OECD Environment Working Papers No. 200

Assessing the climate consistency of finance: Taking stock of methodologies and their links to climate mitigation policy objectives

Jolien Noels and Raphaël Jachnik

https://dx.doi.org/10.1787/d12005e7-en

OECD

Research Collaborative
Tracking Finance for Climate Action

Organisation for Economic Co-operation and Development

ENV/WKP(2022)12

Unclassified **English - Or. English**

3 October 2022

ENVIRONMENT DIRECTORATE

Assessing the climate consistency of finance: Taking stock of methodologies and their links to climate mitigation policy objectives

Environment Working Paper No. 200

By Jolien Noels and Raphaël Jachnik (1)

(1) OECD Environment Directorate.

OECD Working Papers should not be reported as representing the official views of the OECD or if its member countries. The opinions expressed and arguments employed are those of the authors.

Authorised for publication by Jo Tyndall, Director, Environment Directorate.

Keywords: Investment, finance, climate alignment assessment methodologies, greenhouse gas emissions, climate change mitigation scenarios.

JEL Classification: G23, G24, Q54, Q56.

OECD Environment Working Papers are available at www.oecd.org/environment/workingpapers.htm

JT03503745

This document, as well as any data and map included herein, are without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

OECD ENVIRONMENT WORKING PAPERS

OECD Working Papers should not be reported as representing the official views of the OECD or of its member countries. The opinions expressed and arguments employed are those of the author(s). Working Papers describe preliminary results or research in progress by the author(s) and are published to stimulate discussion on a broad range of issues on which the OECD works.

This series is designed to make available to a wider readership selected studies on environmental issues prepared for use within the OECD. Authorship is usually collective, but principal author(s) are named. The papers are generally available only in their original language – English or French – with a summary in the other language.

Comments on Working Papers are welcomed, and may be sent to:
OECD Environment Directorate
2 rue André-Pascal, 75775 Paris Cedex 16, France
or by email: env.contact@oecd.org

OECD Environment Working Papers are published on
www.oecd.org/environment/workingpapers.htm as well as on the OECD iLibrary
(www.oecdilibrary.org)

This document and any map included herein are without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

Note by the Republic of Türkiye: The information in this document with reference to “Cyprus” relates to the southern part of the Island. There is no single authority representing both Turkish and Greek Cypriot people on the Island. Türkiye recognises the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Türkiye shall preserve its position concerning the “Cyprus issue”.

Note by all the European Union Member States of the OECD and the European Union: The Republic of Cyprus is recognised by all members of the United Nations with the exception of Türkiye. The information in this document relates to the area under the effective control of the Government of the Republic of Cyprus.

© OECD (2022)

You can copy, download or print OECD content for your own use, and you can include excerpts from OECD publications, databases and multimedia products in your own documents, presentations, blogs, websites and teaching materials, provided that suitable acknowledgment of OECD as source and copyright owner is given.

All requests for commercial use and translation rights should be submitted to *rights@oecd.org*.

Abstract

This paper analyses existing methodologies developed by commercial services providers, research institutes or civil society organisations for investors and financial institutions, to assess the alignment of their assets and portfolios with the Paris Agreement temperature goal. The analysis is based on four main analytical dimensions: coverage of financial asset classes, choice of greenhouse gas (GHG) performance metrics, selection of climate change mitigation scenarios, and approach for aggregating alignment assessment for a given asset class and at portfolio level. Within these dimensions, the analysis highlights that a range of different and complex methodological choices, as well as current scope and data limitations, impact the environmental integrity and policy relevance of alignment or misalignment results. The paper provides suggestions for improved and more comprehensive financial sector alignment assessment. These include the development of different complementary methodologies to cover a broader range of financial asset classes than the current main focus on listed corporate equity, the development of more tailored mitigation scenarios by climate policy and science communities, better communication of uncertainties by all stakeholders, and the need for a series of indicators to assess progress and impacts that include but are not limited to GHG-based alignment assessments.

Keywords: Investment, finance, climate alignment assessment methodologies, greenhouse gas emissions, climate change mitigation scenarios.

JEL Codes: G23, G24, Q54, Q56.

Résumé

Ce document analyse les méthodologies existantes développées par des fournisseurs de services commerciaux, des instituts de recherche ou des organisations de la société civile et pour les investisseurs et institutions financières, afin d'évaluer l'alignement de leurs actifs et portefeuilles avec l'objectif de température de l'Accord de Paris. L'analyse repose sur quatre dimensions analytiques principales: la couverture des classes d'actifs financiers, le choix des mesures de performance en terme de gaz à effet de serre (GES), la sélection des scénarios d'atténuation du changement climatique, et l'approche pour agréger l'évaluation de l'alignement par classe d'actif financier et au niveau du portefeuille. Au sein de ces dimensions, l'analyse met en évidence qu'une série de choix méthodologiques différents et complexes, ainsi que les limites actuelles en termes de couverture et de données, ont un impact sur l'intégrité environnementale et la pertinence politique des résultats d'alignement ou de non-alignement. Le document fournit des suggestions pour une évaluation améliorée et plus complète de l'alignement du secteur financier. Elles incluent notamment le développement de méthodologies différentes et complémentaires pour couvrir un plus large éventail de classes d'actifs financiers par rapport à l'accent principal mis actuellement sur les l'actionnariat d'entreprises cotées en bourse, le développement de scénarios d'atténuation plus adaptés par les communautés politiques et scientifiques du climat, une meilleure communication des incertitudes par toutes les parties prenantes, et la nécessité de disposer d'une série d'indicateurs permettant d'évaluer les progrès et les impacts comprenant, mais sans s'y limiter, les évaluations d'alignement fondées sur les GES.

Mots-clés: Investissement, financement, méthodes d'évaluation de l'alignement climatique, émissions de gaz à effet de serre, scénarios d'atténuation du changement climatique.

Codes JEL: G23, G24, Q54, Q56.

Acknowledgements

This working paper was authored by Jolien Noels and Raphaël Jachnik, under the guidance of Jane Ellis and overall supervision of Walid Oueslati, Acting Head of the Environment, Transitions and Resilience Division of the OECD's Environment Directorate. It is part of the work programme of the OECD Working Party on Climate, Investment and Development (WPCID) under the Environment Policy Committee (EPOC).

This analysis is also a contribution to the body of work of the Research Collaborative on Tracking Finance for Climate Action, an OECD-led technical research platform to advance and share knowledge for improving the tracking of climate-relevant finance, including to inform finance-related discussions under the United Nations Framework Convention on Climate Change (UNFCCC).

More specifically, the present paper provides evidence of relevance to assessing progress towards Article 2.1c of the Paris Agreement, which calls for "Making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development." By taking stock of and analysing methodologies used by the financial sector to assess alignment from a climate mitigation perspective, the paper complements earlier country-sector pilot studies by the Research Collaborative, that tested options for measuring the such alignment from the perspective of real economy investments.[1]

The paper benefited from:

- Comments and suggestions from OECD colleagues: Geraldine Ang, Joshua Der, Valentina Bellesi, Michael Mullan, Isabella Neuweg, Coline Pouille, Marcia Rocha, Deger Saygin, Cecilia Tam, Simon Touboul, Elia Trippel, and Robert Youngman (Environment Directorate), Sophia Gnych, Catriona Marshall, Giulio Mazzone, and Benjamin Michel (Directorate for Financial and Enterprise Affairs), Pieter Parmentier (Directorate for Science, Technology and Innovation), and Dirk Röttgers (Centre for Tax Policy and Administration).
- Oral feedback and/or written comments from a number of OECD member countries on an initial scoping note and/or a full draft of the report: Chile, Colombia, European Union, Japan, Luxembourg, Norway, the United Kingdom, Switzerland, Sweden, and the United States.

Further, authors are grateful to the following providers of methodologies for their willingness to engage, answer clarification questions as well as provide insights, information and sample data: Arabesque, Carbon Disclosure Project, Carbon Risk Real Estate Monitor, FTSE Russell Beyond Ratings, Carbone 4, MSCI, Paris Agreement Capital Transition Assessment, right. based on science, S&P Sustainble1 (previously Trucost), and Transition Pathway Initiative.

Finally, the authors thank Sama Al Taher Cucci and Jane Kynaston for editorial assistance.

[1] See (Jachnik and Dobrinevski, 2021[141]), (Dobrinevski and Jachnik, 2020[138]) and (Dobrinevski and Jachnik, 2020[139]).

Table of contents

Tables

Figures

Boxes

Executive summary

This paper takes stock of and analyses existing methodologies for the financial sector to assess the alignment of its assets and portfolios with the Paris Agreement (PA) temperature goal. Article 2.1c of the Paris Agreement calls for "*making finance flows consistent with a pathway towards low greenhouse gas* (GHG) *emissions and climate-resilient development*". This formulation contributed to the development of the concept of "climate alignment" of investments and financing. Methodologies to assess progress towards such alignment need to be robust, policy relevant and transparent, as they set incentives for investment decisions and influence the degree to which such decisions have an actual impact on GHG emissions or not. While Article 2.1c refers to both mitigation and resilience, the focus of the present analysis is on mitigation. Parallel efforts to define and assess resilience-aligned finance remain at an early stage.

There is growing landscape of coalitions, frameworks and methodologies promoting the alignment of finance with the temperature goal of the PA. Classifying initiatives according to these three categories helps clarify their purpose and role. However, initiatives may perform multiple and evolving roles over time. In this context, coalitions and frameworks promoting climate-transition and -alignment in the financial sector can build on and be informed by existing international frameworks, such as the OECD's Responsible Business Conduct Due Diligence Guidance.

This study develops an approach to analyse climate-alignment assessment methodologies for the financial sector to help clarify their relevance for assessing progress towards Article 2.1c. The analytical dimensions are: (1) asset class coverage, (2) choice of GHG performance metrics (including targets), (3) climate change mitigation scenario(s) used to assess alignment, and (4) approach to assess alignment at the financial portfolio level. Within these dimensions, the analysis identifies common practices and opportunities for improved and more comprehensive financial sector alignment assessments.

Overall, the absence of agreed approaches to disaggregate the global PA temperature goal and downscale GHG emissions scenarios is a core source of uncertainty and variation when assessing the alignment of financial assets. In practice, different countries, sectors and corporates can and will decarbonise at different rates. Current climate change mitigation scenarios often do not match the sectoral and geographical specificity needed to assess individual assets. In terms of sectors, this notably poses challenges in matching scenarios to economic and financial sectoral classifications. In terms of geography, this may result in methodologies not addressing equity considerations. The climate policy and science community could contribute to improved alignment assessment methodologies by providing more relevant scenarios and reference points for use in the corporate and financial sector.

Gaps in asset class coverage could undermine the environmental integrity of climate-alignment assessments. This paper is the first to analyse climate-alignment assessment methodologies across asset classes beyond listed corporate equity. It finds that several large asset classes, such as private equity, real estate, and infrastructure are underrepresented in such methodologies. This is also the case for sovereign bonds, although individual investors typically have lower ability to directly engage with and influence investees (countries) than for aforelisted asset classes. Limited availability of climate-alignment assessments for these categories of financial assets may result in not capturing a range of underlying economic actors, activities and physical assets responsible for significant portions of GHG emissions.

Different perspectives on climate alignment translates into methodology providers choosing different metrics and temporalities to measure climate performance. This leads to different results

that are difficult to reconcile. In particular, absolute versus intensity-based metrics may find different alignment results for a given asset. The temporal coverage of the methodology is also a strong driver of alignment results and variation. Notably, alignment tends to be assessed more frequently as being achieved using methodologies that only look at a unique point-in-time in 2050. However, such results may allow for delayed action and fail to capture the cumulative emissions that drive temperature outcomes.

The results of climate-alignment assessments are influenced by the coverage of GHG emissions (type and scope) as well as by the treatment of offsets. While the former is mainly constrained by data availability and quality (notably for scope 3 GHG emissions), there remains much opacity about the use of offsets by economic and financial sector actors, which in turn results in a lack of clarity in alignment assessment methodologies. This poses risks to the environmental integrity of alignment assessments, especially given the uncertain additionality of offsets. Those methodologies that explicitly aim to exclude offsets tend to find less alignment in corporate-related financial assets.

New illustrative analysis finds that regardless of the methodology used, listed corporate equity, for which results are available, tends to be mostly not aligned with the PA temperature goal. For those corporate-related financial assets assessed as aligned, such results depend heavily on the different perspectives taken by providers and their assumptions across the dimensions. Further, data availability and consistency remain a challenge even for listed corporate equity.

Aggregate-level assessments of financial portfolios add another layer of complexity and can hide individual activities that may be misaligned. There is no agreed approach to aggregate and allocate alignment results for a given financial asset class, and even less so across different asset classes as these need to follow different alignment assessment methodologies. Several methodologies calculate an “Implied Temperature Rise” metric, but many other methodologies do not yet have a portfolio metric. While portfolio-level metrics and aggregation approaches need to be developed further, such approaches raise environmental integrity concerns, notably by obscuring asset-level performance and methodological differences across asset classes, and thus require careful consideration and methodological transparency.

A dashboard of indicators that includes but is not limited to GHG-based climate-alignment results, can provide a more nuanced and comprehensive view of the contribution of finance to reaching climate policy goals. Climate-alignment assessment is a policy-relevant but complex metric. It relies on many methodological choices and comes with uncertainties and variations in results. A clearer communication of uncertainties by methodology providers is warranted. Improved environmental integrity could be achieved through the development of complementary methodologies to cover a broader range of financial asset classes, and of more tailored scenarios by climate policy and science communities. Complementary indicators of progress, such as measures of the presence and characteristics of concrete plans (including to upscale climate solutions), can further help put GHG-based alignment assessment results in perspective and provide a more holistic view. Further work is needed to design a representative dashboard, complemented with clear communication on underlying assumptions, methodologies and data limitations. This in turn can inform aggregate-level assessments of progress, including under the UNFCCC (Global Stocktake and Biennial Assessment and Overview of Climate Finance Flows).

Further research and analyses can contribute to improved assessments in a number of areas. First, climate-alignment processes in finance can benefit from greater interoperability with other emerging concepts (e.g. transition finance, taxonomies) as well as existing frameworks (e.g. responsible business conduct due diligence). Second, uncertainties and assumptions of climate change mitigation scenarios relied on by climate-alignment assessment methodologies are not well understood. Further research on this could inform the climate integrity of assessments. Third, methodological and indicator development for asset classes other than listed corporate equity are required to ensure assessments do not hide emissions elsewhere, e.g. further work on corporate loans, private equity, mortgages and sovereign bonds, would be beneficial. Finally, efforts to define and assess finance alignment with adaptation and resilience goals need to be explored, including in terms of interrelation with mitigation-related assessments.

1. Introduction

Article 2.1c of the Paris Agreement (PA) calls for "making finance flows consistent with a pathway towards low greenhouse gas (GHG) emissions and climate-resilient development" (UNFCCC, 2015[1]). This formulation contributed to the development of the concept of "climate alignment"[2] or "misalignment" of investments and financing activities by the financial sector (banks, institutional investors), enterprises, and public institutions (e.g. treasuries managing national budgets, development banks).

Investors and financial institutions are increasingly putting forward climate mitigation-related commitments and targets, such as under the Glasgow Financial Alliance for Net Zero (GFANZ), launched in the run up to COP26. However, there is increasing evidence that some climate mitigation-related targets and commitments raise questions of integrity (CPI, 2021[2]; Rogelj et al., 2021[3]), as well as analyses indicating that they may not translate in action and impact on the ground with, for instance, continued financing and investment in fossil fuel combined with limited phase out plans (ShareAction, 2022[4]; BankTrack, 2022[5]; Carbon Tracker, 2022[6]).

Against this backdrop, this paper provides a stocktake and comparison of the increasing number of methodologies developed by research institutes, civil society actors and commercial services providers to assess the degree of alignment or misalignment of the financial sector and financial markets with the PA temperature goal. In doing so, it notably analyses if and how such methodologies directly refer to and relate to the achievement of international and national climate mitigation policy goals.

Based on a tailored analytical approach, this paper draws conclusions on the current state of existing climate-alignment assessment methodologies used in the financial sector. It does so by analysing their assumptions, coverage and gaps, as well as how they may contribute to assessing progress towards climate mitigation policy objectives set by the public sector, most notably the overarching PA temperature goal. New illustrative data further strengthen the findings. Finally, this paper identifies where climate policy makers can prioritise efforts and provides suggestions for improved and more comprehensive and policy-relevant financial sector alignment assessments. This is essential to track progress towards making finance consistent with the PA temperature goals, as highlighted by the UNFCCC Standing Committee on Finance's most recent Biennial Assessment and Overview of Climate Finance Flows (UNFCCC SCF, 2021[7]).

1.1. Context

GHG emission pathways with over 50% chances to limit warming to 1.5°C with no or limited overshoot and those with over 67% chances to limit warming to 2°C require global GHG emissions to peak between 2020 and 2025 (IPCC, 2022[8]). In both cases, rapid and deep GHG emission reductions need to follow throughout 2030, 2040 and 2050, including in non-CO_2 emissions (methane, nitrous oxide, fluorinated gases). Global net zero CO_2 emissions will need to be reached in the early 2050s in modelled pathways that limit warming to 1.5°C (>50%) with no or limited overshoot, and around the early 2070s in modelled pathways that limit warming to 2°C (>67%). Beyond these points in time, many of these pathways would

[2] Some market participants may also refer to climate alignment as Paris alignment.

require net negative CO_2 emissions, which in turn rely on the widespread availability and use of CO_2 removal technologies. Even with the availability of such technologies, deep early reductions in GHG emissions are required in any 1.5°C pathway (Holz et al., 2018[9]).

In turn, at a conceptual level, financial flows and stocks could be considered aligned or misaligned with the PA temperature goal if they contribute to economic systems that are consistent (or inconsistent) with such GHG pathways. In practice, the notions of climate mitigation alignment and consistency not only relate to scaling up finance for activities already aligned with the PA temperature goal, but also to financing activities and economic sectors that need to undergo and implement changes to transition towards net-zero emissions, especially in high-emitting and hard-to-abate sectors.[3] However, there is no agreed or unique way of downscaling the PA's global temperature goal to the level of individual financial assets and underlying economic sectors, actors, or countries, all of which can and will decarbonise at different rates over time. As a result, and as further discussed in this paper, any assessment of the degree of alignment or misalignment of financial assets and portfolios is dependent on a range of different assumptions and methodological choices.

In this context, a number of commercial services providers as well as industry and civil society initiatives have been developing different types of methodologies to assess the climate alignment of financial sector holdings and new investments (PAT, 2020[10]; Institut Louis Bachelier et al., 2020[11]; Schwegler et al., 2022[12]). These methodologies are typically tailored to the profile and needs of different investors and financial intermediaries such as banks, asset managers, and asset owners.[4] The methodologies rely on assumptions about how the GHG emission reductions needed to reach the PA temperature goal are shared and attributed between countries, sectors, as well as business and financial value chains. This is a major source of uncertainty with such assessments.

Despite such limitations, the results derived from climate finance alignment assessment methodologies can help to improve understanding of the interlinkages between the climate performance of the financial sector and climate action on the ground, as well as contribute to influencing investors' decisions. Such decisions, in turn, can influence the real economy and the effective achievement, or not, of the PA temperature goal.

Indeed, the climate consistency and alignment perspective considers the impact of the activities of economic actors, including companies and the financial sector, on climate mitigation and resilience policy goals, i.e. so-called *environmental materiality*[5]. In contrast, the financial and corporate sectors typically look at climate-related information from the perspective of what is financially material to the business, notably in terms of risks, i.e. *financial materiality*. In this context, the Task Force on Climate-related Financial Disclosures (TCFD) categorised climate-related financial risks as transition risks or physical risks (TCFD, 2017[13]; TCFD, 2021[14]) (see Box 1.1). As illustrated in Figure 1.2, the alignment of finance with climate policy goals (environmental materiality perspective) and the management of climate-related financial risks (financial materiality perspective) are interrelated but stem from different starting points and aims, and are also, at least partly, different in scope.

[3] The OECD is has conducted complementary work to develop a guidance on transition finance to support the assessment by investors and financiers of the credibility of corporate climate transition plans and to support corporates in developing such plans (OECD, 2022[24]).

[4] Asset owners include pension funds, endowments, foundations and individual investors.

[5] Environmental materiality refers to the material impact of a company on the environment (Boissinot et al., 2022[18]).

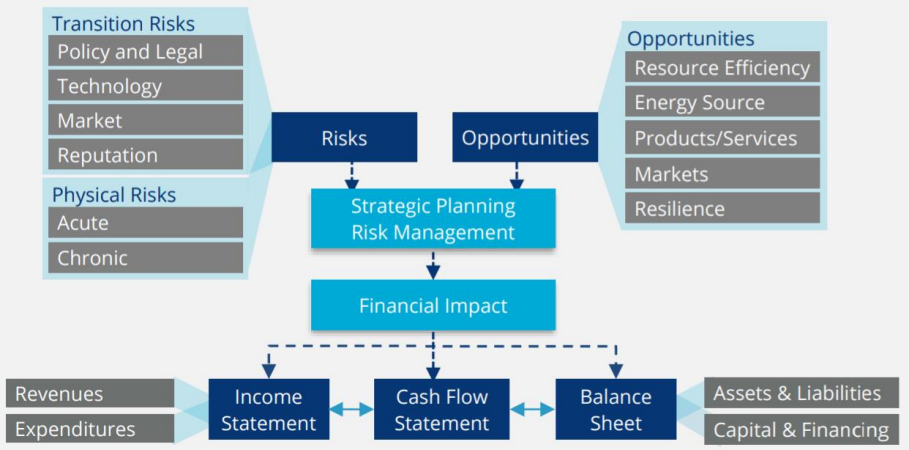
Box 1.1. ESG investing and climate-related financial risks

In the financial sector, Environmental, Social, and Governance (ESG) investing can be defined as an investment approach that seeks to incorporate these three considerations into asset allocation and risk decisions with the aim to generate and preserve financial returns (Boffo and Patalano, 2020[15]). Financial services providers are developing an increasing number of products and practices in this area, including instruments for issuers, third party ratings, principles and guidance. Such products and services primarily aim at informing efficient market functioning, notably in terms of management and pricing of risks and opportunities, in light of wider societal objectives.

Under the Environmental component of ESG analyses, financial market participants, notably the Task Force on Climate-Related Financial Disclosures (TCFD) (TCFD, 2017[13]; TCFD, 2021[14]), have categorised climate-related risks to economic actors (Figure 1.1) as:

- *Transition risks* that arise from changes in public policy, legal, technological, demand and market in order to mitigate climate change. They may be costly due to stranded assets, defaults, and collapse in stock market value (Campiglio and van der Ploeg, 2021[16]).
- *Physical risks* related to the physical impacts of climate change. They become costly to organisations due to direct damage to assets or indirect impacts from supply chain disruption due to extreme events or longer-term changes in climate patterns.

Figure 1.1. TCFD climate-related risks and materiality framework

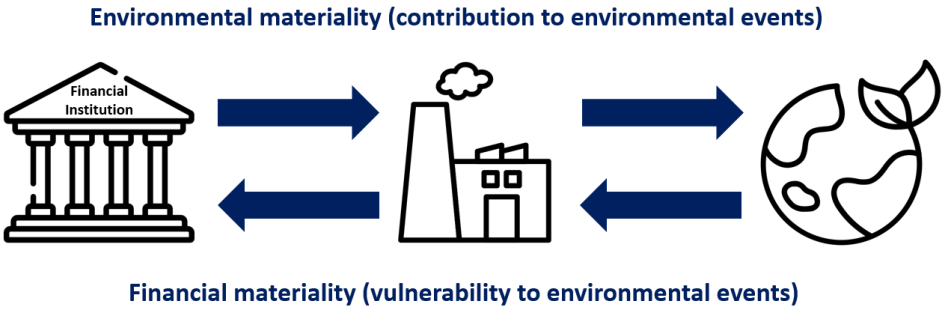


Source: (TCFD, 2017[13]).

In some cases, specific climate-related risk categories are further separated out, such as *liability risks* arising from litigation and other legal action and claims from parties that could seek to recover climate-related losses from others who they believe may have been responsible (Setzer and Higham, 2021[17]).

Concepts used by financial market stakeholders and the climate community are inherently linked. Based on concerns of potential misinformation being provided to the markets due to potential "greenwashing", the environmental 'E' pillar under ESG is for instance increasingly scrutinised from the perspective of its ability to support the PA goal of aligning financial flows with climate change mitigation policy goals. This entails looking at data and metrics similar to those used as input by the alignment assessment methodologies analysed in the present paper.

Figure 1.2. Relating environmental and financial materiality



Source: (Boissinot et al., 2022[18]).

The reliability and acceptability of methodologies for assessing progress towards the PA goal remains subject to the testing and disclosure of underlying assumptions. Such transparency is key to address risks of greenwashing from climate-related metrics more generally. This issue is also faced by environmental, social and governance (ESG) metrics and ratings, designed to contribute to informing financial materiality assessments, Indeed, previous research investigating metrics that underpin the climate mitigation-related rating of ESG assessments identified that a higher rating is not always consistent with an effective contribution to GHG reduction (Boffo and Patalano, 2020[15]; NGFS, 2022[19]; Heeb, Kellers and Kölbel, 2022[20]; OECD, 2022[21]).

1.2. Objective and scope

Climate-alignment assessments of finance require analyses of real economy investments and financing (notably tangible fixed assets[6]) as well as of the financial system (financial markets and financial sector). While both are inherently linked, their respective assessment entails different types of data and analyses. For example, the nature and lifespan of tangible fixed assets has a direct link to GHG emissions (emitted or avoided by the asset), from which most financing transactions and assets under management on financial markets are at least one step upstream.

OECD country-sector pilot studies conducted between 2019 and 2021 under the Research Collaborative on Tracking Finance for Climate Action, explored data and reference points to assess the consistency of real economy investments with climate mitigation policy objectives.[7] By taking stock and analysing the characteristics (in terms of coverage and assumptions) of existing alignment assessment methodologies developed for and by the financial market and sector, the present analysis takes a complementary view. In doing so, the aim is to draw conclusions on the relevance of such methodologies for tracking progress towards the climate mitigation-related part of Article 2.1c of the PA, as well as identify gaps, limitations and possible action points to address them.

[6] Tangible fixed assets typically are physical assets such as infrastructure, land, buildings and equipment.

[7] The pilots covered the building sector in the United Kingdom (Jachnik and Dobrinevski, 2021[141]), the transport sector in Latvia (Dobrinevski and Jachnik, 2020[138]), and the manufacturing sector in Norway (Dobrinevski and Jachnik, 2020[139]). The focus was on gross primary investment flows in new infrastructure or equipment and the refurbishment of such assets, and its underlying sources of finance (in the form of grants, debt-, equity- and guarantee-related instruments). Such focus was motivated by an initial scoping paper (Jachnik, Mirabile and Dobrinevski, 2019[137]) and corresponds to the scope addressed by a range of other country-level analyses (e.g. (Hainaut and Cochran, 2018[144])) and international-level pilot assessments (e.g. (Micale et al., 2020[143]).

Two main approaches can be used to assess the climate alignment of finance with climate mitigation policy goals:

- Outcome-based approaches, which typically compare actual or projected GHG emissions of entities or activities to GHG emissions scenario pathways (or GHG intensity thresholds derived on that basis) as a benchmark. This approach can also be based on other type of information provided by climate mitigation scenarios, such as forecasted technology usage or production capacity.
- Principles-based approaches, which typically classify activities into climate aligned or not (sometimes with an intermediate category), and may address activities that don't result in much direct GHG emissions but can enable or hinder climate mitigation, e.g. road and rail infrastructure.

The majority if not all of the existing climate-alignment assessment methodologies, as reviewed in this paper, are outcome-based. The principle-based approach is, on the other hand, more often used in the context of regulatory processes. For example, the climate mitigation-related technical screening criteria developed under the EU Taxonomy combine both outcome- and principle-based criteria (EU Platform on Sustainable Finance, 2021[22]).

Methodologies that are considered have been developed by commercial services providers, research institutes, civil society or other financial market stakeholders. The methodologies may cover all types of finance and any financial asset class(es), and may assess alignment or misalignment with both international (PA) or national climate mitigation policy goals.

While Article 2.1c of the PA refers to both mitigation and resilience in making finance flows consistent with climate goals (UNFCCC, 2015[1]), the focus in the present analysis is placed on mitigation. The alignment assessment of finance from a climate-resilience perspective faces different challenges and requires different data and assessment methodologies. These are being explored in complementary OECD analytical efforts (Mullan and Ranger, 2022[23]).

