TOO BIG TO FAIL

MEASURING THE ALIGNMENT OF THE BRAZILIAN FUND'S INDUSTRY WITH CLIMATE GOALS

MAY 2023

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About PACTA

Building off a vast climate-related financial database, the PACTA tool aggregates global forward-looking asset-based company data (such as the production plans of a manufacturing plant over the next five years), up to the parent company level. The tool then produces a customized, confidential output report, which allows investors to assess the overall alignment of their portfolios with various climate scenarios and with the Paris Agreement. This report is part of the PACTA Coordinated Projects (PACTA COP): our dedicated program in which we work together with individuals or groups of governments and supervisors to help them apply PACTA to the portfolios of their regulated entities.

CONTENTS

Summary for Policymakers

- Brazil's ratification of the Paris Agreement in 2016 commits the country to reducing greenhouse gas emissions and limiting global temperature increases. However, achieving the agreement's goals requires aligning investment and financing with the necessary rapid transition.

- Brazil has made progress in aligning financial flows with the goal of limiting global temperature rise, but there is still a gap in complying with requirements, measuring climate-related risks, integrating climate-related topics in strategic decisions, and making an impact in the transition to a low-carbon economy.

- In order to contribute to the sustainable finance debate, the present study assess the alignment of Brazilian funds' portfolios with the Paris Agreement goals. The study assessed 5,385 funds' portfolios from 638 different asset managers based in Brazil with around USD 150 billion in assets under management – which represents 10% of the total net worth of the sector.

- A key finding is the high concentration of Brazilian asset managers' portfolios, with around 30% of listed equities and corporate bonds allocated to climate-relevant sectors. Fossil fuels, power, and steel account for 90% of this allocation. While the concentration is expected due to the structure of the Brazilian financial market, it presents challenges and opportunities for managing climate-related risks and promoting a low-carbon economy.

- Another interesting finding is that ESG-classified funds do not demonstrate superior or inferior performance compared to non-ESG funds, highlighting the need to assess their alignment measures, engagement strategies, and prevent greenwashing.

- On the downside of the findings, asset managers' portfolios have a high exposure to assets that will need to be phased out in the mid-term to address climate change, such as oil & gas. Additionally, the production plans of invested companies are significantly misaligned with a net-zero scenario. This suggests that asset managers may face financial losses in the event of a late and sudden transition to a low-carbon economy.

- On the positive side of the findings, Brazil is home to global companies operating in climate-relevant sectors, such as Petrobras, Vale, Gerdau, and more. Asset managers hold a significant ownership stake in these companies through their financial assets. If policymakers encourage and monitor credible joint engagement between asset managers and these companies to align their production plans with a net-zero pathway, it has the potential to create substantial impact on the real economy.

- To advance the global sustainable finance agenda, this study recommends the following to Brazilian financial authorities, **I) invest in capacity building, II) incorporate complementary non-GHG metrics and standards into reporting requirements, III) continuously monitor climate-related risks, IV) encourage and unlock the potential of the financial sector to make an impact in the real economy's transition towards a low-carbon economy.**

- In conclusion, Brazil's large-scale industrial production in climate-relevant sectors, coupled with the vulnerability of its biodiversity and natural resources, poses a global risk to achieving the objectives of the Paris Agreement. However, by implementing credible and enforceable climate actions, Brazil has the potential to become a leader in the sustainable finance agenda and make a positive impact towards meeting global warming targets.

1. Introduction

Research conducted by the IPCC confirms the intensification of climate change (Intergovernmental Panel on Climate Change, 2022). Their findings indicate that climate change is already exerting its influence on every region of the world, manifesting through a range of interconnected impacts. Additionally, the UNFCCC report reveals that global emissions are projected to increase by 16% by 2030 compared to the levels recorded in 2010 (United Nations Framework Convention on Climate Change, 2021). However, to stay on track with the 1.5°C pathway, a reduction of 45% is necessary during the same timeframe. In summary, meeting the objectives outlined in the Paris Agreement remains an immense challenge, and the available timeframe for implementing the required greenhouse gas emission reductions to effectively manage the global carbon budget within a 1.5°C trajectory is rapidly diminishing.

By ratifying the Paris Agreement in 2016, Brazil made a commitment to reducing its greenhouse gas emissions and making concerted efforts to limit the global temperature increase to well below 2°C above pre-industrial levels, with a specific focus on striving to limit the increase to 1.5°C. However, achieving the objectives set forth in the Paris Agreement necessitates the alignment of investment and financing flows with the urgent and necessary transition. Unsurprisingly, the Paris Agreement itself acknowledges this crucial aspect in Article 2.1.(c), which mandates that financial flows be consistent with a trajectory leading to low greenhouse gas emissions and climate-resilient development. Assessing progress in relation to Article 2.1.(c) requires the development of methodologies and approaches that enable the measurement of alignment with emissions reduction pathways. It is essential to have benchmarks and measurement tools in place to effectively manage and catalyze change. Without a means of measurement or a benchmark to gauge progress, it becomes exceedingly challenging to make informed decisions and drive the necessary transformations.

Brazil has made notable progress in aligning financial flows with the objective of keeping global temperature rise well below 2°C. The Brazilian Central Bank has been a pioneer in policies in sustainable finance, including risk management, corporate responsibility, and disclosure requirements pertaining to social, environmental, and climate-related aspects for financial institutions. However, despite these advancements, there remains a visible gap in the country when it comes to compliance with requirements, the assessment of climate-related risks, the integration of climate-related considerations into strategic decision-making, and the ability to drive meaningful change toward a low-carbon economy.

For example, research conducted by the Brazilian Association of Financial Market Institutions (ANBIMA) reveals that 35.5% of the surveyed financial institutions still consider sustainability as a distant topic for their business, perceiving themselves as lacking the capacity to make any significant impact (Associação Brasileira das Entidades dos Mercados Financeiro e de Capitais, 2021). In contrast, only 6.8% of the financial institutions interviewed have successfully incorporated sustainability into their investment strategies.

One of the primary steps that governments and supervisory authorities must take to ensure the stability of their financial systems during the transition to a low-carbon economy is to assess the alignment of financial institutions with climate temperature goals and their trajectory towards them. In this regard, policymakers and supervisory authorities require metrics that possess the following characteristics:

I) Forward-looking: Metrics should have a proactive approach, anticipating future developments rather than solely focusing on current conditions.

II) Near-term time horizons: Metrics should encompass timeframes that are sufficiently close to effectively monitor company commitments and incentivize the transition.

III) Consistent units of measurement: Metrics should employ standardized measurement units that facilitate comparisons between climate scenarios' transition pathways for critical sectors and the planned progress of companies within each sector.

By employing such metrics, policymakers and supervisory authorities can gain crucial insights into the progress and direction of financial institutions, enabling them to devise appropriate strategies and measures to support the transition to a low-carbon economy.

To assist financial authorities in their efforts to measure climate-related risks and align financial flows with a trajectory towards low greenhouse gas emissions, PACTA has been at the forefront of conducting climate scenario assessments at the macroeconomic level through its PACTA Coordinated Projects program. Designed specifically for governments, regulators, and industry associations, PACTA Coordinated Projects aims to apply the PACTA methodology to the portfolios of regulated entities. The program's objective is to evaluate the alignment of both the overall financial sector and individual participating institutions. The insights gained from these assessments can then inform the climate finance strategies of governments, regulators, and participating financial institutions. Several countries and supervisory authorities have already engaged in PACTA Coordinated Projects assessments, including Switzerland, Luxembourg, Norway, Liechtenstein, and Austria. At the supervisory and sectoral level, assessments have been conducted in the Netherlands, United States, Sweden, Mexico, Peru, and Colombia. In Brazil, a previous assessment was carried out in collaboration with the National Superintendence for Pension Funds (PREVIC), focusing on the portfolios of pension funds in 2021.

In a collaborative initiative, PACTA joined forces with the Climate Policy Programme Brazil (PoMuC) of the Brazil-Germany Cooperation for Sustainable Development, along with the Green and Sustainable Finance project (FiBraS), and the Brazilian Securities Commission (CVM), to conduct an assessment of Brazilian funds' portfolios in relation to the goals of the Paris Agreement. The study encompassed the analysis of 5,385 funds' portfolios, managed by 638 different asset managers based in Brazil, totaling approximately USD 150 billion in assets under management, comprising equities and corporate bonds.

The assessment was conducted using publicly available data on fund compositions, sourced from https://dados.cvm.gov.br, with a timestamp of December 2021. Specifically, the study relied on information found in Block 4 of the database, which includes investments in equities, corporate bonds, derivatives, BDRs (Brazilian Depositary Receipts), and other codified assets. It is important to note that the database represents approximately 10% of the total net worth, and thus, the findings presented in this study solely pertain to the positions disclosed in Block 4, rather than the overall positions.

One significant finding of the study is that the portfolios of Brazilian asset managers, as observed in the sample, exhibit a high level of concentration, with an average of 30% of equities and corporate bonds (AuM) allocated to climate-relevant sectors[1], while in other jurisdictions an average of 5% is usual. This concentration primarily revolves around three main sectors: fossil fuels, power, and steel. Surprisingly,

1 Oil & Gas, Coal Mining, Power, Automotive, Aviation, Steel, and Cement

this concentration pattern is observed across all fund classifications, including those labeled as ESG funds. While the concentration of portfolios in specific sectors and companies can be attributed to the structure of the Brazilian financial market, which predominantly focuses on domestic assets, the implications are mixed in terms of managing climate-related risks and driving the transition to a low-carbon economy.

On the downside, asset managers' portfolios are highly exposed to assets that are likely to be phased out in the mid-term if climate change is effectively addressed, such as oil and gas, which are often referred to as stranded assets. Furthermore, these portfolios demonstrate significant exposure to the companies which have production plans that are significantly misaligned with a net-zero scenario. This indicates that in the event of a sudden and delayed transition to a low-carbon economy, asset managers may face some financial losses. On the upside, Brazil hosts globally significant companies operating in climate-relevant sectors, such as Petrobras, Vale, Gerdau, and others. Asset managers, through their financial assets, maintain a substantial ownership stake in these companies. If policymakers take measures to incentivize and monitor credible joint engagement between these asset managers and their invested companies, with the aim of aligning their production plans with a net-zero pathway, the potential for driving positive impact in the real economy could be substantial.

The scale of Brazil's fossil fuel and raw material production highlights the significance of investors collaborating with major companies in the country to enforce alignment. As the eighth largest oil producer and the ninth largest steel producer globally, any failure to align Brazil's financial flows, economic activities, and companies' production plans with a low-carbon trajectory not only jeopardizes the nation's economy and environment but also undermines the world's objective of limiting the global temperature increase to well below 2°C. Therefore, proactive measures from Brazilian financial supervisors, including the Brazilian Securities Commission and the Brazilian Central Bank, are crucial.

These financial supervisory bodies are advised to invest in research to adapt the following measures to the local reality:

I) Measure and evaluate the potential impact of financial risks associated with climate change.

II) Maintain close monitoring of the development of these risks and the extent of exposure to them.

III) Mandate financial institutions to report on and enhance the performance of their investments concerning climate indicators.

IV) Enforce concrete measures from financial institutions to integrate climate stewardship into their investment strategies.

To provide a roadmap for future actions, this report is structured as follows: following this introduction, Section 2 offers valuable insights and background information on the current state of sustainable finance policies in Brazil. Section 3 delves into a comprehensive analysis of corporate bonds and listed equities within the portfolios under examination. This section is organized by sector and includes charts illustrating the exposure of the six peer portfolios to each sector, the technology mix allocation within these portfolios, the regional exposure of physical assets, and the forward-looking alignment results. Lastly, Section 4 presents the study's conclusions and proposes potential next steps based on the findings.

As an additional output of this project, we provide individual interactive reports for each peer group of funds analyzed. Readers are invited to delve into the detailed results of each group by accessing the following links:

Peer group	Link
Ações Indexados (ACIDX)	Access the interactive report here
Ações Ativo (ACAT)	Access the interactive report hezre
Ações ESG (ACESG)	Access the interactive report here
Multimercado Alocação (MLTA)	Access the interactive report here
Multimercado Estratégia (MLTE)	Access the interactive report here
Renda Fixa Crédito Privado (RFCP)	Access the interactive report here

In Section 3.1, readers will find a description of each group to help guide your analysis. Readers are encouraged to explore the results presented in this report in conjunction with the detailed insights provided in the interactive reports.

2. Sustainable Finance in Brazil

Brazil has emerged as a leader in sustainability, driven not only by its rich forests and biodiversity but also by progressive policymaking. As early as 1991, Brazil's National Agricultural Policy recognized the importance of preserving soil quality, conserving natural resources, and restoring ecological balance. In 2004, the Action Plan for the Prevention and Control of Deforestation in the Legal Amazon introduced satellite-based monitoring to combat deforestation, expanded protected areas, established land tenure regularization, and imposed credit restrictions on non-compliant entities. In recent years, Brazil has shifted its focus towards promoting sustainable production practices. The Low-Carbon Agricultural Plan (Plano ABC/ABC+), for instance, provides subsidized credit lines to farmers adopting environmentally friendly agricultural techniques. Furthermore, Brazil demonstrated its commitment to addressing climate change by ratifying the Paris Agreement in 2016, aligning itself with the global framework for climate action.

In the realm of sustainable finance, the Central Bank of Brazil (BCB) has taken significant steps to integrate environmental considerations into its regulations, primarily focusing on financing agricultural activities in protected Amazon areas and supporting climate change mitigation and adaptation measures. Between 2008 and 2010, the BCB introduced a series of policies related to rural credit, implementing measures to ensure environmental compliance. For instance, CMN Resolution No. 3,545/2008 made it mandatory for borrowers to provide documentation demonstrating their adherence to environmental regulations. Furthermore, CMN Resolution No. 3,814/2009 prohibited the financing of crop expansion in environmentally sensitive areas like the Amazon and other protected regions. The BCB also addressed social responsibility by prohibiting the granting of rural credit to individuals or businesses involved in employing workers under conditions resembling slavery (CMN Resolution No. 3,876/2010). In addition, CMN Resolution No. 3,896/2010 introduced mechanisms to facilitate the financing of sustainable agricultural activities. Building upon these initiatives, the BCB continued to enhance sustainability criteria for rural credit through subsequent resolutions. BCB Resolution No. 140/2021 and BCB Resolution No. 204/2022 further strengthened the requirements for qualifying for rural credit and mandated the public disclosure of credit operations receiving governmental subsidies.

The BCB has demonstrated its commitment to promoting sustainability and addressing environmental and social risks in the financial sector through various policies and initiatives. In 2014, the BCB introduced CMN Resolution No. 4,327/2014 and BCB's Circular No. 3,846/2017, which turned mandatory disclosure of Environmental and Social Risks by financial institutions in Brazil. These policies required financial institutions to consider these risks when calculating their capital adequacy.

In a significant move in 2020, the BCB incorporated sustainability as the fifth pillar of its strategic framework, reflecting its dedication to reducing social, environmental, and climate risks within the national economic and financial system. This inclusion led to the development of the Policy on Social, Environmental, and Climate Responsibility (Política de Responsabilidade Social, Ambiental e Climática - PRSAC) and other policies, resolutions, and standards aimed at promoting sustainable practices[2]. In

2 See Resolução nº CMN 4.945/2021, nº 4.943/2021 and nº 4.944/2021

line with international best practices, the BCB incorporated recommendations from the Task Force on Climate-related Financial Disclosures (TCFD) into its reforms. This integration ensured alignment with global standards and enhanced transparency in reporting social, environmental, and climate risks. Furthermore, in 2021, the BCB introduced the requirement for regulated financial institutions to disclose information on their exposure to social, environmental, and climate risks in the Report on Social, Environmental, and Climate Risks and Opportunities (GRSAC Report)[3]. Financial institutions are now obligated to submit this information semi-annually to the BCB[4], enhancing the monitoring and management of these risks in the sector.

While public authorities in Brazil have been at the forefront of the sustainability agenda, the integration of sustainable finance topics into strategic investment decisions by financial institutions is still in its early stages. For instance, research conducted in 2021 by the Brazilian Association of Financial Market Institutions (ANBIMA) concluded that 35.5% of the financial institutions interviewed consider sustainability to be of little relevance to their business and believe they are incapable of achieving any real impact (Associação Brasileira das Entidades dos Mercados Financeiro e de Capitais, 2021). Furthermore, 4.2% of the financial institutions interviewed perceive sustainability as a financial threat and do not see value in discussing the topic. On the other hand, 6.8% of the interviewed financial institutions have incorporated sustainability into their strategies. In February 2022, the Association created a category for ESG Funds, which includes funds with sustainability mandates, meaning that investment decisions are made in line with sustainability principles. Additionally, there are funds that integrate sustainability into their management process, although not necessarily in their investments. Currently, only 20 funds in the ANBIMA database (Associação Brasileira das Entidades dos Mercados Financeiro e de Capitais, 2023) are classified as ESG Funds.

The lack of engagement of the Brazilian financial market in sustainability topics is contradictory to the structure of the market and the significance of Brazilian companies in the transition. Due to regulations and taxation policies that discourage investing abroad, Brazilian financial institutions have high exposure to domestic companies. Consequently, as the local economy is heavily reliant on commodity production, the trend is reflected in the composition of the Brazilian stock market.

