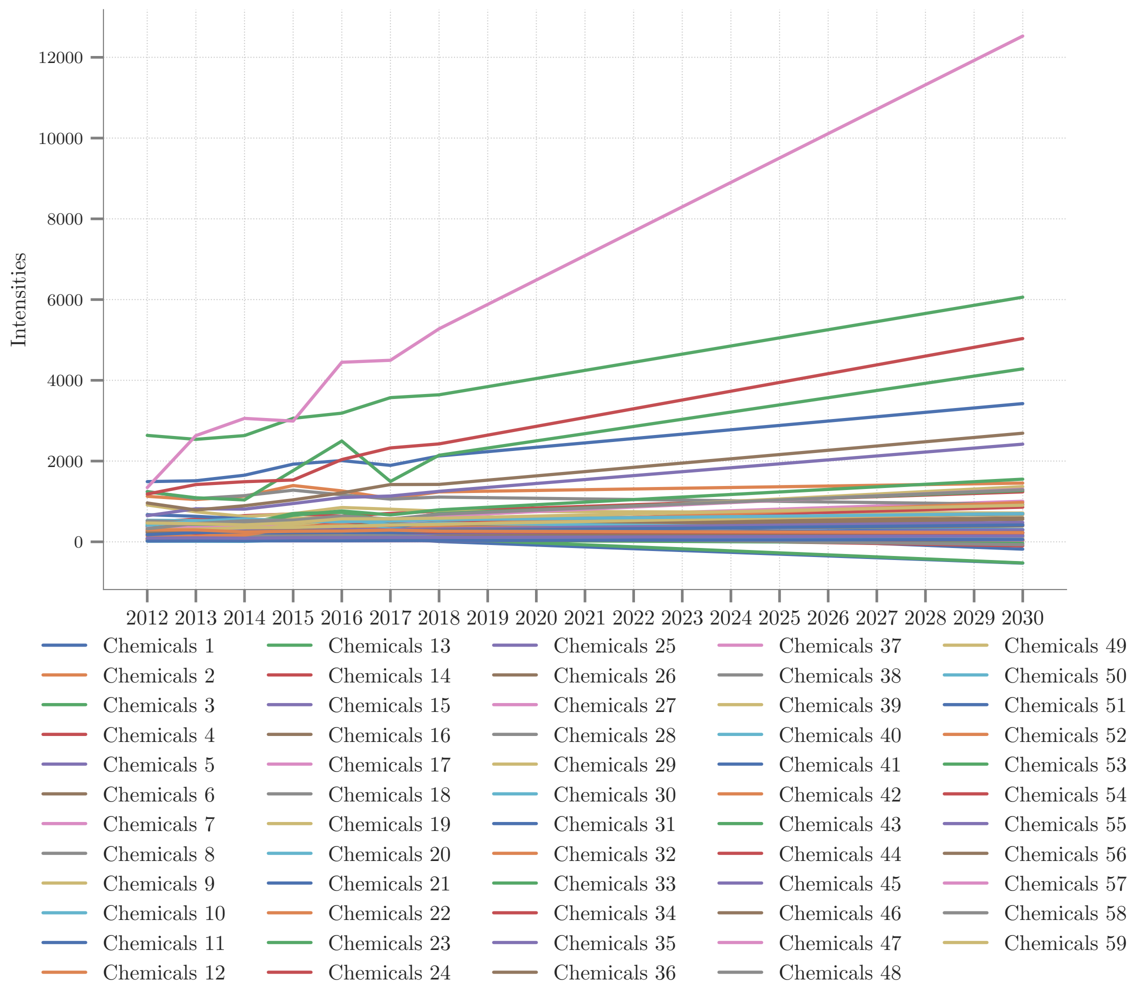


Figure 21: Chemicals and petrochemicals – Relative observed and projected intensity trajectories (% change)