Beyond climate mitigation and resilience, it is important that finance also aligns with other environmental policy goals (e.g. biodiversity, water) as well as contributes to a just transition for workers and communities affected by climate impacts. These considerations are outside the specific scope of the present analysis but the findings presented here can eventually be combined and feed into broader analyses, e.g. in the context of OECD Responsible Business Conduct standards under the OECD Guidelines for Multinational Enterprises (see Section 2.2), which specifies the relevance of these standards for climate change), as well as when assessing alignment in relation multiple Sustainable Development Goals (SDGs). This is consistent with Article 2 of the PA, which sets out the three interlinked goals of climate mitigation, climate resilience and making finance consistent with the former two, in the context of sustainable development and efforts to eradicate poverty (see (UNFCCC SCF, 2021[7]) and (UNFCCC, 2015[1])).

The remainder of this paper is structured as follows:

- Chapter 2 outlines the analytical approach that help structure the analysis presented in this report. In order to provide further context, the chapter first introduces the different steps of the climate alignment process, then provides an overview of finance-related climate alignment coalitions, frameworks and methodologies, before putting forward the dimension used in the remainder of the paper to run an in-depth analysis of climate-alignment assessment methodologies specifically.
- Chapter 3 presents the results of the analysis of methodologies to assess the climate alignment of finance. These results are presented according to the following main analytical dimensions: financial asset class coverage, choice of GHG performance metrics, selection of climate change mitigation scenario(s) to assess alignment, approach for assessing and aggregating alignment at the financial portfolio level.
- Chapter 4 provides illustration of actual results from climate-alignment assessment methodologies for a sample of corporate-related assets, sovereign bonds, as well as of existing attempts to conduct portfolio-level assessments, i.e. aggregating results from individual financial assets.
- Chapter 5 summarises conclusions in terms of common practices and areas for further developments by providers of climate-alignment assessment methodologies, possibilities for climate policy makers to support improved and policy-relevant assessments, as well as implications for international-level assessment of progress towards Article 2.1c of the PA.

2. Analytical approach and dimensions

This chapter introduces the approach that underpins the analysis then presented in Chapter 3. To contextualise the analysis, the chapter first briefly takes stock of the wide-ranging initiatives addressing climate alignment of finance, then positions the climate-alignment process in the context of the existing international framework for Responsible Business Conduct, before detailing the specific dimensions that form the basis for analysing climate-alignment assessment methodologies.

2.1. A dynamic landscape of finance-related initiatives supporting climate alignment

There is a range and growing number of civil society- and business-driven initiatives relevant to or directly supporting climate alignment in the financial and corporate sectors (Table 2.1). Some initiatives to measure and report GHG emissions have been established for a decade or longer, such as the GHG Protocol and the Carbon Disclosure Project (CDP). Further initiatives launched in 2015, the year of the adoption of the PA, have become important anchor points of corporate and investor practices in relation to climate, including the TCFD, the Science Based Targets initiative (SBTi) and the Partnership for Carbon Accounting Financials (PCAF). While the initiatives mentioned in this paper support climate-aligned finance, some of them may also specifically support companies in setting their transition targets or developing a transition plan, for which the OECD has developed guidance (OECD, 2022[24]).

The development of initiatives specifically aimed at assessing the alignment of finance with the PA has been progressive since the adoption of the agreement. It is worth noting that close to all such initiatives originated in “developed” countries, in part as a reflection of the concentration of where the majority of capital and liquidities are available from (IPCC, 2022[8]). In this context, a range of jurisdictions and regulatory bodies are developing their own official climate-related approaches and taxonomies, including in emerging economies (Natixis, 2021[25]; OECD, 2020[26]). As stated above in the Introduction, these are not considered as part of the present analysis. Their development can, however, be informed by civil society- and business-driven initiatives.

Climate alignment-related initiatives can take the form of coalitions, frameworks or methodologies:

- A **coalition** is a collaboration or group of organisations or initiatives with a common goal. The main purpose is typically to convene, engage and mobilise peers or private sector to create leverage and contribute to steer the debate. Coalitions sometimes put forward a pledge of some sort.
- A **framework** is a broad guidance that indicates a general direction and includes a set of principles for achieving certain goals. It, however, typically leaves way to interpretation, for instance by allowing the use of several possible implementation tools and methodologies.
- A **methodology** is a set of practical guidance including precise metrics, rules and reference points to address one or more of the practical steps needed to achieve certain standards and goals or targets. More specifically, climate-alignment assessment methodologies provide a detailed approach for calculating the degree of alignment or misalignment for a given type of asset or actor, sometimes detailed by sector.

Table 2.1. Development timeline of selected initiatives relevant to climate-alignment assessment

Starting year		Examples of initiatives	Coalition	Framework	Methodology
Prior to 2015	GREENHOUSE GAS PROTOCOL	GHG Protocol			■
	CDP	Carbon Disclosure Project		■	
	IIGCC	Institutional Investor Group on Climate Change	■		
2015	TCFD	Task Force on Climate-Related Financial Disclosures	■	■	
	SCIENCE BASED TARGETS	Science Based Targets			■
	PCAF	Partnership for Carbon Accounting Financials			■
2016	right. based on science	right. based on science XDC model			■
2017	Transition Pathway Initiative	Transition Pathway Initiative			■
	Climate Action 100+	Climate Action 100+	■	■	
	NGFS	Network for Greening the Financial System	■	■	
2018	CRREM	Carbon Risk Real Estate Monitor			■
	BEYOND RATINGS	FTSE x Beyond Ratings' method			■
	PACTA Paris Agreement Capital Transition Assessment	Paris Agreement Capital Transition Assessment			■
2019	Climate Safe Lending Network	Climate Safe Lending Network	■	■	
		Net-Zero Asset Owner Alliance (Inaugural 2025 Target Setting Protocol)	■	■	
	Paris Aligned Investment Initiative	IIGCC Paris Aligned Investment Initiative (Net Zero investment framework)	■	■	
2020	carbon impact analytics	Carbone 4 2-infra			■
	CDP WWF	CDP-WWF temperature rating			■
	Trucost ESG Analysis S&P Global	S&P Sustianble1 (formerly Trucost) Paris Alignment			■
2021	GFANZ	Glasgow Financial Alliance for Net Zero (Financial institution net-zero transition plan framework)	■	■	
	MSCI	MSCI Implied Temperature Rise			■
2022	SCIENCE BASED TARGETS	SBTi Financial Institutions Net Zero Expert Advisory Group	■		

Note: Last updated in September 2022. This table does not provide a comprehensive overview but only aims to illustrate the growing number and range of initiatives. Further, the categorisation of initiatives as coalitions, frameworks and methods will rapidly become outdated based on further developments and collaboration between initiatives.
Source: Authors.

Coalitions of financial or corporate organisations may support multiple frameworks, or gradually develop their own frameworks. Sometimes, frameworks progressively dive into further technical details, thereby turning into methodologies. Alternatively, some frameworks and methodologies are developed in close co-operation with one another such as the Climate Action 100+ Net-Zero Benchmark and the Transition Pathway Initiative (TPI). Further, methodologies developed independently by expert institutions may then be referenced by frameworks as possible or recommended implementation tools. As a result, there are many dynamic interlinkages between the initiatives, both:

- Within a category: For instance, the GFANZ coalition launched in the context of UNFCCC COP27, combines pre-existing coalitions: Net Zero Asset Managers initiative (NZAM), the Net Zero Asset Owner Alliance (NZAOA), the Net-Zero Banking Alliance (NZBA), the Net-Zero Insurance Alliance (NZIA), Net Zero Investment Consultants Initiative (NZICI) and the Net Zero Financial Service Providers Alliance (NZFSPA).
- Across the three categories: As an example, the NZAOA indicates that it collaborates with different frameworks and methodologies, including SBTi, the Partnership for Carbon Accounting Financials (PCAF), Institutional Investors Group on Climate Change (IIGCC), TPI, Climate Action 100+ and Paris Agreement Capital Transition Assessment (PACTA).

Some initiatives belong to more than one of the categories and their categorisation can often change over time. As an example, the NZAOA was initially launched as a coalition but then also developed a framework for asset owners to calculate, allocate and set targets to reduce the greenhouse gases associated with their portfolios (NZAOA, 2021[27]). Likewise, the IIGCC was launched as a coalition two decades ago and more recently developed a framework providing a set of recommended actions, metrics and methodologies, through which investors can maximise their contribution to achieving global net zero global emissions by 2050 or sooner (PAII, 2021[28]). Similarly, GFANZ states that one of its work streams supports the further development of work on portfolio alignment metrics for financial institutions (GFANZ, 2021, p. 14[29]). It also developed a '*financial institution net-zero transition plan framework*' in 2022 (GFANZ, 2022[30]).

The above examples make it clear that the ecosystem of initiatives supporting climate alignment in the financial sector is a developing and rapidly changing field. As climate-alignment frameworks remain work in progress, such developments can build on and be informed by relevant existing international standards, which can strengthen the coherence and interoperability of approaches. Such standards notably include those developed under the OECD Centre for on Responsible Business Conduct (RBC).

2.2. The relevance of Responsible Business Conduct standards

The OECD RBC's Guidelines for Multinational Enterprises (MNE Guidelines), consist of government-backed recommendations to multinational enterprises operating in or from adhering countries. The MNE Guidelines currently are the only authoritative, consensus-based, government instrument on RBC operating at the international level. The recommendations cover all areas of business responsibility: disclosure, human rights, employment and industrial relations, consumer interests, science and technology, and the environment, including climate change (OECD, 2011[31]).

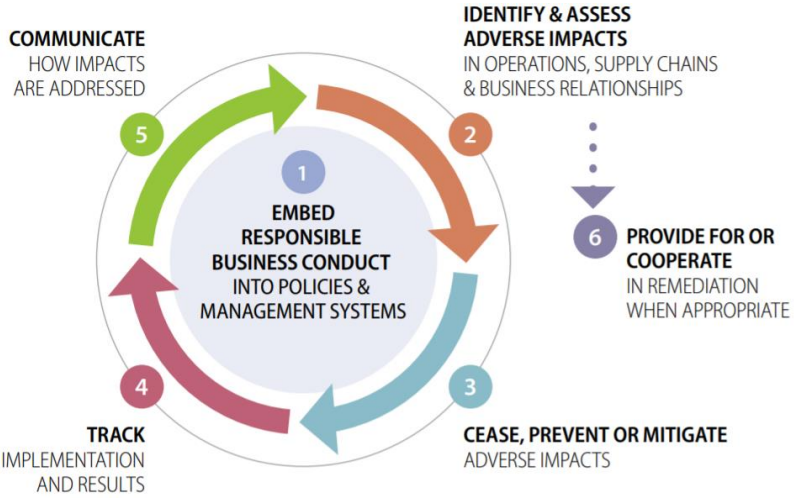
The MNE Guidelines provide non-binding principles and standards for responsible business conduct in a global context consistent with applicable laws and internationally recognised standards. The Guidelines notably set out the expectation for business, including investors and financial institutions, to:

- identify, prevent and mitigate actual and potential adverse impacts of business' operation, supply chains and relationships (including investments) on people, the environment and society
- contribute to economic, environmental and social progress with a view to achieving sustainable development.

To support business (including financial institutions and investors) in implementing the Guidelines, the OECD developed the Due Diligence Guidance, a framework and management system to help businesses assess and address their actual and potential adverse impacts (OECD, 2018[32]). The sectoral applications of the RBC due diligence extends to the financial sector, i.e. institutional investors (OECD, 2017[33]) and banks (OECD, 2019[34]), as well as project and asset finance transactions (forthcoming OECD RBC guidance).

The OECD Due Diligence Guidance lays out six steps in the due diligence process to assess 'RBC alignment' (Figure 2.1), which can be adapted to businesses' specific circumstances: (1) embed RBC into the businesses' policies and management systems; (2) identify and assess actual or potential adverse impacts of a business' own activities as well as those in its supply chains and business relationships, which includes GHG emissions (3) cease, prevent or mitigate such actual or potential adverse impacts, (4) track implementation and results, (5) communicate how impacts are addressed; (6) enable remediation of adverse impacts when appropriate.

Figure 2.1. Due diligence process and supporting measures



Source: (OECD, 2018[32]).

The principles laid out by the Guidelines and the steps of the Due Diligence Guidance make it clear that RBC is an outward-facing approach. This implies that it differs from traditional business risk management systems, which focus on risks to the enterprise, e.g. financial risk, market risk, operational risk, reputational risk (also see Box 1.1 on climate-related risks).

RBC's outward-facing approach, combined with its backing from governments, makes it pertinent in the context of assessing and managing business contributions to the achievement of public policy goals, including climate policy goals. The RBC Due Diligence Guidance can be particularly relevant for businesses seeking to address and reduce GHG emissions across their supply chains in addition to their own operations, i.e. thereby covering GHG emission scopes 1, 2 and 3 as discussed in Section 3.2.3. Such relevance extends to financial institutions and investors, in the context of undertaking due diligence across their investees[8].

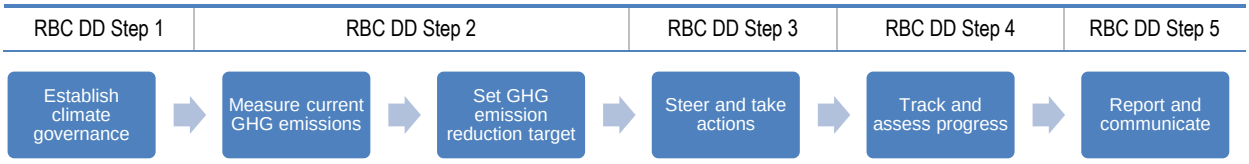
[8] The OECD is developing a paper on "Managing Climate Risks and Impacts through Responsible Business Conduct: A tool for institutional investors" to clarify how the due diligence process recommended by the OECD MNE Guidelines can be applied by investors to prevent and mitigate adverse climate impacts associated with their investee companies.

The climate-specific frameworks identified in Table 2.1. above among the examples of climate alignment initiatives provide guidance towards achieving climate alignment (The Coalition of Finance Ministers for Climate Action, 2021[35]; Katowice Banks & 2DII, 2020[36]; PAII, 2021[28]; PCAF, 2021[37]). These frameworks differ in terms of choice, sequence and naming of steps to be followed, but typically include some or all of the following elements:

- establish climate governance, which involves integrating climate considerations in management practices and policies
- measure current GHG emissions (backward looking)
- set GHG emission reduction target (forward looking)
- steer and take action, which for investors can take the form of, e.g. engagement to facilitate climate transition, managed divestment, or of investment in climate solutions
- track and assess progress, which can involve both backward- and forward-looking perspectives
- report and communicate on results achieved to date.

While not an exact match, these elements are similar in nature to those captured by the RBC Due Diligence process, as per the matching presented in Figure 2.2.

Figure 2.2. Climate-alignment process matched to Responsible Business Conduct Due Diligence steps



Note: RBC DD stands for Responsible Business Conduct Due Diligence, see (OECD, 2018[32]).
Source: Authors informed by (The Coalition of Finance Ministers for Climate Action, 2021[35]; Katowice Banks & 2DII, 2020[36]; PAII, 2021[28]; PCAF, 2020[38]).

Climate-alignment assessment methodologies, which the remainder of the paper focuses on, typically address the *tracking and assessment of progress* step. Most of these methodologies, however, also use as input the measurement of current GHG emissions and the setting of reduction targets, as well as deliver assessment results of relevance to inform reporting and communication.

Prominent methodologies outlining how entities should account for emissions include: the GHG Protocol for non-financial corporates, PCAF's Global GHG Accounting and Reporting standard for financial corporates and UNFCCC National Inventory Submissions (NIR) methodology for countries (relevant for the sovereign bond financial asset class). The SBTi is unique in that it is the only initiative that defines a methodology on how companies in different sectors should set emissions reduction targets (SBTi, 2020[39]). Moreover, the SBTi is in the process of developing a methodology for science-based net-zero targets in the financial sector, supported by its Financial Institutions Net Zero Expert Advisory Group (SBTi, n.d.[40]; SBTi, 2022[41]). There is currently no such equivalent for countries, which define their own targets in the context of their NDCs.

The forthcoming paper also provides an initial overview of how the due diligence process relates to and can draw on other frameworks and tools for assessing, managing or disclosing climate impacts associated with investments.

2.3. Dimensions to analyse climate-alignment assessment methodologies

Methodologies built for the purpose of tracking progress towards climate-alignment of finance were initially mainly developed by research institutes and independent financial analysis entities. More recently, mainstream financial players have developed and commercialised their own methodologies or acquired existing methodologies.

Although no common analytical approach exists to analyse such methodologies, some reviews of existing ones have been conducted, notably:

- In 2020, the TCFD-affiliated Portfolio Alignment Team (PAT) reviewed seven methodologies for portfolio warming metrics (PAT, 2020[10]). The review identified three steps in these methodologies, namely translating carbon budgets into scenarios, assessing company-level alignment, and assessing portfolio-level alignment.
- Similarly, the French research institute Louis Bachelier reviewed existing methodologies available to investors as of 2020 to measure the climate alignment of their assets. The institute finds four general steps, namely (1) assessing the climate performance of the portfolio, (2) selecting appropriate scenarios and reference trajectories, (3) building micro-level temperature benchmarks and (4) assessing alignment and temperature (Institut Louis Bachelier et al., 2020[11]).
- Other stock-taking exercises have been conducted focusing on methodologies to assess climate-related transition risk (Bingler, Colesanti Senni and Monnin, 2021[42]; Bingler and Colesanti Senni, 2022[43]; UNEP FI, 2021[44]). Unless they also explicitly aim to assess alignment, such methodologies are not considered here.

Common dimensions analysed in such previous research include: the type of metric, scope of emissions, sources of current and forward-looking company data, sources of scenarios, scenario granularity, whether the assessment is static or dynamic, how the metric is expressed and how the aggregation to portfolio level is done (Institut Louis Bachelier et al., 2020[11]; PAT, 2020[10]). Institut Louis Bachelier (2020[11]) also considers whether avoided and removed emissions are included, and how to allocate the scenario to companies and portfolios. PAT (2020[10]) further considers how the metric is expressed, e.g. as carbon budget overshoot or implied temperature rise (PAT, 2021[45]).

Compared to these existing studies, the present analysis further integrates the perspective of climate policymakers, by bringing in references from the climate policy literature. Moreover, the analysis also expands other asset classes beyond corporates by also looking at methodologies to assess the climate alignment of sovereign bonds issued by countries, as well as of investments and financing relating to real estate and infrastructure (see Table 3.1 in Section 3.1).

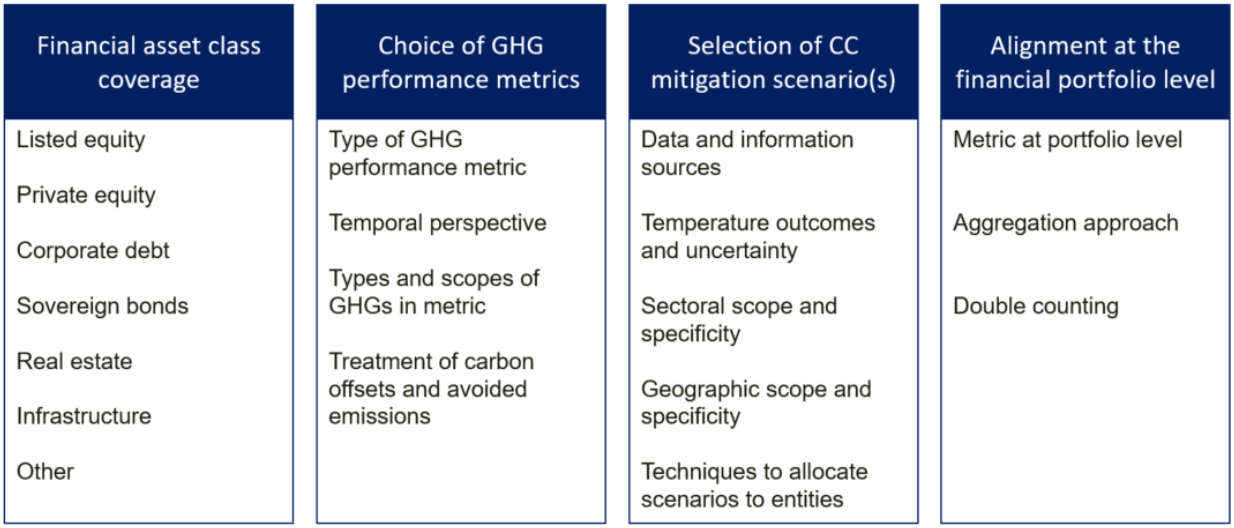
As introduced above, climate-alignment assessment methodologies address the tracking and assessment of progress step of the broader alignment process (Figure 2.2), but also use as input the measurement of current GHG emissions as well as the setting of reduction targets, and feed into reporting. With this in mind, and in order to analyse the characteristics of such methodologies, the present analysis considers the following four overarching analytical dimensions. These dimensions (and sub-dimensions within each) build on the aforementioned previous research as well as aim to reflect issues critical to analysing the relevance of methodologies from a climate policy perspective:

- **Type of financial asset class covered**, such as corporate equity and debt (with a distinction between listed and private companies), sovereign bonds, infrastructure- as well as real estate-related investment and financing (notably mortgages), noting, however, that there is no definitive or comprehensive classification.
- **Choice of GHG performance metrics** (including targets), based on the following sub-dimensions:
  - type of GHG performance metric, e.g. absolute or intensity

- temporal perspective and coverage of metrics, e.g. backward- or forward-looking, short-/medium-/long-term periods, cumulative or one point in time
- types and scopes of GHGs considered
- treatment of carbon offsets and avoided emissions

- **Selection of climate change mitigation scenario(s) to assess alignment**, based on the following sub-dimensions:
  - data and information sources
  - temperature outcomes and uncertainty based on scenario(s) used
  - sectoral scope and specificity
  - geographic scope and specificity
  - techniques to allocate scenarios to entities
- **Approach of assessing alignment at the financial portfolio level**, considering the following sub-dimensions:
  - metric at portfolio level
  - aggregation approach, including across asset classes
  - assessment and avoidance of double counting.

Figure 2.3. Dimensions for analysing climate-alignment assessment methodologies



Note: GHG refers to greenhouse gas, CC to climate change.
Source: Authors.

3. Deep-dive on climate-alignment assessment methodologies in finance

Methodologies to assess alignment of financial assets and portfolios with the PA temperature goal are increasingly being developed on a voluntary basis. As mentioned in Section 2.2, these methodologies build on the measurement of current GHG emissions and on the setting of GHG emission reduction targets. They deliver assessment results of relevance to inform reporting and communication. While this overall remains an evolving area, some initiatives have been established for over five years (Table 2.1). Therefore, now is a good time to take a closer look at the characteristics of these methodologies, notably in terms of how they relate to climate policy goals.

To this end, this chapter analyses a selection of methodologies[9] developed by 16 commercial services providers, research institutions or civil society organisations on the basis of the four analytical dimensions introduced in Section 2.3: coverage of financial asset class (Section 3.1), choice of GHG performance metrics (3.2), climate change mitigation scenarios used to assess alignment (3.3), and approach for aggregating alignment assessment at financial portfolio level (3.4).

The analysis presented in this chapter is the result of a combination of desktop research and consultation with methodology providers. Such consultations (see Acknowledgements) took place to gather further information, insights and views as well as, in some cases to access sample data. In all cases, the presentation of results anonymises individual providers. The rationale for doing so is that the analysis was not intended to evaluate or rank individual existing methodologies, but rather to draw general conclusions on the current and potential relevance of such methodologies to contribute to measuring progress towards the achievement of international and national climate mitigation policy goals.

3.1. Financial asset class coverage

Climate-alignment assessment methodologies are typically developed for specific types of financial assets or asset classes. Such assets can be grouped at different levels and based on different categories, in part due to the fact that the composition of the portfolio of investors and financial institutions differs greatly depending on their type, mandate and strategy. In the present analysis, financial assets, for which existing alignment assessment methodologies could be identified and analysed include: listed equity, private equity, corporate bonds, sovereign bonds, real estate, and infrastructure (noting that investments in real estate and infrastructure typically take the form of equity, bonds or other debt-related instruments). At this stage, no methodology could be identified for other asset types commonly referred to, such as (but not limited to) derivatives, commodities and cash.

[9] Note that one provider can have multiple methodologies for different asset classes.

A complete coverage of financial asset classes in climate-alignment assessment methodologies is desirable for two main reasons:

- To provide a comprehensive picture of the financial sector's holdings and investments. This is increasingly relevant as investors and financial institutions, including government pension funds, possibly central banks as well governments, may start using such methodologies to disclose progress (GFANZ, 2022[46]).
- Such methodologies set incentives for investment strategies and decisions. In this context, it should be noted that the degree of influence from investors on the investee depends on the asset class. While active engagement strategies are often used for corporate-related assets (Flammer, Toffel and Viswanathan, 2021[47]), individual investors have less ability to influence sovereign investees. Nonetheless, passive and active investors may consider the possibility of rebalancing their portfolio towards relatively more climate-aligned sovereign bonds (Cheng, Jondeau and Mojon, 2022[48]).

A single climate-alignment assessment methodology is unlikely to be applicable across all asset classes. Differences in characteristics of financial asset classes contribute to explaining why different financial asset classes may require tailored different decarbonisation mechanisms and, as a result, tailored alignment assessment methodologies. Differences in risk-return profiles may influence the asset composition of different financial institutions and investors, depending on their risk appetite, and under different macroeconomic conditions. For instance, sovereign bonds may be preferred for those seeking stable returns and during periods of recession and/or deflation (as was in part the case during the COVID-19 crisis), while other asset classes may be prioritised during periods of high economic growth (e.g. listed and private equity) or high inflation (e.g. commodities and real estate).

The vast majority of existing climate-alignment assessment methodologies in the financial sector have been developed for listed corporate equity (Table 3.1). In principle, these methodologies can be used for other types of corporate-related financial assets, such as private equity and corporate bonds and loans. In practice however, they are almost exclusively applied to publicly-traded corporate shares, for which data is more widely available. Even when a methodology for listed equity is applied to corporate bonds, there may be limited coverage (TPI, 2021[49]).

The lack of explicit coverage of corporate bonds may be explained by the perspective of the most common users of climate-alignment assessment methodologies, i.e. asset owners or managers aiming to reallocate their investments towards climate-aligned assets. However, non-financial corporates more commonly seek financing for their climate transition via debt rather than equity instruments (OECD, 2022[24]). In this context, corporates may also aim to raise cash for climate-aligned activities through ring-fenced bonds, which may, however, not necessarily imply that the issuer is fully aligned beyond the specific activities financed by the bond. Hence, more methodological development efforts are needed.

In some cases, methodology providers may have customised their methodologies slightly for specific projects or case studies covering other asset classes. For example, private equities and real estate (including mortgages, see (2DII, 2020[50])) can be considered within the PACTA methodology. However, those are not currently covered by the free online tool due to data constraints. Moreover, PACTA for banks has sought to facilitate banks´ access to software and data to analyse the alignment of their loan portfolios. Further, S&P has covered private equity and private debt universes on request by clients. MSCI is also building an alignment methodology for private equity and debt in collaboration with Burgiss Data (MSCI, n.d.[51]). However, the methodologies for asset classes for some methodology providers indicated as 'covered' or 'developing' in Table 3.1 are not (yet) publically available.