For instance, Vale, a Brazilian mining company, holds the title of the world's largest producer of iron ore and nickel, with a market capitalization exceeding USD 70 billion. Vale alone accounts for over 15% of the local stock market index (Ibovespa). Petrobras is another notable example. With a daily production of 2.77 million barrels of oil equivalent (boe) and proven reserves of 9.878 billion barrels of oil equivalent (boe) (Petrobras, 2023), the company ranks among the largest oil producers globally and has a weighting of more than 10% in the local stock market index. Interestingly, Petrobras is also the world's second-largest producer of bioethanol fuel, accounting for over a quarter of global production after the USA. In addition to these companies, Brazil is home to Gerdau, the largest producer of long steel in the Americas, Votorantim Cimentos, the eighth-largest cement producer in the world (IMARC Group, 2013), and power companies that possess the world's second-largest installed capacity of hydroelectric power and the largest installed hydroelectric power capacity in South America, contributing to 60% of the continent's total capacity (International Hydropower Association, 2023). Beyond its industrial and agricultural potential, Brazil boasts the world's largest contiguous area of rainforest and harbors over 10% of the world's known biodiversity, making it the most biodiverse country on the planet (Rainforests Mongabay, 2023).

3 See Resolução BCB nº 139/2021, and Instrução Normativa BCB nº 153/2021

4 See Resolução BCB nº 151/2021

The failure of Brazil's financial industry to align its financial exposures and flows with a pathway to stabilize global warming below 2°C could have severe consequences for the world, considering the significant investments and capital it provides to the country's industrial and agricultural base. Since 1990, CO_2 emissions from the energy sector have more than doubled, with oil being the largest source of emissions (over 60%), followed by coal and natural gas (approximately 18% each). The International Energy Agency (IEA) highlights the challenges Brazil faces as an emerging economy in achieving the Sustainable Development Scenario (SDS), including ensuring access to clean cooking and universal access to energy (International Energy Agency, 2021). On one hand, Brazil has one of the highest shares of renewable energy in the world and a strong focus on biofuels. However, on the other hand, this position is threatened by physical climate risks such as changing weather patterns and environmental stresses like droughts and water scarcity, which are associated with increasing energy demands (International Energy Agency, 2023). These risks further compound the challenges and risks associated with the transition to a sustainable and low-carbon economy.

The heavy exposure of the investment industry to national companies, which play a crucial role in the transition to a low-carbon economy, presents an opportunity for both the financial market and policymakers to promote and enforce sustainable finance practices. This study serves as an important step in raising awareness about the significance of sustainable development goals, including climate change mitigation, and emphasizes the use of forward-looking scenario analysis to develop informed and actionable climate strategies. Moving forward, it is essential to prioritize the integration of sustainability into portfolio allocation decision-making processes and to enhance engagement practices aimed at influencing Brazilian companies to align their production plans with sustainable development and climate mitigation pathways. By encouraging and implementing best practices in sustainable finance, stakeholders can work towards aligning financial flows with sustainable development objectives and addressing the challenges posed by climate change.

3. Exposure and Alignment Metrics

The Paris Agreement Capital Transition Assessment (PACTA) methodology was introduced in 2018 as a tool for assessing the alignment of investor and bank lending portfolios with climate change scenarios. It provides a framework for evaluating the compatibility of equities, bonds, and lending activities with decarbonization pathways. PACTA utilizes five-year forward-looking production plans of companies operating in sectors crucial to climate change to assess their alignment with different decarbonization scenarios. Since its launch, PACTA has gained significant traction, with more than 3500 financial institutions uploading their portfolios to the online investor tool. This widespread adoption demonstrates the growing importance of assessing and managing climate-related risks and opportunities in financial decision-making processes.

The methodology is designed to facilitate actionable alignment measurement by leveraging company production plans and granular data at the asset level. This data allows for the evaluation of alignment in specific production facilities such as power stations, oil wells, and car production plants. PACTA takes into account the scale and pace of technological change and investment anticipated in various climate scenarios to determine the level of alignment. A summary of the methodology is presented Figure 1.

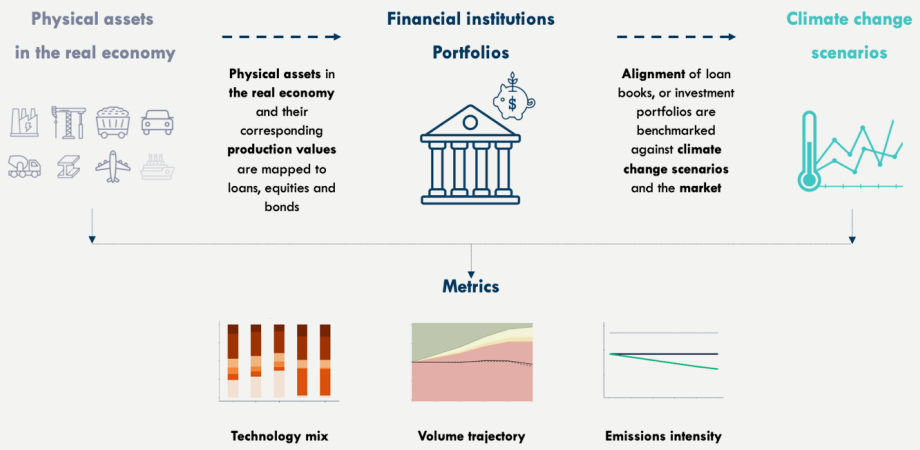


Figure 1: Overview of the PACTA methodology

The PACTA Methodology encompasses several components to assess alignment with climate change scenarios. The quantitative aspect of PACTA involves comparing sectoral decarbonization pathways derived from climate scenarios with the exposure of financial actors to companies operating in climate-relevant sectors. This analysis is conducted using a five-year forward-looking approach, examining the investment and production plans of companies through physical Asset-Based Company Level Data (ABCD). By analyzing the production plans of companies, PACTA identifies their transition profiles and links them to financial instruments. This information is then consolidated and aggregated at the portfolio level to determine the alignment or misalignment between the portfolio's allocation to climate-relevant sectors and the sectoral transitions outlined in different climate scenarios. This assessment allows users

to infer the potential exposure to transition risks and identify potential mitigation opportunities.

This study will analyze the results obtained using three main metrics, each addressing different aspects related to the transition to a low-carbon economy:

- **Sector exposure metric:** This metric focuses on determining the current exposure of the portfolio to economic activities that are most likely to be affected by the transition to a low-carbon economy. It provides insights into the extent to which the portfolio is invested in sectors that may face risks or opportunities arising from the transition.

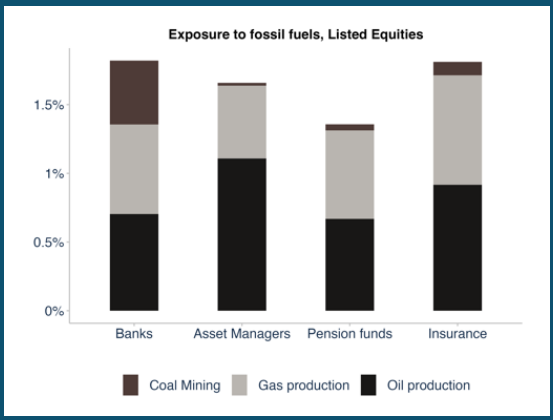
- **Future technology mix metric:** This metric assesses how the portfolio's exposure to high and low-carbon-emitting technologies is expected to change over the next five years. A comparison is made between the portfolio's technology mix and that of a portfolio aligned with the Paris Agreement's goals. This metric helps identify potential shifts in technology investments that can contribute to decarbonization efforts.

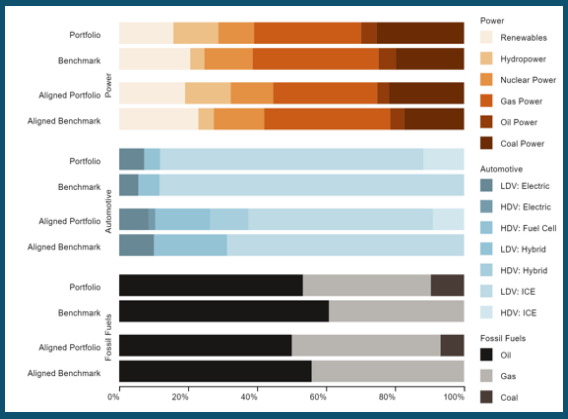
- **Production volume trajectory and emissions intensity metrics:** These metrics evaluate the alignment of the capital commitments and production plans of companies within the portfolio with different climate scenarios and the Paris Agreement. They examine the trajectory of production volumes and emissions intensity of the companies and assess their alignment with decarbonization goals. This analysis provides insights into the sustainability of companies' production plans and their potential exposure to transition risks.

Box 1: How to read and interpret the main PACTA metrics?

A PACTA analysis measures alignment using three different metrics: Exposure by economic activity and as shown by the technology share mix, and alignment via either the Production Volume Trajectory or Emissions Intensities. The technology mix and the volume trajectory are used for the power, fossil fuels, and automotive sectors, for which there exist clearly defined technology decarbonization pathways. For example, in the power sector, there are technologies to transition to, i.e., coal-fired power generation can shift to renewable energies. For the other sectors, where technology decarbonization pathways are not yet well defined, such as steel, cement, and aviation, PACTA uses an emissions intensity metric to compare it to scenario benchmarks.

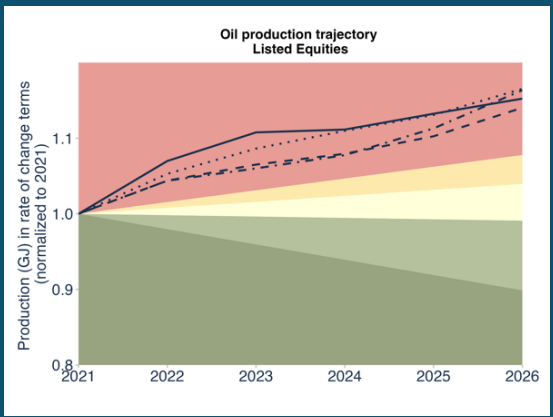
The **sector exposure metric** shows the estimated share of the portfolio that is currently exposed to companies with assets in the fossil fuels, power, aviation, cement, steel, and automotive sector. It is calculated by first taking the weight of the portfolio that is exposed to companies in each of these sectors and then calculating the technology breakdown of assets owned by these companies. The portfolio's current technology exposure is compared to the market portfolio, which is calculated based on the exposure of the global universe of assets in the relevant asset class to the sectors, as well as to the peers participating in the tests. Based on this metric, financial institutions, and supervisors can gain additional clarity on the extent to which investment portfolios are exposed to transition risk and climate compatibility issues based on their capital allocation to different sectors and their associated technologies.

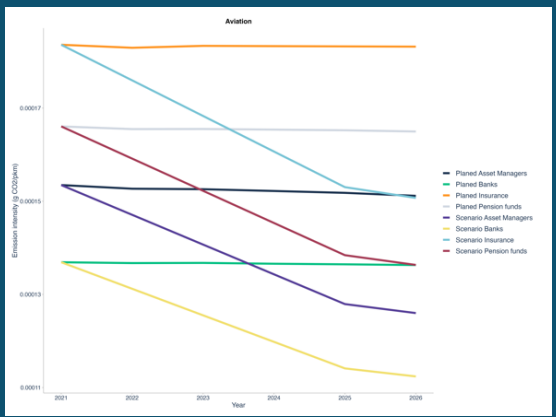




The **future technology mix metric** illustrates the portfolio's expected technology mix in the power, automotive, oil and gas, and coal mining sectors over the next five years. It is calculated by taking the portfolio's current exposure to each technology and then applying the trajectory of the exposure over time based on disclosed capital commitments and production plans. It represents the change in the technology mix implied by the next five-year production values as shown in the production volume trajectory charts. The metric is compared to peers, the market, and a technology mix aligned with Paris Agreement goals (e.g., the Net Zero by 2050 scenario of the IEA). On the basis of this information supervisors and financial institutions can potentially manage concentration risks and take into account portfolio diversification considerations.

The **production volume trajectory metric** tracks and measures the portfolio's alignment for selected climate-relevant technologies relative to various IEA and European Commission Joint Research Center (JRC) transition scenarios. The trajectory of company assets within the global listed equity or corporate bond market is also shown for the different peer groups in this report. The metric is forward-looking and compares the portfolio's expected production trajectories in different technologies to scenario-aligned trajectories over the next five years. The portfolio's expected trajectory is based on the underlying investee companies' investment plans for the next five years, while the market's trajectory is the combination of the forward-looking investment plans of a selected benchmark index in the respective asset class for the same period.





The first visualization type (below left) is a production volume trajectory chart. This chart tracks and measures the corporate bond portfolio's exposure to a given sector production (the black lines) in comparison to the IEA and JRC scenarios (the background colors). The alignment of emission intensities by sector is also plotted (below right) compared to the IEA's Net Zero by 2050 scenario (below right). This chart uses the current emissions intensity of companies within the portfolio as a starting point and shows how this is expected to develop over the next five years based on the plans of the company and what would be expected under the scenario.

3.1 Coverage of this study

The Brazilian asset management industry collectively oversees a total net worth of USD 1.5 trillion. For the purpose of this study, the database of "other codified assets"[5] available on CVM's website was utilized. This comprehensive database includes various types of assets such as equities, corporate bonds, derivatives, and more. The investment portfolios analyzed in this study account for approximately USD 150.1 billion in assets under management as of December 31, 2021. It is important to note that this amount represents roughly 10% of the total net worth of the Brazilian funds' industry. All findings and conclusions derived from this study are specific to the assets included in the "other codified assets" database. These assets correspond to the portfolios of 5,385 funds managed by 638 different asset managers operating within Brazil and subject to CVM's supervision. To facilitate analysis, the funds were grouped into six different categories based on guidance provided by CVM and under the general funds' classification established by ANBIMA[6]. Table 1 in the report provides a concise description of these groups, helping to categorize and understand the composition of the analyzed portfolios.

Funds classification	Description
Ações Indexados (ACIDX – Indexed equity funds)	Funds that aim to replicate an equity market benchmark. The remaining cash position must be allocated in fixed-income funds.
Ações Ativo (ACAT – Active equity funds)	Funds that aim to overcome an equity market benchmark or funds that have no benchmark. The funds' composition must be supported by an investment thesis. The remaining cash position must be allocated in fixed-income funds.
Ações ESG (ACESG – Equity ESG funds)	Subcategory of Ações Ativo, which invests in companies with good levels of social and corporate sustainability in the long term. Funds must disclose their investment strategy to define the positive screening of assets.
Multimercado Alocação (MLTA – Multimarket allocation funds)	Funds with a diverse risk profile, which have no concentration of assets in one single factor. These funds aim for long-term results, under the strategy of asset allocation.

5 In CVM's database (https://dados.cvm.gov.br/dataset/fi-doc-cda) the sample used in this study can be found under the name "Bloco 4: Demais Ativos Codificados"

6 For more information, please check the ANBIMA definition for each fund category at the "Cartilha da Nova Classificação de Fundos"

Multimercado Estratégia (MLTE – Multimarket strategy funds)	Funds with a diverse risk profile, which have no concentration of assets in one single factor. Funds in this category are based on the prevailing strategies adopted and supported by the investment process defined by the manager. The fund type allows for leverage.
Renda Fixa Crédito Privado (RFCP – Fixed income funds)	Funds with allocation mainly in fixed-income assets from private corporates.

Table 1: Peer groups classification description

As the names suggest, the fund classifications indicate that the majority of Ações Ativo (ACAT), Ações ESG (ACESG), and Ações Indexados (ACIDX) funds are primarily invested in listed equities. These funds focus on actively managed equity investments, ESG (Environmental, Social, and Governance) focused equities, and index-based equity investments, respectively. Renda Fixa Crédito Privado (RFCP) funds are mostly allocated to bonds. These funds primarily invest in fixed-income securities issued by private entities. The remaining fund categories, which have mixed strategies, are allocated to both listed equities, bonds, and other asset classes.

Considering the composition of the analyzed data, it is not surprising to find that more than 90% of the total value of the portfolios included in this study is allocated to listed equities and corporate bonds. These asset classes are explicitly covered by the PACTA analysis and fall within the scope of this study. However, it is important to note that the value analyzed represents only around 10% of the total assets under management in the Brazilian asset management industry. Therefore, while the findings provide valuable insights into the allocation within the portfolios studied, they may not necessarily be representative of the entire industry. To conduct the analysis, data for both listed equity and bond holdings, as well as fund shares, was obtained from Factset, a financial database and analytical software. In the case of fund shares, the data allows for a look-through at the portfolios of the funds themselves. This approach considers the equities and bonds held by the funds as indirect ownership of assets, and they are accordingly aggregated into their respective categories.