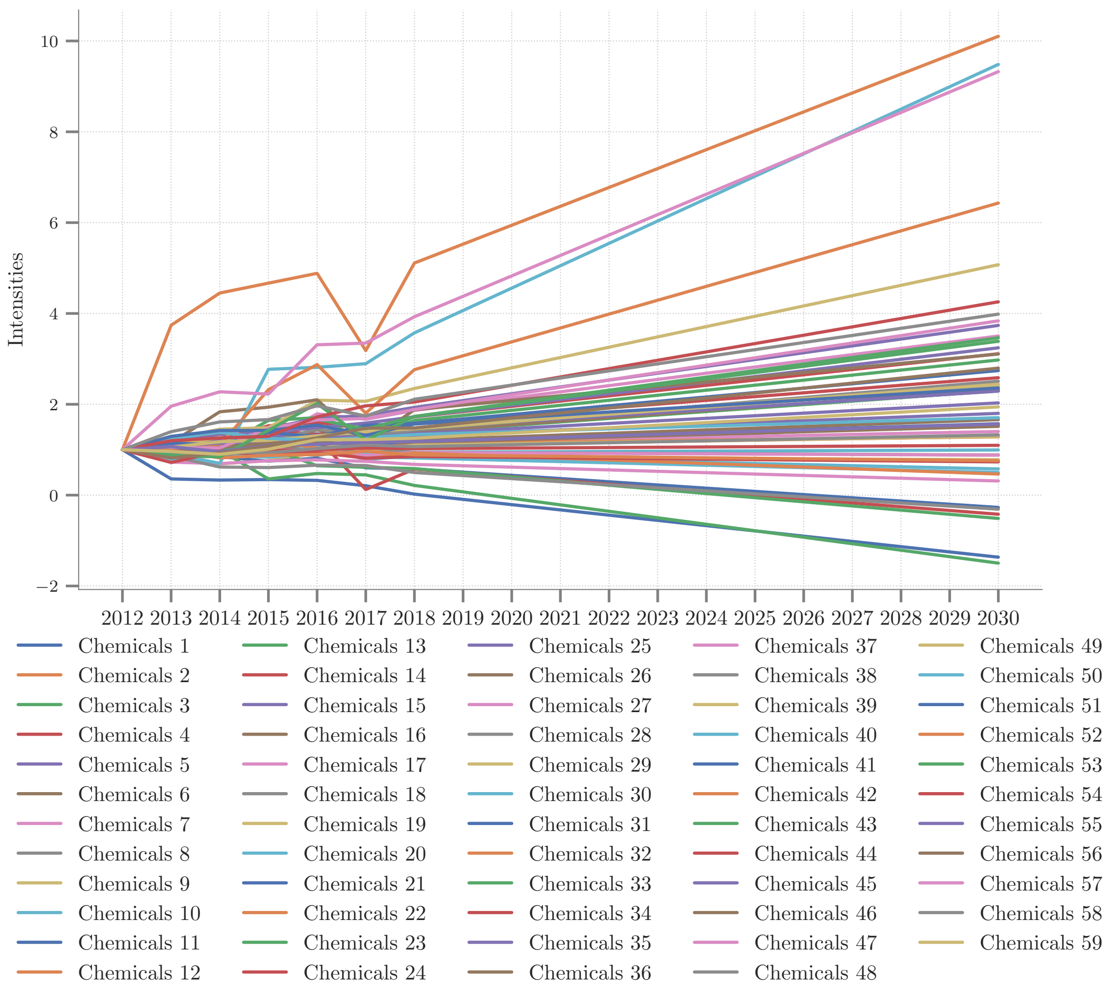
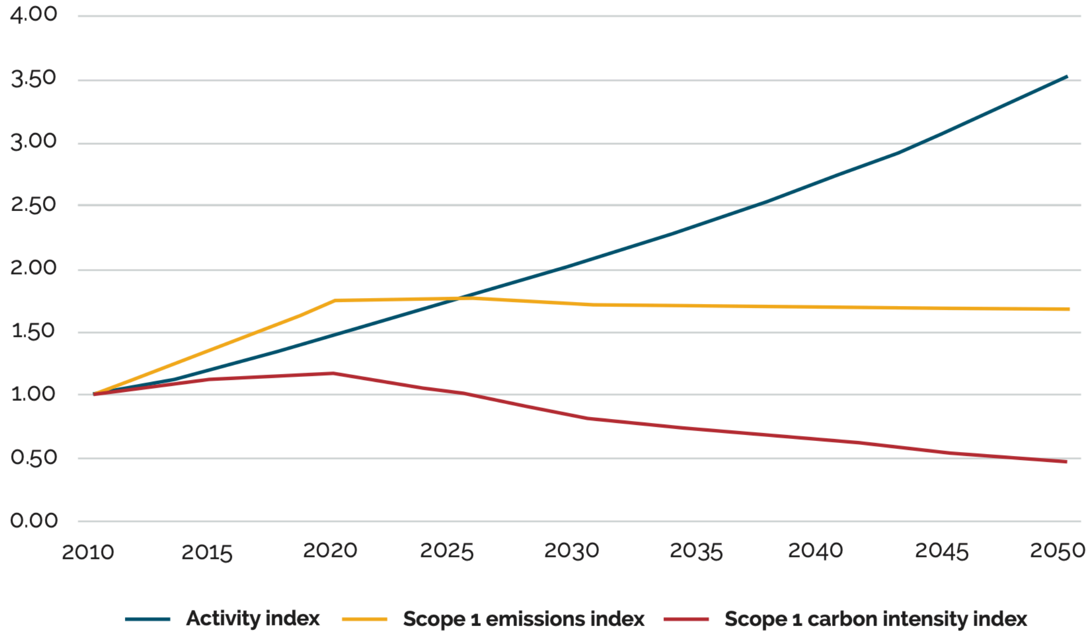
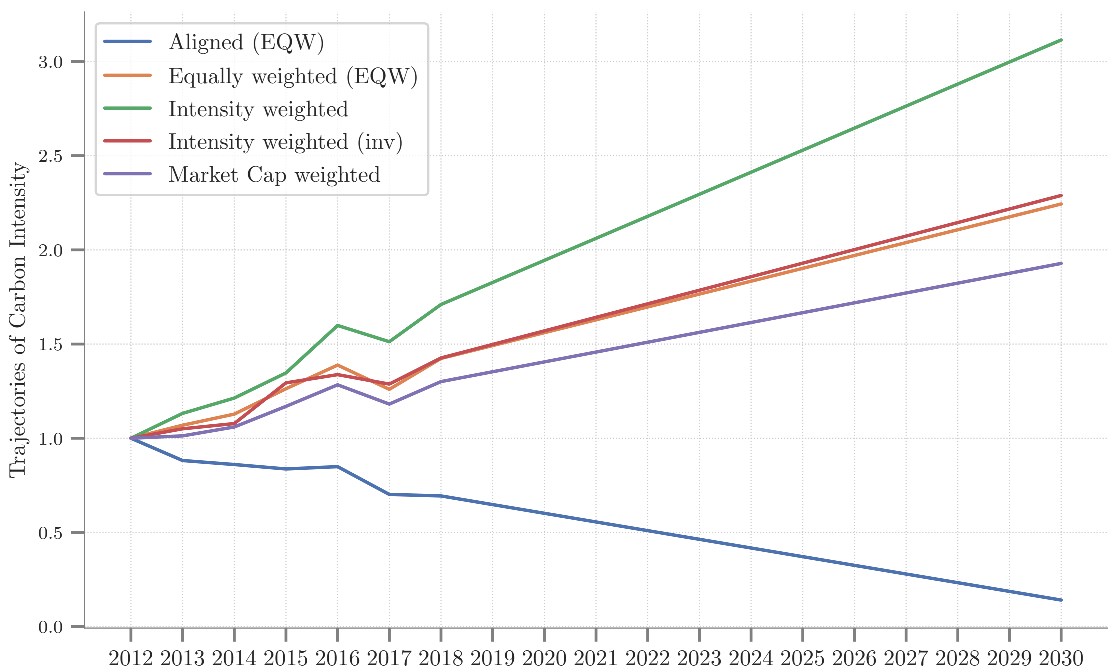