Table 3.1. Financial asset classes covered by climate-alignment assessment methodologies

Methodology	Listed equity	Private equity	Corporate debt	Sovereign bonds	Real estate	Infra-structure
2DII PACTA						
Arabesque S-Ray Temperature Score						
FTSE x Beyond Ratings' method						
Carbone 4 Finance Carbon Impact Analytics (CIA)						
Carbon Risk Real Estate Monitor (CRREM)						
CDP-WWF Temperature Ratings						
EcoAct ClimFIT temperature						
I Care & Consult SB2A/SBAM						
LO Portfolio Temperature Alignment Tool (LOPTA)						
Mirova Alignment Method						
MSCI's Implied Temp Rating						
Ninety One Net Zero Sovereign Index						
Ortec Finance Climate ALIGN						
right. based on science XDC model						
S&P Sustainable1 (formerly Trucost) Paris Alignment						
TPI (Carbon Performance)						

Asset class coverage by methodology provider: Covered | Developing | Not covered

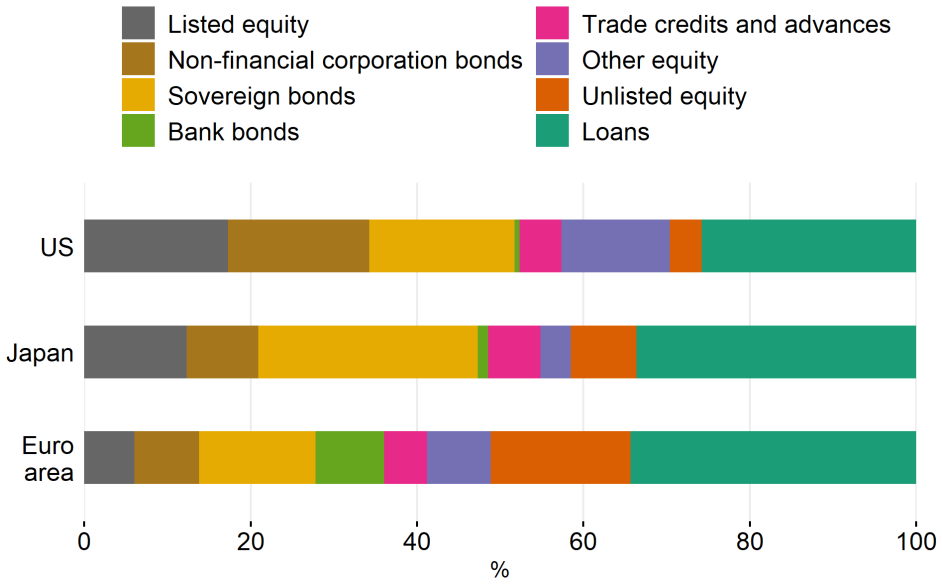
Note: Last updated in September 2022.
Source: Authors based on publicly-available information and, for some providers, bilateral consultations.

The underrepresentation of several large asset classes in climate-alignment assessment methodologies may result in an incomplete assessment of the alignment of financial portfolios. Although some initial methodologies have been developed for sovereign bonds and real estate, these asset classes would benefit from further methodological developments. For instance, the methodology developed by the Carbon Risk Real Estate Monitor (CRREM) can inform methodological developments by other providers expanding to real estate.

Figure 3.1 illustrates the relative importance of different financial instruments in three developed countries' different jurisdictions, namely the United States, Japan and the Eurozone.

- Loans (e.g. to corporates or households) represent the largest financing source in all three jurisdictions but are difficult for third parties to assess given data confidentiality and public unavailability. Analyses of private equity face similar data limitations.
- Sovereign bonds represent between 10% and 30% of instruments used for in the aggregate financing of economic sectors.
- On the other hand, such aggregate view typically does not separate out investments in the real estate and infrastructure asset classes mentioned above, but includes them under the general categories of "equity" and "bonds".

Figure 3.1. Financing structures of the euro area, US and Japanese economies



Note: By type of instrument. 10-year average between 2009 and 2018.
Source: Adapted from (ECB, 2020[52]).

It stems from the above that the limited availability of climate-alignment assessments for certain financial assets may result in not capturing a range of underlying actors, activities, as well as economic and physical assets responsible for significant portions of GHG emissions. Such partial coverage may also result in unintended incentives. For example, asset holding could move from listed to unlisted companies, which are currently less scrutinised by climate-alignment methodologies. Such transfers could mean that on aggregate emissions are not reduced. As an illustration, the six largest Western listed oil companies sold almost $44bn of fossil-fuel assets between 2018 and 2022 mainly to private-equity firms (The Economist, 2022[53]).

3.2. Choice of GHG performance metrics

In measuring the GHG performance of financial assets, climate-alignment assessment methodologies can use a variety of metrics. They can also choose different timelines as well as differ in the types and scopes of emissions they cover. Comparing the different approaches that methodology providers have chosen can help to improve understanding of their advantages and disadvantages. Further, as discussed at the end of the section and in conclusions, there are complementary alignment-related metrics that can be considered in order to provide a more nuanced perspective than by only looking at GHG-based metrics.

3.2.1. Type of GHG performance metrics

Metrics to assess the GHG performance of financial assets can be in absolute or intensity terms. The exact specification of these metrics can differ depending on the financial asset class.

For corporates, three main methods currently exist to measure GHG performance:

- Absolute Emissions Contraction (AEC) is a method that considers the rate at which companies reduce their absolute emissions, irrespective of the initial emissions level (SBTi, 2020[54]). It allows companies to set absolute emissions targets, defined as an overall reduction in the amount of

GHGs emitted to the atmosphere by a target year relative to a base year. The reduction rate of their emissions can then be compared to the reduction rate in the absolute emissions of a scenario.

- The Sectoral Decarbonisation Approach (SDA) is a method that derives physical emissions intensity pathways for companies based on sectoral emissions and activities pathways from existing mitigation scenarios (Krabbe et al., 2015[55]). Companies can set physical intensity targets that can be compared to sectoral pathways.
- Economic Intensity Contraction (EIC) is also an intensity-based method but it uses economic outputs instead of physical outputs in the denominator (SBTi, 2020[54]). One common approach under this method is the GHG per Value Added (GEVA) approach (Randers, 2012[56]).

Table 3.2. Overview of GHG performance metrics for corporates

	Advantages	Disadvantages	Data needs	Data availability
AEC: Absolute Emissions Contraction (Rate of change in GHG emissions)	• Emissions reductions are predictable • Less data intensive • More clearly relates to the remaining carbon budget and climate impacts of cumulative carbon emissions • Can be applied to all asset classes • Incentivises efficiency improvements and substitution of higher-emitting products or technologies with lower emitting alternatives	• Increased GHG performance can be due to decreased output rather than improved performance • Could disincentivise business growth, even for activities with a better climate performance. This particularly affects start-ups and young companies	Low	High
SDA: Sectoral Decarbonisation Approach (GHG emissions divided by physical output)	• Reflects GHG performance and efficiency improvements regardless of entity size, business growth and price changes • Applicable to homogenous sectors, companies and asset classes • Incentivises both efficiency improvements and growth into or expansion of lower-emitting products or technologies	• Data intensive • Difficult to apply to companies with diverse activities and in heterogeneous sectors • Absolute emissions could still increase while intensity-based climate performance improves	High	Low
EIC: Economic Intensity Contraction (GHG emissions divided by economic output)	• Reflects GHG performance and efficiency improvements regardless of entity size • Applicable to non-homogenous sectors and companies • Economic/Financial denominator is easy to understand for an investor audience • Relates more closely the decoupling between emissions and the economy • Incentivises both efficiency improvements and growth into or expansion of lower-emitting products or technologies	• Volatile with macroeconomic conditions may make it difficult to track true changes in GHG performance • Absolute emissions could still increase while intensity-based climate performance improves • Difficult to assess the PA consistency of projections for economic denominators (e.g. GDP).	Medium	Medium

Note: Data needs refers to both needs on corporate GHG emissions data and other corporate output data such as production volumes, value added or financial performance. Data availability is generally higher for listed than unlisted companies, however, the relative availability remains the same.
Source: Authors based on (SBTi, 2021[57]; Schwegler et al., 2022[12]; Rekker et al., 2022[58]) and on publicly-available information from and bilateral consultations with methodology providers.

Different corporate GHG performance metrics have different advantages and disadvantages (SBTi, 2021[57]), as summarised in Table 3.2. In the AEC approach, the contribution to total emissions reductions is predictable and transparent. Practically, the AEC approach also has the advantage of requiring less data. On the other hand, emissions reductions can be the consequence of a decline in output instead of an improvement of performance. To address this concern, intensity-based metrics are typically considered. Physical intensity metrics reflect GHG performance and efficiency improvements regardless of entity size and business growth. The SDA approach allows for better comparison across corporate assets within the

same and homogenous sector. On the other hand, data requirements are higher (see Box 3.2), and companies with diverse activities may find it difficult to define a single common metric. EIC metrics provide more flexibility to companies with diverse activities. However, this metric can be volatile based on changing financial performance, e.g. revenues in the denominator can fluctuate regardless of changes in emissions efficiency, and are subject to extrinsic factors including economic and financial macro-conditions. The metric can therefore change drastically regardless of changes in emissions linked to physical outputs, which makes it less environmentally robust.

Box 3.1. Applicability to private equity: unlisted large companies and SMEs

Several obstacles challenge the integration of climate-alignment assessments for private equity (Ceres & SustainAbility Institute by ERM, 2021[59]). These include more limited access to quality data compared to listed equity, the lack of a universal standard for setting net-zero goals and inconsistent regulatory requirements globally. Although there is currently no universally accepted methodology on setting net-zero targets, private equity firms and their portfolio companies can implement methodologies used by listed firms such as the SBTi.

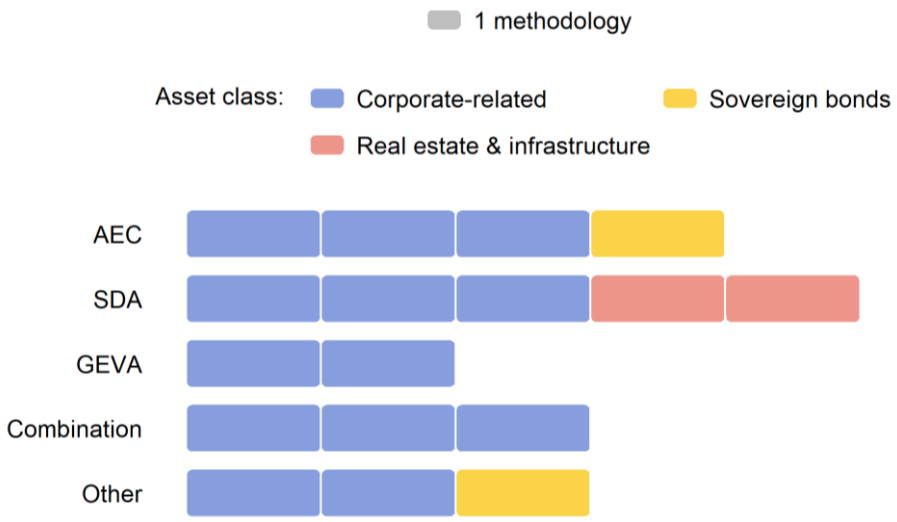
Generally, data required for current climate-alignment assessments are not available for SMEs. SMEs have a lower capacity to generate data on historic emissions and targets. To this end, the SBTi has developed a simplified net-zero target setting methodology for SMEs (SBTi, 2021[57]). The methodology is less stringent than for large listed firms, seeing the more limited resources SMEs have compared to large corporations. Unlike larger companies, the SBTi does not require SMEs to set targets for their Scope 3 emissions. The OECD Guidance on Transition Finance also proposes a tailored approach for SMEs on a number of elements included in corporate transition plans, such as on the inclusion of scope 3 emissions in reporting and target-setting (OECD, 2022[24]).

Current climate-alignment assessment methodologies follow a variety of approaches, but an intensity-based approach is most common across asset classes (Figure 3.2). Especially, methodologies for corporates, infrastructure and real estate most often rely on intensity-based metrics. Providers using the SDA metric are typically using similar denominators, such as kWh for the electricity sector and tons of cementitious product in the cement sector. For the GEVA approach, providers often use revenue instead of value added, as data is more available. Providers that also consider corporate debt aside from listed equity, typically use enterprise value in the denominator.

For corporates, consultations with methodology providers highlighted that different perspectives on corporate climate performance translate into different choices of metrics:

- Several providers mentioned that the GEVA approach is more intuitive for investors than other approaches such as SDA. Reasons for this include that the financial denominator is easy to understand for an investor audience, that GEVA relates more closely the decoupling between emissions and the economy, and that GEVA may better reflect the business case for corporates. Moreover, this metric is often preferred to achieve a larger coverage of companies rather than a selection in particularly emissions-intensive sectors.
- On the other hand, some providers prefer the AEC approach as it more clearly relates to the remaining carbon budget and climate impacts of cumulative carbon emissions. It may, therefore, be more suited for assessments towards climate mitigation policy goals.
- Some providers noted that SDA takes into account several limitations of other approaches, such as size, growth and price changes. However, this approach is more data-intensive and hence often limits the coverage of assets in a portfolio. Hence, several providers combine SDA with other approaches to achieve a more comprehensive coverage of companies in a given portfolio.

Figure 3.2. Number of methodologies using a given type of GHG performance metric



Note: AEC is Absolute Emissions Contraction, SDA is Sectoral Decarbonisation Approach, and GEVA is Greenhouse Gas Emissions per Value Added. Combination refers to a mix of the three previously mentioned approaches and others.
Source: Authors' analysis based on publicly-available information and, for some providers, bilateral consultations.

As each metric comes with pros and cons, a dashboard of indicators may be more insightful. Additional to the different perspectives taken by the methodology providers, some methodologies are developing complementary metrics, e.g. on the recent GHG performance of corporates. This adds an element of credibility when the main alignment metric considers corporate targets in the far future. Over time, indicators on the actual performance against corporate targets will become more essential to evaluate actual progress. In order to provide a more nuanced perspective, to include credibility considerations, and to link more closely to real-economy actions, there is also a need to look beyond GHG emission-based metrics only. Here, one approach consists of analysing forward looking capacity, production and capital expenditure[10] plans of companies. This is notably done by PACTA (2DII, n.d.[60]).

[10] Capital expenditure refers to money spend by corporates to purchase, maintain, or upgrade their physical assets, such as buildings and equipment. It relates more closely to real-economy decision-making.

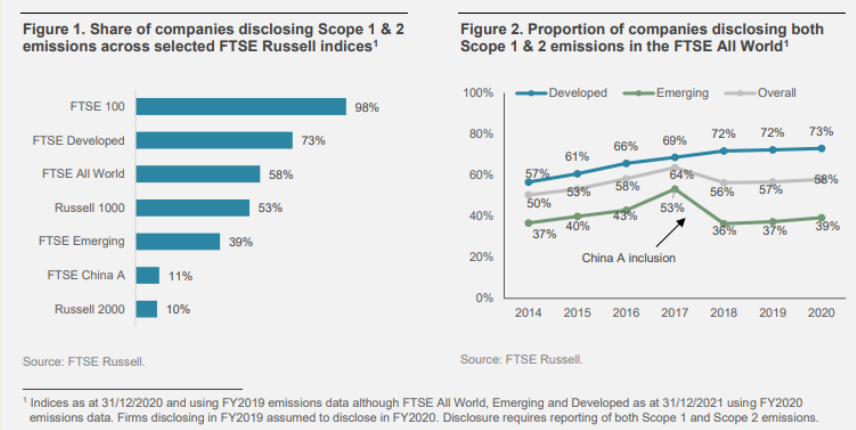
Box 3.2. Corporate data sources used by climate-alignment assessment methodologies

As Table 3.2 shows, different methodologies have different data needs. Current data gaps for corporate-related financial asset assessments encompass several dimensions: availability (coverage, granularity, accessibility), reliability (quality, auditability, transparency) and comparability (NGFS, 2022[61]). Such data limitations are more acute for the SDA and EIC approaches because more types of data are needed additional to historical and projected emissions.

Sources of historical entity data

Current and historical emissions can be self-reported by a company or modelled by the methodology provider (or an external data provider) (PAT, 2020[10]). Historical data needed for corporates, depending on the methodology, include absolute emissions, production outputs, value added or revenue. Some providers, such as CDP and TPI, rely solely on self-reported disclosure by companies in their climate-alignment assessments (CDP & WWF, 2020[62]). This may also provide an incentive to companies to improve disclosure. Many other providers also rely on modelled data, at least to some degree. When methodologies aim to rely primarily on reported emissions, disclosure is often too limited to achieve sufficient coverage for a portfolio analysis (Figure 3.3). Moreover, reported emissions may be unverified. Modelled data helps improve coverage especially for entities in emerging and developing economies and for unlisted companies. On the other hand, modelled data increases uncertainty as it is based on assumptions and, often, on sectoral averages.

Figure 3.3. Share of companies disclosing Scope 1 and 2 emissions



Source: (Simmons et al., 2022[63]).

Sources and assumptions of forward-looking entity data

Forward-looking data collected by climate-alignment assessment providers typically refer to emissions reduction targets, more rarely also to planned capital expenditure. This data needs to be self-reported by the entities. In the absence of such targets, historical emissions intensities are often held constant by methodology providers to understand the gap between where the entity would be in the future if it did not change and where it needs to be to be climate aligned. Alternatively, providers may assume that past average subindustry or company-specific trends in emissions intensity and activity growth continue (e.g. (S&P Global and Natixis, 2021[64])). For intensity-based metrics, companies need to disclose either emissions intensity-based targets or projections of the respective denominator, such as production volumes or revenue. In case the latter is not included, current volumes or revenue could be assumed constant to the target date.

For sovereign bonds, the AEC and EIC approaches can in principle be used as well. However, only few alignment assessment methodologies have been developed to date. In their Climate Liabilities Assessment Integrated Methodology (CLAIM), FTSE-Beyond Ratings calculate a country's projected GHG performance based on the targeted reductions in absolute emissions as implied by its NDC (Emin et al., 2021[65]). Several climate-alignment assessment providers are in the process of also developing a methodology for sovereign bonds. For instance, the methodology provider *right. based on science* is developing on intensity-based metric, in terms of CO_2e per capita (Robinson-Tillett, 2021[66]). Such physical intensity metric is preferred by *right. based on science* over an EIC approach in terms of emissions per GDP as the latter could disproportionally disfavour developing countries, which have lower GDP per capita.

Investors in sovereign debt need rigorous metrics that gauge the climate-alignment of national policies (Domínguez-Jiménez and Lehmann, 2021[67]). A range of tools, not explicitly designed to be used by the financial sector, have or are being developed to assess countries' climate mitigation performance based on different quantitative and qualitative metrics. Examples of such work include forthcoming work by the OECD under the International Programme for Action on Climate for instance and work done by Climate Action Tracker (Climate Action Tracker, 2022[68]).

Existing methodologies for **infrastructure and real estate** follow the SDA. For example, CRREM uses floor area as a denominator (CRREM, 2020[69]). For Carbone 4's 2-Infra methodology, the denominator depends on the use of the infrastructure asset: e.g. km for a road, kWh for an electricity plant (Carbone 4, 2020[70]).

3.2.2. Temporal perspective and coverage of metrics

The temporal boundary of a GHG performance metric can drive alignment results (Thomä, Dupré and Hayne, 2018[71]). There are three elements to consider the temporal perspective of a GHG performance metric, namely whether it is backward- or forward-looking, whether it considers a short medium or long time period, and whether the metric is only compared with a scenario at a certain point in time or across a time period.

Metrics with backward-looking and forward-looking perspectives can serve different purposes. Backward-looking metrics can be used for an ex-post assessment of alignment, analysing whether an entity has followed a scenario in the past (Institut Louis Bachelier et al., 2020[11]). On the other hand, forward-looking metrics are more dynamic as they aim to assess whether an entity is on track to comply with the remaining carbon budget for a certain temperature goal. Past performance does not necessarily correlate with future performance. Indeed, metrics based solely on historical data may not be well suited to assess climate-alignment due to non-linearity, non-stationarity, path-dependencies and endogeneity issues (Bingler, Colesanti Senni and Monnin, 2021[42]).

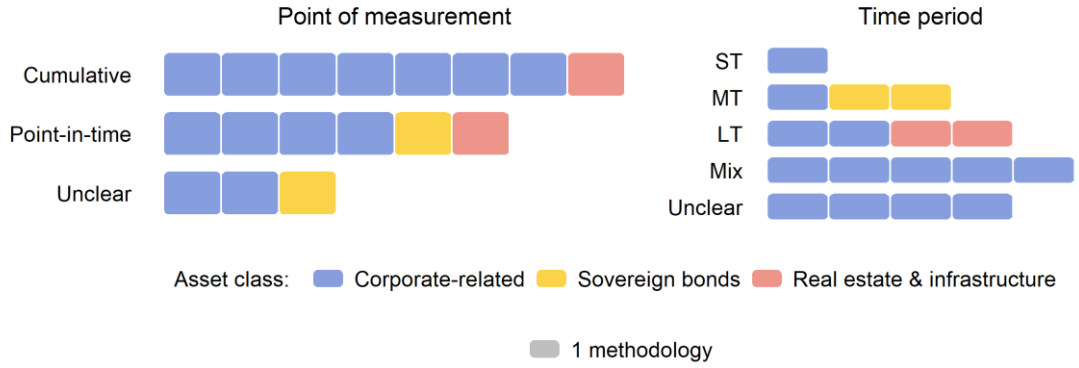
In terms of time period, while each choice and action at any point in time matters, 2025, 2030 and 2050 are all important policy milestones towards reaching the PA temperature goal. The most recent IPCC assessment indicates 2025 as the year when global emissions should peak, as early action is essential in reducing risks of crossing climate tipping points. Further, global emissions need to reach net-zero between 2045 and 2055, in order to limit warming to 1.5 °C with no or limited overshoot (IPCC, 2022[72]). While the PA and its accompanying decision call for long-term low-greenhouse gas emission development strategies, countries also submit short-term targets to 2030 in their NDCs (Meinshausen et al., 2022[73]). Many countries are setting targets to reach net zero by mid-century or shortly thereafter, although the scope and coverage of such targets can vary widely (Jeudy-Hugo, Lo Re and Falduto, 2021[74]). Long-term strategies can substantially shape short- and mid-term priorities, policies and investment pipelines, leading to significant cost reductions in the long term by avoiding stranded assets (Falduto and Rocha, 2020[75])..

Methodological recommendations for corporate-related financial assets are consistent with these considerations. SBTi requires that corporate targets and mitigation performance assessments should

cover a minimum of five years and a maximum of 10 years (SBTi, 2021[57]). SBTi further recommends companies to set long-term targets and set near-term milestones at five-year intervals. The rationale for this is that setting long-term net-zero targets encourages planning to manage the long-term risks and opportunities connected with climate change. These may include the creation of new services and markets and the need for large capital investments that offer GHG benefits. Further, some research also pointed out the importance of measuring progress from a base year at 2015 or earlier to capture emissions reductions that have been achieved well before 2020 and since the adoption of the PA (Rekker et al., 2022[58]).

In terms of point of measurement, the comparison of a GHG performance metric with a scenario can happen at one point-in-time or over a time period. The alignment of a metric assessed in a certain point in time can be driven by the year of choice (Institut Louis Bachelier et al., 2020[11]). The assessment of a metric over a time period can be either done through the assessment of the change in the trend of the metric or the cumulative difference between the metric and the scenario over years.

Figure 3.4. Number of methodologies following a given temporal perspective



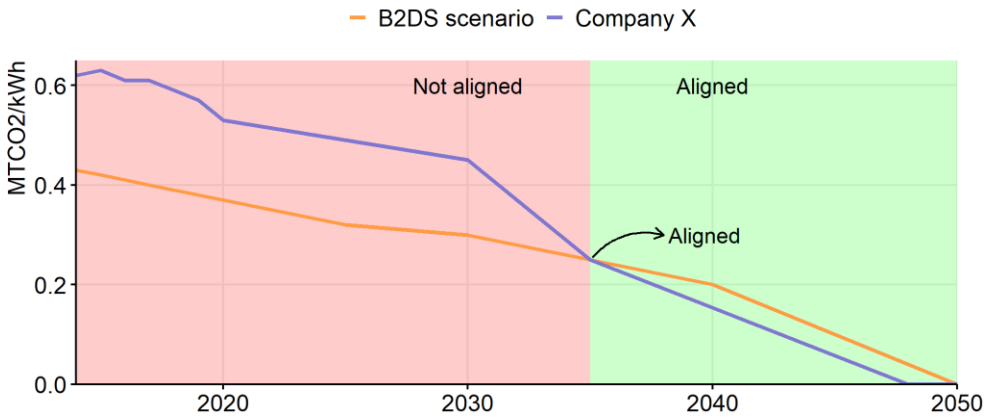
Note: ST is short term, meaning until 2025. MT is medium term, meaning until 2030-2035. LT is long term, meaning until 2050 and beyond.
Source: Authors' analysis based on publicly-available information and, for some providers, bilateral consultations.

For corporates, existing climate-alignment assessment methods rely on a range of different temporal perspectives (Figure 3.4). Some methodologies only consider the short term, some only the long term, and some consider both resulting in multiple assessment results for multiple years. For example, Arabesque and CDP assess alignment by comparing GHG performance in 2030 and 2050. PACTA, on the other hand, only considers the next five years as the assessment methodology relies on forward-looking corporate production and capital expenditure plans, which typically don't extend further in time. Based on consultations (see Acknowledgements), many providers see a need to track near-term targets and alignment, as it may better predict early action. Further, there is almost an even contribution of methodologies considering just a snapshot (i.e. point-in-time) or cumulative emissions over a time period. While the majority of methodologies are purely forward-looking (based on targets), S&P Sustainable1 takes into account a medium-term historical and medium-term forward looking period in its GHG performance metric. Some of the other providers also make use of such information, but rather to produce complementary metrics rather than as an integral part in the alignment metric methodology.

For sovereign bonds, existing climate-alignment assessment methodologies consider the medium-term (Figure 3.4). Based on consultations (see Acknowledgements), this view is supported because the submission of long-term national targets to the UNFCCC are not mandatory under the PA. Existing climate-alignment assessment methods for investments in **infrastructure and real estate** take an even longer-term perspective, owing to the long lifespan of underlying physical assets.

Figure 3.5 illustrates with a stylised example the potential impact of the choice of temporal perspective. Considering the example, long-term point-in-time metrics without interim points of measurement (e.g. in 2030) or cumulative measurement may find that assets are aligned (in e.g. 2050) while they emit more than the carbon budget would allow.

Figure 3.5. Stylised example of point-in-time alignment assessment over time for an electric utility



Note: B2DS is a Below 2 Degrees scenario. Company X shows the decarbonisation trajectory of a fictive company.
Source: Authors.

3.2.3. Types and scopes of greenhouse gases in metrics

The coverage of GHG emissions in climate-alignment assessment methodologies relates to two aspects: the types of GHGs and the scope of emissions covered. This section illustrates that while the coverage of types of GHGs follows a similar logic across asset classes, the categorisation in terms of scope of GHG tends to differ depending on the asset class covered. Corporate-related, real estate and infrastructure financial assets rely on GHG accounting according to the scope 1, 2 and 3 categorisation[11], whereas metrics for sovereign bonds rely on country's national-level GHG inventories.

To understand the full extent of global warming, economic actors should measure and disclose total emissions of all types of GHGs or in CO_2-equivalent terms, i.e. both GHGs with lifetimes around 100 years or longer, notably CO_2 and nitrous oxide, and Short-Lived Climate Forcers (SLCFs), notably methane and some hydrofluorocarbons (IPCC, 2022[72]). Some research further suggests that governments and corporations should indicate the separate contribution of each type of GHGs to total CO_2-equivalent emissions in their targets and measurement of progress (Allen et al., 2022[76]).

For corporates, building on the GHG Protocol, the SBTi requires that GHG performance metrics (relating to both historic emissions and targets) cover at least 95% of company-wide Scope 1 and 2 emissions and account for all relevant Scope 3 emissions[12] (SBTi, 2021[57]). Scope 3 emission relate to the responsibility of companies along their value chain, both upstream and downstream, a core element of RBC due diligence standards that address the role of business in causing, contributing and directly linking to adverse environmental impacts along supply chains and business relationships (see Section 2.2). The relevance

[11] Scope 1 are direct emissions from owned or controlled assets, Scope 2 indirect emissions from the generation of purchased energy, and Scope 3 are indirect emissions from any other up- and down-stream activities related to the company's product (World Resources Institute & World Business Council for Sustainable evelopment, 2004[83]). These were defined via the GHG Protocol, a reference point for corporate level reporting and accounting.

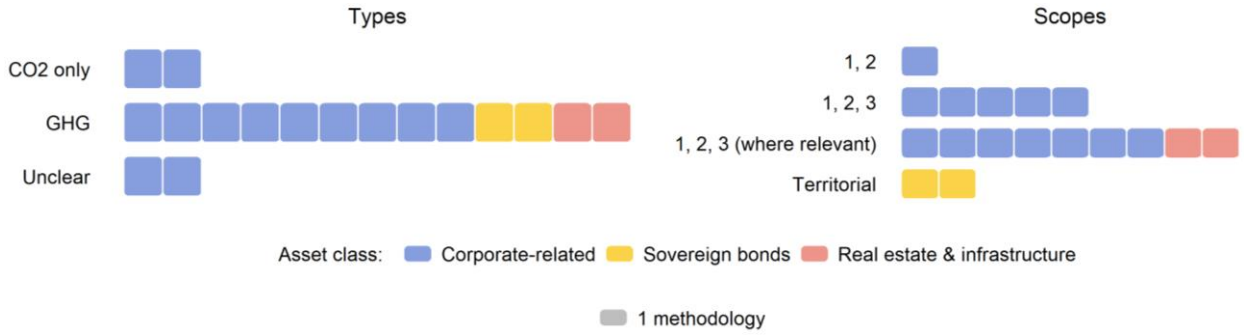
[12] Relevant emissions are determined based on the average share of emissions each category represents for an average company in a given sector.

of Scope 3 emissions, which relate to the company value chain both upstream and downstream, depend on the sector and where across the value chain the company sits. Estimates indicate they are especially important in sectors such as oil and gas and car manufacturing, for which they account for the majority of emissions across the three scopes (Hertwich and Wood, 2018[77]).