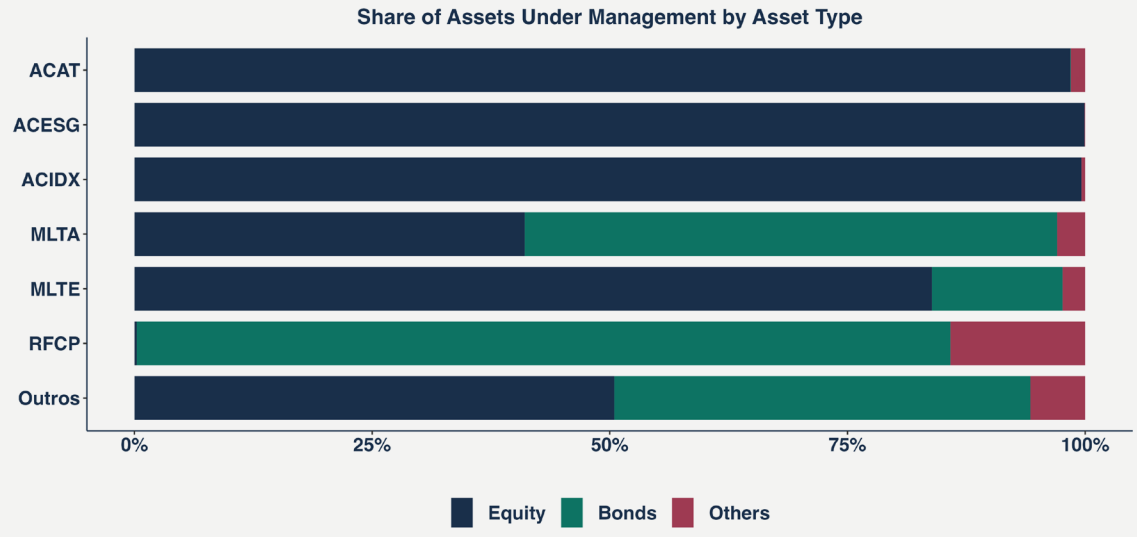


Figure 2: Breakdown of the assets under management analyzed by asset class category

The sectors covered by the PACTA analysis (which, to remember, are fossil fuels, power, automotive, aviation, steel, and cement) account for a range of 10% to 55% of the total investment value of the portfolios analyzed, as shown in Figure 3. Among the different fund categories, the Multimercado Alocação (MLTA) portfolios exhibit the highest percentage of listed equity investments in PACTA sectors or climate-relevant sectors, amounting to 56%. This is followed by the Renda Fixa Crédito Privado (RFCP) funds, which allocate 52% of their portfolios to bonds within these sectors. It is worth noting that the proportion of portfolios exposed to climate-relevant sectors in Brazil is significantly higher compared to other jurisdictions where similar studies have been conducted. In those cases, the averages typically ranged between 5% and 15%. In a previous study conducted with portfolios from PREVIC (the Brazilian pension funds regulator), the share of total assets allocated to climate-relevant sectors amounted to 19% for listed equity portfolios and 18% for corporate bond portfolios. This indicates that the asset managers have a higher exposure to climate-relevant sectors compared to the pension funds.

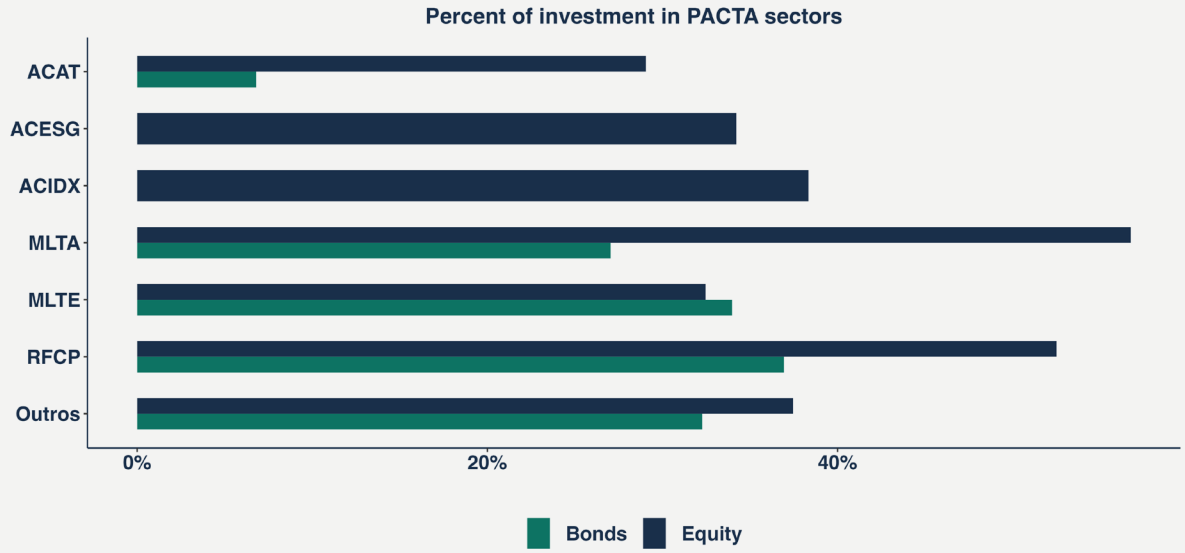


Figure 3: Proportion of assets under management in PACTA sectors by fund group

In terms of total investments in listed equities within the PACTA sectors, the combination of oil & gas extraction and power generation represents over 50% of portfolio allocations in climate-relevant sectors (refer to Figure 4). Additionally, steel holds a significant weight in portfolios, contributing an average of 25% to equity allocations in climate-relevant sectors. This allocation pattern is primarily driven by the considerable exposure to Vale, with 4.5% of all portfolios being allocated to Vale equities, making it the top invested company in the Brazilian fund industry. It is noteworthy that all analyzed fund groups demonstrate a similar distribution of portfolios across the aforementioned three sectors in listed equities. Concerning corporate bond investments, nearly the entire portfolio is allocated to the power sector (refer to Figure 5). The exposure of Brazilian asset managers to the steel sector is unparalleled when compared to other countries and jurisdictions where similar studies have been conducted, with an average of 10% of the total value in climate-relevant sectors.

It is important to highlight that, based on the portfolio weight approach employed in this metric, the Brazilian fund industry does not have exposure to coal mining, despite Vale having coal mining assets in various countries. This discrepancy arises from the sector attribution methodology for each metric (refer to box 2 below). The portfolio weight approach, utilized in exposure metrics, solely considers assets that pertain to the company's primary activity. Therefore, Vale is attributed only to steel production, as it is

the primary sector in which the company operates. On the other hand, the ownership approach used in equities, applied in production volume trajectory metrics, accounts for production in all technologies, even if they are not the company's primary sector of activity. Consequently, Vale is attributed to both steel and coal mining production, despite steel being its main activity.

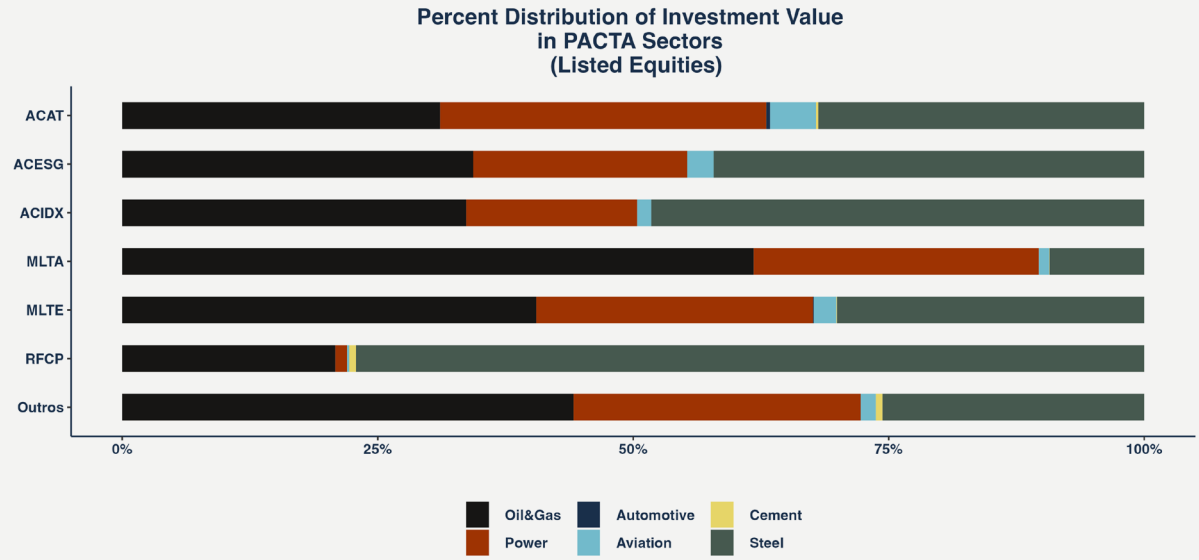


Figure 4: Distribution of the value in listed equity investments across PACTA sectors by fund group

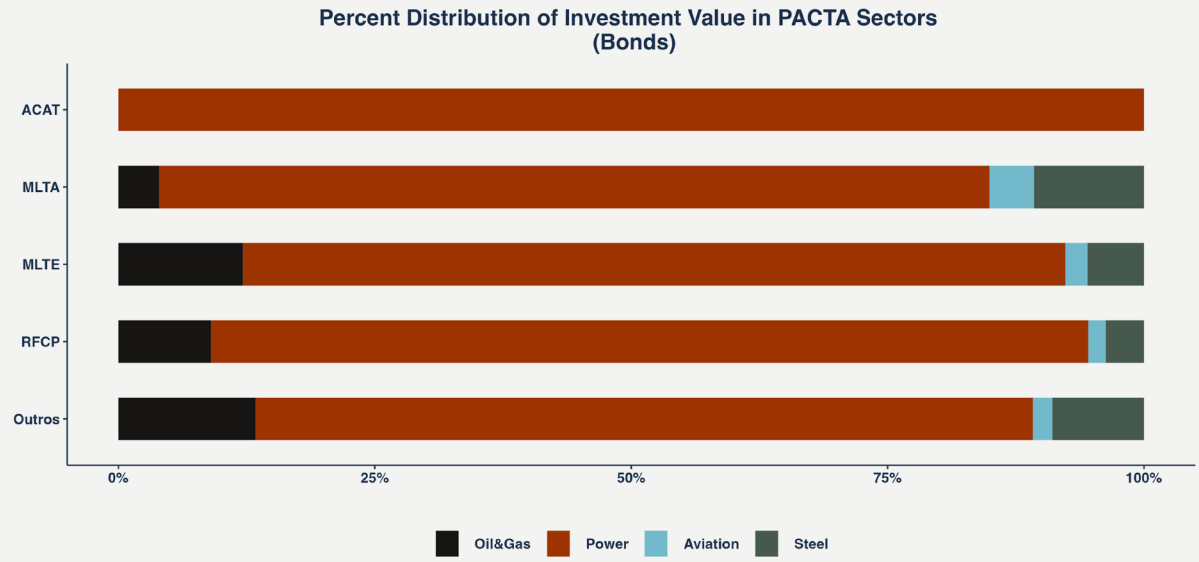


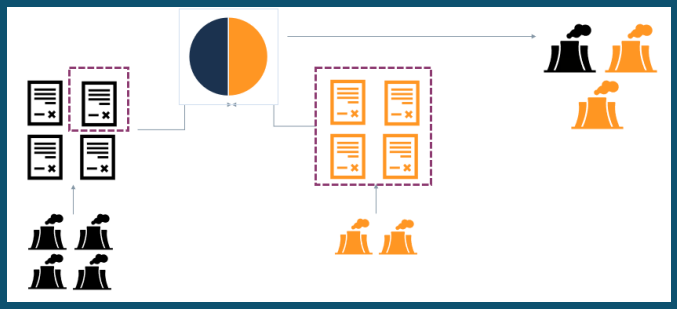
Figure 5: Distribution of the value in bonds investments across PACTA sectors by fund group

Box 2: Ownership Weight vs. Portfolio Weight Approach

The **Ownership Weight Approach (OA)** is based on what the investor owns. It is only used for equity as the equity holder has a proportion of the company that is delimited by the number of shares that they own. As the owner of a proportion of the company, they have control of a portion of the company, depending on the share category it owns.

As an example, let us assume there are two companies that compose a portfolio, each one of them issuing four shares, and the portfolio is the owner of one share of the blue company and four shares of the yellow company (see the illustration below).

Under the ownership approach, 25% of the production of the assets owned by the blue company (1 power station) and 100% of the assets owned by the yellow company (2 power stations) will be attributed to the portfolio. This approach is used mainly in production volume trajectory metrics due to its characteristics of attributing production to the portfolio. Also, in the sense of attributing direct responsibility to companies' production of different technologies, this approach allows the allocation of the production of companies beyond its main activity sector.



The **Portfolio Weight Approach (PA)**, on the other hand, allocates the production of the physical assets of the companies based on the proportion that the company represents in the portfolio. Although bondholders have some bargaining power with the issuer, they do not have decision-making rights, which is why the Ownership Weight Approach cannot be applied to bonds.

The result of the previous example under the Portfolio Weight Approach would be as follows: If the same portfolio is composed of two companies that are equally weighted, the Portfolio Weight Approach would attribute half of the production of the assets owned by the blue company and half of the production owned by the yellow company to the portfolio. Thus, two power stations from the blue company, and one power station from the yellow company.

As mentioned previously, in the individual interactive reports, users can choose the allocation methodology applied in each of their charts, however, for the purpose of this report, the portfolio weight approach was used for corporate bonds and the ownership approach weight for listed equity. The latter attribution method is mainly applied to exposure metrics and accounts only for production in the main activity of the company invested.

The concentration of listed equities and corporate bonds within the climate-relevant sector (as shown in Figure 4 and Figure 5) presents a dual opportunity for both the supervisory body and the Brazilian funds' industry. Firstly, there is the potential for enhancing the management of climate-change risks. Secondly, there exists an opportunity to influence company decisions and performance.

Regarding the improved management of climate-related risks, the results raise concerns due to the concentration of exposure in high-carbon technologies that, based on scenarios, are expected to be phased out in the medium term. This concentration may pose a risk if a late and abrupt transition occurs. From a supervisory perspective, it becomes crucial to ensure that financial institutions begin monitoring their exposure in sectors that are likely to be severely affected by climate change (such as oil and gas, power, etc.) and assess the associated value at risk linked to such investments both presently and in the future. Additionally, forward-looking components should be considered in the assessment process.

While increased exposure to climate-relevant sectors entails higher transition risks, it also means that the Brazilian fund industry possesses a significant level of influence over the strategic plans of these companies. This presents an opportunity for the industry to exert its influence and drive change by encouraging companies to adapt their technologies and establish plans for transitioning towards low-carbon production. If the market is concentrated in a small number of companies, collaborative engagement by investors, coupled with the exercise of their voting rights, can prove highly effective. Investors can proactively request concrete plans from investee companies to align their production with various climate change scenarios. This joint engagement approach can be a powerful catalyst for companies to take action and implement necessary changes.

There are various mechanisms through which an asset manager can generate a positive impact on the real economy through its investment portfolios. Box 3 provides examples of how to transition from risk management to actively promoting positive change in the real economy. From a pure risk management perspective, which falls within the mandate of supervisory authorities like CVM, the preferred method to reduce transition risks would be to exclude climate-related companies from portfolios. Nevertheless, this strategy is suboptimal – and might even be unfeasible due to the dependence of the Brazilian economy on commodities production - since if an investor sells such assets, someone else is likely to purchase them, even if they are impaired, resulting in no substantial change in the real economy.

In cases such as Brazil, where the market is heavily concentrated in a few companies, the possibility of joint exclusion can be considered as a last resort. This approach may involve boycotting new asset issuance, thereby limiting access to capital. Combined with engagement efforts and the exercising of voting rights, this approach can effectively promote mitigation measures that lead to the alignment of production practices. By combining various strategies, such as engagement, voting rights, and potential exclusion as a last resort, asset managers can not only manage transition risks but also actively influence companies to align their production practices with sustainability goals. This comprehensive approach enables asset managers to make a tangible impact on the real economy, driving positive change beyond mere risk management.

Box 3: Strategies for financial institutions to achieve impact in the real economy

Over the last few years, there has been increasing awareness within the financial community of the need for investment strategies to achieve an impact on the real economy. In practice a financial institution can have an impact on the behavior of its investee companies through two broad mechanisms:

- By providing financial support for the transitioning or growth of a company, or
- By supporting companies to transition or grow by using non-financial levers.

The challenge is to adapt impact mechanisms and related climate actions to each individual financial institution and the asset classes they invest in and/or finance. The mechanisms for maximizing the impact of an investor in listed equity compared to a bank providing credit will be different because the opportunities and constraints are very different. For example, secondary markets for equity do not represent an injection of new capital into companies, so the financial support mechanisms are less relevant.

The figure below provides some examples of climate actions that fall under these two broad impact mechanisms and have been identified both from literature and knowledge of the market practice. Other distinct actions exist, such as holdings in infrastructure and real estate funds that manage illiquid assets, but their use will be specific to the investment strategy of an institution.

FINANCIAL SUPPORT	NON-FINANCIAL SUPPORT
• Provision of capital to underfinanced companies (concessional or not) • A focus on Initial Public Offerings (IPO) and pre-IPO equity i.e., primary issuance • Offering of capital at conditional rates • Divestment, exclusion, screening, or conditioning on secondary markets	• Exercising of shareholder rights • Direct engagement with investees • Collaborative engagement in conjunction with other investees • Policy advocacy to change business operating conditions

According to previous research by the 2° Investing Initiative (Ralite, Hagedorn, & Ghirardi, 2021) published in 2021, actions classified under these two categories do not all have the same level of evidence of effectiveness. Direct engagement with companies, the allocation of conditional capital, and the provision of capital at concessional rates are associated with the highest evidence of effectiveness in terms of impacting the behavior of companies. On the other hand, divestment, exclusion, or screening on secondary markets are associated with limited evidence of effectiveness and more recent studies refer to their effectiveness only under specific conditions, for example where divestment is a coordinated action by a large number of institutional investors.