Figure 22: Chemical and petrochemicals



Source: Sectoral Decarbonitization Approach – https://sciencebasedtargets.org/wp-content/uploads/2015/05/Sectoral-Decarbonization-Approach-Report.pdf

Figure 23: Chemicals and petrochemicals sector portfolios intensity trajectories



GICS Sub-Industry Code	GICS Sub-Industry	SDA-Sector
45203015	Electronic Components	
45203020	Electronic Manufacturing Services	
45301010	Semiconductor Equipment	
45301020	Semiconductors	
20301010	Air Freight and Logistics	Other transport
20303010	Marine	
20304020	Trucking	
55101010	Electric utilities	Power Generation
55103010	Multi-Utilities	
55105010	Independent power producers and energy traders	
55105020	Renewable Electricity	
15105020	Paper Products	Pulp and Paper
20304010	Railroads	Rail passenger transport
20201010	Commercial Printing	Services / Commercial Buildings
20201050	Environmental & Facilities Services	
20201060	Office Services & Supplies	
20201070	Diversified Support Services	
20201080	Security & Alarm Services	
20202010	Human Resource & Employment Services	
20202020	Research & Consulting Services	
20305010	Airport Services	
20305020	Highways & Railtracks	
20305030	Marine Ports & Services	
25301010	Casinos & Gaming	
25301020	Hotels, Resorts & Cruise Lines	
25301030	Leisure Facilities	
25301040	Restaurants	
25302010	Education Services	
25302020	Specialized Consumer Services	
25501010	Distributors	
25502020	Internet Retail	
25503010	Department Stores	
25503020	General Merchandise Stores	
25504010	Apparel Retail	
25504020	Computer & Electronics Retail	
25504030	Home Improvement Retail	
25504040	Software Specialty Stores	
25504050	Automotive Retail	
30101010	Drug Retail	
30101020	Food Distributors	
30101030	Food Retail	
30101040	Hypermarkets & Super Centers	
35102010	Health Care Distributors	
35102015	Health Care Services	
35102020	Health Care Facilities	
35102030	Managed Health Care	
35201010	Biotechnology	
35203010	Life Sciences Tools & Services	
40101010	Diversified Banks	
40101015	Regional Banks	
40102010	Thrifts & Mortgage Finance	