Most climate-alignment assessment methodologies consider all types of GHGs and the widest scope possible based on available data (Figure 3.6). All methodology providers for corporate assets include both Scope 1 and 2 emissions. A large majority also aim to include Scope 3 although limited data availability and quality is a major challenge (Thomä, Dupré and Hayne, 2018[71]). As a result, some methodologies choose to only include Scope 3 emissions when they represent a significant portion of total emissions. Those that do include Scope 3 emissions often rely on modelled or estimated data, as further discussed in Box 3.2).

For real estate and infrastructure, similarly, methodologies include non-CO_2 GHGs and Scope 3 emissions where relevant and based on the availability of data or estimates. For example CRREM includes Scope 3 of real estate in terms of tenant electricity and embodied carbon in reference to retrofits (CRREM, 2020[69]).

Figure 3.6. Coverage of types and scopes of GHGs for each methodology provider



Note: GHGs refers to all relevant GHGs in respective sectors. Methodologies including Scopes 1, 2, 3 reflects that they include all scopes regardless of their relevance to a specific sector. Methodologies including Scopes 1, 2, 3 (where relevant) reflects that they include those scopes that are relevant for a given sector.
Source: Authors' analysis based on publicly-available information and, for some providers, bilateral consultations.

For sovereign bonds, existing climate-alignment assessment methodologies, as well as those under development at the time of writing, attribute all GHG emissions within the territory of the country to the central government as debt issuer (Figure 3.6). Indeed, the central government has a formative role in determining the future path of GHG emissions through policies, regulation, taxation and subsidies (Domínguez-Jiménez and Lehmann, 2021[67]). The IPCC's Task Force on National Greenhouse Gas Inventories first issued guidelines in 1994. The 2006 version of such IPCC guidelines (IPCC, 2006[78]), refined in 2019 (IPCC, 2019[79]), is the current standard that countries[13] are expected to follow. On that basis, the scope of a national inventory has to, in principle, cover all anthropogenic GHG emissions (CO_2, CH_4, N_2O, HFCs, PFCs, SF_6 and NF_3) produced on its territory in energy, industrial process and product use, agriculture land use change and forestry, and waste sectors. The guidelines provide extensive information on how to compile an inventory, including in terms of method to estimate emissions (in simple

[13] Under the UNFCCC Parties are required to submit a national inventory of anthropogenic emissions by sources, and removals by sinks, of all greenhouse gases (GHGs), Annex I countries as part of their Biennial Reports, non-Annex I Parties as part of their national communications.

terms multiplying an emission factor by activity data). In practice, not all non-Annex I Parties to the UNFCCC may have the capabilities to report comprehensively.

Box 3.3. Corporate boundaries

For corporate-related assets, ownership boundaries could be an important aspect in defining the analytical scope of both alignment assessments in terms of geography and business activities, especially for large conglomerates (Thomä, Dupré and Hayne, 2018[71]). The corporate boundaries can affect the level of emissions. These considerations should be reflected in GHG accounting. Ownership boundaries relate questions of how to account subsidiaries in annual accounts and partially owned assets. In this context, the GHG Protocol defines three different approaches for determining the organisational boundaries of corporate GHG inventories:

- Operational control: A company accounts for 100% of the emissions from operations at which it has the full authority to introduce and implement operating policies. It does not account for any of the emissions from operations in which it owns an interest but does not have operational control.
- Financial control: A company accounts for 100% of the emissions from operations at which it can direct financial and operating activities with a view to gaining economic benefits from those activities.
- Equity share: A company accounts for GHG emissions from operations according to its share of equity in the operation. The equity share reflects economic interest, which is the extent of rights a company has to the risks and rewards flowing from an operation.

The boundaries of targets and metrics should be the same for each asset/company (SBTi, 2021[57]). The choice of these or other approaches may be specific to the accounting objective, and indeed will not necessarily be consistently applied in one annual report of a company. This can be a challenge for climate-change alignment tracking initiatives that divide one by the other.

Such production-based approach forms the basis for the UNFCCC reporting guidelines of annual inventories (UNFCCC, 2014[80]). These inventories provide information on the development of GHG emissions at national level over time, as well as, for Annex I Parties only, represent the scenario from which national GHG reduction targets are set (see Section 3.2.1).[14]

As a result of differences in corporate and national GHG accounting, and as further discussed in Section 3.4, combining assessments for different types of financial assets (e.g. sovereign and private-sector bonds) at the level of a financial portfolio results in methodological difficulties and inconsistencies, notably an intractable double-counting problem. Notably, accounting for scope 3 emissions can lead to double- or multiple-counting of the same emissions by individual actors along the corporate, real estate or infrastructure asset value chain. This may not be an issue for assessing the alignment of individual economic actors and assets (where on the contrary it may result in enhanced ambition and action), nor, more generally, for intensity-based metrics. However, such multiple counting

[14] The main methodological alternative consists in compiling a consumption-based inventory, which captures GHG emissions occurring within and outside the national boundaries due to consumption, whether produced domestically or imported, i.e. emissions embodied in trade netting out exports. In almost every EU country, consumption-based emissions are higher than those arising from local production as captured in UNFCCC inventories, as is the case in most developed countries as demonstrated by OECD Green Growth indicators (OECD, 2020[145]). In developing countries, the situation is different: some have both low production- and demand-based GHG emissions, while others have higher production- than demand-based emissions (IPCC, 2022[72]). At the time of writing, the only known country intending to set an official target for consumption-based emissions was Sweden (Climate Home News, 2022[146]).

can pose an environmental integrity issue when trying to aggregate corporate GHG metrics to reconcile them with national, sectoral and global carbon budgets.

3.2.4. Treatment of offsets and avoided emissions in metrics

Climate science and literature treat **offsets** with caution, notably in terms of the risk they pose of delaying or replacing actual GHG reductions, as well as in relation to their environmental integrity and additionally. In the context of net-zero emissions, the urgency of absolute emission reductions remains (Fankhauser et al., 2021[81]). These reductions need to be front-loaded and to cover all emission sources. This means carbon dioxide removals should be used cautiously and the use of carbon offsets should be regulated effectively. There are many questions around the integrity and additionally of offsets. For example, over half of the carbon offsets allocated in the Clean Development Mechanism (CDM) went to projects that would very likely have been developed anyway, i.e. lack of additionally (Calel et al., 2021[82]). The sale of offsets in the CDM may in fact have significantly increased global emissions.

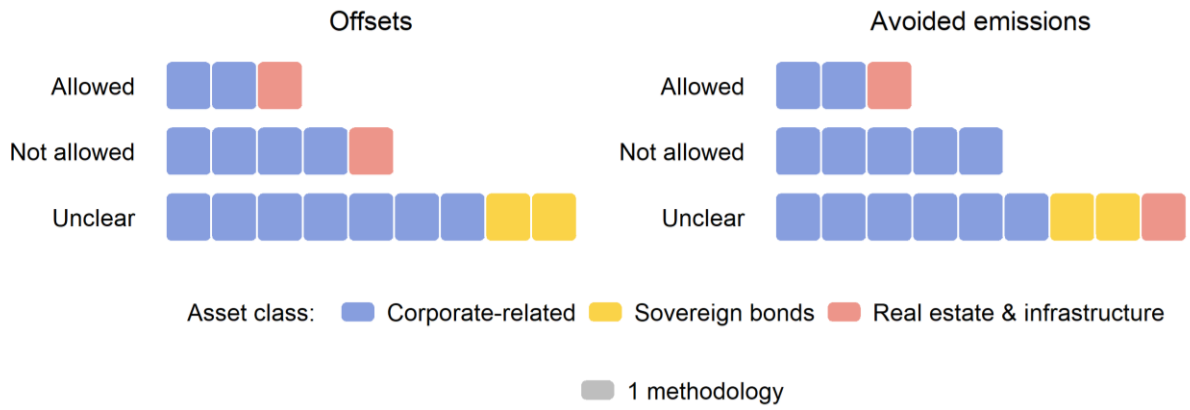
In this context, the SBTi standard states that offsets cannot be counted as reductions towards meeting a near-term target (SBTi, 2021[57]). Companies must account for reductions resulting from direct action within their operations or value chains. Moreover, the GHG protocol treats biogenic CO_2 (both sequestration, e.g. uptake by forests, and emissions, e.g. burning biomass) as separate from Scope 1, 2 and 3 emissions (World Resources Institute & World Business Council for Sustainable evelopment, 2004[83]).

Avoided emissions are currently defined and understood differently by different communities. For a country, in the context of international carbon markets, avoided emissions refer to activities that avoid potential sources of stored GHG emissions from being emitted to the atmosphere within its territory, such as the non-exploitation of fossil fuel reserves, maintaining land use and agricultural practices that retain already-stored carbon, and avoided deforestation (Jeudy-Hugo, Lo Re and Falduto, 2021[74]). For corporates, avoided emissions typically refer to emissions avoided during the use phase, by a company's customer compared to using a more carbon-intensive product than the less-carbon intensive product from the company, e.g. appliances that more energy efficient than comparable models available on the marketplace. A similar logic can applies to real estate and infrastructure.

In all cases, there are no agreed methods or standards to count counterfactuals and calculate avoided emissions. For corporates, avoided emissions do not occur during the product's life cycle inventory. Consequently, SBTi does not allow avoided emissions to be included in GHG performance metrics and requires that they are accounted for and reported separately from Scope 1, 2 and 3 emissions, including any Scope 3 metric or target (SBTi, 2021[57]). Further, assumptions regarding avoided emissions are vulnerable to the risk of non-permanence of the underlying activities. In the case of countries for instance, "fossil fuels could be kept in the ground (or deforestation could be avoided) for the time in which financial support from the sale of international credits is received, and subsequently extracted (or deforested, respectively)" (Jeudy-Hugo, Lo Re and Falduto, 2021[74]).

Many methodologies for the different asset classes considered do not explicitly state how offsets are treated, a few also allow avoided emissions (Figure 3.7). Arabesque Temperature Score methodology is one of the few methodologies that explicitly states that it does not take emissions offsetting into account, referring to the GHG Protocol and the SBTi (Arabesque, n.d.[84]). Further, PACTA in particular does not account for offsets and avoided emissions as its methodology focusses on technology shift and capital expenditure rather than emissions targets.

Figure 3.7. Treatment of offsets and avoided emissions by methodology providers



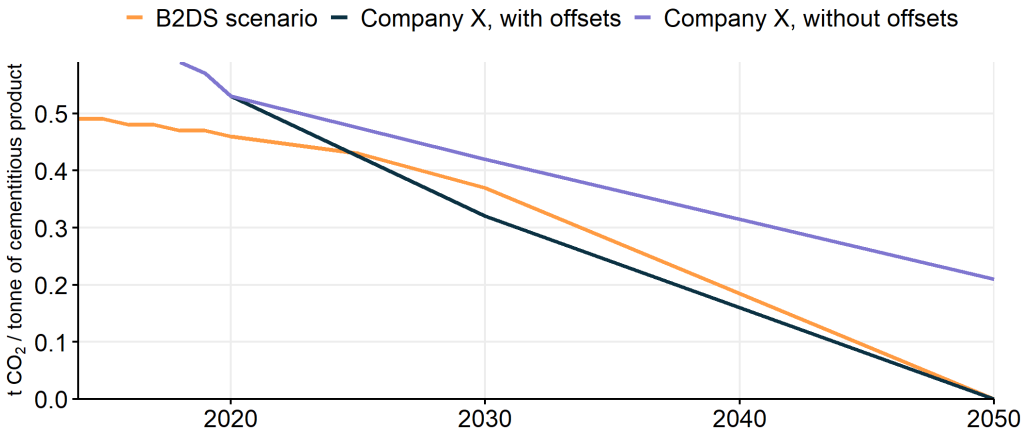
Note. Unclear typically means that the methodology provider does not explicitly state if or how offsets or avoided emissions are treated.
Source: Authors' analysis based on publicly-available information and, for some providers, bilateral consultations.

The lack of clarity on how offsets are treated in climate-alignment assessment methodologies may be a consequence of the lack of clarity and transparency of the use of offsets in metrics, targets and plans of economic actors themselves. An analysis of 25 major global companies with climate pledges found that companies are not yet transparent about their use of offsets (NewClimate Institute and Carbon Market Watch, 2022[85]). Lawmakers have picked up on this limitation. For instance, in March 2022, the U.S. Securities and Exchange Commission (SEC) proposed a rule on mandatory climate-related disclosure, which would require listed companies to disclose how offsets are used in their emissions reduction strategies (SEC, 2022[86]).

Indeed, to ensure the environmental integrity of alignment assessments, companies tracking and reporting systems need to separate the reliance on offsets, both in emissions accounting as well as in the context of emission reduction targets. Figure 3.8 shows how the inclusion of offsets can make a difference for climate-alignment results, taking the example of a cement company that aims to reduce its CO_2e emissions per tonne of cementitious product produced by 40% between 2020 and 2030. If in fact, the company plans half of its reduction through offsets, the 2030 intensity excluding those offsets would not be aligned.

For sovereign bonds, as explained in Section 3.2.3, the alignment assessment relates directly to country-level metrics, GHG inventory as well as targets. Similarly to company targets, national targets are typically unclear on whether and the extent to which they intend to rely on carbon offsets (Black et al., 2021[87]). As is the case for corporate-related financial assets, this lack of clarity negatively impacts the environmental integrity of climate-alignment assessments of sovereign bonds, which in turn can question their relevance in contributing to measure progress towards climate mitigation policy goals.

Figure 3.8. Stylised example of the treatment of offsets in the decarbonisation pathway of an electric utility



Note: B2DS is a Below 2 Degrees scenario. Company X shows the decarbonisation trajectory of a fictive company.
Source: Authors.

3.3. Selection of climate change mitigation scenarios

Generally, carbon budgets calculated by scientists apply to the global atmosphere. Translating these into GHG reduction scenarios for countries, sectors, companies and other entities or asset classes requires hypotheses and, in some areas, value judgements (Fankhauser et al., 2021[81]). Initiatives assessing climate alignment in finance may use different sources for such scenarios, define different sectoral and geographic specificity and may or may not consider their relevance and applicability to both developed and developing countries.

3.3.1. Scenario data and information sources

Many institutions worldwide provide climate change mitigation scenarios, as illustrated by the over 3,000 quantitative scenarios submitted to the IPCC's Sixth Assessment Report (AR6) database[15] and assessed in the most recent IPCC publication (IPCC, 2022, p. Chapter 3[8]). This database provides an overview of the wide range of modelled emission pathways and scenarios in the existing literature.

Emissions scenarios project the evolution of GHG emissions based on a set of internally consistent assumptions about future socio-economic conditions and related mitigation measures (IPCC, 2022[72]). In the AR6 database, about half of modelled emissions scenarios are built on cost-effective approaches, relying on least-cost emission abatement options globally to reach a certain temperature goal. The majority of modelled scenarios do not make assumptions about global equity.

While IPCC publications consider a wide range of scenarios, some are more prominent. The Shared Socioeconomic Pathways (SSP) is a collection of scenarios based on five narratives describing alternative socio-economic developments (Riahi et al., 2017[88]), which were used for the IPCC sixth Assessment Report (AR6). The Representative Concentration Pathways (RCP) are a set of four scenarios containing emission, concentration and land-use projections with detailed spatial data (van Vuuren et al., 2011[89]). They underpinned the IPCC fifth Assessment Report (AR5). Additional to the pathways, the IPCC

[15] The International Institute for Applied Systems Analysis (IIASA) hosts the scenarios and data used in the IPCC reports (Byers et al., 2022[147]). This includes the IAMC 1.5°C Scenario Explorer (Huppmann et al., 2019[142]), which covers the pathways used in the Special Report on Global Warming of 1.5°C (IPCC, 2018[140]).

considers an approach to calculate the remaining carbon budgets for different temperature objectives (IPCC, 2022[72]).

Other individual scenarios may provide more insights on sectors and regions, depending on the analytical purpose and target audience they have been designed for, such as scenarios developed by the:

- The International Energy Agency (IEA): The IEA has developed a set of scenarios in its World Energy Outlook (IEA, 2021[90]). It also published further global and macro-regional pathways for broad sectors in their Energy Technology Perspectives (IEA, 2020[91]).
- The Network for Greening the Financial System (NGFS): The NGFS is building its own Climate Scenarios Database, which currently consists of six scenarios classified in three categories: orderly transition, disorderly transition, and hot house world (Bertram et al., 2021[92]). These scenarios are being designed with the help of climate scientists and build on the socio-economic assumptions in the SSP scenarios.
- The European Commission's Joint Research Centre (JRC): The JRC has developed its so-called POLES model which simulates technology dynamics and can be used to generate scenarios under its Global Energy and Climate Outlook (GECO) for different regions (Després et al., 2018[93]; Keramidas et al., 2021[94]).
- The Institution for Sustainable Futures (ISF): The ISF has developed the One Earth Climate Model (OECM) scenarios, which are somewhat unique because they consider sector classifications used in financial and economic accounting rather than the IPCC sector classifications (i.e. GICS) (Teske et al., 2022[95]).

Further, some institutions have built scenarios for specific sectors and countries. For example, the En-ROADS initiative, IRENA World Energy Transitions Outlook (WETO) 1.5°C Pathway, Greenpeace advanced energy (r)evolution, deep decarbonisation pathways project, and the US EIA's Annual Energy Outlook (CPI, 2020[96]; Institut Louis Bachelier et al., 2020[11]; IRENA, 2021[97]).

Most of the existing climate-alignment assessment methodologies reviewed in this paper rely on one or a few of the above mentioned scenarios, as summarised in Table 3.3. IEA scenarios currently dominate, with over half of the methodologies for corporate-related assets considering IEA scenarios for their climate-alignment assessments. They are also particularly used for more sector-specific financial assets such as real estate (CRREM, 2020[69]). Some scenarios are only considered by one of the providers (e.g. scenarios from the JRC by PACTA).

While climate-alignment assessment methodologies for other asset classes than corporates may rely on similar scenario sources as those used by corporate-specific methodologies, they often undergo more transformations because additional assumptions may be added. Alternatively a few methodologies develop or use proprietary scenarios, e.g. Carbone 4 CIARA, a methodology specifically developed for infrastructure investments, relies on a scenario provided by Enerdata (Carbone 4, 2020[70]).

Methodology providers typically update their methodologies as new versions of the same scenario become available. This is illustrated by the multiple IEA Sustainable Development Scenarios (SDS) in Table 3.3. Further, during consultations (see Acknowledgements), several providers indicated that the potential use of scenarios from NGFS and ISF will be explored more in future iterations of their methodologies. The providers right. based and PACTA already allow users to choose a scenario among multiple options. This allows users to compare multiple scenarios for the same temperature rise instead of a single scenario for each temperature outcomes, as is the case for most providers.

Table 3.3. Main climate change mitigation scenarios for 2°C or below used by the methodologies reviewed

Scenario	Model	GHGs covered	Emissions sources	Global carbon budget	Temperature rise (and likelihood)	Horizon
International Energy Agency (IEA)						
NZE	WEM 2021	CO_2	Energy and industrial processes	500 $GtCO_2$, 2020-2050	1.5°C (50%)	2050
SDS	WEM 2021	CO_2		?	1.65°C (50%)	2050
SDS	WEM 2020	CO_2		?	1.65°C (50%)	2050
SDS	WEM 2019	CO_2		880 $GtCO_2$, 2018-2070	1.65°C (50%) / 1.8°C (66%)	2040
SDS	ETP 2020	CO_2		?	1.8°C (66%)	2070
B2DS	ETP 2017	CO_2		750 $GtCO_2$*, 2015-2100	1.75°C (50%)	2060
2DS	ETP 2017	CO_2		1170 $GtCO_2$*, 2015-2100	2°C (50%)	2060
European Commission's Joint Research Centre (JRC)						
GECO 1.5°C uniform	POLES JRC 2021	All GHGs	All (Energy and industrial processes, AFOLU)	500 $GtCO_2$, 2020-2100	1.5°C (50%)	2070
GECO 1.5°C Differentiated	POLES JRC 2021	All GHGs		500 $GtCO_2$, 2020-2100	1.5°C (50%)	2070
GECO 1.5°C	POLES JRC 2020	All GHGs		300-330 $GtCO_2$, 2018-2100	1.5°C (66%)	2050
GECO 2°C	POLES JRC 2020	All GHGs		870-920 $GtCO_2$, 2018-2100	Below 2°C (50%)	2050
Network for Greening the Financial System (NGFS)						
NGFS2 Net-Zero 2050	GCAM 5.3, MESSAGEix-GLOBIOM_1.1, REMIND-MAgPIE 2.1-4.2	All GHGs	All (Energy and industrial processes, AFOLU)	400 $GtCO_2$, 2011-2100	1.5°C (50%)	2100
NGFS2 Divergent Net Zero Policies	GCAM 5.3, MESSAGEix-GLOBIOM 1.1, REMIND-MAgPIE 2.1-4.2	All GHGs		400 $GtCO_2$, 2011-2100	1.5°C (50%)	2100
NGFS2 Below 2°C	GCAM 5.3, MESSAGEix-GLOBIOM 1.1, REMIND-MAgPIE 2.1-4.2	All GHGs		1000 $GtCO_2$, 2011-2100	Below 2°C (67%)	2100
NGFS2 Delayed transition	GCAM 5.3, MESSAGEix-GLOBIOM 1.1, REMIND-MAgPIE 2.1-4.2	All GHGs		1000 $GtCO_2$, 2011-2100	Below 2°C (67%)	2100
Institution for Sustainable Futures (ISF)						
OECM 1.5°C	OECM	All GHGs	Energy	450 $GtCO_2$*, 2015-2050	1.5°C (50%)	2050
OECM 2°C	OECM	All GHGs		590 $GtCO_2$*, 2015-2050	Below 2°C (80-85%)	2050
ISF Net Zero	OECM	All GHGs		400 $GtCO_2$*, 2020-2050	1.5°C (66%)	2050

Note 1: Last updated in July 2022. Scenarios or scenario sources referenced by the online documentation of or through consultations with climate-alignment assessment methodology providers are included. Proprietary scenarios are not included. The table also does not reflect methodologies that use an absolute carbon budget or the full database of scenarios captured by the IPCC fifth or sixth assessment.
Note: 2: The * in the column 'Global carbon budget' refers to budgets excluding AFOLU emissions. Likelihood refers to the probability of staying below a given temperature rise by 2100.
Note 3: The acronyms refer to the following. GHG: greenhouse gas, AFOLU: Agriculture, Forestry and Other Land Uses, NZE: Net Zero Emissions, SDS: Sustainable Development Scenario, B2DS: Beyond 2°C Scenario, IEA: International Energy Agency, 2DS: 2°C Scenario, WEM: World Energy Model, ETP: Energy Technology Perspectives, GECO: Global Energy and Climate Outlook, POLES: Prospective Outlook on Long-Term Energy Systems, JRC: Joint Research Centre, NGFS: Network for Greening the Financial System, OECM: One Earth Climate Model, ISF: Institute for Sustainable Futures, GCAM: Global Change Analysis Model, MESSAGEix: Model for Energy Supply Strategy Alternatives and their General Environmental Impact, GLOBIOM: GLobal BIOsphere Management, REMIND: REgional Model of Investment and Development, MAgPIE: Model of Agricultural Production and its Impact on the Environment.
Source: Authors.

Based on consultations, the choice of the IEA is motivated by its sectoral specificity, which alternative scenarios may lack (at the time of writing), especially prior to the more recent OECM scenarios. On the other hand, the addition or public availability of more geographical specificity is desired. Consultations further highlighted that IEA scenarios are often complemented with other scenarios and data because they either do not sufficiently cover a 1.5 degrees objective (i.e. prior to the release of their net zero roadmap (IEA, 2021[98])) and do not cover non-CO_2 GHGs. A ratio may be applied to the IEA scenarios to add non-CO_2 GHGs. The latter may be done using information from other scenarios in the IPCC database or by interpolating industry trends using data points from academic papers, information from industry representation organisations or other institutes e.g. methane tracker. Another, adjustment that may be made is including Carbon Dioxide Removal (CDR).

Some methodologies, for both corporate- and sovereign-related assets, consider the IPCC remaining carbon budgets instead of scenario pathways. For example, MSCI currently uses the Global 2°C Carbon Budget (MSCI, 2021[99]) based on the IPCC Special Report on 1.5 °C, but this may be updated to a 1.5°C carbon budget using newer publications. Further, the FTSE-Beyond Ratings method for sovereign assets reconciles national budgets with the global emissions budgets for different temperature goal as published by the IPCC.

Finally, it should be noted that in addition to GHG emission trajectories, scenarios can provide a wide range of information and data associated with such trajectories, e.g. underlying assumptions about the evolution of underlying capacity and production volumes. Pending such information and data are made publicly available, they can be used as input to a more comprehensive and nuanced analysis. As discussed in other parts and in the Conclusions and implications chapter of the paper, this can form part of future dashboards of indicators that would include but not be limited to GHG-based metrics and assessments.

3.3.2. Temperature outcomes and uncertainty based on scenario(s) used

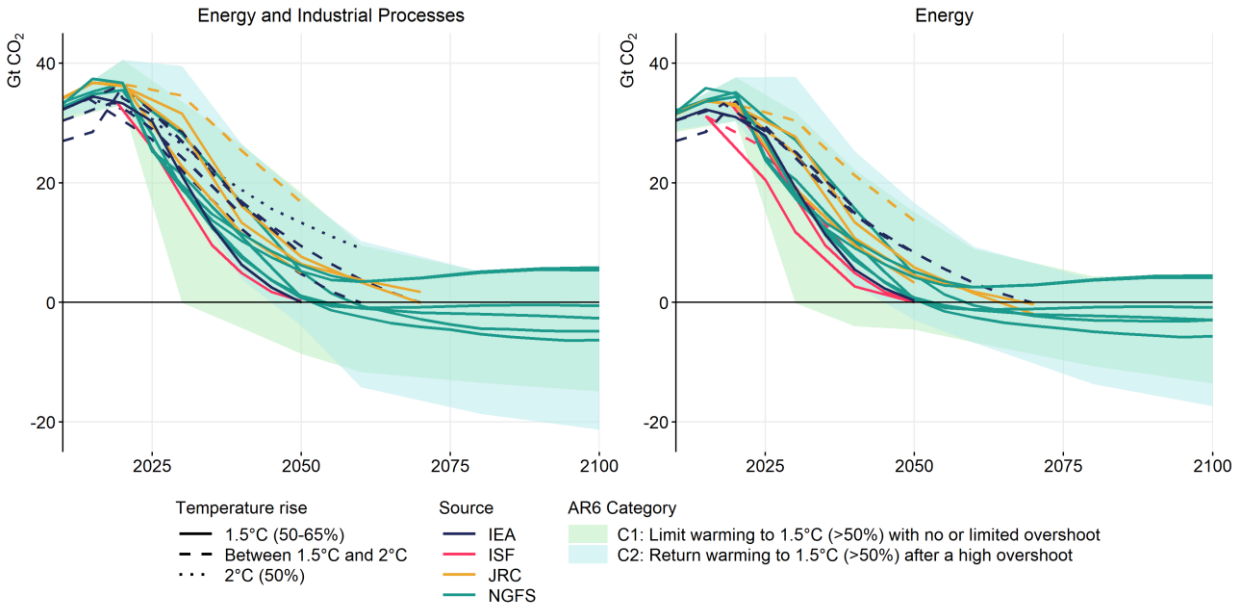
Climate scientists can calculate the remaining carbon budget for a given temperature goal. This is because there is a near-linear relationship between cumulative anthropogenic CO_2 emissions and the global warming they cause. Each 1,000 $GtCO_2$ of cumulative CO_2 emissions is assessed to likely cause a 0.27°C to 0.63°C increase in global surface temperature with a best estimate of 0.45°C. This quantity is referred to as the transient climate response to cumulative CO_2 emissions (TCRE) (IPCC, 2021[100]; Rogelj et al., 2019[101]; Matthews et al., 2009[102]).