3.2 Climate alignment measurement

The PACTA method relies on forward-looking production and capacity data concerning the climate-relevant sectors, which encompass oil and gas production, coal mining, power generation, automotive manufacturing, aviation, and industry (specifically steel and cement). This method is designed to allocate macroeconomic objectives, aligned with the goals of the Paris Agreement, to microeconomic entities, namely companies. PACTA achieves this by analyzing the production assets underlying companies that have issued listed equity and corporate bonds. By examining these assets and their projected impact on climate-relevant sectors, the method provides a framework for assessing and aligning companies' activities with the goals of the Paris Agreement. It offers a way to link macro-level environmental targets with the specific actions and responsibilities of individual companies in these sectors.

In this section, we present and discuss the results obtained from the analysis of portfolio data made publicly available by CVM's open data platform[7]. We analyze the portfolios' exposures to different climate-relevant sectors and examine the forward-looking production trajectory of portfolio holdings in these sectors. Our primary focus is on comparing these trajectories to the sectoral decarbonization pathways designed by the IEA and the JRC. Detailed descriptions of the scenarios from which these pathways are derived can be found in Annex II.

It is important to emphasize that the analysis of alignment (i.e., the forward-looking assessment) for listed equities and corporate bonds utilizes different portfolio attribution methods. Therefore, a direct comparison of the results between portfolios in the two asset classes requires careful consideration. For listed equities, the portfolio attribution of production is conducted using the ownership approach. This approach assigns production results based on the proportion of outstanding shares owned by investors in the respective companies. On the other hand, for corporate bonds, the attribution of production is performed using the portfolio weight approach. This approach attributes the production of the ultimate obligor for the debt to the portfolio based on the size of the holdings relative to the holdings of debt from other companies in the same sector. To gain a comprehensive understanding of both attribution approaches, a detailed explanation can be found in Annex I of the report.

All the obtained results are compared to specific benchmarks for listed equities and corporate bonds. For listed equities, the benchmark used in the analysis is the ETF for iShares MSCI Emerging Markets. This ETF consists of a portfolio of emerging market equities. By comparing the results of the portfolios to this benchmark, it allows for an assessment of their performance and alignment with the broader emerging market equity market. For corporate bonds, the benchmark used is the iShares Global Corp Bond UCITS ETF. This ETF is designed to track the performance of an index composed of investment-grade corporate bonds. The index includes bonds issued by companies from both emerging and developed markets. Comparing the portfolio results to this benchmark provides insights into the performance and alignment of the portfolios with the investment-grade corporate bond market.

It is important to note that the timestamp of this report is December 31, 2021. As a result, all the data presented in the analysis reflects static results as of that specific date. In charts or visuals where the start date is indicated as "2021," it should be interpreted as representing the end of the year 2021 rather than the full 12-month period of the year 2021.

This section is divided by the sector analyzed. All main PACTA metrics are displayed for each sector analyzed together with its interpretation and conclusions.

7 For reference, all data can be downloaded in this website: https://dados.cvm.gov.br/dataset/fi-doc-cda

3.2.1 Fossil Fuels

Brazil is the largest oil producer in Latin America and ranks as the eighth-largest oil producer globally. Additionally, it stands as the fifth-largest oil consumer worldwide (International Trade Administration, 2023). The national oil company, Petrobras, holds a dominant position, contributing to approximately 90% of Brazil's oil production. The majority of Petrobras' activities are focused on offshore operations, which will remain the primary focus of the company's investments in the coming five years.

Given Brazil's status as the largest oil producer in Latin America, it would be expected to take a leading role in regional decarbonization efforts. However, the national forecast for oil production indicates a significant increase from 3.6 million barrels per day in 2022 to 5.5 million barrels per day by 2029, as outlined in the 10-year national energy expansion plan (Empresa de Pesquisa Energética, 2020). This projection presents a challenge in terms of aligning with decarbonization goals and transitioning to more sustainable energy sources.

The production of oil and gas plays a crucial role in Brazil's economy, with Petrobras holding a central position within the financial market. Notably, the ordinary and common shares of Petrobras account for over 10% of the weight of the national stock market index, known as the Ibovespa (B3, 2023). This highlights the significance of Petrobras within the Brazilian financial landscape. Furthermore, as Petrobras is partially state-owned, the revenue generated from its oil and gas production contributes to public spending and supports the achievement of socio-economic goals. The company's activities contribute to the government's ability to invest in various sectors, provide public services, and pursue developmental objectives. This connection between Petrobras' revenue and public spending underscores the interdependence between the company's operations and the broader socio-economic goals of Brazil.

Considering the significant importance of the fossil fuel sector to Brazil's economy and the financial market, it is reasonable that the Brazilian fund industry exhibits an average exposure of 10% in its equity portfolios to this sector (refer to Figure 6). This level of exposure is notably higher than that of the iShares MSCI Emerging Markets benchmark and other countries where similar studies have been conducted.

Among the different fund categories, the Multimercado Ações (MLTA) funds stand out with a particularly high exposure of over 30% in their equity portfolios to the fossil fuel sector. It is also interesting to notice that the funds classified as ESG has as much exposure to fossil fuels as the other funds' categories. The exposure to the fossil fuel sector is not a problem in itself, but the alignment of these investments regarding the environmental goals present in ESG standards combined with the evaluation of actions funds are taking to align their positions are important aspects to monitor. This finding requires attention from the authorities as it might be a result either of a lack of precise definition of the ESG or, in an extreme case, greenwashing.

In contrast, the exposure to fossil fuels in bond portfolios is considerably lower compared to equity portfolios, amounting to less than 3%. This exposure level is also lower than the benchmark, indicating a relatively reduced allocation to the fossil fuel sector in bond investments.

Within the analyzed production technologies comprising the fossil fuel sector, investments exhibit a significant concentration in oil, while gas represents less than 10% of the total exposure on average. It is worth noting that the exposure metric employed in PACTA uses the portfolio weight approach, which results in no exposure to coal mining, despite the presence of major mining and metals operations in Vale. As explained previously in this report, the lack of exposure to coal occurs because Vale is primarily classified within the steel sector, and therefore its coal assets are not considered in this specific metric.

However, it is important to highlight that Vale's coal assets will be evaluated and accounted for in the volume production trajectory metric, which employs the ownership approach. This approach considers the overall production volume of different technologies, including coal mining, even if it is not the company's primary sector of activity. Thus, the assessment of Vale's coal assets will be factored into the volume production trajectory analysis.

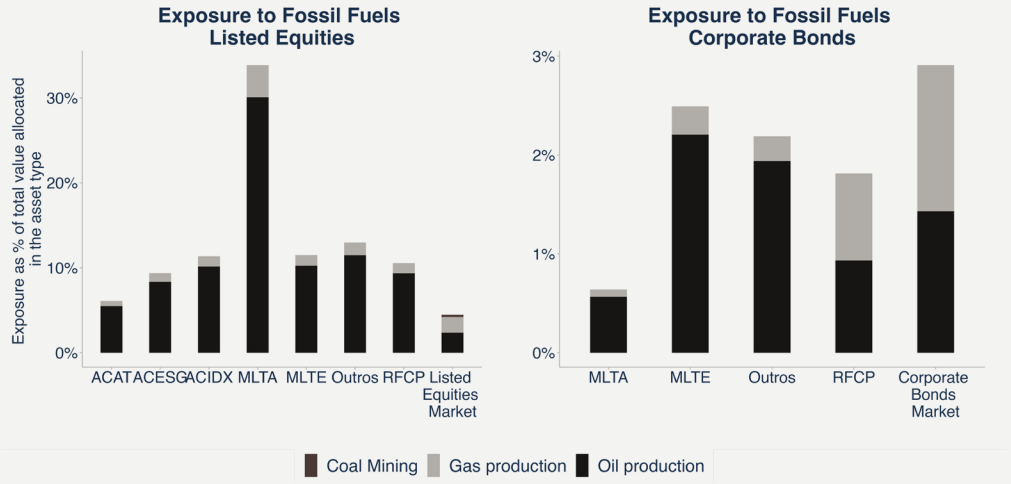


Figure 6: Share of aggregated portfolio value (exposure) invested in companies active in fossil fuel industries, by fund group

In addition to the already high exposure to the fossil fuel sector, the production plans of oil and gas investee companies indicate a significant increase in the next five years. This growth trajectory is in misalignment with the net-zero scenario outlined by the International Energy Agency (IEA) and goes against the goals set by the Paris Agreement (refer Figure 7). The current trend of production plans aligns with a pathway that would result in a temperature rise exceeding 2.7°C, which is considerably higher than the target set by the Paris Agreement. This not only has detrimental implications for the environment but also raises significant concerns about the future sustainability of the Brazilian fund industry.

It is essential to acknowledge that fossil fuels will need to be phased out within the next three decades. According to the IEA's net-zero scenario, there is no room in the carbon budget for new investments in oil and gas fields or the expansion of coal mines since 2021 (International Energy Agency, 2021). In the event of a delayed and sudden transition to a low-carbon economy in Brazil, funds with substantial allocations to these high-carbon technologies may face financial losses due to their significant exposure to fossil fuels. The risk is further exacerbated by the fact that all fund groups appear to be heavily invested in the same few oil and gas producers, as indicated by the overlapping lines in the charts. Consequently, if any of these producers experience stranded assets due to climate-related risks (both transition and physical), it would impact all funds and investors.

The higher the exposure to the fossil fuel sector, the greater the potential value at risk, necessitating close monitoring of future climate risks within the portfolios of the Multimarket Allocation funds (Multimercado Alocação - MLTA). It is crucial to remain vigilant about climate-related risks and their potential impacts on investments in order to safeguard against potential financial vulnerabilities and ensure the long-term resilience of portfolios.

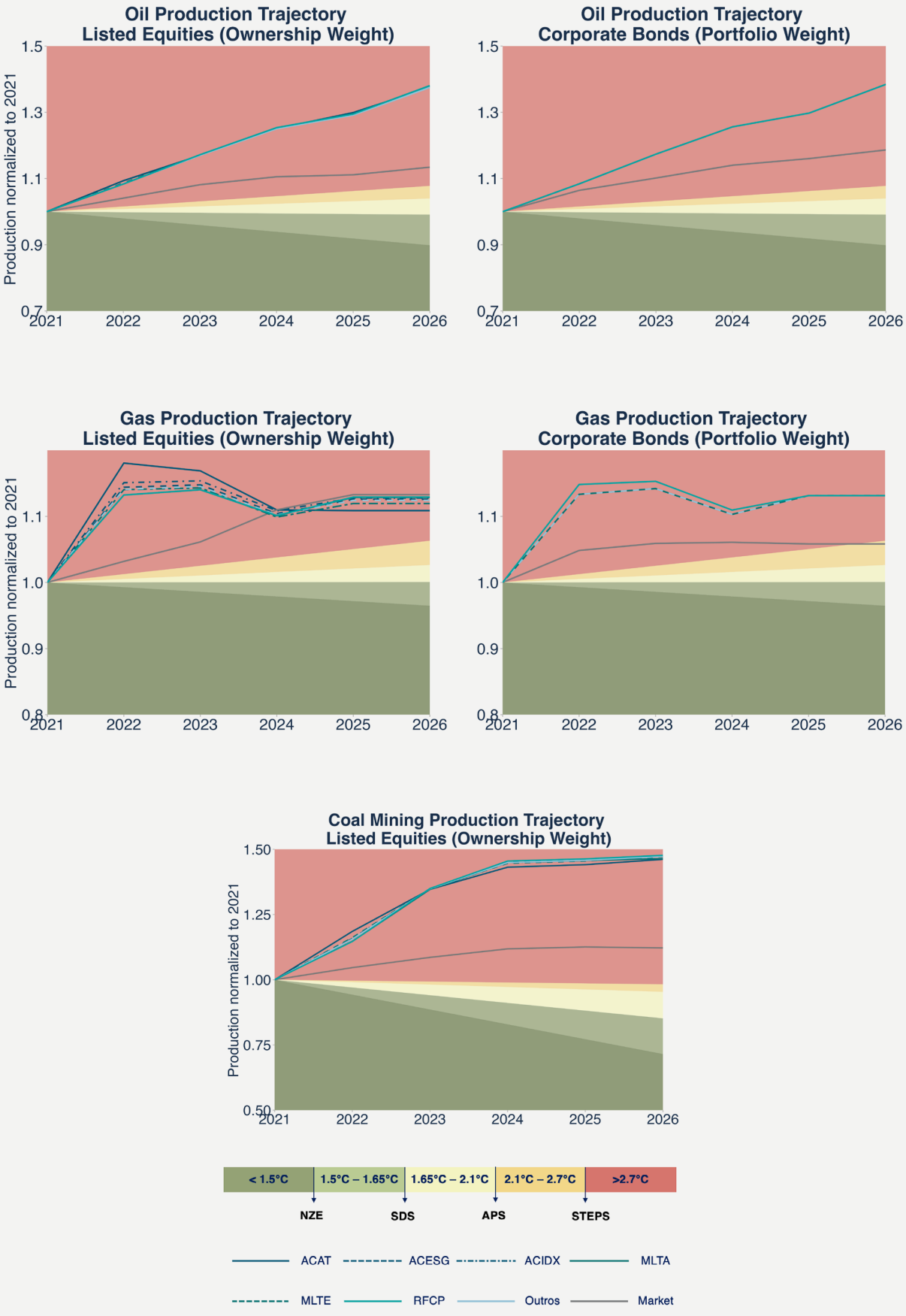


Figure 7: Alignment of oil, gas, and coal mining production plans with global decarbonization scenarios

Box 4: A glance at the Petrobras and Vale volume production trajectories

In Brazil, asset managers have significant allocations and exposure to two major companies involved in oil, gas, and coal production: Petrobras and Vale.

Vale is the world's largest producer of iron ore, iron pellets, and nickel, with additional operations in manganese, ferroalloys, copper, gold, silver, and cobalt. In 2021, Vale announced its intention to exit the coal business and focus on its core operations and becoming a leader in low-carbon mining (Vale SA, 2023). However, despite this announcement, the company reported an increase in annual coal production, reaching 8.5 million metric tons (SteelOrbis, 2023). It is important to note that Vale sold its coal assets as a going concern to an Indian conglomerate in 2022, indicating that any reduction in exposure to coal production for Vale's investees resulted from this divestment rather than a closure of production capacity.

Petrobras, the Brazilian state-owned oil and gas producer, exceeded its planned oil and gas production in 2022 by 3.2%, producing 2.684 million barrels of oil equivalent per day compared to the expected 2.600 million (Rigzone, 2023). The company continues to invest in the development of new offshore platforms, particularly in exploiting deep offshore reserves such as the Buzios field (Bnamericas, 2023). Petrobras also announced a USD 16 billion revitalization program for one of its offshore basins (Offshore Energy, 2023). In a positive move towards developing low-carbon energy sources, Petrobras signed an agreement with the Norwegian national producer Equinor in March 2023 to evaluate the potential for seven offshore wind projects in Brazil (Equinor, 2023). However, it is noteworthy that since 2016, Petrobras has progressively divested from large-scale bioethanol production to focus on oil and gas production.

These developments contrast with the pathways outlined by the International Energy Agency (IEA), which indicate a significant decrease in fossil fuel demand. According to the IEA, oil demand is expected to reach its peak before 2030, with eventual declines projected in all scenarios. Coal faces an even more drastic decline in demand. Gas, on the other hand, is still considered a transitional fuel and is expected to experience growth in demand over the next five years, with divergent trends in subsequent years based on different scenarios. Overall, the share of fossil fuels in the primary energy mix is projected to decrease to around 70% by 2030 in the IEA's Sustainable Development Scenario. In the IEA's Net Zero by 2050 scenario, a significant scale-up of clean energy sources is required, resulting in a reduction in fossil fuel demand to the extent that no new development or exploitation is needed from 2021 onwards.

In light of these projections, the production plans of Petrobras in oil and gas and Vale in coal, despite the divestment, are not aligned with the Net Zero by 2050 scenario, as depicted in Figure 8. It is also worth noting that the production volume trajectories of Petrobras and Vale in the fossil fuel sector align with the trajectories expected for all peer groups, as shown in Figure 7. This reinforces the hypothesis of exposure to transition risk in the event of a delayed and sudden adjustment to a low-carbon economy.