Table 6: Sectoral Mapping SDA sector vs. GICS

GICS Sub-Industry Code	GICS Sub-Industry	SDA-Sector
15104010	Aluminum	Aluminum
20302010	Airlines	Aviation passenger transport
15102010	Construction Materials	Cement
15101010	Commodity Chemicals	Chemicals and petrochemicals
15101020	Diversified Chemicals	
15101030	Fertilizers and Agricultural Chemicals	
15101040	Industrial Gases	
15101050	Specialty Chemicals	
15104050	Steel	Iron and Steel
15103010	Metal & Glass Containers	Other Industry
15103020	Paper Packaging	
15104020	Diversified Metals and Mining	
15104030	Gold	
15104040	Precious Metals & Minerals	
15104045	Silver	
15105010	Forest Products	
20101010	Aerospace & Defense	
20102010	Building Products	
20103010	Construction & Engineering	
20104010	Electrical Components & Equipment	
20104020	Heavy Electrical Equipment	
20106010	Construction Machinery & Heavy Trucks	
20106015	Agricultural & Farm Machinery	
20106020	Industrial Machinery	
25101010	Auto Parts & Equipment	
25101020	Tires & Rubber	
25102010	Automobile Manufacturers	
25102020	Motorcycle Manufacturers	
25201010	Consumer Electronics	
25201020	Home Furnishings	
25201030	Homebuilding	
25201040	Household Appliances	
25201050	Housewares & Specialties	
25202010	Leisure Products	
25203010	Apparel, Accessories & Luxury Goods	
25203020	Footwear	
25203030	Textiles	
30201010	Brewers	
30201020	Distillers & Vintners	
30201030	Soft Drinks	
30202030	Packaged Foods & Meats	
30301010	Household Products	
30302010	Personal Products	
35101010	Health Care Equipment	
35101020	Health Care Supplies	
35202010	Pharmaceuticals	
45201020	Communications Equipment	
45202030	Technology Hardware, Storage, & Peripherals	
45203010	Electronic Equipment & Instruments	

GICS Sub-Industry Code	GICS Sub-Industry	SDA-Sector
40201020	Other Diversified Financial Services	
40201030	Multi-Sector Holdings	
40201040	Technology Specialized Finance	
40202010	Consumer Finance	
40203010	Asset Management & Custody Banks	Services / Commercial Buildings
40203020	Investment Banking & Brokerage	
40203030	Diversified Capital Markets	
40204010	Mortgage REITs	
40301010	Insurance Brokers	
40301020	Life & Health Insurance	
40301030	Multi-line Insurance	
40301040	Property & Casualty Insurance	
40301050	Reinsurance	
45102010	IT Consulting & Other Services	
45102020	Data Processing & Outsourced Services	
45102030	Internet Software & Services	
45103010	Application Software	
45103020	Systems Software	
45203030	Technology Distributors	
50101010	Alternative Carriers	
50101020	Integrated Telecommunication Services	
50102010	Wireless Telecommunication Services	
50201010	Advertising	
50201020	Broadcasting	
50201030	Cable & Satellite	
50201040	Publishing	
50202010	Movies & Entertainment	
50202020	Interactive Home Entertainment	
55104010	Water Utilities	
60101010	Diversified REITs	
60101020	Industrial REITs	
60101030	Hotel & Resort REITs	
60101040	Office REITs	
60101050	Health Care REITs	
60101060	Residential REITs	
60101070	Retail REITs	
60101080	Specialized REITs	
60102010	Diversified Real Estate Activities	
60102020	Real Estate Operating Companies	
60102030	Real Estate Development	
60102040	Real Estate Services	
10102010	Integrated oil and gas	Sectors and activities not covered by the method
10102030	Oil and gas refining and marketing	
10102050	Coal and consumable fuel	
30202020	Agriculture products	

Source: Science Based Target Initiative – https://sciencebasedtargets.org/ and Amundi Quantitative Research.

Amundi
ASSET MANAGEMENT

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