Carbon budgets calculated in this way to be consistent with a certain temperature outcome, can be used as boundary conditions for mitigation scenario pathways. Temperature outcomes of scenarios can also be calculated using so called climate emulator models, which are reduced complexity climate models (IPCC, 2022[72]). Either way, the scenarios come with a probability of how likely they are to keep temperature rise below a certain degree.

shows the likelihood of staying within a certain temperature rise for each scenario used by the climate-alignment methodology providers. For example, while the IEA NZE scenario is characterised by a 50% likelihood of keeping global warming below 1.5 degrees Celsius by 2100, the ISF Net Zero scenario is characterised by a 67% likelihood for such temperature increase.

Different scenarios can represent different ways to reach a given temperature objective. Figure 3.9 shows the pathways of the different scenarios considered by the methodology providers for different temperature alignments. It highlights the fact that the choice of any single scenario will have an impact on the alignment result for a given asset. In part to address this issue, the CDP-WWF Temperature Ratings methodology starts with the full sample of scenarios captured by the IPCC hosted by the IIASA database. It then applies a range of selection criteria, e.g. scenarios with early action and low reliance on unproven carbon removal technologies. Sources of scenario uncertainties will be further explored in follow-up OECD analysis to the present paper.

Figure 3.9. Comparison of climate change mitigation scenario pathways used by methodologies



Note: Scenarios listed in Table 3.3 are included. For some scenarios only data for the combined emissions from "energy and industrial processes" and for some only for "energy" could be found. The AR6 Category envelopes are calculated as the maximum range in the years 2010, 2020, 2030, 2040, 2050, 2060, 2080, 2100.
Source: Authors.

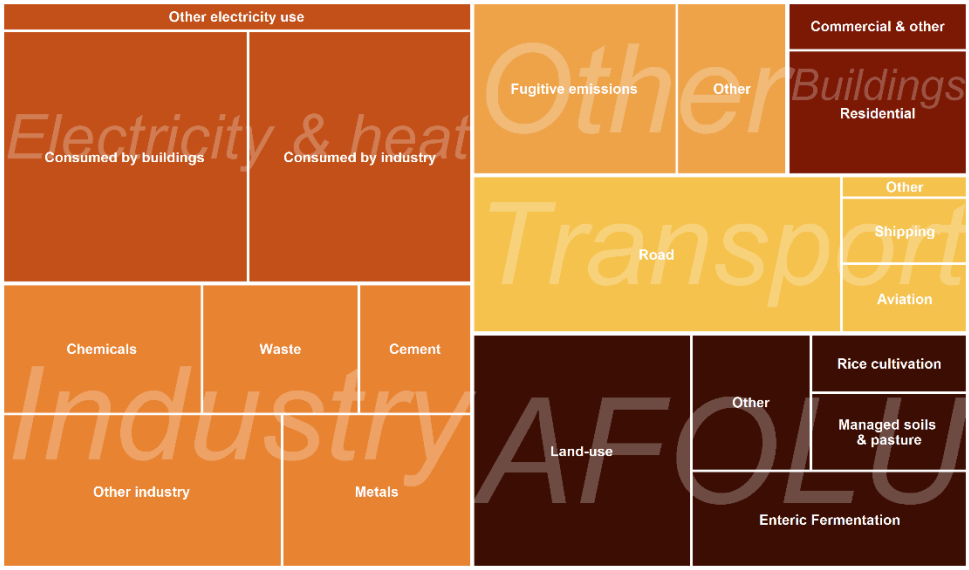
Most methodologies use scenarios for a few different temperature outcomes and define alignment of an entity based on the most ambitious scenario it is aligned with. However, the communication of climate-alignment assessment results typically does not refer back to the likelihoods of staying within the temperature rise that a given asset is aligned with.

A few methodologies aim to calculate an exact temperature rise that is implied by the under- or overshoot- of an entity, assuming a similar emission profile for all other entities. For example MSCI converts the company-level relative emissions over-/undershoot to degrees of warming using the TCRE approach. Similarly, the FTSE-Beyond Ratings method calculates the ratio of emissions under a country's NDC and emissions the country can emit under a 2 degrees scenario (Emin et al., 2021[65]). Then, it applies this to the global carbon budget consistent with 2 degrees warming, and finally, applies the TCRE to this.

3.3.3. Sectoral scope and specificity

As presented in Figure 3.10, different sectors have different emissions profiles. Each sector is characterised by different mitigation levers and different marginal abatement costs (IPCC, 2022[8]; IEA, 2021[98]). For example, the industry sector is both emissions-intensive and particularly hard to abate as many of the required net-zero technologies cannot be deployed at full scale yet (IEA, 2018[103]; Bataille et al., 2018[104]; OECD, 2022[105]).

Figure 3.10. Sectoral contribution to global GHG emissions in 2018



Note: The surface of each square represents the share that subsector contributes to global GHG emissions. AFOLU refers to Agriculture, Forestry and Other Land Use.
Source: Authors' calculations based on (Lamb et al., 2021[106]).

The timing of GHG reductions in a given sector depends on abatement costs, the availability of CDR options, near-term emissions levels and the amount of non-CO_2 abatement (IPCC, 2022[8]). As a result, different scenarios make different assumptions about the scale and speed of emissions reductions over time and, as a result, the timing of reaching net-zero emissions in each sector (IEA, 2021[98]). These differences in sectoral assumptions lead to different investment needs (IPCC, 2022[72]) and hence different assessments of alignment for a given physical and financial asset.

Integrated Assessment Models (IAMs) can include sectoral specificities but cannot match the granularity of sector-specific pathways that can be developed from sectoral studies. However, sector-specific models may miss potential feedbacks and cross-sectoral linkages that are captured by IAMs (IPCC, 2022[8]). Nevertheless, sectoral models and IAMs are complementary as sectoral models can include more sectoral detail and mitigation options, while IAMs include all emissions sources.

For corporate-related assets, every methodology reviewed, for which information was available, considers some degree of sectoral specificity in its alignment assessment. However, the scope of sectors covered may differ. For example, PACTA and TPI only cover the emissions-intensive sectors as these are considered most relevant to the needed transition. Methodologies aiming to cover all sectors (such as (Arabesque, n.d.[84]), (MSCI, 2021[99]), (right. based on science, n.d.[107]) or (S&P Global, 2020[108])) need to match sector classifications defined for economic purposes (e.g. NACE or GICS) with sector classifications defined for the purposes of tracking GHG emissions and designing scenarios (e.g. IPCC sectors). As became apparent during consultations, such mappings are challenging and require some judgement calls, notably because the nature of companies' activities is typically better characterised based on granular (4-digit) sub-sectors, which GHG data and scenarios typically cannot match. Such issues are even more challenging when one company is active in multiple sectors.

For sovereign bonds, sectoral specificity is less relevant as sovereign bonds are typically issued without being earmarked to finance a specific sector. As a result, existing methodologies for sovereign bonds conduct sector-agnostic alignment assessments based on national-level GHG data and scenarios derived from IAMs. **For real estate and infrastructure**, on the other hand, sectoral specificity is especially

relevant. Relevant methodologies aim to distinguish property and infrastructure types and related decarbonisation pathways. For example, the climate-alignment assessment methodology for infrastructure by Carbone 4 distinguishes 65 asset types in energy, mobility, water, tertiary buildings, waste and telecoms (Carbone 4, 2020[70]).

3.3.4. Geographic scope and granularity

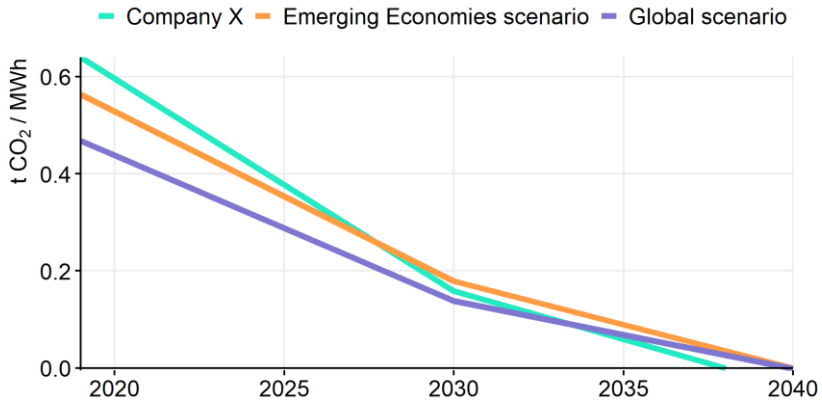
The geographic granularity of the scenarios used by the climate-alignment assessment methodologies has an impact on the alignment results of financial assets. Exclusively relying on global mitigation pathways prevents from taking into account technical, political and social considerations at the regional and national level (Jiang, Peters and Green, 2019[109]).

However, going from global to national mitigation scenarios is challenging (van Soest, 2022[110]). IAMs and studies on GHG and carbon neutrality have mainly been developed at the global level (van Soest, den Elzen and van Vuuren, 2021[111]). National and sectoral models can be used to study national mitigation scenarios with high granularity. However, their application in isolation does not make it possible to shed light on whether such scenarios are in line with the global carbon budgets and the PA temperature goal. For the latter, global IAMs are needed as they provide the boundary conditions in the form of carbon budgets across countries (Schaeffer et al., 2020[112]). These challenges are relevant to the financial sector and its climate-alignment assessments.

Looking at forward-looking mitigation information put forward by countries themselves, NDCs, submitted to the UNFCCC give an indication of the national political intentions at an aggregate level without providing sector-specific information. Further, when combined and added up, available analyses, by e.g. UNEP (2021[113]), indicate that they do not currently make it possible to reach the PA temperature goal. Besides NDCs, Parties to the UNFCCC should strive to formulate and communicate long-term low greenhouse gas emission development strategies. However, given the resources and capacities needed to put such strategy in place (Rocha and Falduto, 2019[114]), they remain limited (51 as of June 2022) and mostly stemming from developed county Parties (Aguilar Jaber et al., 2020[115]). Moreover, their sectoral specificity and granularity is not sufficient to be used as input to financial asset alignment assessments.

For corporate-related financial assets, all climate-alignment assessment methodologies reviewed rely on global scenarios. A few, such as PACTA and TPI, include scenarios for macro-regions for a subset of their assessments, where such regional breakdown is available from the scenarios. Global scenarios may be suitable for globalised companies and sectors, e.g. automotive, cement. However, many smaller companies, but also large companies in certain sectors typically have their main operations within one macro region. For example, TPI now considers regional scenarios for electric utilities (Dietz et al., 2021[116]). Whether corporate pathways are compared to global or regional scenarios can significantly impact alignment results. For example in Figure 3.11, fictive company X with all its operations in emerging economies would already be considered aligned with the illustrative scenario for emerging economies in 2030, while it would only align with the more ambitious global scenario around 2034. However, most corporate-focussed methodologies do not currently explicitly mention considerations for developing countries and/or distinctions that may result from different national circumstances.

Figure 3.11. Stylised example of company alignment against a regional scenario for the power sector



Note: Company X is a power producer with all of its assets located in emerging economies.
Source: Adapted from (Dietz et al., 2021[116]).

For sovereign bonds, real estate and infrastructure, climate-alignment assessment methodology providers typically build on global or regional scenarios. They however, then need to downscale these themselves as alignment assessments in such asset classes require country-specific scenarios, which may or may not include considerations of equity and differentiated responsibilities and capacities. Downscaling methodologies are discussed in the next section 3.3.5.

Climate change mitigation scenarios are crucial inputs to climate-alignment assessment methodologies. Methodology providers depend on the climate policy community to provide scenarios with more geographic and sectoral detail. This was also echoed by an OECD industry survey conducted in the context of preparing a guidance on transition finance, where 69% of respondents stated that the lack of such pathways is a key obstacle to identifying companies committed to a Paris-aligned transition trajectory (OECD, 2022[24]).

3.3.5. Downscaling scenarios to entities

To assess the alignment of a financial asset, the alignment scenario needs to be scaled down to the level of that asset, e.g. a company for corporate-related financial assets, a country for sovereign bonds, and a specific physical asset for infrastructure and real estate. The main barrier to downscaling is that it requires value judgement and agreement on burden sharing, i.e. the absolute or relative share and speed of emission reductions assigned to the entity. Therefore, the discussion on downscaling scenarios to the asset-level builds on the discussion in Section 3.3.4 of global versus national pathways (especially for sovereign bonds where the asset-level entity is a country), as well as relating to sectors (Section 3.3.3).

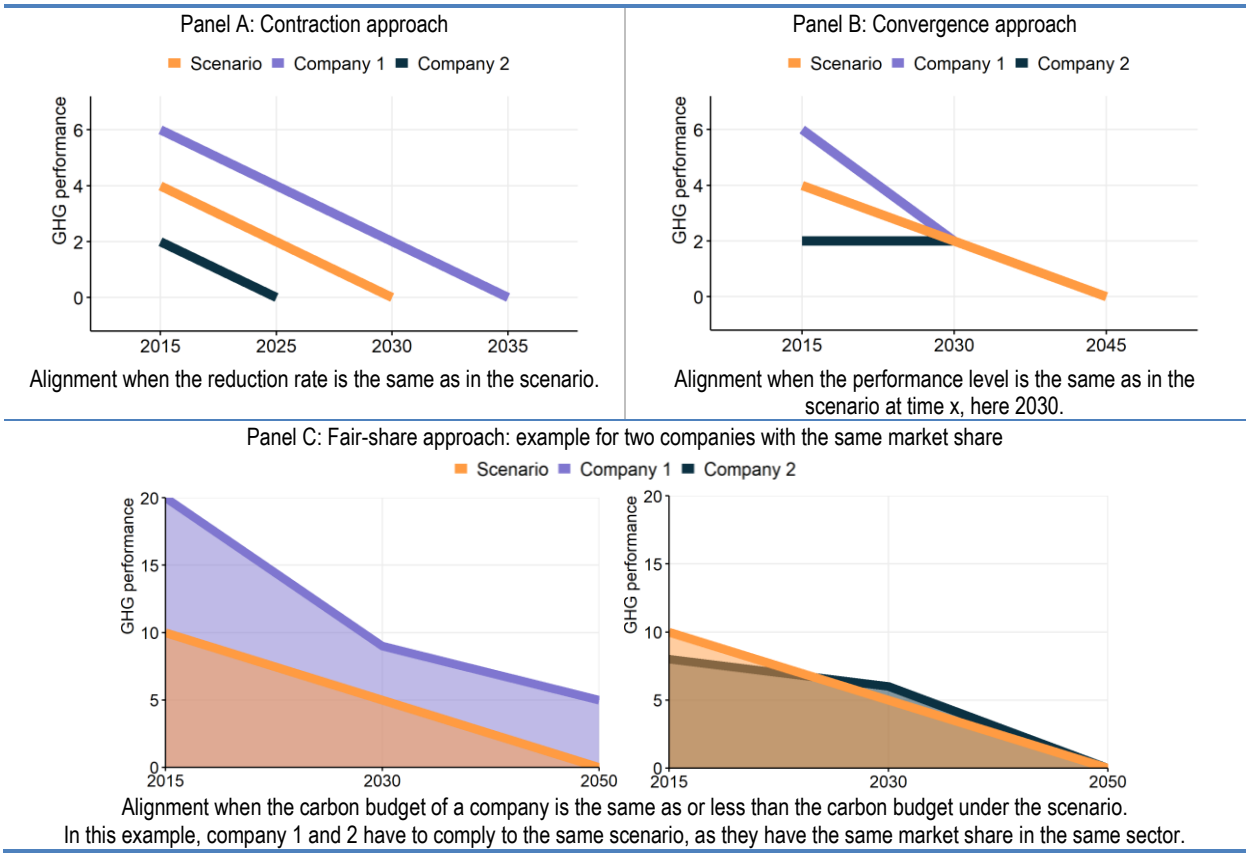
For corporate-focussed methodologies, a scenario needs to be assigned to each firm, additional to being specific to the sector of that firm. Even when methodologies do not explicitly assign the scenario they rely on to individual companies, they make implicit assumptions about the speed at which companies need to decarbonise. There are a few existing approaches to compare entities to sector-level scenarios or to explicitly allocate macro scenarios to entities (Institut Louis Bachelier et al., 2020[11]; Schwegler et al., 2022[12]; SBTi, 2021[57]).

- In the *contraction approach*, a company is considered aligned if it reduces emissions at the same speed as the sectoral scenario. In this case, a fixed reduction rate is set for absolute emissions or carbon intensities for all companies in a given sector or overall in the economy (Figure 3.12

panel A). The expansion approach is a variation of this approach for methodologies that assess for example production-based pathways of corporates assets focussed on renewable energy.

- In the *convergence approach,* a company is considered aligned if it converges towards the (sector-level) scenario by a given point in time. In this case every company in a given sector needs to achieve the same climate performance, typically in intensity-based terms, at that point in time (Figure 3.12 panel B). Hence, entities that are already performing well have to improve relatively less to be aligned. A slight variation of this approach is to assess a company as aligned if it convergences towards a range anywhere at or below the scenario by a given point in time.

Figure 3.12. Stylised examples of different approaches for downscaling climate mitigation scenarios to entities



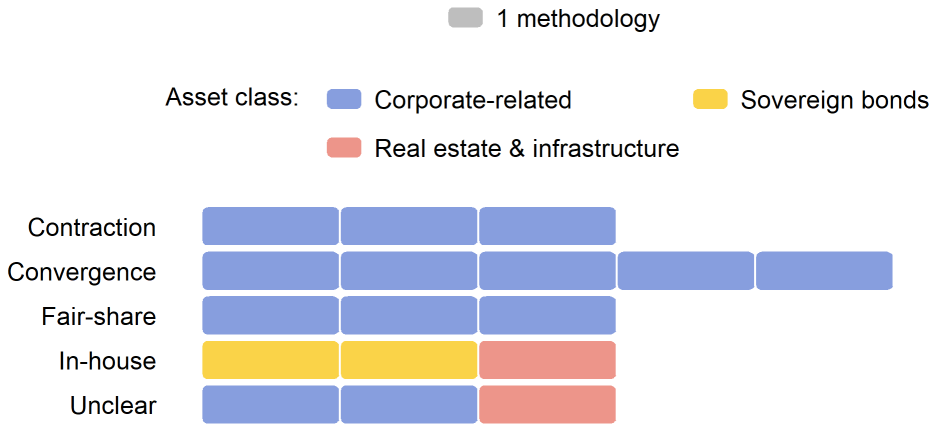
Note: GHG emissions performance could be in terms of absolute emissions (e.g. tCO_2e) or emissions intensity (e.g. tCO_2e per ton of steel). Contraction approach is typically used for absolute-based metrics, convergence for intensity-based metrics.
Source: Authors based on (Schwegler et al., 2022[12]).

- In the *fair-share approach*, a company-specific carbon budget or scenario is allocated to each company. A few variations are possible.
  - The market-share approach distributes the sectoral scenario proportionally to companies' market share (by revenue, production or capacity for example). For example, two companies in the same sector with the same market share could receive the same carbon budgets while having different emissions profiles (Figure 3.12 panel C).
  - The historic-responsibility approach considers cumulative historic contributions and distributes the remaining sectoral budget on that basis. This implies for instance that entities having emitted below the budget level in the past may temporarily surpass the budget in the future.

- The economic-efficiency or least-cost approach distributes the sectoral scenario based on relative cost or efficiency, which is similar to what the IEA Energy Technology Perspectives scenarios did to distribute global carbon budgets to sectors. This requires company-level data on abatement costs, which makes this approach challenging.

Most climate-alignment assessment methodologies for corporate equity and bonds follow a convergence approach (Figure 3.13). On that basis, companies that are currently more emissions-intensive will need to reduce emissions faster than companies that are already closer to the scenario. The convergence approach may be best suitable for large companies with global operations where activities may be less clearly linked to specific countries. On the other hand, a contraction approach is common for absolute emissions-based metrics, where companies need to reduce emissions at the same rate, regardless of their current and past emissions. However, companies may have different abatement cost curves, investment capacities and access to financing, especially in developing countries, which could call for a differentiated approach.

Figure 3.13. Approaches to downscaling scenarios by methodology providers



Source: Authors' analysis based on publicly-available information and, for some methodologies, bilateral consultations with the providers.

As discussed in section 3.3.4, downscaling global to national scenarios is challenging. Few scenarios, which have both national and sectoral specificity, are available. Therefore, climate-alignment methodologies for sovereign bonds, real estate and infrastructure developed their own approaches to downscaling scenarios to the country-level. For example, the FTSE-Beyond Ratings method developed a probabilistic approach to determine the most likely carbon budget for each country (Emin et al., 2021[65]). Their approach starts from the Kaya equation, which multiplies population, GDP per capita, energy intensity, and carbon intensity, breaking it down into 15 criteria. Based on these, two million simulations that test multiple ways of combining criteria are run. Another example is the scenarios developed by CRREM for real estate, which downscale global scenarios for the buildings sector based on current country performance and forward looking considerations (CRREM, 2020[69]). In this context, the further development of national-level scenarios, including by countries themselves, would greatly facilitate alignment assessments for asset classes that require such granularity.

3.4. Approach for assessing alignment at the financial portfolio level

The previous sections looked at how climate-mitigation alignment is assessed for individual investments or financial assets, e.g. an equity investment or holding in one company, the purchase or holding of bonds issued by a specific corporate or government. Aggregating results for individual financial assets to the portfolio level adds another layer of complexity as it requires weighing the contribution of different assets across different sectors (the assessment of which typically relies on sector-specific scenarios and metrics), as well as adjusting for the potential double counting of emissions where relevant (PAT, 2020[10]). These issues become even more complex when considering portfolio-level aggregation across multiple asset classes, e.g. corporate-related equity and debt, sovereign bonds, real estate and infrastructure.

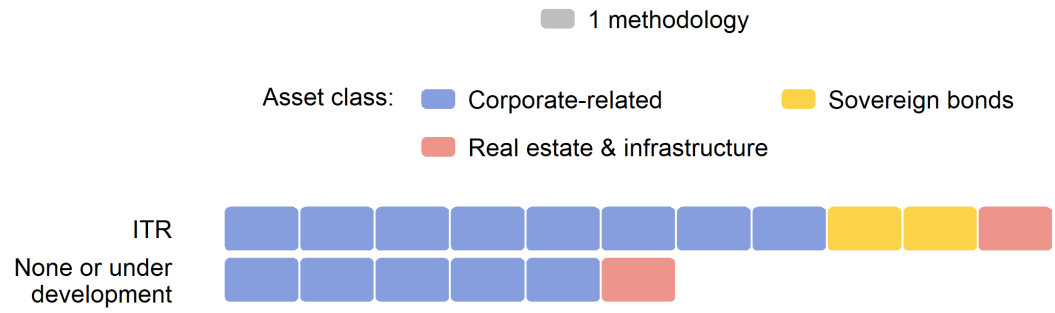
3.4.1. Metric at the portfolio level

Similarly to what can be done at asset level (see Section 3.2.1), portfolio-level alignment can be assessed in different ways (PAT, 2021[45]; GFANZ, 2022[117]).

- The most complex is the Implied Temperature Rise (ITR) or degree warming metric, which takes the form of a global warming outcome if the global economy was to exhibit same level of performance as the financial portfolio being assessed (SBTi, 2022[118]; PAT, 2020[10]). These are typically based on measuring financed emissions of a portfolio (PCAF, 2020[38]). Similar to asset-level analysis, financed emissions from a portfolio can be calculated in absolute terms or intensity-based. There are two types of intensity metrics, namely sector-based physical emissions intensity and weighted average economic carbon intensity (SBTi, 2022[118]).
- A slightly simpler variation of the ITR to assess portfolio-level alignment is the scenario divergence model which estimates a percentage deviation compared with a scenario but does not calculate an exact temperature (PAT, 2021[45]).
- Other metrics include a binary target measurement or share of a portfolio with climate-aligned targets (PAT, 2021[45]; Schwegler et al., 2022[12]).

Among the climate-alignment assessment methodologies reviewed as part of the present analysis, many are still developing their portfolio-level assessments metric (Figure 3.14). The ones that have already developed one all follow an Implied Temperature Rise (ITR) approach.

Figure 3.14. Portfolio-level metric used by methodology providers



Note: ITR refers to Implied Temperature Rise.
Source: Authors' analysis based on publicly-available information and, for some providers, bilateral consultations.

3.4.2. Aggregation approaches

To estimate a portfolio's ITR, an approach for aggregating asset-level assessments needs to be chosen. This can either be done by going back to asset-level under- or over-shoot of emissions and aggregating bottom-up, or by taking a simple weighted average of asset-level assessments (PAT, 2020[10]). In both cases, the exact calculations using these approaches may differ by asset class.

Corporate equity and debt

Methodologies to aggregate corporate equity and debt portfolios are still in the making, but some approaches have been developed (Schwegler et al., 2022[12]; Institut Louis Bachelier et al., 2020[11]; CDP & WWF, 2020[62]; Thomä, Dupré and Hayne, 2018[71]; GFANZ, 2022[46]; PAT, 2020[10]):

- In the *aggregated budget approach*, the over- or under-shoot of each corporate asset is summed. This can be done either for total corporate emissions or the share of those emissions financed by the respective investor. In particular, the latter approach compares the sum of "owned" projected GHG emissions against the sum of "owned" carbon budgets for the underlying holdings. This brings the additional complexity that financed or owned emissions and carbon budgets of the company need to be calculated explicitly.
- For the *weighted average approach*, the asset-level alignment metrics (e.g. ITR) are weighted based on the relative weight of each company in the portfolio. This weight can either be defined by the ownership stake of a financial institution for equity portfolios or the enterprise value for bonds portfolios.
- A third approach combines the first and second approach. The *portfolio-owned approach* weighs the asset-level alignment metrics by their respective proportion of company emissions financed by the investor.
- Other variations are possible and being explored: the enterprise value and cash emissions weighted temperature score approach, the total assets emissions weighted temperature score approach, or the revenue owned emissions weighted temperature score approach.

Currently, there is no clear dominant aggregation approach across climate-alignment assessment methodology providers for corporates, which use different approaches, sometimes tailored for different users of their methodology. For example, CDP uses a weighted average approach, but within that is still considering several options of weighing (CDP & WWF, 2020[62]). In contrast, MSCI uses an aggregated budget approach (MSCI, 2021[99]).

Additional to portfolio aggregation across all economic sectors, assets could be aggregated by sector, as is done by PACTA (2DII, n.d.[60]). Such sectoral portfolio aggregation is especially relevant for methodologies that use sector-specific metrics and focus on corporate assets that are emissions-intensive and either transitioning or being phased out, as well as on corporate assets that are developing climate solutions (e.g. in the renewable energy sector). This is a different perspective that is particularly relevant to inform active engagement strategies with investees.

Other asset classes

Similar to corporate equity and bonds, individual climate-alignment assessments for sovereign bonds can be aggregated at the portfolio level using an aggregate budget or a weighted average approach. Assessments can be aggregated on the basis of market values of respective bonds or national contributions to total emissions or GDP. For example, FTSE-Beyond Ratings propose to use the weighted average approach based on the bonds' market value (Emin et al., 2021[65]).

For real estate and infrastructure portfolios, both the aggregated budget approach and the weighted average approach can be used as well. Carbone 4's infrastructure methodology uses a combination of

both approaches. It takes the over- or under-shoot of each asset. Then, it weighs these asset-level result based on the holding share of the asset manager (Carbone 4, 2020[70]). The Carbon Risk Real Estate Monitor calculates an aggregate-level average GHG intensity based on the floor area of each real estate asset (CRREM, 2020[69]).

Complexity of aggregation across asset classes

As shown in Table 3.1 in section 3.1, methodologies are currently underdeveloped for several asset classes and a limited number of methodology providers cover multiple asset classes. The providers having developed or acquired methodologies for different asset classes include PACTA, Carbone 4 and right. based on science, and some further providers are in process of doing so as well, e.g. S&P Sustainable1. As a result, there only have been very limited attempts to date to produce portfolio-level alignment assessments across multiple asset classes.