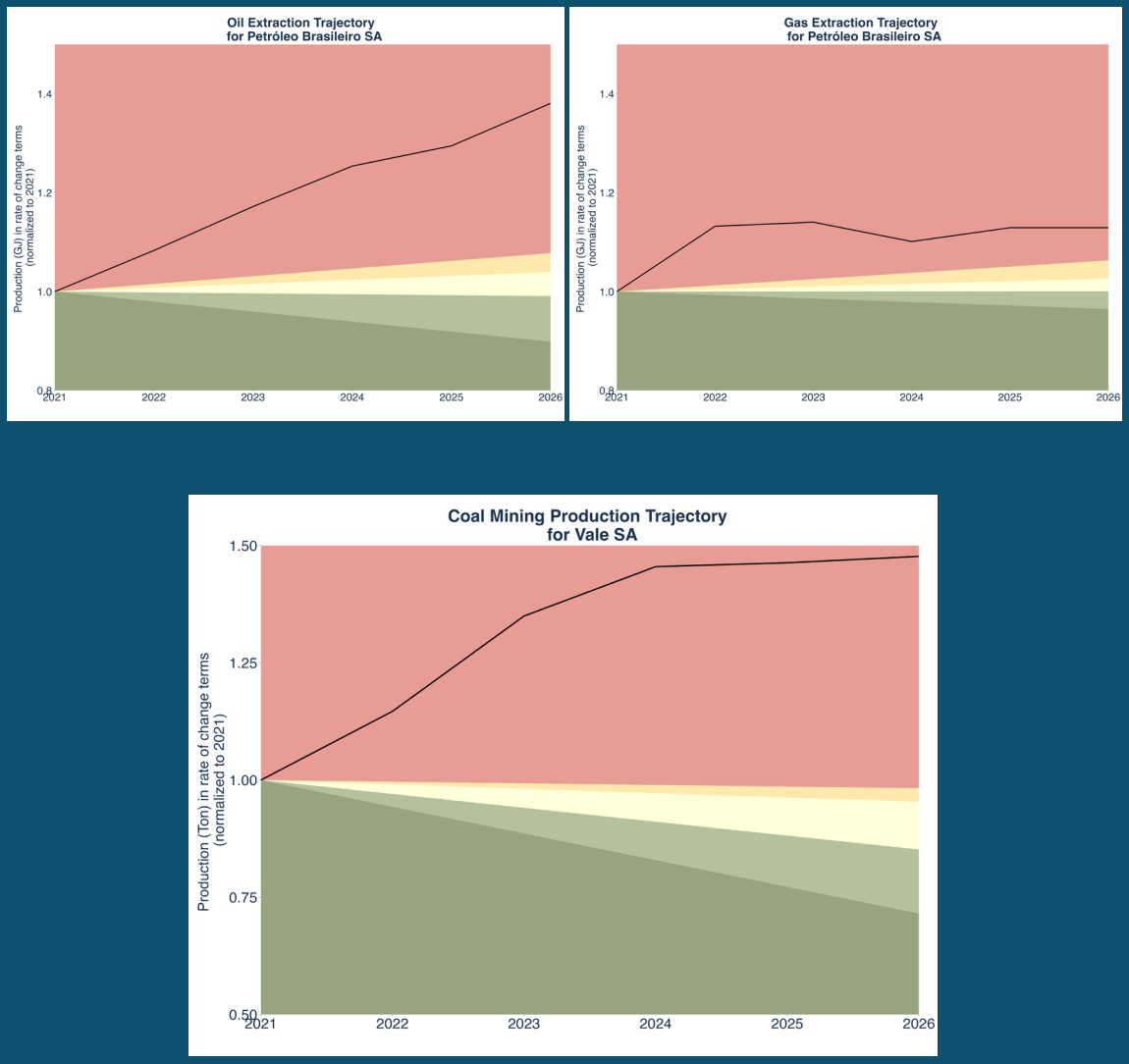


Figure 8: Alignment of Petrobras and Vale in oil, gas, and coal mining with global decarbonization pathways

3.2.2 Power

The power sector has been undergoing a significant transformation globally, driven by various factors including the declining costs of renewable energy sources, increased awareness of climate change, and the need to reduce greenhouse gas emissions. Over the past five years, there has been a notable shift in power production and consumption patterns. Renewable energy sources, such as wind and solar photovoltaic (PV), have experienced substantial growth in capacity. The rapid decrease in the cost of renewable technologies has made them increasingly competitive with fossil fuel production in many regions. This has led to a surge in the installation of wind and solar PV systems, resulting in a significant increase in their overall capacity.

The Covid-19 pandemic and the recent energy crisis have also played a role in shaping consumer behavior and influencing global and regional energy markets. These events have highlighted the importance of secure and sustainable energy sources, driving further interest and investment in renewable energy technologies. As the world transitions towards a low-carbon future, electricity is expected to play

a central role, not only in power generation but also in the electrification of various sectors such as transportation and heavy industries like steel production. This shift necessitates financial flows to support the development of new renewable energy capacity and the adoption of clean technologies. Investments are required to expand hydropower and renewables capacity, along with the reinforcement and extension of electricity supply infrastructure. Overall, the transformation of the power sector reflects the global commitment to reduce reliance on fossil fuels and transition towards cleaner, more sustainable energy sources. This transition presents opportunities for financial institutions, investors, and governments to support the development of renewable energy projects and the implementation of necessary technological advancements to achieve a greener and more resilient energy system.

According to data from the Brazilian Energy Balance (BEN) and the International Energy Agency (IEA), Brazil's power sector stands out as one of the least carbon-intensive in the world. In 2020, renewables accounted for approximately 48% of the energy mix, surpassing the global average of 14%. It is worth noting that hydroelectric power plays a crucial role in Brazil's electricity production, representing around 65% of the country's electricity mix. Furthermore, other renewable sources like biomass thermal generation, solar, and wind are steadily gaining importance, further contributing to Brazil's comparative initial advantage in the renewable energy sector.

Despite the favorable characteristics of Brazil's power sector, there are still areas that require improvement. According to the International Energy Agency (IEA), in order for Brazil to effectively contribute to achieving a pathway of keeping global temperature rise below 2°C, there is a need to increase renewable capacity by 43% by 2030 compared to the levels in 2020. Additionally, the high reliance on hydroelectric power should be diversified by integrating other technologies like wind and solar photovoltaic (PV) into the energy mix.

Simultaneously, as climate change leads to a higher occurrence of droughts and reservoirs accumulate silt and vegetation, hydroelectric power companies may confront a substantial decline in their power generation capacity. This, in turn, can result in escalated energy costs and a greater reliance on non-renewable sources, such as oil, within Brazil. Recent endeavors like the Belo Monte project have already demonstrated a significant reduction in output compared to their intended capacity. In 2021, the influence of weather-related events had a notable impact on power prices in Brazil, prompting a more than threefold year-on-year surge in the country's liquefied natural gas imports. Unfortunately, the outlook appears unfavorable when considering the forecast by the Intergovernmental Panel on Climate Change (IPCC) (Seneviratne, 2012), which predicts an escalation in the frequency and intensity of cyclical climatic phenomena like El Niño-Southern Oscillations (ENSO). These events have the potential to exacerbate extreme regional precipitation and heighten risks to hydropower generation by altering water availability, increasing sedimentation, or inflicting physical damage to infrastructure (IPCC, 2014).

In addition to the physical and transition risks, the growing social risks associated with climate change can also affect the functioning of hydropower plants and energy generation. A UN study (Cernea, 2004) identifies four primary categories of adverse social effects linked to hydroelectric projects, which can pose challenges to the operational viability of such plants. These categories include:

I) Forced population displacement and impoverishment: Hydropower projects often necessitate the resettlement of communities residing in areas designated for dam construction. The displacement of these populations can lead to social and economic hardships.

II) Boomtown formation around major constructions: The development

of large-scale hydroelectric projects can result in the rapid influx of workers and the subsequent formation of boomtowns in the vicinity. This sudden population increase can strain local infrastructure and services.

III) Unanticipated changes in downstream agro-production systems: The construction of dams and reservoirs can bring about unintended alterations to downstream agricultural production systems. These changes can disrupt existing farming practices and impact local communities that rely on agriculture for their livelihoods.

IV) Loss of cultural heritage assets: The inundation of land for reservoirs can result in the submergence of culturally significant sites and the loss of tangible and intangible heritage. This can have profound social and emotional implications for affected communities.

These social risks associated with hydropower projects highlight the importance of considering not only the technical and economic aspects but also the social and cultural dimensions when planning and implementing such energy generation initiatives.

When examining the Brazilian funds industry's exposure to the power sector, the analysis reveals that, on average, approximately 5-10% of the portfolios surveyed have allocations to this sector. Among the peer groups, the Multimarket Allocation (MLTA) funds exhibit the highest exposure, with over 15% of their equities and bonds portfolios allocated to the power sector. These findings align with a previous PACTA study conducted for the Brazilian National Superintendence for Pension Funds, which reported that around 15% of bonds portfolios and 7% of equities portfolios were allocated to the power sector. In comparison, developed countries such as Switzerland and Norway typically exhibit lower exposure to the power sector, with allocations not usually exceeding 5% of portfolios.

In both equities and bonds, Brazilian asset managers exhibit a significantly higher exposure to the power sector compared to market benchmarks (refer to Figure 9). Among the various technologies within the sector, hydroelectric power receives the highest financial allocation, followed by coal power and then renewables (with renewables being particularly notable in bonds portfolios). It can be observed that overall, the portfolios are largely allocated to low-carbon technologies, and this is primarily attributed to the existing technology mix of the electricity grid in Brazil.

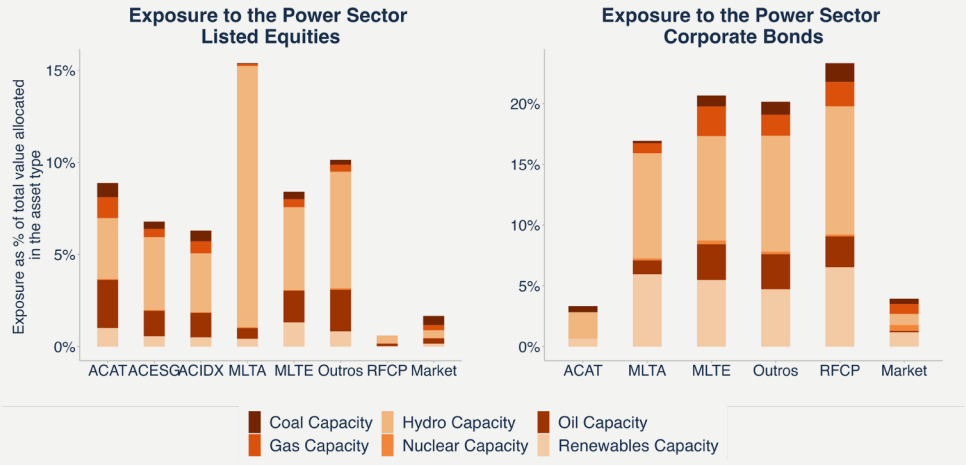


Figure 9: Share of aggregated portfolio value (exposure) invested in companies active in the power industry, by fund group

The power technology mixes that underlie the exposure of the Brazilian fund industry to the power sector and their alignment measurements for the next five years are depicted in Figure 10 and Figure 11. The bars representing the planned production of invested companies in each technology for 2021 and 2026 illustrate the forward-looking aspect. To align with the IEA's Net Zero by 2050 scenario by 2026, it is evident that all categories of funds would need to more than triple their exposure to renewables while reducing their exposure to coal and gas power capacity by approximately half. Furthermore, careful attention should be given to how this increased exposure is achieved, with a specific focus on investments made by companies to expand their production capacity, rather than relying solely on portfolio reallocations to increase exposure to renewables.

Across all asset categories, the planned expansion of renewables in all groups is relatively modest over the next five years. However, in the case of fixed income funds (RFCP) and their bond portfolios, the companies they are exposed to have indicated a planned increase in the share of renewables from 20% to 35%. Nevertheless, this falls short of the 46% share required to align with the Net Zero by 2050 scenario. Among the other peer groups, there is an average anticipated increase in the share of renewables in equities portfolios from 4% in 2021 to 9% in 2026. However, to achieve alignment with the scenario, a share of 35% is necessary.

Once again, we highlight that the group of funds labeled as ESG has no additional exposure to renewables or low-carbon technologies than other funds groups, and the build-out planned is also not nearly close to the scenario requirement for 2026 – also a similar trend to the other funds' classifications.

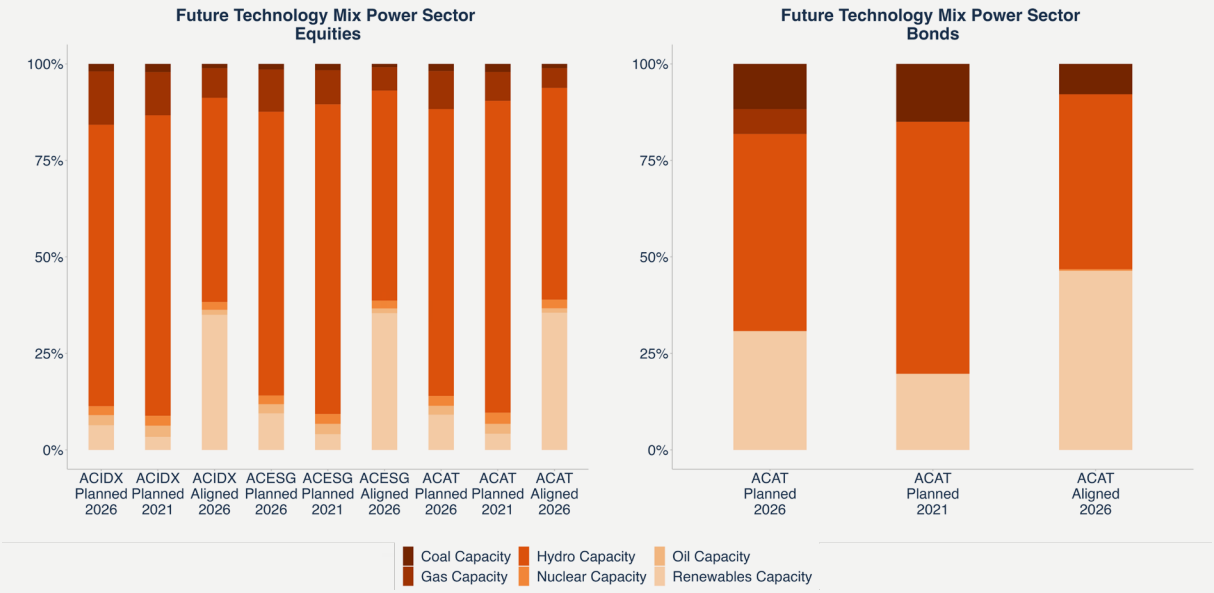


Figure 10: Technology mix as a percentage of allocated exposure to the power sector, equity funds groups

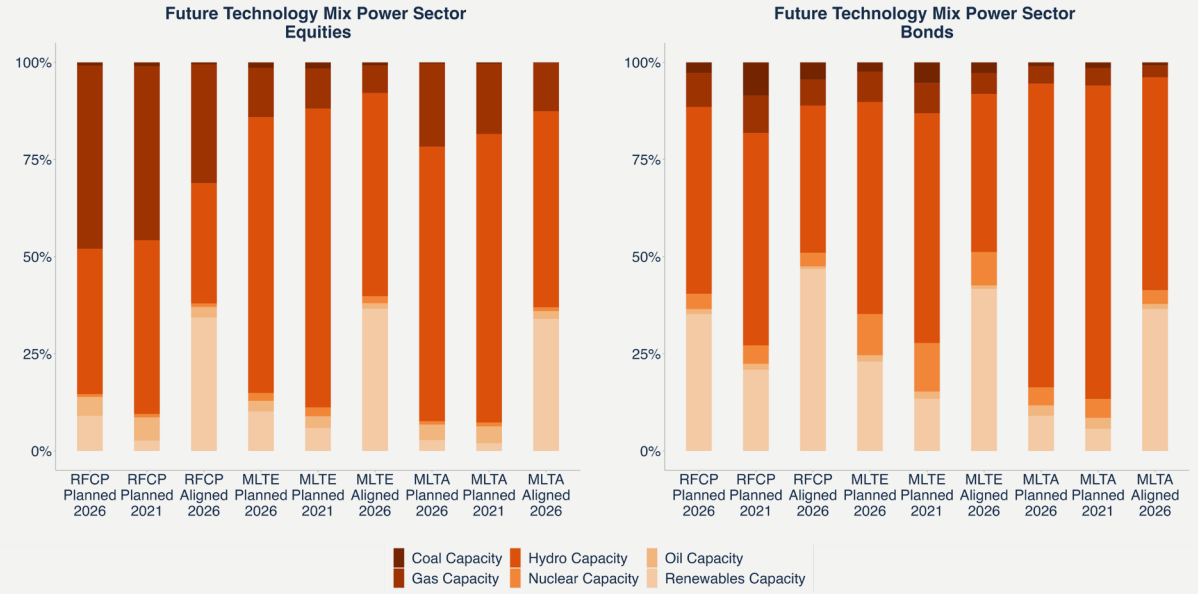


Figure 11: Technology mix as percentage of allocated exposure to the power sector, multimarket and fixed-income funds groups

In accordance with the overall trend in technology mix, the volume production trajectory of the underlying assets in the portfolios of the Brazilian fund industry shows misalignment across almost all technologies and asset types analyzed for the next five years (see Figure 12). In terms of high-carbon technologies, coal-fired power capacity is projected to remain relatively stable in equities portfolios or decrease in bonds portfolios over the next five years. Gas capacity is expected to see a slow increase across all groups of funds and asset classes, leading to misalignment with the IEA Net Zero by 2050 scenario towards the end of the period. Oil power capacity is projected to remain stable, while the scenario indicates a rapid decrease.

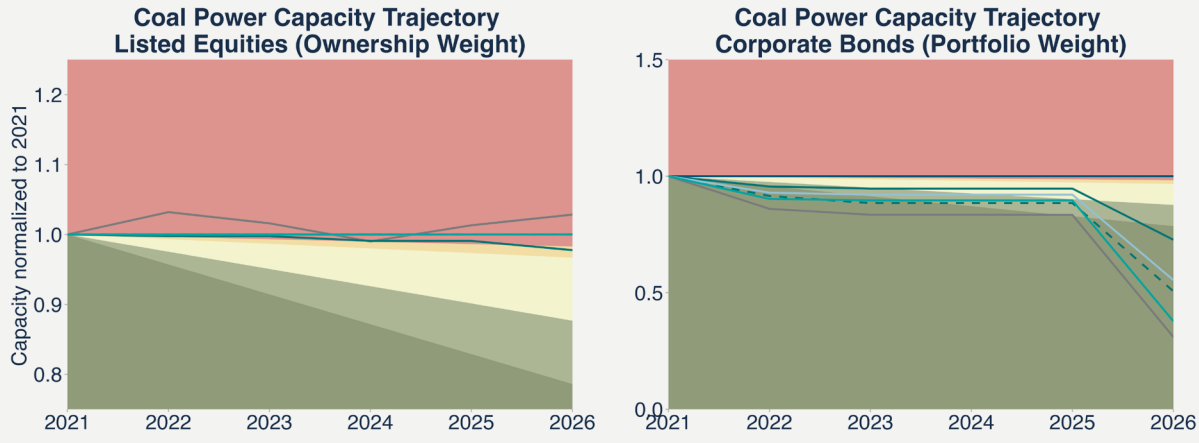


Figure 12: Alignment of coal, gas, and coal power capacity plans with global decarbonization scenarios

The forward-looking production plans for low-carbon technologies in the portfolios of the Brazilian fund industry also present challenges (see Figure 13). Hydroelectric power capacity shows relatively better results, with most groups of funds aligning with the Net Zero by 2050 scenario by the end of the five-year period. However, the capacity remains almost constant for the majority of the period, with minimal increases. It is important to note that expanding hydroelectric power capacity requires significant infrastructure investments, long planning and construction timelines, and the identification of suitable sites with adequate water resources. Therefore, immediate investment is necessary to increase hydroelectric power capacity in the future, and financial flows need to shift from high-carbon technologies to companies that are expanding their capacity in low-carbon technologies.

In the case of renewables, the scenarios indicate a need for a 25% to 45% increase in capacity to align with the continuous build-out required in the coming years. However, most of the portfolios of asset managers remain misaligned throughout the analyzed period.

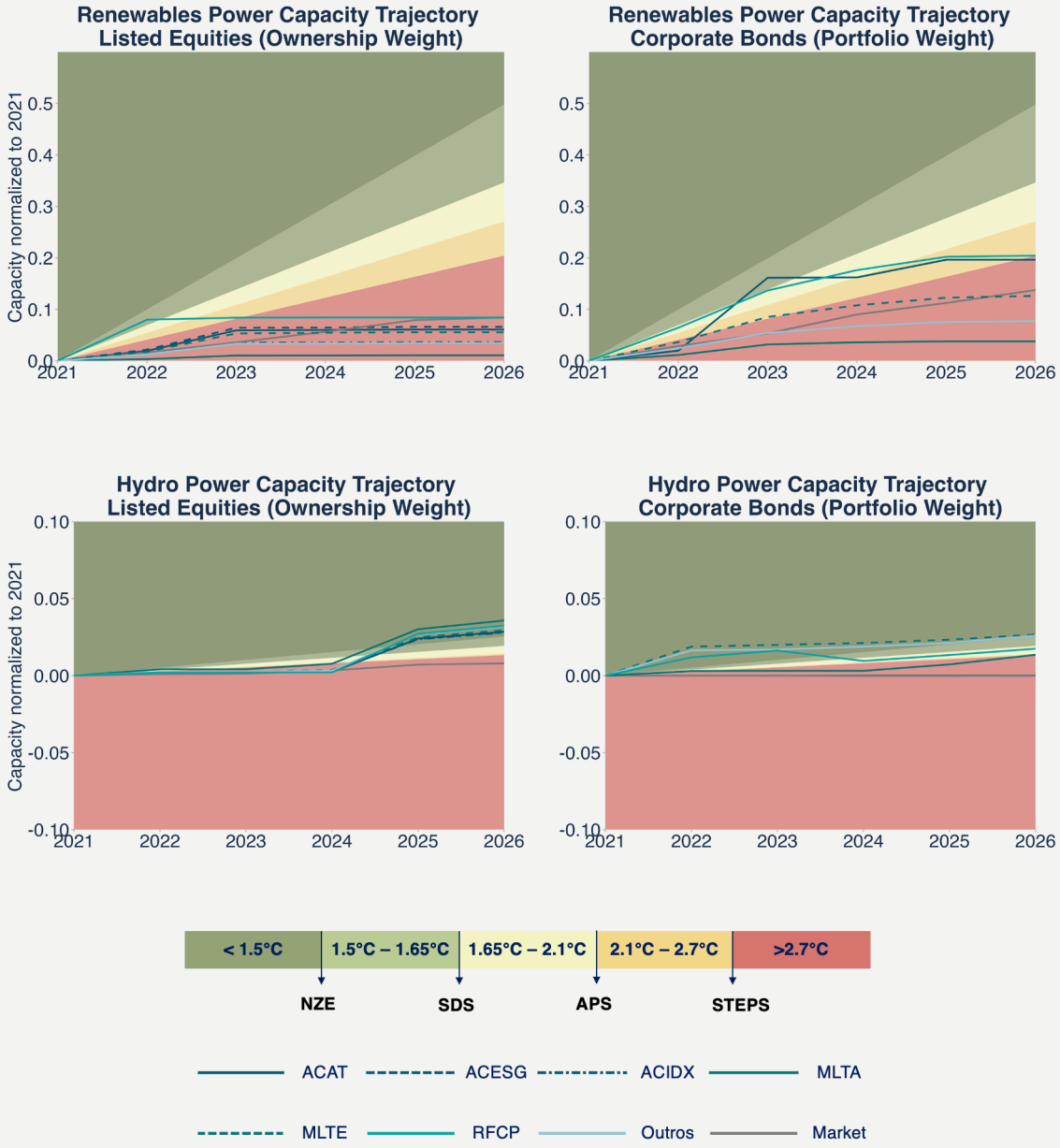


Figure 13: Alignment of renewables and hydropower capacity plans with global decarbonization scenarios

3.2.3 Automotive

Brazil has a rich automotive industry heritage and has long been a prominent player in car manufacturing within Latin America. Renowned global car manufacturers such as Fiat Chrysler Automobiles, Volkswagen, Ford, and General Motors have established their plants in the country to cater to the demand of what is currently the sixth-largest car market worldwide (Statista, 2023). On a national scale, Brazil holds the position of the eighth-largest producer of passenger vehicles (Statista, 2023). Beyond car production, Brazil boasts a well-established supply chain comprising car parts manufacturers that support the overall manufacturing process. Moreover, the country has a successful track record in embracing biofuels for passenger cars and transportation as a whole. This includes not only light vehicles but also heavy-duty vehicles and even aviation. Brazil's fleet of vehicles has the capability to operate with both gasoline and ethanol, derived from sugar cane. This dual-fuel capability provides a distinct advantage as the use of

liquid biofuels is projected to increase in all scenarios outlined by the International Energy Agency (IEA). Specifically, in the Net Zero by 2050 scenario, the use of liquid biofuels is expected to more than double by 2030, with a growing proportion derived from non-food crop feedstocks.

Despite Brazil's historical significance in the automotive sector, it is important to note that the country does not have a domestic car manufacturer of its own. As a result, the exposure of the analyzed funds to the automotive sector is primarily focused on investments in foreign companies. These investments include prominent names such as Tesla, General Motors, Ford, Harley-Davidson Inc, Honda Motors, and Toyota Motors.

When examining the exposure metric, it becomes evident that the funds' equities portfolios have a relatively low allocation to the automotive sector, accounting for less than 0.25% of the total equities portfolio. There is no exposure to the automotive sector observed in the bond portfolios of the analyzed funds.

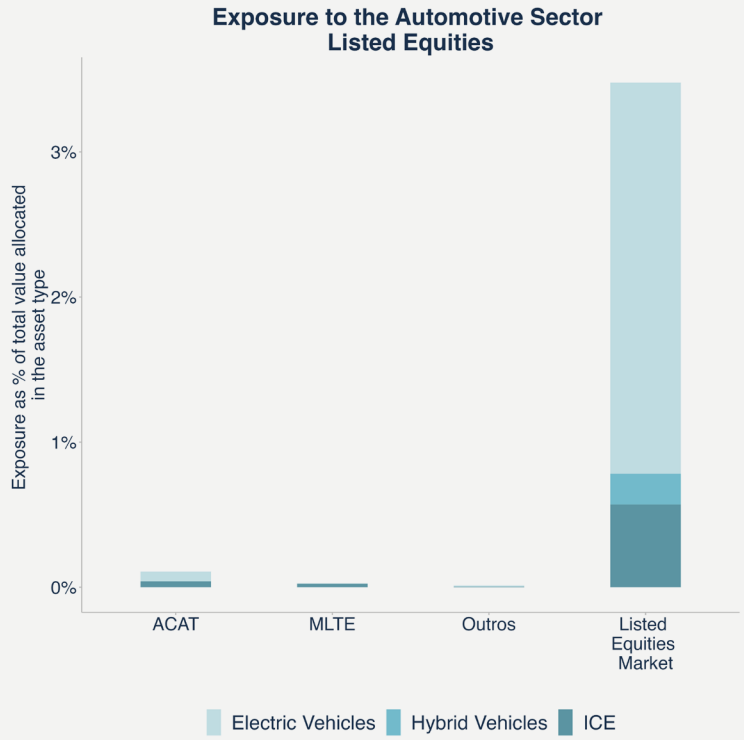


Figure 14: Share of aggregated equity portfolio value (exposure) invested in companies active in automotive industry, by fund group

Given the limited exposure of the analyzed funds to the automotive sector, it would be beneficial for the supervisor to adopt a comprehensive approach to monitor alignment, transition risks, and the impact of asset managers on promoting changes within the sector. In addition to utilizing tools like PACTA, other sources of analysis should be considered.

One such source of analysis could involve a collaboration between the Brazilian Securities and Exchange Commission (CVM) and the Central Bank of Brazil to conduct a joint assessment of the lending portfolios held by major banks. This analysis would provide insights into the overall production profile that financial institutions are financing, as well as the risks they are exposed to. By examining the lending practices of these banks, a clearer picture can be formed regarding the role they play in supporting the automotive industry and the potential risks associated with their financing activities. In addition, a qualitative approach should be considered when evaluating how sustainability topics are being

addressed by development banks in Brazil that provide support to car manufacturers during the lending approval process. Development banks are a crucial source of capital for the industry in the country, and understanding their approach to sustainability can provide valuable insights into the sector's trajectory and potential areas for improvement.

Despite the limited exposure and mainly foreign investments in the automotive sector, it is important to review the alignment charts for Internal Combustion Engine (ICE) and electric vehicle (EV) production. Although no immediate action may be triggered by the small exposure, these charts serve as a starting point for discussions regarding the alignment of financial flows in the automotive sector.

Figure 15 and Figure 16 indicate that asset managers' positions in ICE technology are projected to increase by 10% to 20% over the next five years. This trajectory is misaligned and exceeds the expected benchmark trajectory. Conversely, the production of electric vehicles demonstrates full alignment with the goal of limiting temperature rise below 2°C, as indicated by the Global Energy and Climate Outlook Scenario. While the current exposure to the automotive sector may not warrant immediate action, it is crucial to initiate conversations about the alignment of financial flows within the sector. By addressing the misaligned trajectory in ICE technology and recognizing the alignment of electric vehicle production with climate goals, opportunities can be identified to encourage a shift towards more sustainable and low-carbon transportation options.

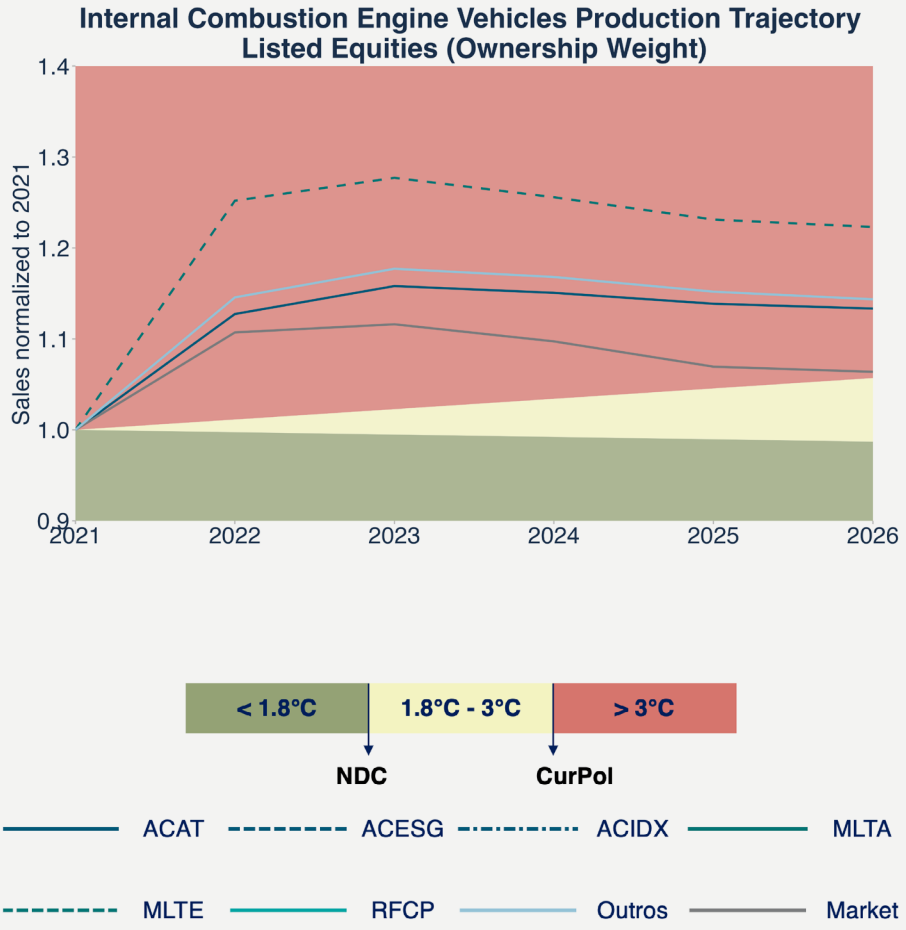


Figure 15: Alignment of Internal Combustion Engine vehicles production with global decarbonization scenario

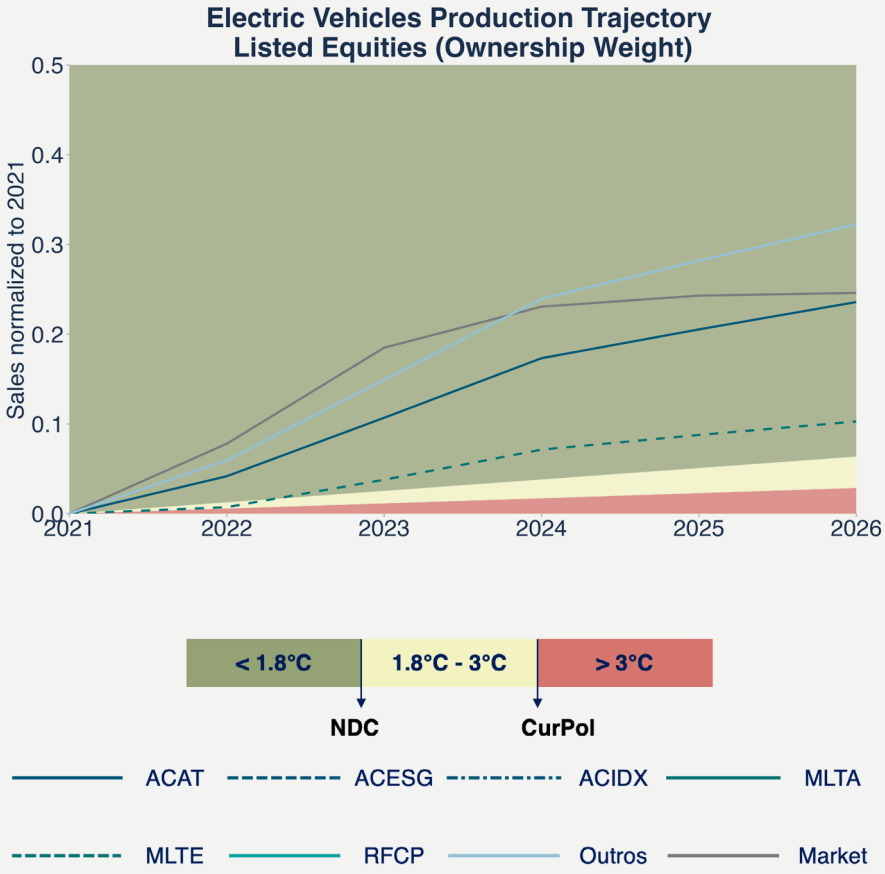


Figure 16: Alignment of Electric vehicle production with global decarbonization scenario

3.2.4 Aviation

Brazil is home to Embraer, one of the largest aircraft manufacturers globally. Embraer specializes in the production of regional and short-haul aircraft, which are utilized by major airline companies like American Airlines, Delta, United, Air Canada, KLM, as well as Brazilian airlines Azul and Gol.

In June 2022, Embraer achieved a significant milestone by successfully conducting a 70-minute flight using sustainable fuel (Embraer, 2023). Although the solution has not yet received certification due to the absence of standards for aircraft operating with non-blended fuels, Embraer has expressed its readiness to make the sustainable fuel commercially available. This development highlights Embraer's commitment to sustainable aviation and reducing the environmental impact of air travel. By exploring alternative fuel options, Embraer aims to contribute to the aviation industry's efforts in mitigating carbon emissions and promoting greener practices.