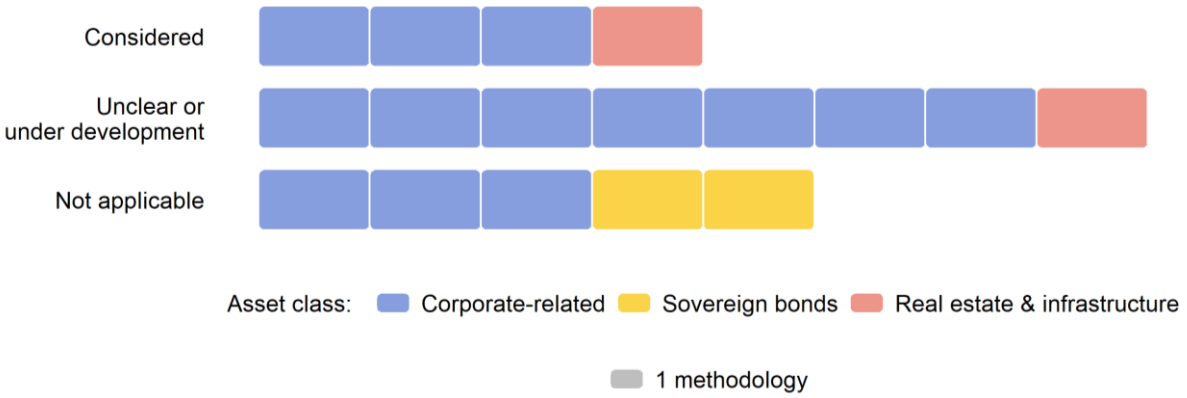
In any case, calculating a portfolio-level alignment metric across multiple asset classes requires further methodological assumptions and adds significant complexity compared to aggregation within a given asset class. This is notably due to the fact that, as discussed in Sections 3.1 to 3.3, the methodologies to assess alignment at the level of individual assets differ from one asset class to the other, especially if expanding beyond corporate-related assets. Further, as mentioned above, metrics and resulting alignment assessments can differ from one economic sector to the other, thereby further making it even more difficult to derive a meaningful portfolio-level assessment. Hence, portfolio-level alignment assessment across asset classes and sectors may not necessarily produce robust and reliable results, which in turn could question their relevance for informing progress towards climate mitigation policy goals. With this in mind, further developments in this area would in any case warrant cautiousness, full methodological transparency and clear communication of uncertainties and error margins.

3.4.3. Double counting of emissions

International-level collective assessment of progress towards global carbon budgets and the PA temperature goal requires minimising double counting of GHG emission reductions and avoidance across actors, including investors and financial institutions. Within the investment and financial value chain, double counting of emissions can occur at multiple levels, namely between financial institutions co-financing the same entity or activity, between transactions within the same financial institutions, across different asset classes, as well as within the same asset class (PCAF, 2020[38]). Double-counting is problematic for portfolio-level assessments of climate alignment if GHG emissions that are counted double are interpreted as actual total emissions into the atmosphere, or if the double-counting distorts the ITR calculation within the portfolio (Schwegler et al., 2022[12]).

Approaches to adjust for double counting are still in the early stages of development (Portfolio Alignment Team, 2020[119]). As a result, most methodologies do not currently explicitly clarify how they adjust for double counting (Figure 3.15), although most indicated that this is an area they are working on. *Right. based on science* is one of the few methodologies that currently explicitly adjusts for double counting by only including 50% of Scope 2 and Scope 3 emissions when aggregating to the portfolio-level (right. based on science, n.d.[107]). This is an area for further methodological work in order to develop less arbitrary approaches, for instance those that take into account the extent to which supply chains of companies within an investor portfolio actually overlap.

Figure 3.15. Methodology providers considering double counting



Note: Not applicable means that the methodology either does not include Scope 3 emissions or does not have an aggregate portfolio-level metric.
Source: Authors' analysis based on publicly-available information and, for some providers, bilateral consultations.

4. Illustration of results from climate-alignment assessments

Methodology providers assess financial assets as aligned or misaligned from a mitigation perspective if the underlying assets contribute to economic systems that are consistent with GHG pathways that limit warming to the PA temperature goal. As detailed in Chapter 3, individual methodologies, however, differ in perspective, scope, metrics, methodological assumptions and input GHG reduction scenarios. This chapter illustrates differences in assessment results across anonymised methodology providers. The aim in doing so is not only to illustrate the impact of these differences, but also to highlight that different climate-alignment assessment results may sometimes be complementary rather than always contradictory.

The main focus of the chapter is on results from corporate-related alignment assessment methodologies since, as summarised in Table 3.1 and detailed throughout Chapter 3, only very few methodologies have been fully developed for other asset classes, thus preventing meaningful comparisons of results. Still, the chapter explores some examples for other asset classes, including sovereign bonds. Further, consistent with the metrics used by the majority of alignment assessment methods (see Section 3.2), this chapter relies on GHG-based alignment assessment results, while acknowledging that other metrics can be complementary for a more holistic assessment of financial sector alignment.

4.1. Illustration of results for listed corporate equity

4.1.1. Overlaps and differences in corporate alignment assessment results

The following analyses considers a selection of companies in eight emissions-intensive sectors across seven macro-regions. The companies are selected based on size and region of headquarters within the eight selected emissions-intensive sectors. They are typically part of the CA100+ focus companies[16]. Robustness was checked by performing the analysis on an additional sample of companies with similar characteristics. The analysis illustrates the climate-alignment assessment results based on a selection of six climate-alignment assessment providers, for which data was either publicly available or shared by the methodology provider with the authors. The six methodologies can differ greatly across the different dimensions analysed in Chapter 3. Some methodologies assess alignment in the short- and medium-term, or both. Results are separated.

Figure 4.1 shows that every individual company in the sample is assessed as not aligned by 2050 by at least one provider. However, the comparison also shows that not a single company in the selection has the same climate-alignment assessment. The correlation among assessments for the same companies is low. Indeed, companies assessed as aligned with a 1.5 degrees scenario by one provider, can be assessed

[16] CA100 has selected 166 focus companies for increased engagement by its members. These companies were identified as key to driving the net-zero emissions transition and contribute directly or indirectly to up to 80% of corporate industrial GHG emissions (CA100, n.d.[149]).

as not aligned by all others. Still, Provider B most frequently finds that a company is aligned. Figure 4.1 also illustrates that most providers run into issues on data availability. Moreover, these illustrations show a continued need for data availability and consistency. Even for listed corporate equity, where methodologies are available, the level of uncertainty is high.

Figure 4.1. Results of long-term alignment assessments for selected corporates

Sector	Region	Provider A	Provider B	Provider C	Provider E	Provider D
Airlines	Asia	Not aligned	Not aligned	Not available	2 Degrees	Not aligned
Airlines	Pacific	Not aligned	Not aligned	1.5 Degrees	Not aligned	Not aligned
Airlines	North-America	Not aligned	Not aligned	Not aligned	Not aligned	2 Degrees
Autos	Asia	1.5 Degrees	2 Degrees	Not aligned	Not aligned	Not aligned
Autos	Europe	1.5 Degrees	2 Degrees	Not aligned	Not aligned	Not aligned
Autos	North-America	1.5 Degrees	2 Degrees	Not aligned	Not aligned	Not aligned
Shipping	Europe	Not aligned	1.5 Degrees	Not aligned	Not aligned	Not aligned
Shipping	Asia	Not aligned	Not available	Not available	Not aligned	Not aligned
Shipping	Asia	Not aligned	1.5 Degrees	Not available	Not aligned	Not available
Steel	Latin-America	Not aligned	2 Degrees	Not available	2 Degrees	Not available
Steel	Asia	Not aligned	Not aligned	Not available	2 Degrees	Not aligned
Steel	Europe	Not aligned	2 Degrees	Not aligned	Not aligned	Not aligned
Chemicals	Africa	Not aligned	Not available	Not available	Not available	Not aligned
Chemicals	Asia	Not aligned	Not available	Not aligned	Not aligned	Not aligned
Chemicals	Europe	Not aligned	Not available	Not aligned	Not aligned	Not aligned
Cement	Latin-America	Not aligned	2 Degrees	Not available	Not available	2 Degrees
Cement	Europe	2 Degrees	2 Degrees	Not available	Not aligned	Not aligned
Cement	Africa	Not aligned	Not aligned	Not available	Not aligned	Not aligned
Aluminium	Middle-East	Not available	Not aligned	Not available	Not available	Not aligned
Aluminium	Europe	Not aligned	2 Degrees	Not available	Not aligned	Not aligned
Aluminium	North-America	Not aligned	Not aligned	Not available	Not aligned	Not available
Power Utilities	Asia	2 Degrees	Not aligned	2 Degrees	Not available	Not aligned
Power Utilities	North-America	Not aligned	1.5 Degrees	Not aligned	Not available	2 Degrees
Power Utilities	Pacific	2 Degrees	Not aligned	Not aligned	Not available	Not aligned

Note: Results are latest available assessments for alignment in 2050. ITR results are assigned to the relevant category as this illustration aims to show the level of alignment and exact temperature results come with a higher level of uncertainty. 'Not aligned' means not aligned with a 2 degrees or below scenario as assessed by the methodology provider. 'Not available' means either not enough data to apply the methodology or no methodology available for that sector by the provider.
Source: Authors' calculations based on data from five selected providers.

Assessment results for the selected companies for the medium term hint at similar conclusions as for the long-term assessments (Figure 4.2). Nearly all corporates are assessed as not aligned by at least one provider. While there are relatively more corporates assessed as aligned by 2030-2035 than by 2050, fewer methodologies assess medium-term alignment and alignment is generally weak.

Better understanding of the robustness and integrity of these results is important because alignment assessments are increasingly being used both for reporting purposes as well as to contribute to informing investment decisions. Based on such mis-alignment results investors may consider the possibility of divesting, now or at a given point of time in the future from certain assets and change their asset allocation (Schwegler et al., 2022[12]; Church of England's National Investing Bodies, 2022[120]; Responsible Investor, 2021[121]; Reuters, 2020[122]).

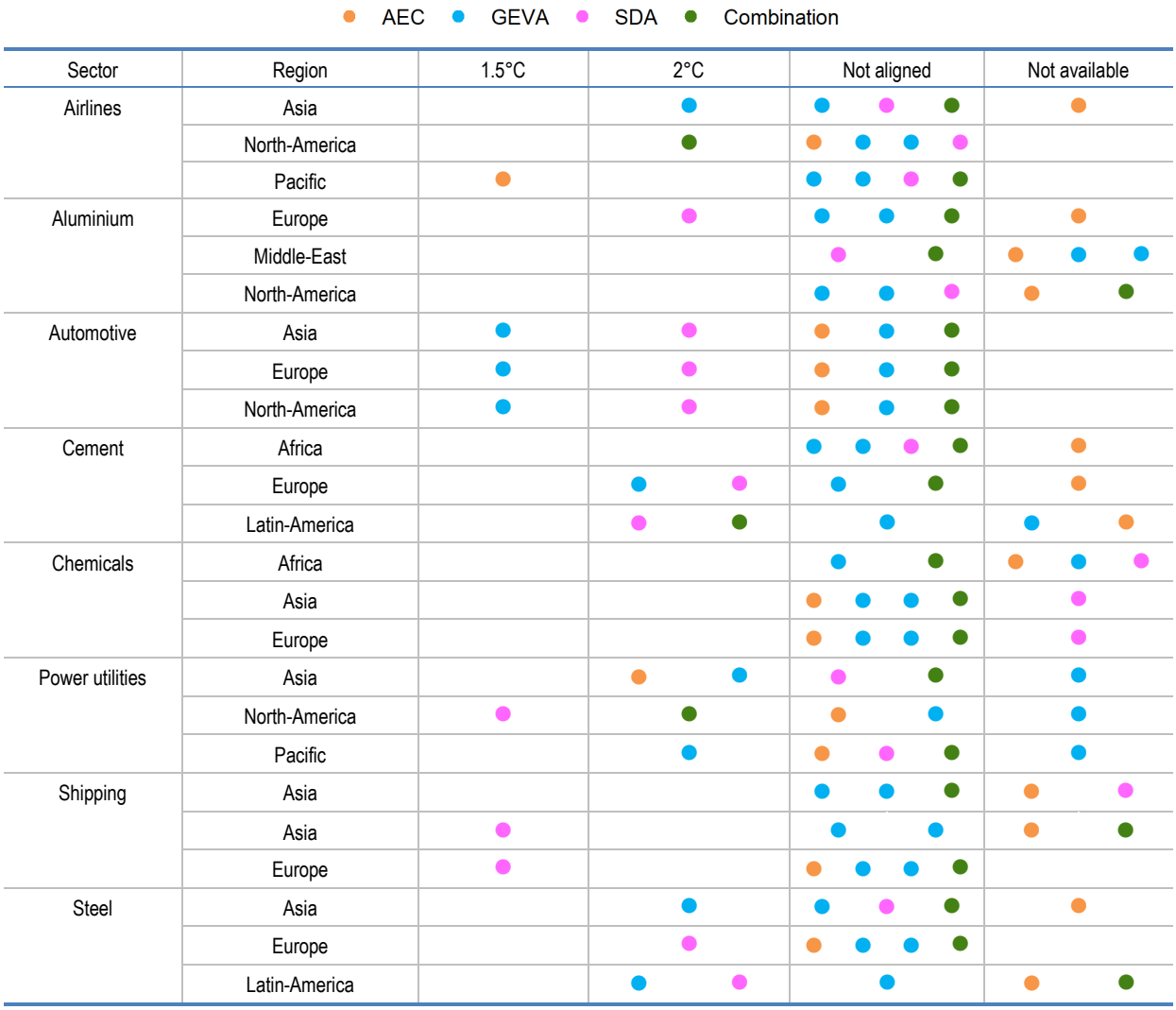
Figure 4.2. Results of medium-term alignment assessments for selected corporates

Sector	Region	Provider A	Provider E	Provider F
Airlines	Asia	1.5 Degrees	2 Degrees	Not aligned
Airlines	Pacific	Not aligned	Not aligned	2 Degrees
Airlines	North-America	1.5 Degrees	2 Degrees	1.5 Degrees
Autos	Asia	1.5 Degrees	Not aligned	1.5 Degrees
Autos	Europe	1.5 Degrees	2 Degrees	Not aligned
Autos	North-America	1.5 Degrees	Not aligned	Not aligned
Shipping	Europe	1.5 Degrees	Not aligned	Not aligned
Shipping	Asia	1.5 Degrees	Not aligned	2 Degrees
Shipping	Asia	Not aligned	2 Degrees	Not aligned
Steel	Latin-America	Not aligned	2 Degrees	Not aligned
Steel	Asia	Not aligned	2 Degrees	Not aligned
Steel	Europe	Not aligned	Not aligned	Not aligned
Chemicals	Africa	Not aligned	Not available	Not aligned
Chemicals	Asia	Not aligned	Not aligned	Not aligned
Chemicals	Europe	Not aligned	2 Degrees	Not aligned
Cement	Latin-America	Not aligned	Not available	2 Degrees
Cement	Europe	2 Degrees	Not aligned	Not aligned
Cement	Africa	Not aligned	Not aligned	1.5 Degrees
Aluminium	Middle-East	Not available	Not available	Not available
Aluminium	Europe	Not aligned	2 Degrees	Not aligned
Aluminium	North-America	Not aligned	Not aligned	2 Degrees
Power Utilities	Asia	1.5 Degrees	Not available	Not aligned
Power Utilities	North-America	Not aligned	Not available	Not aligned
Power Utilities	Pacific	2 Degrees	Not available	Not aligned

Note: Results are latest available assessments for alignment in 2030 or 3025. ITR results are assigned to the relevant category as this illustration aims to show the level of alignment and exact temperature results come with a higher level of uncertainty. 'Not aligned' means not aligned with a 2 degrees or below scenario as assessed by the methodology provider. 'Not available' means either not enough data to apply the methodology or no methodology available for that sector by the provider.
Source: Authors' calculations based on data from three selected providers.

While most climate-alignment assessment providers use similar corporate data and information sources, individual providers choose different GHG performance metrics based on their respective advantages and disadvantages, as discussed in Section 3.2. Such choice, in turn, contributes to explain variations in results observed in Figure 4.1 and Figure 4.2. Based on the company sample, alignment appears to be less frequent for methodologies using an AEC-type metric, while none-disclosure is less likely for methodologies using a GEVA metric (Figure 4.3).

Figure 4.3. Alignment assessment results for selected corporates by type of metric and temperature outcome



Note: Results are latest available assessments for alignment in 2050. Each dot represents the assessment of one methodology for the respective company. Not available means either not enough data to apply the methodology or no methodology available for that sector by the provider.
Source: Authors' analysis based on data from five selected providers of alignment assessment methodologies for corporates.

Figure 4.4 further illustrates that the temporal perspective can influence the alignment result. Based on this sample, alignment is more common for methodologies that assess alignment for a single point-in-time, whereas it appears to be harder to be aligned when the methodology considers a cumulative assessment. Cumulative alignment is, however, vital to be consistent with the remaining carbon budget for any given temperature outcome.

Figure 4.4. Alignment assessment for selected corporates' temporal perspective

Note: Results are latest available assessments for alignment in 2050. Each dot represents the assessment of one methodology for the respective company. Not available means either not enough data to apply the methodology or no methodology available for that sector by the provider.
Source: Authors' analysis based on data from five selected providers of alignment assessment methodologies for corporates.

Methodological choices across other dimensions also contribute to differences in alignment results. For example, methodologies that do not allow offsets, find less companies are aligned within the sample data (Figure 4.5). Similar analysis can be done for the coverage of scopes of emissions or other dimensions. However, results were not always conclusive based on this sample.

Figure 4.5. Alignment assessment for selected corporates per consideration for offsets

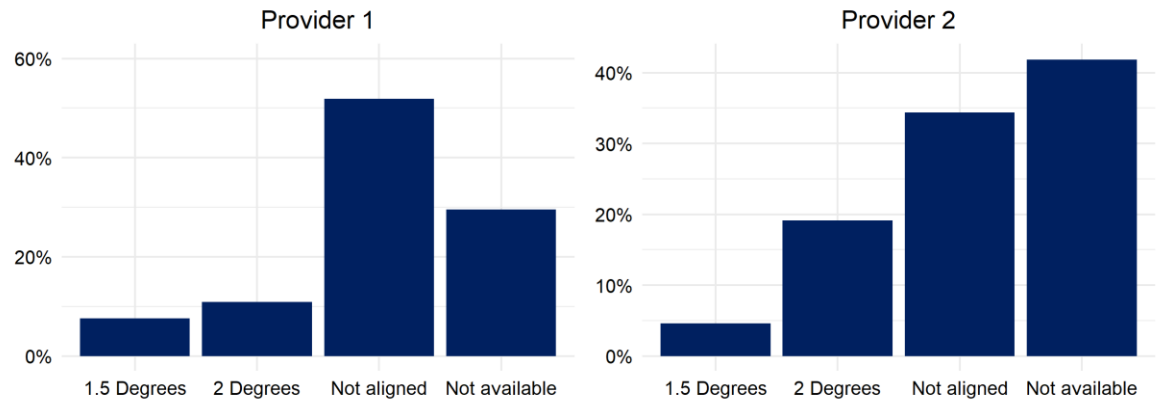
Sector	Region	1.5°C	2°C	Not aligned	No disclosure
Airlines	Asia				
	North-America				
	Pacific				
Aluminium	Europe				
	Middle-East				
	North-America				
Automotive	Asia				
	Europe				
	North-America				
Cement	Africa				
	Europe				
	Latin-America				
Chemicals	Africa				
	Asia				
	Europe				
Power utilities	Asia				
	North-America				
	Pacific				
Shipping	Asia				
	Asia				
	Europe				
Steel	Asia				
	Europe				
	Latin-America				

Note: Results are latest available assessments for alignment in 2050. Each dot represents the assessment of one methodology for the respective company. Not available means either not enough data to apply the methodology or no methodology available for that sector by the provider.
Source: Authors' analysis based on data from 5 selected providers of alignment assessment methodologies for corporates.

Two climate-alignment assessment providers accessibly share their full universe of alignment results for listed corporate equity. Using this data, this paper finds that most listed corporate equity is assessed as not aligned or no alignment assessment is available (Figure 4.6). This finding is for instance consistent with analysis conducted by MSCI itself for its 'All Country World Investable Market Index'[17] using its ITR metric and data, which found that listed companies are collectively on a pathway to keep warming well above 2°C (MSCI, 2022[123]). While alignment results for a given company may differ across providers, alignment assessments of listed corporate equity typically tend to find mis-alignment and unavailability of assessment.

[17] This index includes nearly 10,000 large-, mid- and small-cap traded listed companies across 23 developed and 27 emerging markets.

Figure 4.6. Examples of alignment results across providers' full universe of assessments



Note: Provider 1 and 2 have a different sample of corporates. Not available means either not enough data to apply the methodology to a given company or no methodology available for the sector of a given company by the provider.
Source: Authors' analysis based on data from two selected providers.

4.1.2. Parallels between corporate alignment assessment results and ESG scores

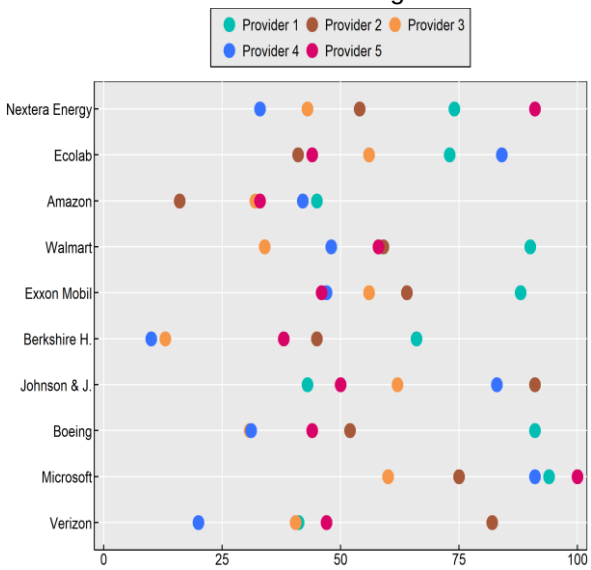
A parallel can be drawn between the variations in climate-alignment assessment scores between different methodology providers and a similar trend of climate scores within ESG assessments (Figure 4.7). Previous OECD research has highlighted a similar variation of climate mitigation-related elements within the E score. This variation may be even greater among companies and sectors that need to undergo particularly large transformations due to the net-zero emissions transition.

Figure 4.7. Climate mitigation alignment (left) and ESG ratings and issuer credit ratings (right)

Climate-alignment assessment

Sector	Company	Provider A	Provider B	Provider C	Provider D	Provider E
Power Utilities	NextEra Energy	Not aligned	Not aligned	Not aligned	Not aligned	Not aligned
Process Industries	Ecolab	1.5 Degrees	Not available	Not available	Not available	Not aligned
Retail Trade	Amazon	Not aligned	Not available	Not available	Not aligned	Not available
Retail Trade	Walmart	2 Degrees	Not available	2 Degrees	Not aligned	Not aligned
Energy Minerals	Exxon Mobil	Not aligned	Not aligned	Not aligned	Not aligned	Not aligned
Finance	Berkshire Hathaway	Not aligned	Not available	Not aligned	Not aligned	Not aligned
Health Technology	Johnson & Johnson	1.5 Degrees	Not available	Not available	Not aligned	Not aligned
Electronic Technology	Boeing	1.5 Degrees	Not available	Not available	Not aligned	Not aligned
Technology Services	Microsoft	2 Degrees	Not available	Not available	2 Degrees	Not aligned
Communications	Verizon	2 Degrees	Not available	Not available	Not aligned	2 Degrees

ESG rating



Note: Sample of public companies selected by largest market capitalisation as to represent different industries in the US. Alignment data is for 2022, and ESG and issuer credits ratings for 2019.
Source: Authors' analysis based on selected providers and (Boffo and Patalano, 2020[15]).

4.2. Illustration of results for sovereign bonds

Figure 4.8 shows some first illustrative results for sovereign bonds based on data shared by two providers, noting that the methodology for one of them was not assessed in Chapter 3, as the underlying information was not publicly available at the time of writing. The illustrative results cover a selection of ten countries across continents and from different income groups. The two providers provide results for different timeframes, respectively for 2030 and 2050. Besides observing that more than half of the countries are assessed as not aligned by one or both providers, deriving further conclusions would require a deeper analysis across a broader dataset and larger number of methodology providers.

Figure 4.8. Illustrations of climate-alignment results for selected sovereign bonds

Region	Income group	2030 | Provider 1	2050 | Provider 2
Africa	Upper-middle	Not aligned	Not aligned
Africa	Low	1.5 Degrees	2 Degrees
Americas	High	Not aligned	Not aligned
Americas	Upper-middle	2 Degrees	Not aligned
Asia	High	Not aligned	Not aligned
Asia	Lower-middle	2 Degrees	2 Degrees
Europe	High	2 Degrees	Not aligned
Europe	Upper-middle	Not aligned	Not aligned
Oceania	Upper-middle	Not available	2 Degrees
Oceania	High	Not aligned	Not aligned

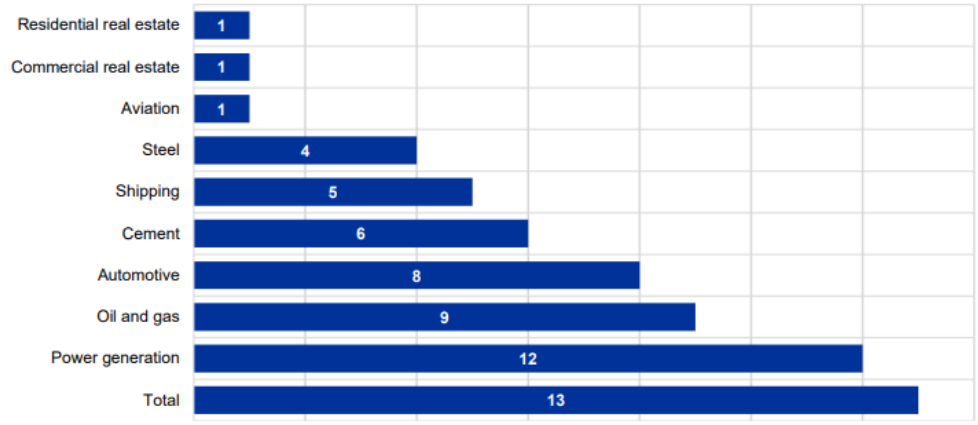
Note: 'Not aligned' means not aligned with a 2 degrees or below scenario as assessed by the methodology provider. 'Not available' means that the country was assessed by the methodology as having a non-quantifiable target. Countries and methodology providers are anonymised.
Source: Authors' calculations based on data from selected providers and income group classifications from the World Bank.

4.3. Portfolio applications by investors, banks and other financial institutions

An increasing number of financial institutions (notably commercial banks, asset owners and asset managers) are putting forward different types of GHG reduction and net-zero commitments and targets, with a vast majority from Western Europe and North America (Climate Policy Initiative, 2022[124]). However, in a recent survey, the European Central Bank (ECB) found that among commercial banks, within the Eurozone, that had put forward a commitment towards the PA, less than half have provided qualitative and quantitative information. Relating to portfolio alignment more specifically, only 13 out of 112 banks in their survey sample (covering Eurozone countries) had conducted such an assessment (ECB, 2022[125]).

Among those 13, the majority did so for corporate-related assets, notably in sectors relating to energy and industry, while only 2 did so for real estate (Figure 4.9). In terms of financial asset classes and instruments, the ECB survey finds that the following tend to be covered by financed emissions reporting: listed equity and corporate bonds (6% of all banks in the sample), business loans (4% of all banks in the sample), project finance (1% of all banks in the sample), commercial real estate (3% of all banks in the sample), mortgages (6% of all banks in the sample), and motor vehicle loans (2% of all banks in the sample).

Figure 4.9. Number of banks in the Eurozone having conducted a portfolio alignment assessment (by sector)



Note: The total European Central Bank sample survey included 112 institutions directly supervised by the ECB, within which, as per the above, only 12% (13 institutions) had conducted a portfolio alignment assessment as of 2021.
Source: (ECB, 2022[125]).

The ECB survey results for commercial banks within the Eurozone are coherent with the findings of this paper on available methodologies for financial sector and market alignment assessment, as detailed in Chapter 3. As methodological developments are still limited for certain asset classes and for aggregating asset-level assessments to the portfolio level, financial institutions may struggle assessing their portfolios.

Nevertheless, financial institutions have started using the above-mentioned methodologies. Non-exhaustive examples include:

- AXA, one of the largest insurance companies globally, which also has an asset management branch, used MSCI Carbon Delta and FTSE-Beyond Ratings methodologies to assess the warming potential of its corporate (both equity and debt) and sovereign debt holdings respectively (AXA Group, 2021[126]; AXA Group, 2022[127]). AXA chose not to aggregate those two together, as it would require additional assumptions, consistent with the findings outlined in Section 3.4 of the present paper. In 2021, the MSCI warming potential[18] assessment was of 3.3°C for corporate equity and 3.7°C for corporate debt, though with significant variations by sector (energy-related asset holdings characterised by the highest warming potential with nearly 5°C for equity and over 6°C for debt). Using FTSE-Beyond Ratings methodology, the warming potential of AXA's Sovereign Debt in 2021 reached 2°C (Figure 4.10). AXA's warming potential for sovereign bonds is relatively low because of its large AUM in France, which has a low warming potential based on FTSE-Beyond Ratings' assessment.