In the pursuit of greening portfolios in the aviation sector, asset managers should consider not only the availability of sustainable aircraft fuel but also the efforts made by airlines to improve operational efficiency and enhance the performance of their aircraft fleets. Operational efficiency measures can significantly contribute to reducing carbon emissions and improving environmental sustainability. Given the considerable lead times involved in investing in new aircraft and the extensive research and development required to introduce innovative materials, designs, and technologies, it is crucial that investee companies are actively involved in the development and testing of low or zero-carbon fuels

and technologies. This ensures that these advancements can be commercialized in a timely manner, enabling the aviation industry to maintain its momentum towards sector-wide decarbonization, particularly during the critical period leading up to 2030.

The analysis reveals that the funds analyzed have a minimal allocation, less than 1%, to the aviation sector in their listed equities portfolios. This finding aligns with similar studies conducted in other countries. The exposure is primarily concentrated in the passenger aviation segment, reflecting the focus of national airline companies such as Azul and Gol. It is worth noting that there is no exposure to the aviation sector in the corporate bond portfolios of the funds analyzed.

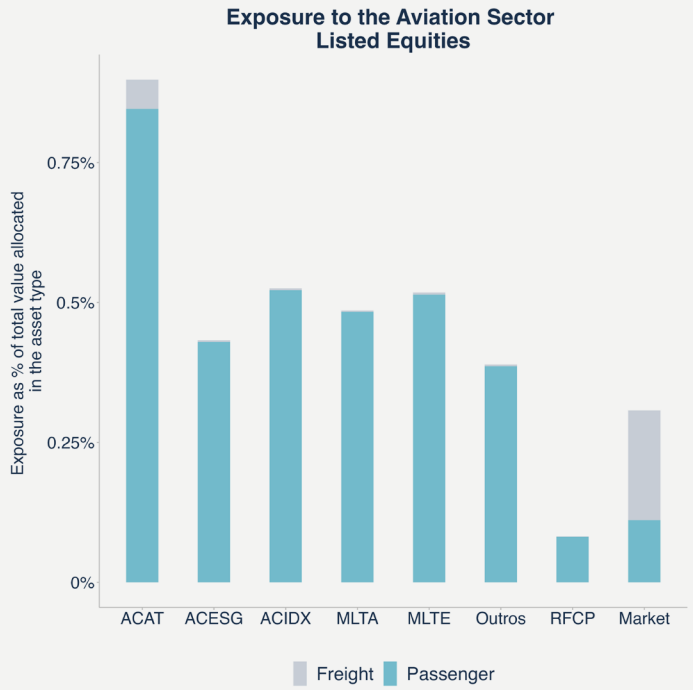


Figure 17: Share of aggregated equity portfolio value (exposure) invested in companies active in aviation industry, by fund group

The analysis of emissions intensity alignment reveals a disparity between the emission reduction targets that airlines should be aiming for and their current trajectory. The measurement is based on the 1.5°C scenario of the JRC GECO scenarios.

According to the analysis, airlines will need to reduce their emissions intensity per revenue passenger kilometer and per tons of freight handled by 10 to 20% over the next five years. However, the current trajectories of the investee companies in Brazilian fund portfolios indicate a significant gap in achieving these reduction targets. This misalignment poses a risk for equity portfolios in the aviation sector, as they may remain a considerable distance from the alignment trajectory. It highlights the importance for asset managers to engage with airlines and aviation companies to encourage and support their efforts in reducing emissions and improving sustainability practices. By actively working with investee companies, asset managers can help drive the necessary changes to close the gap and achieve alignment with emission reduction targets in the aviation sector.

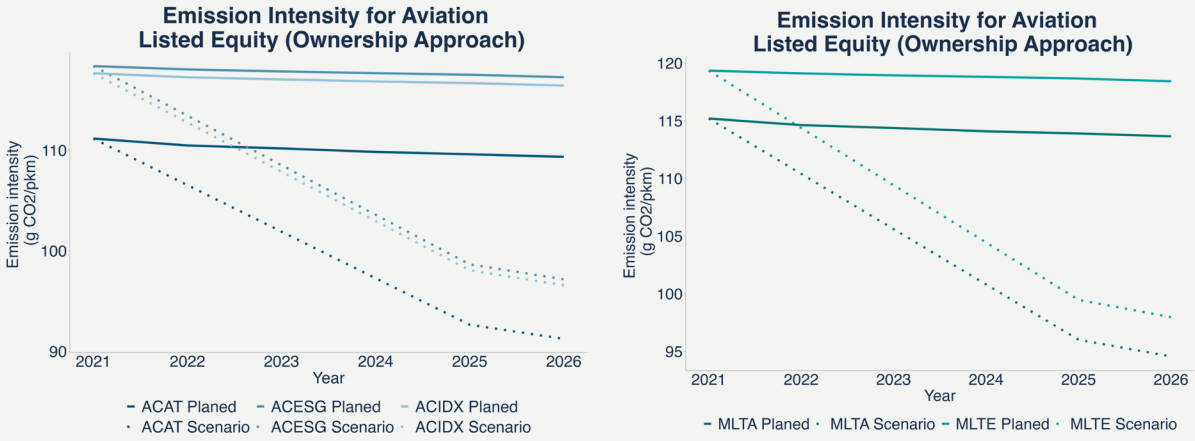


Figure 18: Current fleet emission intensity vs reduction required under GECO 1.5C scenario for the aviation sector, by equity funds (left) and multimarket and fixed-income funds (right)

3.2.5 Steel

The steel sector is recognized as an emissions-intensive and hard-to-abate industry, responsible for approximately 4% of global CO2 emissions. As the demand for steel is projected to increase by 30% by 2050 under business-as-usual scenarios, the financial sector plays a crucial role in driving sustainability in this sector. Lending, through a combination of debt finance and securities, represents one of the primary sources of capital for the steel industry. According to the IEA's World Energy Outlook 2021, the iron and steel sectors have a significant impact in bridging the gap between the Announced Policies Scenario (APS) and the Net Zero by 2050 scenario. The Net Zero by 2050 scenario considers various factors such as improvements in steel-intensive industries, an increase in steel recycling rates, and the more efficient use of steel in construction and other end-uses. These measures contribute to a lower steel demand, aligning with the objective of achieving net-zero emissions by 2050.

The steel industry is currently characterized by the predominance of high CO_2 emitting technologies, namely Blast Furnace (BF) and Basic Oxygen Furnace (BOF). These technologies heavily rely on coal as an energy source and reducing agent, resulting in significant carbon emissions. However, there are transition technologies available in the sector that offer promising solutions for decarbonization.

One such technology is the Electric Arc Furnace (EAF), which plays a central role in the decarbonization of the steel sector. EAFs utilize scrap steel as a feedstock, reducing the reliance on primary production from iron ore, such as pig iron. Compared to traditional methods, EAFs are considerably less energy-intensive and emit fewer greenhouse gases. The emissions intensity of EAF plants is influenced to a large extent by the decarbonization of the electricity grid from which they draw their power. Therefore, the transition to cleaner and renewable sources of electricity is crucial for achieving significant reductions in emissions within the steel sector. Investments and initiatives targeting the decarbonization of the electricity sector can have a direct positive impact on the emissions intensity of EAFs and the overall sustainability of the steel industry.

In addition to Electric Arc Furnace (EAF) technology, the transition to net-zero steel production will likely require the deployment of various other technologies. These include combinations of EAF with direct reduced iron (DRI), the utilization of natural gas, hydrogen, and biomass as fuel and reducing agents, as well as the implementation of carbon capture technologies. While EAF technology is already commercially available, most of the other transition technologies are still in the development phase. To

achieve the required emissions intensity reductions by 2030 and 2035, it is crucial for steel producers to actively participate in projects aimed at developing and scaling up these technologies for large-scale production between 2025 and 2035. By investing in research, development, and innovation, steel producers can contribute to the advancement of these transition technologies. Collaborative efforts between industry stakeholders, research institutions, and governments are vital to accelerate the development and commercialization of these technologies.

Brazil's steel sector is primarily dominated by major companies including Vale, Gerdau, Usiminas, and ArcelorMittal Brasil. Collectively, these companies contribute to an annual production of approximately 35 million metric tons of steel. The sector has demonstrated steady growth, averaging around 2% per year (B2B Industry, 2023). Brazil's favorable business environment, coupled with tax incentives specifically targeted at steel production, has positioned the country among the world's largest steel producers. These incentives have played a significant role in attracting investments and supporting the expansion of the steel industry within Brazil. The combination of abundant raw materials, skilled labor, and favorable government policies has created a conducive environment for the growth and development of the steel sector in Brazil. As a result, the country has established itself as a key player in the global steel market (World Atlas, 2023).

The funds industry in Brazil has a significant allocation to the steel sector, with investments ranging from 10% to 40% of their equities portfolios. This percentage is notably higher compared to the financial sectors of other countries, where the average allocation to the sector is around 3% of portfolios. On the other hand, the bond portfolios have a relatively lower exposure, with less than 5% of their total assets invested in the steel sector. Within the steel sector, the majority of the exposure in both equities and bonds is allocated to Basic Oxygen Furnace (BOF) production. This is primarily due to the fact that Electric Arc Furnace (EAF) production, which is considered a more environmentally friendly technology, is still emerging in Brazil. Currently, EAF production accounts for only 20% of the total national steel production in terms of technology (World Steel Association, 2021).

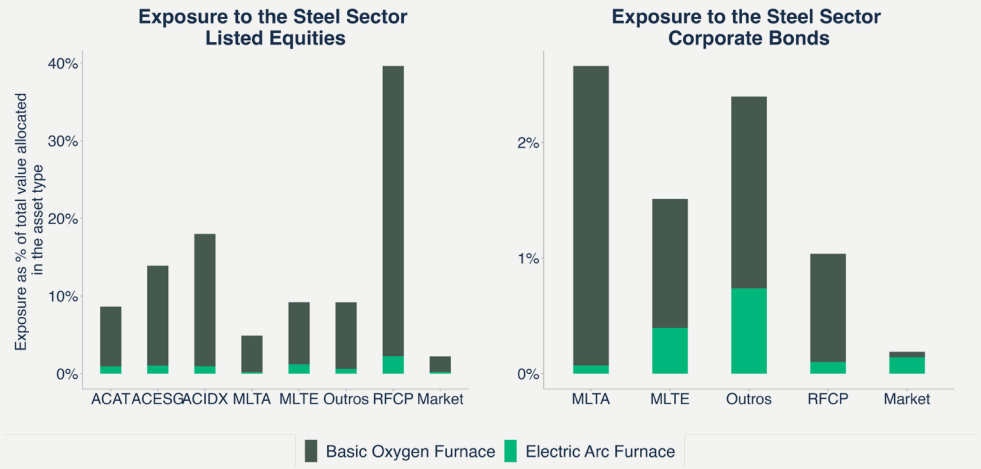


Figure 19: Share of aggregated portfolio value (exposure) invested in companies active in steel industry, by fund group

The emissions intensity of the two steel production technologies, Blast Furnace (BF) and Basic Oxygen Furnace (BOF), are depicted in Figure 20 and Figure 21. In order to align with a 1.5°C pathway, steel companies that are invested in or financed by Brazilian fund industry equity and corporate bond portfolios will need to reduce their emission intensity by approximately 20% by 2026. However, it's important to note that there are limitations in obtaining comprehensive forward-looking CO2 emissions

and production data for the steel sector. Changes in future emissions intensities of steel-producing companies are currently only partially forward-looking and can be influenced by changes in asset ownership. Therefore, the graphs primarily provide insights into the existing emissions intensities of the companies in relation to the scenario emissions intensity in 2026. Considering the long investment cycles in the steel sector, these insights can inform discussions about the required investments to achieve the targets for 2026 and beyond.

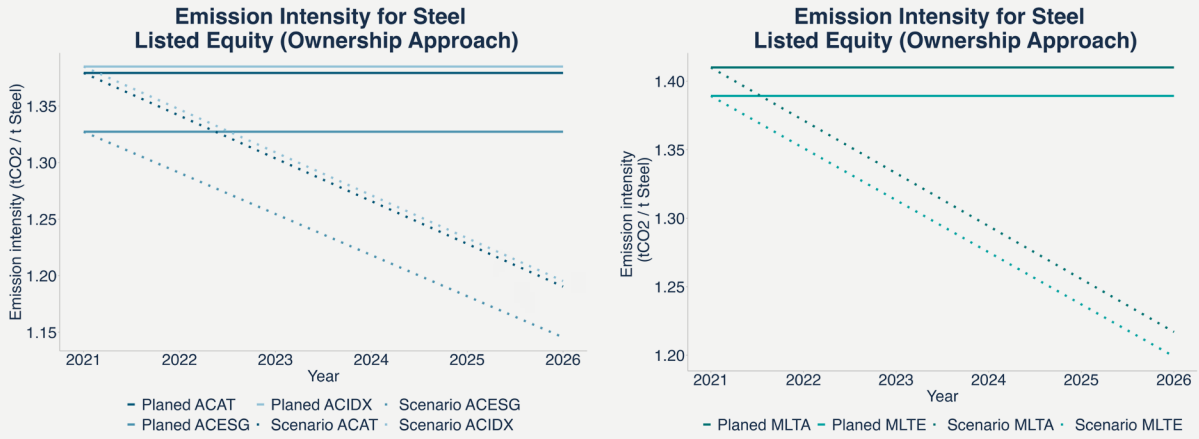


Figure 20: Current emission intensity vs reduction required under IEA NZE scenario for the steel sector in equity portfolios, by equity funds group (left) and multimarket funds groups (right)

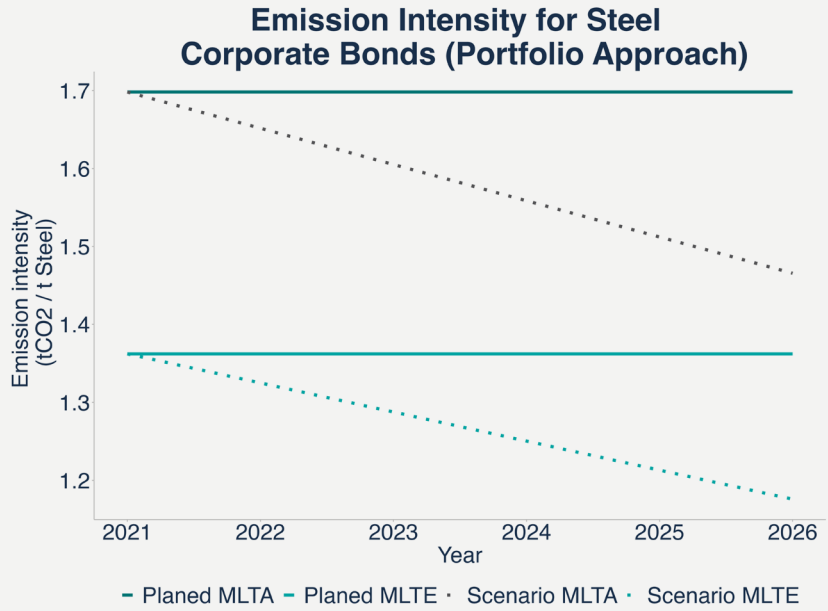


Figure 21: Current emission intensity vs reduction required under IEA NZE scenario for the steel sector in corporate bonds portfolios, by multimarket funds groups

3.2.6 Cement

The cement sector is a significant contributor to industrial CO_2 emissions, ranking as the second-largest emitter. It also has the highest emissions per revenue dollar compared to other challenging sectors like steel. The sector's emissions intensity is approximately 6.9kg CO_2/USD. Similar to steel, cement demand

is primarily driven by the construction sector and infrastructure projects. Under a business-as-usual scenario, global development is expected to lead to a moderate increase in cement demand until 2030. Scenarios indicate that decarbonizing the cement sector will require a combination of measures. These include implementing more resource-efficient construction practices, substituting clinker (the main source of CO_2 emissions in cement manufacturing) with alternative cementitious materials, adopting alternative kiln energy sources, and employing carbon capture technologies. It's important to note that there is no single technology transition that can fully decarbonize the sector. While various low-carbon solutions can be identified, they have not yet reached commercial availability.

The portfolios managed by Brazilian asset managers have a very small allocation, less than 0.1% of the total invested amount, in the cement sector across both equity and bond asset classes. Due to the minimal exposure to the sector, it is not possible to conduct a comprehensive analysis or draw meaningful conclusions regarding the alignment of these portfolios with climate goals or the associated transition risks in the cement sector. The limited investment in this sector suggests that the impact of cement production and its transition to lower-carbon alternatives may have minimal influence on the portfolios' overall climate alignment.

4. Conclusion

The PACTA assessment, a collaborative effort involving the 2° Investing Initiative, RMI, CVM, and GIZ, represents a significant milestone in the efforts to align the financial sector with climate goals. This study provides an extensive analysis of 5,385 funds managed by 638 different asset managers in Brazil, encompassing total assets under management of approximately USD 150 billion - which represents roughly around 10% of the industry's net worth. The analysis utilizes publicly available data on fund compositions as of December 2021. Key climate scenario alignment metrics are employed to evaluate portfolio exposure to climate-relevant sectors, the allocation to high and low-carbon technologies, and the alignment of investee companies' capital commitments (production plans) over a five-year period with sector pathways.