[18] The MSCI warming potential metric is now also referred to as the MSCI ITR metric.

Figure 4.10. Example of ITR ratings for AXA's sovereign bonds portfolio based on FTSE-Beyond Ratings

	AXA Sovereign Debt			Benchmark	
2021	AUM %	Temperature (°C)	Cov. Temp %	Weight	Temperature (°C)
Australia	0.6%	4.09	100.00%	1.8%	4.09
Belgium	7.4%	2.08	100.00%	1.5%	2.08
Canada	0.5%	3.05	100.00%	2.1%	3.05
Denmark	0.0%	1.89	100.00%	0.3%	1.89
France	24.4%	1.62	100.00%	6.6%	1.62
Germany	6.8%	1.86	100.00%	4.5%	1.86
Italy	7.8%	1.76	100.00%	6.0%	1.76
Japan	13.6%	2.25	100.00%	18.4%	2.25
Netherlands	2.5%	2.10	100.00%	1.3%	2.10
Other countries	16.5%	2.05	93.57%		
SNAT	6.7%	1.88	99.96%		
Spain	6.1%	1.79	100.00%	3.9%	1.79
Sweden	0.0%	0.81	100.00%	0.2%	0.81
United Kingdom	1.0%	1.73	100.00%	7.2%	1.73
United States	6.1%	2.89	100.00%	46.3%	2.89
Total	100.0%	1.98	98.93%	100.0%	2.44

Note: Implied temperature rise (ITR) ratings measure the most likely global warming outcome if the global economy was to exhibit same level of ambition as a given sovereign bond. For example, if every country emits like France, then the ITR is 1.62°C according to this methodology and assessment. SNAT refers to sub-nationals.
Source: (AXA Group, 2021[126]).

- The asset manager Amundi used the CDP-WWF Temperature Ratings data to assess the climate alignment of four of its global and multisector equity funds (Amundi, 2020[128]). Figure 4.11 shows the implied temperature rise for the four selected equity funds by Amundi. Results indicate that all funds were assessed with an ITR above 2°C. The results also display a relatively low sensitivity of results to the inclusion or not of corporate scope 3 emissions.

Figure 4.11. Example of using ITR ratings for four Amundi equity funds based on CDP-WWF methodology

Fund name	CDP temperature rating	
	Scope 1+2	Scope 1+2+3
Amundi Funds Global Equity Sustainable Income	2.2 °C	2.7 °C
CPR Invest - Climate Action	2.3 °C	2.7 °C
CPR Invest - Food For Generations	2.6 °C	2.6 °C
Amundi Global Ecology ESG	2.6 °C	2.6 °C

Note: Implied temperature rise (ITR) ratings measure the most likely global warming outcome if the global economy was to exhibit same level of ambition as a given equity fund.
Source: (Amundi, 2020[128]).

At the more aggregate level of national financial centres, a number of countries have tested the use of the PACTA methodology:

- Switzerland was the first to do so and has since 2017 conducted biennial assessments. PACTA Climate Tests assess alignment for global corporate equity and bonds portfolios held by Swiss

financial institutions and for Swiss real estate (mortgages) portfolios held by 30 Swiss banks (PACTA, 2022[129]; 2DII, 2020[50]). Results were not aggregated across asset classes. The Norwegian government and the Financial Supervisory Authority of Norway have worked together with 2DII to use PACTA to assess the alignment of the Norwegian financial sector with the PA (2DII, 2022[130]). In particular, the study covers portfolios from 41 Norwegian financial institutions covering 70% to 90% of total assets under management by asset managers, insurance companies, and pension funds in Norway. Overall, Norwegian financial institutions are less exposed to climate-relevant PACTA sectors[19] than financial institutions in countries like Switzerland.

- Sweden has used the PACTA methodology for banks to assess its loan books. Only 2.7% of the banks' total lending to non-financial companies is in PACTA sectors. It notes that particularly real estate assets should be included to make the analysis more relevant at the portfolio level. (Finansinspektionen & Sveriges Riksbank, 2022[131]) Additionally, an alignment assessment of Swedish insurance undertakings has been performed (Finansinspektionen, 2021[132]).
- South American countries tested the climate alignment of a part of their financial sector and the individual participating institutions under the PACTA Coordinated Projects program. In Peru, the climate alignment of equity and bonds in the PACTA sectors were assessed for the five Pension Funds (2DII and the Peruvian Responsible Investment Program, 2022[133]). In Colombia, the climate alignment of the investment portfolios of 20 insurance companies were analysed (2DII, 2022[134]). Results highlight that their listed equity and corporate bonds holdings in high-carbon technologies are not on track to be aligned with the PA temperature goal, while increased capital expenditure for renewable power capacity is also needed (Figure 4.12). Additionally, the Financial Superintendency of Colombia worked together with 2DII to use PACTA to assess the alignment of the private pension funds with the PA. This assessment covered 8.1% of total assets under management.

Figure 4.12. Alignment results of investment portfolios of insurance companies in Colombia based on PACTA

	Power				
	Coal capacity	Gas capacity	Oil capacity	Renewable capacity	Hydropower capacity
Listed Equity (USD 3.4 m)	2.7°C – 3.2°C	> 3.2°C	> 3.2°C	> 3.2°C	<2°C
Corporate Bonds (USD 400.7 m)	2.7°C – 3.2°C	2.7°C – 3.2°C	> 3.2°C	2.7°C – 3.2°C	<2°C

Source: (2DII, 2022[134])

- A pilot study with a group of Malaysian banks shows that 8 out the 10 climate critical technologies assessed are not aligned with the goals of the PA (2DII and WWF Malaysia, 2022[135]). The study recommends to match loan book exposures to the real economy at the direct loan taker level and to use a portfolio weighted approach for results at the portfolio level.

While all the above examples of assessments find that none or only few of the institutions, investors or funds are currently aligned with the PA, they can help identify opportunities to take action. Investors may encourage more ambitious targets, plans and actions e.g. through engagement with investees, notably for

[19] PACTA sectors include seven of the most carbon-intensive sectors in the economy, namely oil and gas, coal, power, automotive, cement, aviation, and steel.

corporate-related assets, or different allocation approaches[20]. However these assessment results come with a range of underlying assumptions and uncertainties, which are often not or only partly communicated and not necessarily understood by users.

Further, gaps in asset coverage by methodologies and data availability within asset classes need to be overcome in order for portfolio level assessments to become more comprehensive and reflective of the full range of underlying real economy actors and assets. Although this chapter has shown illustrative results for asset classes other than corporate equity, it remains a developing field.

Finally, as already mentioned in Chapter 3, there is potential for different methodologies and respective metrics to complement each other, and hence create a dashboard of indicators, which can include both GHG-based and capacity-based metrics. However, further research is needed to design a template of different indicators, including multiple GHG-based indicators that would complement each other well providing a full picture of real-economy action. The Swiss Climate Scores are a first effort towards this (See Box 4.1).

Box 4.1. Swiss Climate Scores

Additional to the PACTA Climate Tests, Switzerland is proposing the *Swiss Climate Scores*, which is a set of indicators to assess progress of its financial market to transitioning to net-zero greenhouse gas emissions by 2050 (FOEN, 2022[136]). Six indicators will show how climate-friendly the companies held in Swiss financial portfolios operate today and what they plan to do in the future. The set of indicators include:

- GHG emissions
- Exposure to fossil fuel activities
- Verified commitments to net-zero
- Management to net-zero
- Credible climate stewardship
- Global warming potential or ITR, i.e. alignment assessment result

The Swiss Climate Scores are a voluntary instrument that was developed in close cooperation with the financial sector and NGOs. They build on existing work by GFANZ and the TCFD. Currently, the ITR indicator is optional and no specific methodology is advised.

[20] For example, asset allocation in a portfolio can picked by minimising the tracking error compared to a benchmark portfolio, conditional on satisfying a carbon budget which is consistent with 1.5°C temperature increase (Bolton, Kacperczyk and Samama, 2022[148]).

5. Conclusions and implications

This final chapter presents conclusions drawn based on the analysis of existing methodologies used by investors and financial institutions to assess the alignment of their financial assets and portfolios with the PA temperature goal. The focus of these conclusions is on lessons learnt and possible action points to improve the comprehensiveness and policy relevance of such financial sector alignment assessments. Based on this, areas for future research are also identified.

5.1. Climate-alignment assessment of finance: emerging concepts and initiatives

The formulation of Article 2.1c of the PA contributed to the development of the concept “climate alignment” of investments and financing by financial institutions. At an aggregate level, financial flows could be considered aligned or misaligned with the PA temperature goal if they contribute to economic systems that are consistent (or inconsistent) with such GHG pathways. However, there is no agreed or unique way of downscaling the PA’s global temperature goal to the level of individual financial assets and underlying economic sectors, actors, or countries which represents a challenge to assessing the climate-alignment of investments and financing. In any case, methodologies to assess progress towards climate alignment need to be robust, policy relevant and transparent, as they set incentives for investment decisions and influence the degree to which such decisions have an actual impact on GHG emissions or not.

Climate-alignment assessments of finance and climate-related financial risk assessments overlap but take different perspectives. The alignment assessment of finance considers the impact of the activities of economic actors on climate mitigation and resilience policy goals, so-called “environmental materiality”. Conversely, climate-related risks assessments in the financial sector consider the potential consequences that climate change and climate policies may have for their business, so-called financial materiality. This paper takes the former perspective.

Climate alignment of finance relates to both mitigation and resilience. However, efforts to define and assess finance aligned with adaptation and resilience goals remain at an early stage. Policymakers need to bring more clarity on climate resilience objectives to support more advanced developments of these efforts. This paper therefore focused on the alignment of finance with climate mitigation policy goals.

Classifying initiatives supporting the alignment of finance with the PA as coalitions, frameworks or methodologies helps clarify their respective purpose and role. Such clarity is needed within what is a dynamic and growing yet partly confusing landscape of initiatives. However, initiatives may perform multiple roles and evolve over time. Some coalitions, frameworks and methodologies have developed in close co-operation. Moreover, current initiatives mostly originate from developed countries, which can hinder their applicability and legitimacy in emerging economies and developing country contexts.

Initiatives promoting climate alignment in finance can build on and be informed by existing international frameworks and standards for business. The OECD’s Responsible Business Conduct (RBC) Due Diligence Guidance, backed by 48 countries, provides a pertinent framework addressing the impacts of financial and non-financial businesses in relation to public policy objectives, including climate policy goals. The six steps

of the RBC due diligence process[21] can be particularly relevant in the context of assessing the contribution of the financial sector to GHG emissions and emissions reductions both from corporate operations and across the supply chain. Climate-alignment assessment methodologies mainly address the *tracking and assessment of progress* step.

5.2. Climate-alignment assessment methodologies for the financial sector: common practices and areas for further development

This study develops an analytical approach to analyse climate-alignment assessment methodologies for the financial sector. The dimensions are: (1) the asset class coverage, (2) the GHG performance metrics (including targets), (3) the climate change mitigation scenario(s) used to assess alignment, and (4) the approach to assess alignment at the financial portfolio level.

While portfolios of investors and financial institutions typically include a range of different asset classes, methodologies for asset classes other than corporate equity are underdeveloped. Although civil society institutions and commercial data providers are increasingly developing climate-alignment assessment methodologies for financial assets and portfolios, several large and policy relevant asset classes are not or only partially covered by existing methodologies. These include private equity, corporate bonds and loans, and real estate. This is also the case for sovereign bonds, although individual investors typically have lower ability to directly engage with and influence investees (countries) than in the case of aforelisted asset classes. Such partial coverage results in an incomplete assessment of financial portfolios and underlying real-economy assets responsible for significant portions of GHG emissions. Bonds and loans have for instance been identified as critical sources of finance for the transition of high-emission and hard-to-abate sectors.

Such gaps in coverage could undermine the environmental integrity of climate-alignment assessment methodologies and associated results. For example, financing of emissions-intensive assets can move from listed to private equity. This would improve the climate-alignment of listed equity portfolios, which are more commonly monitored. However, alignment across asset classes would not be improved and emissions in the real economy could remain at the same level. Currently, this would not be picked up due to a lack of coverage for private equity. A more comprehensive coverage of asset classes is needed, taking into account limited information availability and capacity for certain types of actors such as small and medium-sized enterprises.

Different perspectives on corporate climate alignment translates into methodology providers choosing different metrics. Different metrics have different (dis)advantages which may highlight different aspects of corporate climate performance. Three main methods currently exist: Absolute Emissions Contraction (AEC), Sectoral Decarbonisation Approach (SDA) and Economic Intensity Contraction (EIC). These three metrics are all commonly used by methodology providers but lead to a range of results that are difficult to reconcile. The advantage of the AEC approach, the only approach build on absolute emissions, is that it more clearly relates to the remaining carbon budget. Additionally, improvements in climate-mitigation performance depend solely on reductions in emissions. The EIC approach controls for entity size and business growth[22], is easier to understand for an investor audience and is relevant to

[21] (1) embed RBC into the businesses' policies and management systems; (2) identify and assess actual or potential adverse impacts of a business' own activities as well as those in its supply chains and business relationships; (3) cease, prevent or mitigate such actual or potential adverse impacts, (4) track implementation and results, (5) communicate how impacts are addressed; (6) enable remediation of adverse impacts when appropriate.

[22] Corporate climate performance measured through approaches based on absolute emissions such as AEC can advance when companies reduce their outputs or generally decrease in size through for example selling a part of their

analyse non-homogenous sectors. The SDA, which further controls for price changes may work particularly well for industrial sectors that need to undergo large transformations in the net-zero transition. However, the AEC and SDA, both intensity-based approaches, are vulnerable to changes in e.g. business output. Using absolute approaches on the other hand makes the comparison across entities of different sizes challenging.

A range of metrics can be used for non-corporate related asset classes, thereby also reflecting different perspectives on the climate-mitigation performance of other economic actors (such as governments) and real economy assets (such as real estate and infrastructure). Coherent with the lack of methodologies for other asset classes, few metrics are available for financial asset classes that cover these. Still, several methodology providers indicated being in the process of developing metrics for non-corporate related asset classes.

The choice of scenario, and the range of assumptions and characteristics that come with it, play an important role in the alignment assessment results. Currently, the methodology providers are using scenarios from a limited number of sources, namely from the IEA, NGFS, JRC and ISF. However, scenarios for the same temperature outcome but from a different source differ in their speed of decarbonisation and in the contribution of different sectors. As scenario pathways differ across sources, so do the resulting alignment of decarbonisation pathways of financial assets. Additionally, these scenarios come with a likelihood of reaching a certain temperature outcome. Such likelihood is not currently communicated together with the alignment assessments. This information would help relay the inherent uncertainties that characterise scenarios for reaching a certain temperature objective.

Climate scenarios available to and used by climate-alignment assessment methodologies typically come with little geographical granularity. Some methodology providers have developed their own approaches to downscale global GHG emission scenarios or develop national scenarios. For sovereign bonds (issued by countries), as well as for real estate (where buildings sector characteristics differ significantly across countries), methodology providers have developed national scenarios. For corporate-related assets, many methodologies follow a convergence approach to downscale aggregate-level scenarios to individual corporate entities.

The lack of agreed methods to downscale is a significant source of uncertainty and variation in different assessments of what is climate-aligned or not. Climate change mitigation scenarios are a crucial input from the climate policy and science community. Currently, most climate change mitigation scenarios do not match the specificity needed for the climate-alignment assessments of financial assets. The development of more relevant scenarios and reference points for the use in the corporate and financial sector could include more sector- and geographically-specific scenarios.

While several global climate-mitigation scenarios used by providers include some sectoral specificity, matching input data and metrics to sectoral scenarios is challenging. Scenarios are typically produced by the climate policy and science community, while finance-related climate-performance metrics are developed by the financial sector community. Sectoral and sub-sector classifications and specificity used by each community differ. Matching data on economic sectors with sectoral GHG emissions data is for instance not straightforward. The climate policy community may therefore enhance activities in developing finance-relevant scenarios to reduce disconnects between scenarios and metrics and allow the development of improved methodologies.

Policy makers need to provide or encourage clear guidance on emission reduction target setting accounting rules, including on offsets. The results of a climate-alignment assessment can be influenced

business. Approaches based emission intensity, such as EIC and SDA, control for this because they have a denominator that correlates with firm size, and business growth in physical or economic terms.

by both the coverage of GHG emissions as well as by the treatment of offsets[23]. The IPCC recommends economic actors to disclose all scopes and types of emissions. This is most often the intention of methodology providers, who are, however constrained by data availability and reliability. Methodologies that explicitly aim to exclude the use of offsets tend to find less alignment in corporate-related financial assets, as shown through new illustrative analysis in this paper. However, there remains much opacity about the use and inclusion of offsets. This is likely due to a lack of clarity and transparency of the use of offsets in metrics, targets and plans of economic actors themselves.

The temporal coverage of a GHG performance metric is also a strong driver of variations in alignment results, in turn affecting their policy relevance and environmental integrity. Different methodologies consider a short-, medium- or long-term time period, or a combination of those. The end year of the time period over which an investor considers an asset becomes even more important depending on whether the metric is only compared with an emissions scenario at a certain point in time or across a time period. Results from new illustrative analysis in this paper show that alignment is more frequently achieved for methodologies that assess alignment only at a certain and distant point in time in the future, e.g. 2050. Such assessments do not incentivise early action and may allow for carbon lock-in in the meantime, thereby underestimating climate impacts as cumulative emissions are what drives temperature outcomes.

Approaches for aggregating alignment results within each asset class need to be further developed in order to assess progress made by financial institutions and asset owners and managers. Several climate-alignment methodologies follow the Implied Temperature Rise metric at the portfolio level. However, this metric comes with a high degree of uncertainty. Moreover, the aggregation approaches underlying this metric for a given asset class are under development, with many potential options resulting in diverging results. Furthermore, when assets are assessed across overlapping value chains, aggregating results may cause double counting of emissions due to the inclusion of so-called Scope 3 emissions. Many methodologies do not yet have a portfolio metric, even for listed equity portfolios where asset-level assessment methodologies and results are most common.

Aggregate-level assessments of financial portfolios add another significant layer of complexity to climate-alignment assessments and can mask individual activities that may be misaligned. Available illustrations of portfolio-level alignment results show that existing assessments are not aggregated across asset classes, i.e. within a given portfolio, separate assessments are conducted for different asset classes based on different underlying methodologies. Calculating a portfolio-level alignment metric across multiple asset classes would require further methodological assumptions and complexity to those raised for aggregation within a given asset class. Hence, portfolio-level alignment assessment across asset classes may not necessarily produce robust and reliable results, which in turn could question their relevance for informing progress towards climate mitigation policy goals.

5.3. Implications and further work on measuring progress towards Article 2.1c

This paper includes new analysis and illustrations showing that alignment results differ significantly across methodology providers. These variations illustrate that climate-alignment assessments are complex and rely on a range of dimensions. They come with uncertainties and variations. Moreover, there are multiple choices of metrics that can be used, which lead to different results. Different choices and results can be useful if they can complement each other and their complementarity is clearly communicated. Additionally, although different methodologies may find different alignment results for a given company, the paper finds

[23] When companies rely and account for offsets in their historical emissions and targets, they can improve their corporate climate mitigation performance. Therefore, if and how offsets are included influences the alignment analysis. Analogous logic applies to other economic actors such as governments.

that most corporate equity assets are not aligned. For those corporate asset with a climate-aligned target, further work can be done on relating past performance on reducing GHG emissions and reaching past short-term GHG performance targets.

Rather than being the unique indicator of progress, GHG-based alignment assessment results can be one element of a dashboard of finance-related indicators. The inclusion of complementary indicators of relevance to climate change mitigation (e.g. presence and characteristics of concrete plans to upscale climate solutions) can provide a more nuanced and holistic perspective. However, further research is needed to design a template of different indicators, including both GHG-based indicators and other indicators that would complement each other well providing a full picture of real-economy action. Furthermore, such holistic view can be extended through complementary work on assessing the alignment of finance from a resilience perspective. This could involve pilot studies across mitigation and resilience objectives, linking both, and possibly also connecting climate alignment with similar assessments for other environmental policy goals. In this context, the OECD-led Research Collaborative on Tracking Finance for Climate Action will pursue further work on indicator and dashboard development in collaboration with relevant OECD bodies and initiatives, considering both sectoral and country-level aggregation.

Research gaps on methodologies to assess climate alignment of asset classes other than corporate equity are challenging the environmental integrity and policy relevance of current assessments. The underrepresentation of several large asset classes, representing large proportions of GHGs and assets under management, challenge the environmental integrity of current climate-alignment assessments. Further analysis on private equity, corporate loans and sovereign bonds for example could be explored in follow up work. While the degree of influence investors can have on the investee depends on the asset class, a complete coverage of financial asset classes in climate-alignment assessment methodologies is desirable for two main reasons. Firs, providing a comprehensive picture of the financial sector's holdings and investments is increasingly relevant as financial institutions and governments are starting to use such methodologies to disclose progress. Second, such methodologies set incentives for investment strategies and decisions. For example, passive and active investors may consider the possibility of rebalancing their portfolio towards relatively more climate-aligned assets.

Alignment assessments lack geographical specificity and diversity. Many of the current methodologies are developed by and for initiatives in developed countries. Literature on the relevance and applicability of such methodologies in developing countries' contexts is limited. Work is needed to reconcile climate-alignment frameworks and assessment methodologies with both ongoing initiatives relating to transition finance in relatively less developed countries and for high-emitting or hard-to-abate sectors, as well as with principles-based approaches and taxonomies developed by individual jurisdictions.

The assumptions and uncertainties of scenarios are important and thus need to be better understood and communicated. The choice of a climate mitigation scenario heavily influences the alignment result. Initial observations from this paper can be deepened by further characterising mitigation scenarios that inform alignment assessment methodologies, as well as translating climate scenarios to better match the scope and granularity of financial and economic data from the financial system to address challenges of diverging scopes and granularity.

Assessments of the climate-alignment of finance generally depend on the availability and reliability of a large amount and range microdata. Methodology providers already mix reported and modelled data. Further work can be done to explore the use of robust proxies to address data gaps for tracking the alignment of finance both with climate mitigation and resilience policy goals. In doing so, data- and human resources-related synergies between work on climate-related alignment and risk assessments of finance could be found. A lack of data availability and consistency, even for corporate-related assets where methodologies are available, continues to challenge climate-alignment assessments. Reporting standards and third-part data verification helps improves this.

While there is a continued need for improved assessment and tracking, this remains a means to an end. Further efforts should place a strong focus on measuring the concrete impact of finance in terms of GHG reductions and improved resilience in the real economy, including via financing the upscale of climate solutions. This, however, requires addressing data and methodological challenges to go from financial to real-economy assets. In order to better to assess the impact of current efforts, enabling conditions and policy to make finance consistent with the PA goals also need to be monitored and their effects better understood.

References

2DII (2022), *From Bogotá to Paris? Measuring the climate alignment of Colombian insurance companies' portfolios*, https://2degrees-investing.org/wp-content/uploads/2022/03/From-Bogota-to-Paris.pdf. [134]

2DII (2022), *Heading North? Assessing the Alignment of Norway's Financial Sector with the Paris Agreement*, https://2degrees-investing.org/wp-content/uploads/2022/01/Norway_metareport.pdf. [130]

2DII (2020), *Bridging the Gap: Measuring progress on the climate goal alignment & climate actions of Swiss financial institutions*, https://2degrees-investing.org/resource/bridging-the-gap/. [50]

2DII (n.d.), *Paris Agreement Capital Transition Assessment*, https://www.transitionmonitor.com/. [60]

2DII and the Peruvian Responsible Investment Program (2022), *Assessing Readiness for the Low-Carbon Transition*, https://2degrees-investing.org/wp-content/uploads/2022/02/Peru-Climate-Scenario-Analysis.pdf. [133]

2DII and WWF Malaysia (2022), *Climate Portfolio Alignment for Corporate Lending in Malaysia: A pilot study using the PACTA methodology and recommendations for Malaysian Banks*, https://2degrees-investing.org/wp-content/uploads/2022/02/Climate-Portfolio-Alignment-for-Corporate-Lending-in-Malaysia.pdf. [135]

Aguilar Jaber, A. et al. (2020), "Long-term low emissions development strategies: Cross-country experience", *OECD Environment Working Papers*, No. 160, OECD Publishing, Paris, https://doi.org/10.1787/1c1d8005-en. [115]

Allen, M. et al. (2022), "Indicate separate contributions of long-lived and short-lived greenhouse gases in emission targets", *npj Climate and Atmospheric Science*, Vol. 5/1, https://doi.org/10.1038/s41612-021-00226-2. [76]

Amundi (2020), *CDP pioneers new temperature rating of companies for investors*, https://int.media.amundi.com/news/cdp-pioneers-new-temperature-rating-of-companies-for-investors-3c1f-b6afb.html (accessed on 29 June 2022). [128]

Arabesque (n.d.), *Temperature™ Score Frequently Asked Questions*, https://www.arabesque.com/docs/sray/marketing/temperature/Temperature_Score_FAQ.pdf (accessed on 8 March 2022). [84]

AXA Group (2022), *2022 Climate and Biodiversity Report: Accelerating Transition*, https://www-axa-com.cdn.axa-contento-118412.eu/www-axa-com/109c504e-bc3f-4e3a-bca0-5c3e1ccb65bb_AXA2022_Climate_and_Biodiversity-Report_Final_22_07_19.pdf. [127]

AXA Group (2021), *2021 Climate Report: the decisive decade*, https://www-axa-com.cdn.axa-contento-118412.eu/www-axa-com/db5d9f4b-4bb9-4029-ad51-b9e0e20301fb_2021_Climate_Report.pdf. [126]

BankTrack (2022), *Banking on climate chaos: fossil fuel finance report 2022*, https://www.banktrack.org/download/banking_on_climate_chaos_2022/2022_banking_on_climate_chaos.pdf. [5]

Bataille, C. et al. (2018), "A review of technology and policy deep decarbonization pathway options for making energy-intensive industry production consistent with the Paris Agreement", *Journal of Cleaner Production*, Vol. 187, pp. 960-973, https://doi.org/10.1016/j.jclepro.2018.03.107. [104]

Bertram, C. et al. (2021), *NGFS Climate Scenario Database: Technical Documentation V2.2*, http://pure.iiasa.ac.at/id/eprint/17511/1/ngfs_climate_scenarios_technical_documentation__phase2_june2021.pdf. [92]

Bingler, J. and C. Colesanti Senni (2022), "Taming the Green Swan: a criteria-based analysis to improve the understanding of climate-related financial risk assessment tools", *Climate Policy*, Vol. 22/3, pp. 356-370, https://doi.org/10.1080/14693062.2022.2032569. [43]

Bingler, J., C. Colesanti Senni and P. Monnin (2021), *Climate Transition Risk Metrics: Understanding Convergence and Divergence across Firms and Providers*, https://doi.org/10.3929/ethz-b-000505345. [42]

Black, R. et al. (2021), *Taking Stock: A global assessment of net zero targets*, Energy & Climate Intelligence Unit and Oxford Net Zero, https://ca1-eci.edcdn.com/reports/ECIU-Oxford_Taking_Stock.pdf. [87]

Boffo, R. and R. Patalano (2020), *ESG Investing: Practices, Progress and Challenges*, OECD Paris, https://www.oecd.org/finance/ESG-Investing-Practices-Progress-Challenges.pdf. [15]

Boissinot, J. et al. (2022), *Aligning financial and monetary policies with the concept of double materiality: rationales, proposals and challenges*, Grantham Research Institute on climate change and the environment, https://www.lse.ac.uk/granthaminstitute/publication/aligning-financial-and-monetary-policies-with-the-concept-of-double-materiality/ (accessed on 5 July 2022). [18]

Bolton, P., M. Kacperczyk and F. Samama (2022), "Net-Zero Carbon Portfolio Alignment", *Financial Analysts Journal*, Vol. 78/2, pp. 19-33, https://doi.org/10.1080/0015198X.2022.2033105. [148]

Byers, E. et al. (2022), *AR6 Scenarios Database hosted by IIASA*, International Institute for Applied Systems Analysis,, https://doi.org/10.5281/zenodo.5886912. [147]

CA100 (n.d.), *companies*, https://www.climateaction100.org/whos-involved/companies/. [149]

Calel, R. et al. (2021), *Do carbon offsets offset carbon? Centre for Climate Change Economics and Policy Working Paper 398/Grantham Research Institute on Climate Change and the Environment Working Paper 371. London: London School of Economics and Political Science*, https://www.lse.ac.uk/granthaminstitute/wp-content/uploads/2021/11/working-paper-371-Calel-et-al..pdf. [82]

Campiglio, E. and F. van der Ploeg (2021), *Macro-Financial Transition Risks in the Fight Against Global Warming, Working Paper 21-15*, https://media.rff.org/documents/Campiglio_van_der_Ploeg_-_Macrofinancial_transition_risks_-_EIEE_WP.pdf. [16]

Carbon Tracker (2022), *Absolute Impact: Why Oil and Gas Companies Need Credible Plans to Meet Climate Targets*, https://carbontracker.org/reports/absolute-impact-2022/. [6]

Carbone 4 (2020), *Assessing infrastructure portfolios'alignment with the Paris Agreement*, https://www.carbone4.com/wp-content/uploads/2020/09/Carbone4_2-infra_challenge_methodological_guide_july2020.pdf. [70]

CDP & WWF (2020), *Temperature Rating Methodology: A temperature rating method for targets, corporates, and portfolios*, https://cdn.cdp.net/cdp-production/comfy/cms/files/files/000/003/741/original/Temperature_scoring_-_beta_methodology.pdf. [62]

Ceres & SustainAbility Institute by ERM (2021), *The changing climate for private equity*, https://www.sustainability.com/globalassets/sustainability.com/thinking/pdfs/2021/ceres-sustainability-institute---the-changing-climate-for-private-equity.pdf. [59]

Cheng, G., E. Jondeau and B. Mojon (2022), *Building portfolios of sovereign securities with decreasing carbon footprints, BIS Working Papers, No 1038*, Bank for International Settlements. [48]

Church of England's National Investing Bodies (2022), *Church of England restricts investment in climate laggards*, https://www.churchofengland.org/media-and-news/press-releases/church-england-restricts-investment-climate-laggards. [120]

Climate Action Tracker (2022), *Methodology | Climate Action Tracker*, https://climateactiontracker.org/methodology/ (accessed on 6 May 2022). [68]

Climate Home News (2022), *Sweden set to be world's first country to target consumption-based emission cuts*, https://www.climatechangenews.com/2022/04/08/sweden-set-to-be-worlds-first-country-to-target-consumption-based-emission-cuts/ (accessed on 2 May 2022). [146]

Climate Policy Initiative (2022), *Private Financial Institutions' Paris Alignment Commitments: 2022 Update*, https://www.climatepolicyinitiative.org/publication/private-financial-institutions-paris-alignment-commitments-2022-update/ (accessed on 30 June 2022). [124]

CPI (2021), *Private Financial Institutions' Commitments to Paris Alignment*, Climate Policy Initiative, https://www.climatepolicyinitiative.org/wp-content/uploads/2021/10/CPI_Private-FI-Commitments-Tracking-1.pdf. [2]

CPI (2020), *A Proposed Method for Measuring Paris Alignment of New Investment*, https://www.climatepolicyinitiative.org/wp-content/uploads/2020/12/2.-A-Proposed-Method-for-Measuring-Paris-Alignment-of-New-Investment-3.pdf. [96]

CRREM (2020), *Carbon Risk Real Estate Monitor: Risk Assessment Reference Guide*, https://www.crrem.eu/wp-content/uploads/2020/09/CRREM-Risk-Assessment-Reference-Guide-2020-09-21.pdf. [69]

Després, J. et al. (2018), *POLES-JRC model documentation, EUR 29454 EN*, Publications Office of the European Union, Luxembourg, https://doi.org/10.2760/814959. [93]

Dietz, S. et al. (2021), *Carbon Performance assessment of electric utilities: note on methodology*, Transition Pathway Initiative, https://www.transitionpathwayinitiative.org/publications/94.pdf?type=Publication. [116]

Dobrinevski, A. and R. Jachnik (2020), "Exploring options to measure the climate consistency of real economy investments : The manufacturing industries of Norway", *OECD Environment Working Papers*, No. 159, OECD Publishing, Paris, https://dx.doi.org/10.1787/1012bd81-en. [139]

Dobrinevski, A. and R. Jachnik (2020), "Exploring options to measure the climate consistency of real economy investments: The transport sector in Latvia", *OECD Environment Working Papers*, No. 163, OECD Publishing, Paris, https://dx.doi.org/10.1787/48d53aac-en. [138]

Domínguez-Jiménez, M. and A. Lehmann (2021), *Accounting for climate policies in Europe's sovereign debt market, Policy Contribution 10/2021, Bruegel*, https://www.bruegel.org/wp-content/uploads/2021/05/PC-10-2021-030521_.pdf. [67]

ECB (2022), *Supervisory assessment of institutions' climate-related and environmental risks disclosures*, https://www.bankingsupervision.europa.eu/ecb/pub/pdf/ssm.ECB_Report_on_climate_and_environmental_disclosures_202203~4ae33f2a70.en.pdf. [125]

ECB (2020), *Financial Integration and Structure in the Euro Area*, https://www.ecb.europa.eu/pub/pdf/fie/ecb.fie202003~197074785e.en.pdf. [52]

Emin, G. et al. (2021), *How To Measure The Temperature Of Sovereign Assets*, FTSE Russell, https://content.ftserussell.com/sites/default/files/how_to_measure_the_temperature_of_sovereign_assets_final.pdf. [65]

EU Platform on Sustainable Finance (2021), *Public Consultation Report on Taxonomy extension options linked to environmental objectives*, https://ec.europa.eu/info/sites/default/files/business_economy_euro/banking_and_finance/documents/sustainable-finance-platform-report-taxonomy-extension-july2021_en.pdf. [22]

Falduto, C. and M. Rocha (2020), "Aligning short-term climate action with long-term climate goals: Opportunities and options for enhancing alignment between NDCs and long-term strategies", *OECD/IEA Climate Change Expert Group Papers*, No. 2020/02, OECD Publishing, Paris, https://dx.doi.org/10.1787/7c980fce-en. [75]

Fankhauser, S. et al. (2021), "The meaning of net zero and how to get it right", *Nature Climate Change*, Vol. 12/1, pp. 15-21, https://doi.org/10.1038/s41558-021-01245-w. [81]

Finansinspektionen (2021), *Sustainability Report 2021 – the climate in focus*, Finansinspektionen, https://www.fi.se/contentassets/53fc92b51bd144989d7a53c538eb2c25/hallbarhetsrapport-2021-klimatet-fokus-hela-eng.pdf. [132]

Finansinspektionen & Sveriges Riksbank (2022), *Transition risks in the banks' loan portfolios – an application of PACTA*, https://www.fi.se/contentassets/ca8c6ae951b4417cbeb6ee4f26022735/omstallningsrisker-bankers-laneportfoljer-pacta-eng.pdf. [131]

Flammer, C., M. Toffel and K. Viswanathan (2021), "Shareholder activism and firms' voluntary disclosure of climate change risks", *Strategic Management Journal*, Vol. 42/10, pp. 1850-1879, https://doi.org/10.1002/smj.3313. [47]

FOEN (2022), *Swiss Climate Scores*, https://www.sif.admin.ch/sif/en/home/swiss-climate-scores/brief-summary.html. [136]

GFANZ (2022), *2022 concept note on Portfolio Alignment Measurement*, Glasgow Financial Alliance for Net Zero, https://assets.bbhub.io/company/sites/63/2022/06/GFANZ_-2022-Concept-Note-on-Portfolio-Alignment-Measurement_June2022.pdf. [117]

GFANZ (2022), *Measuring portfolio alignment: Enhancement, convergence, and adoption*, https://assets.bbhub.io/company/sites/63/2022/07/GFANZ-Portfolio-Alignment-Measurement-August2022.pdf. [46]

GFANZ (2022), *Recommendations and Guidance on Financial Institution Net-zero Transition Plans*, https://assets.bbhub.io/company/sites/63/2022/06/GFANZ_Recommendations-and-Guidance-on-Net-zero-Transition-Plans-for-the-Financial-Sector_June2022.pdf. [30]

GFANZ (2021), *The Glasgow Financial Alliance for Net Zero: Our progress and plan towards a net zero global economy*, https://assets.bbhub.io/company/sites/63/2021/11/GFANZ-Progress-Report.pdf. [29]

Hainaut, H. and I. Cochran (2018), "The Landscape of domestic climate investment and finance flows: Methodological lessons from five years of application in France", *International Economics*, Vol. 155, pp. 69-83, https://doi.org/10.1016/J.INTECO.2018.06.002. [144]

Heeb, F., A. Kellers and J. Kölbel (2022), *Does ESG integration impact the real economy? A theory of change and review of current evidence*, Swiss Federal Office for the Environment (FOEN), https://www.csp.uzh.ch/en/research/Practitioner-Research/Does-ESG-integration-impact-the-real-economy.html. [20]

Hertwich, E. and R. Wood (2018), "The growing importance of scope 3 greenhouse gas emissions from industry", *Environmental Research Letters*, Vol. 13/10, p. 104013, https://iopscience.iop.org/article/10.1088/1748-9326/aae19a#erlaae19as3. [77]

Holz, C. et al. (2018), "Ratcheting ambition to limit warming to 1.5 °C–trade-offs between emission reductions and carbon dioxide removal", *Environmental Research Letters*, Vol. 13/6, p. 064028, https://doi.org/10.1088/1748-9326/aac0c1. [9]

Huppmann, D. et al. (2019), "IAMC 1.5°C Scenario Explorer and Data hosted by IIASA", *Integrated Assessment Modeling Consortium & International Institute for Applied Systems Analysis, 2019*, https://doi.org/10.5281/zenodo.3363345. [142]

IEA (2021), *Net Zero by 2050: A Roadmap for the Global Energy Sector*, OECD Publishing, Paris, https://dx.doi.org/10.1787/c8328405-en. [98]

IEA (2021), *World Energy Outlook 2021*, OECD Publishing, Paris, https://dx.doi.org/10.1787/14fcb638-en. [90]

IEA (2020), *Energy Technology Perspectives 2020*, OECD Publishing, Paris, https://dx.doi.org/10.1787/d07136f0-en. [91]

IEA (2018), *Low-Carbon Transition in the Cement Industry*, IEA Technology Roadmaps, International Energy Agency, Paris, https://dx.doi.org/10.1787/9789264300248-en. [103]

Institut Louis Bachelier et al. (2020), *The Alignment Cookbook - A Technical Review of Methodologies Assessing a Portfolio's Alignment with Low-carbon Trajectories or Temperature Goal*, https://www.louisbachelier.org/wp-content/uploads/2020/10/cookbook.pdf. [11]

IPCC (2022), *Climate Change 2022: Mitigation of Climate Change*, https://www.ipcc.ch/report/ar6/wg3/ (accessed on 28 April 2022). [72]

IPCC (2022), *Climate Change 2022: Mitigation of Climate Change*, https://www.ipcc.ch/report/ar6/wg3/. [8]

IPCC (2021), *AR6 Climate Change 2021: The Physical Science Basis*, https://www.ipcc.ch/report/ar6/wg1/. [100]

IPCC (2019), *2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories*, https://www.ipcc.ch/report/2019-refinement-to-the-2006-ipcc-guidelines-for-national-greenhouse-gas-inventories/. [79]

IPCC (2018), *Global Warming of 1.5 ºC*, https://www.ipcc.ch/sr15/. [140]

IPCC (2006), *2006 IPCC Guidelines for National Greenhouse Gas Inventories*, https://www.ipcc-nggip.iges.or.jp/public/2006gl/. [78]

IRENA (2021), *World Energy Transitions Outlook: 1.5°C Pathway*, International Renewable Energy Agency, Abu Dhabi. [97]

Jachnik, R. and A. Dobrinevski (2021), "Measuring the alignment of real economy investments with climate mitigation objectives: The United Kingdom's buildings sector", *OECD Environment Working Papers*, No. 172, OECD Publishing, Paris, https://dx.doi.org/10.1787/8eccb72a-en. [141]

Jachnik, R., M. Mirabile and A. Dobrinevski (2019), "Tracking finance flows towards assessing their consistency with climate objectives", *OECD Environment Working Papers*, No. 146, OECD Publishing, Paris, https://dx.doi.org/10.1787/82cc3a4c-en. [137]

Jeudy-Hugo, S., L. Lo Re and C. Falduto (2021), "Understanding countries' net-zero emissions targets", *OECD/IEA Climate Change Expert Group Papers*, No. 2021/03, OECD Publishing, Paris, https://dx.doi.org/10.1787/8d25a20c-en. [74]

Jiang, X., G. Peters and C. Green (2019), "Global Rules Mask the Mitigation Challenge Facing Developing Countries", *Earth's Future*, Vol. 7/4, pp. 428-432, https://doi.org/10.1029/2018ef001078. [109]

Katowice Banks & 2DII (2020), *Credit Portfolio Alignment: An application of the PACTA methodology by Katowice Banks in partnership with 2DII*, https://2degrees-investing.org/wp-content/uploads/2020/09/Katowice-Banks-2020-Credit-Portfolio-Alignment.pdf. [36]

Keramidas, K. et al. (2021), *Global Energy and Climate Outlook 2021: Advancing towards climate neutrality, EUR 30861 EN*, Publications Office of the European Union, Luxembourg, https://doi.org/10.2760/410610. [94]

Krabbe, O. et al. (2015), "Aligning corporate greenhouse-gas emissions targets with climate goals", *Nature Climate Change*, Vol. 5, pp. 1057–1060, https://doi.org/10.1038/nclimate2770. [55]

Lamb, W. et al. (2021), "A review of trends and drivers of greenhouse gas emissions by sector from 1990 to 2018", *Environmental Research Letters*, Vol. 16/7, p. 073005, https://doi.org/10.1088/1748-9326/abee4e. [106]

Matthews, H. et al. (2009), "The proportionality of global warming to cumulative carbon emissions", *Nature*, Vol. 459/7248, pp. 829-832, https://doi.org/10.1038/nature08047. [102]

Meinshausen, M. et al. (2022), "Realization of Paris Agreement pledges may limit warming just below 2 °C", *Nature*, Vol. 604/7905, pp. 304-309, https://doi.org/10.1038/s41586-022-04553-z. [73]

Micale, V. et al. (2020), *Paris Misaligned: An Assessment of Global Power Sector Investment*, Climate Policy Initiative, https://www.climatepolicyinitiative.org/publication/paris-misaligned/ (accessed on 2 February 2021). [143]

MSCI (2022), *The MSCI Net-Zero Tracker*, https://www.msci.com/documents/1296102/26195050/NetZero-Tracker-June2022.pdf. [123]

MSCI (2021), *Implied Temperature Rise Methodology*, https://www.msci.com/documents/1296102/27422075/Implied-Temperature-Rise-Methodology-Summary.pdf. [99]

MSCI (n.d.), *Carbon Footprinting for Private Equity and Debt*, https://www.msci.com/our-solutions/climate-investing/carbon-footprinting-for-private-equity-and-debt (accessed on 7 September 2022). [51]

Mullan, M. and N. Ranger (2022), "Climate-resilient finance and investment: Framing paper", *OECD Environment Working Papers*, No. 196, OECD Publishing, Paris, https://doi.org/10.1787/223ad3b9-en. [23]

Natixis (2021), *The New Geography of Taxonomies*, https://gsh.cib.natixis.com/our-center-of-expertise/articles/the-new-geography-of-taxonomies (accessed on 21 June 2022). [25]

NewClimate Institute and Carbon Market Watch (2022), *Corporate Climate Responsibility Monitor 2022*, https://newclimate.org/2022/02/07/corporate-climate-responsibility-monitor-2022/. [85]

NGFS (2022), *Enhancing Market Transparency in Green and Transition Finance*, https://www.ngfs.net/en/enhancing-market-transparency-green-and-transition-finance. [19]

NGFS (2022), *Final report on bridging data gaps*, Network for Greening the Financial System, https://www.ngfs.net/sites/default/files/medias/documents/final_report_on_bridging_data_gaps.pdf. [61]

NZAOA (2021), *Inaugural 2025 Target Setting Protocol: U.N.-convened net-zero asset owner alliance monitoring reporting and verification track*, https://www.unepfi.org/wordpress/wp-content/uploads/2021/01/Alliance-Target-Setting-Protocol-2021.pdf. [27]

OECD (2022), "ESG ratings and climate transition: An assessment of the alignment of E pillar scores and metrics", *OECD Business and Finance Policy Papers*, No. 06, OECD Publishing, Paris, https://dx.doi.org/10.1787/2fa21143-en. [21]

OECD (2022), "Framework for industry's net-zero transition: Developing financing solutions in emerging and developing economies", *OECD Environment Policy Papers*, No. 32, OECD Publishing, Paris, https://doi.org/10.1787/0c5e2bac-en. [105]

OECD (2022), *OECD Guidance on Transition Finance: Ensuring Credibility of Corporate Climate Transition Plans*, OECD Publishing, Paris, https://doi.org/10.1787/7c68a1ee-en. [24]

OECD (2020), *ESG reporting and disclosure principles*, https://nbg.gov.ge/en/financial-stability/esg-reporting-and-disclosure. [26]

OECD (2020), "Green growth indicators (Edition 2020)", *OECD Environment Statistics* (database), https://dx.doi.org/10.1787/726a0247-en (accessed on 2 May 2022). [145]

OECD (2019), *Due Diligence for Responsible Corporate Lending and Securities Underwriting Key considerations for banks implementing the OECD Guidelines for Multinational Enterprises*. [34]

OECD (2018), *OECD Due Diligence Guidance for Responsible Business Conduct*, http://mneguidelines.oecd.org/OECD-Due-Diligence-Guidance-for-Responsible-Business-Conduct.pdf. [32]

OECD (2017), *Responsible business conduct for institutional investors Key considerations for due diligence under the OECD Guidelines for Multinational Enterprises*. [33]

OECD (2011), *OECD Guidelines for Multinational Enterprises, 2011 Edition*, OECD Publishing, Paris, https://dx.doi.org/10.1787/9789264115415-en. [31]

PACTA (2022), *PACTA Climate Test Switzerland 2022*, https://www.transitionmonitor.com/pacta-cop/pacta-ch-2022/. [129]

PAII (2021), *Net Zero Investment Framework Implementation Guide*, https://www.iigcc.org/download/net-zero-investment-framework-implementation-guide/?wpdmdl=4425&refresh=61dc725f9d3e31641837151. [28]

PAT (2021), *Measuring Portfolio Alignment: Technical Consideration*, https://www.tcfdhub.org/wp-content/uploads/2021/10/PAT_Measuring_Portfolio_Alignment_Technical_Considerations.pdf . [45]

PAT (2020), *Measuring Portfolio Alignment: Assessing the position of companies and portfolios on the path to net zero*, https://www.tcfdhub.org/wp-content/uploads/2020/10/PAT-Report-20201109-Final.pdf. [10]

PCAF (2021), *Strategic framework for Paris alignment: A global landscape overview of resources for financial institutions, from measuring financed emissions to taking action*, https://carbonaccountingfinancials.com/files/2021-04/strategic-framework-for-paris-alignment.pdf?515d2dd9f1. [37]

PCAF (2020), *The global GHG accounting and reporting standard for the financial industry*, https://carbonaccountingfinancials.com/files/downloads/PCAF-Global-GHG-Standard.pdf. [38]

Portfolio Alignment Team (2020), *Measuring Portfolio Alignment: Assessing the position of companies and portfolios on the path to net zero*, https://www.tcfdhub.org/wp-content/uploads/2020/10/PAT-Report-20201109-Final.pdf. [119]

Randers, J. (2012), "Greenhouse gas emissions per unit of value added ("GEVA") — A corporate guide to voluntary climate action", *Energy Policy*, Vol. 48, pp. 46-55, https://doi.org/10.1016/j.enpol.2012.04.041. [56]

Rekker, S. et al. (2022), "Measuring corporate Paris Compliance using a strict science-based approach", *Nature Communications*, Vol. 13/1, https://doi.org/10.1038/s41467-022-31143-4. [58]

Responsible Investor (2021), *To be able to copy & paste content to share with others please contact us at subscriptions@peimedia.com to upgrade your subscription to the appropriate licence*, https://www.responsible-investor.com/pka-could-ditch-paris-misaligned-ca100-companies-as-early-as-next-year/. [121]

Reuters (2020), *Church of England pension fund shifts $789 million to climate index*, https://www.reuters.com/article/us-climatechange-church-of-england-pensi-idUSKBN1ZT1DE. [122]

Riahi, K. et al. (2017), "The Shared Socioeconomic Pathways and their energy, land use, and greenhouse gas emissions implications: An overview", *Global Environmental Change*, Vol. 42, pp. 153-168, https://doi.org/10.1016/j.gloenvcha.2016.05.009. [88]

right. based on science (n.d.), *What is the XDC Model?*, https://www.right-basedonscience.de/en/xdc-model/ (accessed on 6 May 2022). [107]

Robinson-Tillett, S. (2021), *The Elephant in the Room: Investors are finally talking about climate and sovereign bonds*, Responsible Investor, https://www.responsible-investor.com/the-elephant-in-the-room-investors-are-finally-talking-about-climate-and-sovereign-bonds/ (accessed on 4 May 2022). [66]

Rocha, M. and C. Falduto (2019), "Key questions guiding the process of setting up long-term low-emissions development strategies"*, OECD/IEA Climate Change Expert Group Papers*, No. 2019/04, OECD Publishing, Paris, https://doi.org/10.1787/54c2d2cc-en. [114]

Rogelj, J. et al. (2019), "Estimating and tracking the remaining carbon budget for stringent climate targets", *Nature*, Vol. 571/7765, pp. 335-342, https://doi.org/10.1038/s41586-019-1368-z. [101]

Rogelj, J. et al. (2021), "Net-zero emissions targets are vague: three ways to fix", *Nature*, Vol. 591/7850, pp. 365-368, https://doi.org/10.1038/d41586-021-00662-3. [3]

S&P Global (2020), *Trucost Paris Alignment*, https://www.marketplace.spglobal.com/en/datasets/trucost-paris-alignment-(186). [108]

S&P Global and Natixis (2021), *Investor Portfolio Alignment with the Paris Agreement: A Trucost multi-sector, multi-asset class approach*, https://www.spglobal.com/_assets/documents/marketplace/sp-global-sustainable1_investor-portfolio-alignment-with-the-paris-agreement.pdf. [64]

SBTi (2022), *Foundations for science-based net-zero target setting in the financial sector*, https://sciencebasedtargets.org/resources/files/SBTi-Finance-Net-Zero-Foundations-paper.pdf. [118]

SBTi (2022), *The SBTi's next big step for Net-Zero Finance*, https://sciencebasedtargets.org/blog/the-sbtis-next-big-step-for-net-zero-finance (accessed on 7 September 2022). [41]

SBTi (2021), *SBTi Corporate Manual Version 2.0*, https://sciencebasedtargets.org/resources/files/SBTi-Corporate-Manual.pdf. [57]

SBTi (2020), *Science-Based Target Setting Manual*, https://sciencebasedtargets.org/resources/legacy/2017/04/SBTi-manual.pdf. [54]

SBTi (2020), *The SBTi Net-Zero Corporate Manual*, https://sciencebasedtargets.org/resources/files/SBTis-Net-Zero-Standard-Corporate-Manual.pdf. [39]

SBTi (n.d.), *Net-zero for financial institutions*, https://sciencebasedtargets.org/net-zero-for-financial-institutions (accessed on 7 September 2022). [40]

Schaeffer, R. et al. (2020), "Comparing transformation pathways across major economies", *Climatic Change*, Vol. 162/4, pp. 1787-1803, https://doi.org/10.1007/s10584-020-02837-9. [112]

Schwegler, R. et al. (2022), *Portfolio Climate Alignment: Understanding unwanted disincentives when using climate alignment methodologies*, Swiss Federal Office for the Environment (FOEN), https://www.bafu.admin.ch/dam/bafu/de/dokumente/klima/externe-studien-berichte/Report_Portfolio%20Climate%20Alignment_Infras_HSG_22.06.2022.pdf.download.pdf/Report_Portfolio%20Climate%20Alignment_Infras_HSG_22.06.2022.pdf. [12]

SEC (2022), *The Enhancement and Standardization of Climate-Related Disclosures for Investors*, https://www.sec.gov/rules/proposed/2022/33-11042.pdf. [86]

Setzer, J. and C. Higham (2021), *Global trends in climate change litigation: 2021 snapshot*, London: Grantham Research Institute on Climate Change and the Environment and Centre for Climate Change, https://www.lse.ac.uk/granthaminstitute/wp-content/uploads/2021/07/Global-trends-in-climate-change-litigation_2021-snapshot.pdf. [17]

ShareAction (2022), *Oil & gas expansion A lose-lose bet for banks and their investors*, https://shareaction.org/reports/oil-gas-expansion-a-lose-lose-bet-for-banks-and-their-investors. [4]

Simmons, J. et al. (2022), *Mind the gaps: Clarifying corporate carbon*, FTSE Russell, https://content.ftserussell.com/sites/default/files/mind_the_gaps_-_clarifying_corporate_carbon_final_0.pdf. [63]

TCFD (2021), *Annex: Implementing the Recommendations of the Task Force on Climate-related Financial Disclosures*, https://assets.bbhub.io/company/sites/60/2020/10/FINAL-TCFD-Annex-Amended-121517.pdf. [14]

TCFD (2017), *Final Report: Recommendations of the Task Force on Climate-related Financial Disclosures. Task Force on Climate-related Financial Disclosures*, https://assets.bbhub.io/company/sites/60/2020/10/FINAL-2017-TCFD-Report-11052018.pdf. [13]

Teske, S. et al. (2022), "1.5 °C pathways for the Global Industry Classification (GICS) sectors chemicals, aluminium, and steel", *SN Applied Sciences*, Vol. 4/4, https://doi.org/10.1007/s42452-022-05004-0. [95]

The Coalition of Finance Ministers for Climate Action (2021), *Introduction to Commitments and Measurement Methods for Private Financial Sector Portfolio Alignment with the Paris Agreement: Summary for Policymakers*, https://www.financeministersforclimate.org/sites/cape/files/inline-files/Financial%20Sector%20Paris%20Alignment%20%28CFMCA%29%20-%20Summary%20for%20Policymakers_0.pdf. [35]

The Economist (2022), "Who buys the dirty energy assets public companies no longer want?", https://www.economist.com/finance-and-economics/who-buys-the-dirty-energy-assets-public-companies-no-longer-want/21807594. [53]

Thomä, J., S. Dupré and M. Hayne (2018), "A Taxonomy of Climate Accounting Principles for Financial Portfolios", *Sustainability*, Vol. 10/2, p. 328, https://doi.org/10.3390/su10020328. [71]

TPI (2021), *Management Quality and Carbon Performance of Energy Companies: November 2021 Update*, https://www.transitionpathwayinitiative.org/publications/91.pdf?type=Publication. [49]

UNEP (2021), *Emissions Gap Report 2021*, https://www.unep.org/resources/emissions-gap-report-2021. [113]

UNEP FI (2021), *The Climate Risk Landscape: Mapping Climate-related Financial Risk Assessment Methodologies*, Un Environment Programme, https://www.unepfi.org/publications/banking-publications/the-climate-risk-landscape/. [44]

UNFCCC (2015), *The Paris Agreement*, https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement. [1]

UNFCCC (2014), *UNFCCC reporting guidelines on annual inventories for Parties included in Annex I to the Convention*, https://unfccc.int/process-and-meetings/transparency-and-reporting/reporting-and-review-under-the-convention/greenhouse-gas-inventories-annex-i-parties/reporting-requirements. [80]

UNFCCC SCF (2021), *Biennial Assessment and Overview of Climate Finance Flows*, https://unfccc.int/topics/climate-finance/resources/biennial-assessment-and-overview-of-climate-finance-flows (accessed on 8 September 2022). [7]

van Soest, H. (2022), *Mind the Gap : Applying Integrated Assessment Models to Inform International and National Climate Policy on Bridging the Emissions Gap*, Utrecht University, https://doi.org/10.33540/1311. [110]

van Soest, H., M. den Elzen and D. van Vuuren (2021), "Net-zero emission targets for major emitting countries consistent with the Paris Agreement", *Nature Communications*, Vol. 12/1, https://doi.org/10.1038/s41467-021-22294-x. [111]

van Vuuren, D. et al. (2011), "The representative concentration pathways: an overview", *Climatic Change*, Vol. 109/1-2, pp. 5-31, https://doi.org/10.1007/s10584-011-0148-z. [89]

World Resources Institute & World Business Council for Sustainable evelopment (2004), *GHG Protocol Corporate Accounting and Reporting Standard*, https://ghgprotocol.org/sites/default/files/standards/ghg-protocol-revised.pdf. [83]