The study reveals a significant allocation of portfolios to climate-relevant sectors, surpassing the levels observed in other jurisdictions. Between 10% and 55% of the total investment value in listed equities and bonds is directed towards sectors such as fossil fuels, power, automotive, aviation, steel, and cement. This percentage stands in contrast to the typical range of 5% to 15% found in similar studies. The higher exposure in Brazil can be attributed, in part, to the prominence of state and private enterprises focused on primary energy and raw materials production, which hold significant importance in the Brazilian economy. Notably, the oil and gas extraction and power generation sectors account for more than 50% of equities portfolios allocated to climate-relevant sectors, while steel comprises an average of 25% of equities in these sectors.

On average, Brazilian funds have allocated 10% of their portfolios to the fossil fuel sector. However, the production plans of oil and gas companies in which these funds are invested indicate an increase in production over the next five years. This trajectory is misaligned with the IEA's Net Zero by 2050 scenario, both in equities and bonds. The projected increase in production suggests a pathway that would result in a temperature rise exceeding 2.7°C, significantly higher than the target set by the Paris Agreement. These trends have implications not only for the environment but also raise concerns about the potential future exposure to transition risks for the Brazilian fund industry. As fossil fuels need to be phased out in the next three decades, funds heavily allocated to this sector may face financial losses if a late and sudden transition to a low-carbon economy occurs in Brazil. Additionally, the high concentration of investments in a small number of oil and gas producers further exacerbates these risks.

The power sector holds significant relevance in the composition of funds, accounting for 5% to 10% of total assets. Brazilian asset managers have a higher exposure to the power sector compared to the market benchmarks used in this analysis. Hydroelectric power has the highest allocation of assets, followed by coal power and renewables (particularly in bonds). While most assets are allocated to low-carbon technologies, a concentration of investments in hydroelectric power could expose investors to reduced financial performance due to physical environmental risks. The Intergovernmental Panel on Climate Change (IPCC) forecasts that climate change could increase risks to hydroelectric power generation through factors such as altered water availability, increased sediments, methane emissions, and physical damage to assets, particularly in the context of more frequent events like El Niño-Southern Oscillations (ENSO). These physical risks pose a potential pressure on hydroelectric power investments.

When analyzing the volume production trajectory for renewable power in the next five years, it is evident that the portfolios of the Brazilian funds industry are misaligned across various asset types. The planned growth in renewable power capacity invested in or financed by asset managers is not projected to be fast enough to reach the pathway outlined in the IEA's Net Zero by 2050 scenario, which requires a significant increase in renewable power capacity by 2026. Additionally, the high-carbon power capacity is not declining at the necessary pace to limit global warming to 1.5°C or below.

Brazil's steel sector holds a prominent position in the global market, housing headquarters and production facilities for major steel-producing companies like Vale, Gerdau, and Usiminas. Given the sector's significance to the overall economy, Brazilian funds have allocated between 10% to 40% of their equities portfolios to steel, which is considerably higher than the average allocation in other countries (typically around 3% of portfolios). This deviation from market benchmarks indicates the importance of the steel sector within the Brazilian investment landscape. While data on future CO_2 emissions and production in the steel sector is limited, sector pathways make it clear that companies within fund managers' portfolios will need to reduce their emissions intensity by approximately 20% by 2026 to align with a 1.5°C pathway. Achieving this alignment will require substantial investments as the current steel production in Brazil heavily relies on high-emitting production technologies.

Another noteworthy finding of this report is that ESG-classified funds do not demonstrate superior or inferior performance compared to other funds that do not prioritize sustainability considerations, as indicated by the metrics provided in this report. It is important to acknowledge that if the local market itself is not aligned with the goals of the Paris Agreement, it becomes unrealistic to expect funds to be fully aligned. However, it remains crucial for regulatory bodies to assess the measures implemented by ESG-labeled funds to achieve alignment. For example, if a fund still maintains exposure to fossil fuels, it is essential to understand the strategic actions undertaken by fund managers to exert pressure on local companies and encourage them to transition towards greener technologies. Furthermore, it is imperative to evaluate the extent of engagement displayed by ESG-labeled funds both within their own industry and collectively with other asset managers when dealing with companies that are knowingly misaligned. Additionally, it is vital to assess whether the criteria for obtaining an ESG label are sufficiently specific to prevent instances of greenwashing. A thorough evaluation of the standards and requirements associated with obtaining an ESG label is necessary to ensure the credibility and authenticity of sustainability claims made by funds.

The unique characteristics of the Brazilian financial market, such as the concentration of companies operating in climate-relevant sectors on a global scale, along with specific challenges related to physical climate change and biodiversity in the region, present a distinct challenge for supervisors and regulators in the country. These challenges necessitate a careful approach to measuring and managing climate-related risks while also ensuring that financial institutions are effectively aligning their portfolios. On one hand, it is crucial for authorities to accurately assess and balance the risks associated with climate change and its impact on the financial sector. This involves understanding the vulnerabilities and potential disruptions faced by financial institutions due to climate-related events and trends. On the other hand, regulators must also ensure that financial institutions are actively and meaningfully aligning their portfolios with climate goals and objectives. This requires monitoring and evaluating the actions and strategies employed by these institutions to contribute to the transition to a more sustainable and low-carbon economy. It involves promoting impactful and effective measures that facilitate the alignment of investment decisions with climate targets.

The findings of this report highlight the need for increased attention to portfolio allocation in climate-relevant sectors from a risk management perspective. Asset managers have allocated a higher-than-

average proportion of their portfolios to companies that rely on production technologies expected to be phased out in the medium term, such as oil & gas and BOF steel. This indicates the importance of reevaluating and adjusting portfolio allocations to align with evolving market trends and the transition to a low-carbon economy. Even in the power sector, where financial institutions have an advantage by investing in companies with hydroelectric power capacity, the material impact of physical climate risks is already being felt by both companies and investors. This underscores the significance of incorporating climate-related risks, including physical risks, into risk management frameworks and decision-making processes. From an alignment standpoint, the outlook is concerning. Companies engaged in high-carbon technologies have plans to significantly increase their production, exceeding levels that are consistent with achieving net-zero pathways. On the other hand, investee companies involved in low-carbon technologies are not expanding their production at a fast enough pace to meet Brazil's commitments under the Paris Agreement. This highlights the need to foster an environment that encourages and supports the growth of low-carbon technologies while phasing out high-carbon alternatives.

The unique characteristics of Brazil's financial sector present an opportunity to have a significant and immediate impact in driving companies towards supporting the transition to a low-carbon economy. The country's largest banks and funds are heavily invested in and provide financing to a select few companies. This concentration of influence provides the potential for a joint-engagement strategy that can effectively encourage these companies to adopt concrete transition plans.

By leveraging their collective power, financial institutions can play a pivotal role in driving change. They can exert pressure on companies such as Petrobras, Vale, and Gerdau by requiring them to develop and implement specific transition plans as a condition for continued financing. This approach encourages companies to align their production pathways with a trajectory that is compatible with the goal of limiting global warming to well below 2°C, as outlined in the Paris Agreement. Engagement strategies that involve collaboration and dialogue with these companies are an important first step. Financial institutions can work closely with the companies they invest in to understand their current practices, identify areas for improvement, and establish targets and timelines for transitioning to more sustainable and low-carbon practices. However, in cases where engagement efforts do not yield the desired results, divestment threats can serve as a last resort. The potential withdrawal of financial support can send a strong signal to companies, highlighting the need for urgent action and alignment with climate goals.

To advance the global sustainable finance agenda, this study suggests the following recommendations to the Brazilian financial authorities:

I) Invest in capacity building: The financial market is in the early stages of understanding how to incorporate sustainability topics into investment strategies. Therefore, it is crucial to invest in workshops, assessments, training, and participation in national and international debates to accelerate progress. Urgent action on climate change necessitates swift action, and building expertise and knowledge is essential.

II) Implement complementary non-GHG metrics and standards: Reporting requirements should go beyond CO_2 emissions and include objective metrics to evaluate companies' contribution to climate change mitigation. This includes assessing how companies' capital commitments translate into the adoption or phase-out of low and high-carbon technologies. Using broader metrics will enhance the assessment of companies' transition plans and ensure the credibility of their efforts.

III) Continuously monitor climate-related risks: Authorities should integrate transition and physical risks into overall risk assessments, considering their impact on credit, market risk, and the cost of capital. Monitoring and understanding climate-related financial risks will enable proactive engagement and minimize potential negative impacts.

IV) Encourage and unlock the potential for impact: Portfolio reallocation and divestments alone will not be sufficient, and may not even be feasible in the Brazilian context. Financial authorities should encourage credible engagement by investors with issuers and measure the outcomes of these engagements. A qualitative approach to engagement strategies, along with quantitative metrics, is necessary to assess the effectiveness of engagement efforts. Joint engagement practices should be prioritized to maximize influence, considering the concentration of financial actors and corporates in the market.

In conclusion, Brazil's global production scale in climate-relevant sectors, combined with the risks to its biodiversity and natural resources, poses a global risk to meeting the objectives of the Paris Agreement. However, by implementing credible and enforceable climate actions, Brazil has the potential to become a leader in the sustainable finance agenda and contribute significantly to meeting global warming targets and sustainable development goals.

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Annex I: The PACTA Methodology

A) General considerations

The PACTA Methodology consists of several components. The quantitative part of it compares what needs to happen in sectoral decarbonization pathways determined through climate scenarios, with financial actors' exposures to companies in climate-relevant sectors. To do so, PACTA provides a five-year forward-looking, bottom-up analysis. It looks at the investment and production plans of companies, based on physical Asset-Based Company Level Data (ABCD), and consolidates that information to identify the transition profile of the companies and their related financial instruments. That way, PACTA can aggregate the production data to the portfolio level and compare that information to the production plans projected in different climate scenarios. The (mis-) alignment between the portfolio and these scenarios allows users to infer the potential exposure to transition risks and opportunities.

In total, the present study analysis consists of three components that aim to answer the following questions:

- **Exposure Analysis.** What is the current exposure of the portfolio to the economic activities that are most affected by the transition to a low-carbon economy?
- **Future Exposure Analysis.** How will the exposure of the portfolio change in the next five years, and how does it compare to a portfolio that is aligned with the Paris Agreement?
- **Scenario Analysis.** How aligned are the investment and production plans of companies in the portfolio with different climate scenarios and the Paris Agreement?

Further information on the methodology applied to answer those questions will be provided in the following sub-sections which will elaborate on the coverage, data inputs, allocation methods, PACTA metrics, and climate action analysis.

B) Coverage

I) Asset classes covered

The PACTA Methodology covers listed equity and corporate bond portfolios. The selection of asset classes covered by the methodology responds to the key role corporate issuers have in the transition to the low-carbon economy and the flexibility investors have to carry out different actions that allow mitigation of portfolio-level climate-related risks and risks in the real economy. PACTA further not only covers single titles but also funds. A fund look-through was applied automatically. However, to increase coverage, PACTA recommended users to do the look-through themselves if they were not satisfied with the coverage of the automated procedure.

II) Sectors covered

The PACTA methodology covers eight of the most carbon-intensive sectors in the global economy (i.e., the sectors most exposed to transition risks) – oil, gas, coal, power, automotive, cement, aviation, and steel (the "PACTA sectors"). Together, they are responsible for around 70% of the global CO_2 emissions. In each sector, PACTA focuses on the part of their value chain with the highest contribution in terms of CO_2 emissions. For example, in the oil and gas sector, the focus is on upstream activities related to production, while in the power sector, the focus is on power generation and related sources of energy.

III) Data inputs

A) Portfolio data

To run the portfolio assessment, participants provide an input file containing security information for each portfolio to be analyzed. It includes the following information:

- Investor and portfolio names
- One ISIN per listed instrument (funds are identified by their ISIN. Securities in each fund are included in the analysis)
- The market value of the financial assets held in the portfolio
- The currency code corresponding to the market value
- A timestamp of the portfolio

B) Financial data

Financial data is used to assign securities to its correspondent sector and link companies along the ownership tree (i.e., subsidiaries to parent companies). Financial data is also used to identify the composition of funds and allocate these assets to portfolios as indirect ownership – if the portfolio is exposed to funds. The financial data is sourced by FactSet – a financial database software.

C) Physical Asset-Based Company Data (ABCD)

For each sector covered in the analysis, PACTA sources data from the data provider Asset Resolution (AR). AR sources its data from independent industry data providers that obtain data on individual assets in climate-relevant industries using a variety of research capabilities, including web scraping, desk research, and direct engagement with the industry. The asset-based company-level data covers more than 280,000 individual physical assets (e.g., individual power plants, oil fields etc.).

The figure below shows the coverage of asset-level data relative to estimated global production figures—the global benchmark—for the power, oil & gas, coal, and automotive sectors. The figure highlights the share of assets that have been mapped to financial data and are thus included in the analysis.

D) Scenario data

Measuring alignment requires scenarios that explain what needs to happen in a sector to decarbonize. While climate change scenarios do not predict the future, they provide essential information to understand climate change, and the pathways projected to reach certain goals. In the efforts to tackle

climate change, it is critical to understand what can and should happen to mitigate climate change. It is important to note that climate scenarios are built under different assumptions, and therefore can propose different courses of action to achieve climate targets. The table below shows an overview of the scenarios used in this report and which sectors they cover. Further details on climate scenarios are provided in Annex II.

C) Allocation Methods: Ownership versus portfolio weight approach

In the interactive report available for each portfolio, among the options for calculating and plotting the results, users can select between two methodologies - the Portfolio Weight Approach and the Ownership Weight Approach. These methodologies are used to attribute the physical assets of a company to the financial instrument or portfolio. The Ownership Weight Approach is only available for equity, and the Portfolio Weight Approach is available for both bonds and equity. For this Meta report, it was decided to use the Ownership Weight Approach for listed equity and the Portfolio Weight Approach for corporate bonds.

As the explanations above show, even though both the Portfolio Weight Approach (PA) and the Ownership Weight Approach (OA) allocate physical assets to financial portfolios, they are based on different calculation methods. The OA approach allocates the "owned" physical assets of investors to their portfolio and thereby depicts production values from a real-world and macro perspective, while the PA allocates physical assets based on the weight of a company within the portfolio. I.e., the PA comes rather from a risk perspective of the individual institution.

These differences reflect that both approaches answer slightly different questions, based on the asset classes they are used for. While the ownership of listed equity allows attributing responsibility of physical assets to an investor and the investor has decision-making power based on their shares, the investment in corporate bonds do not allow the same level of engagement, which is why the PA rather reflects a risk-perspective on the exposure to the transition-related (mis-)alignment.

Please see an overview of the key differences between the two approaches below:

Ownership weight approach (for listed equity only)

- Answers the following question: How can the responsibility for the physical assets and total production be allocated to financial assets?
- Allocates production to your portfolio based on your real-world ownership.
- Does not include funds as funds are not directly owned and therefore investors cannot engage with invested companies in the same way as with directly owned financial assets.
- Allows monitoring of climate alignment of real production and is therefore especially useful from a macro and political perspective.

Not applicable to corporate bonds in PACTA.

Portfolio weight approach (for corporate bonds in this analysis)

- Answers the following question: How exposed is your portfolio to different technologies?

• The portfolio weight approach is a representation of the investor's allocation choice and is inferred as a more risk-intuitive allocation rule.

• Does not show "ownership" of technologies in the real world, but rather takes a risk perspective focusing on the exposure to companies and technologies.

• Applicable to listed equity and corporate bonds.

D) PACTA Metrics

The PACTA analysis measures alignment using three different metrics: Exposure shown as the Technology Share Mix, alignment with either the Production Volume Trajectory, or the Emission Intensities. The technology mix and the volume trajectory are used for the power, fossil fuels, and automotive sectors, for which there exist clearly defined technology decarbonization pathways. For example, in the power sector, there are technologies to transition to, i.e., coal-fired power generation can shift to renewable energies. For other sectors, where technology decarbonization pathways are not so well defined, such as steel, cement, and aviation, PACTA uses an emission intensity metric to compare it to scenario benchmarks. Each of these three metrics is explained below.

I) Exposure: technology share mix

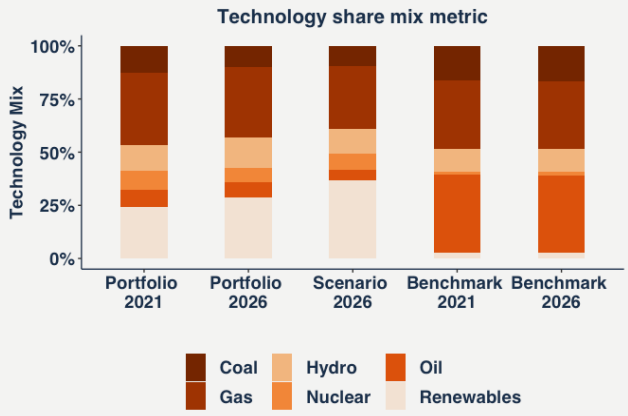
of investment therein. The portfolio's technology mix is compared to the scenario and a market benchmark (see Figure below as an example).

The technology share mix metric focuses on technology shifts within the power, fossil fuels, and automotive sectors, namely:

• the changes in the technological processes by which outputs are produced (e.g., shift from coal-fueled to renewable-fueled power capacity);

• changes in the nature of the output itself (e.g., shift from internal combustion engines to electric vehicles).

This metric measures the portfolio's relative exposure to the economic activities that are impacted by the transition to a low-carbon economy. It is a function of how diversified the investments' portfolios are across the companies they invest in and how diversified these companies' activities are across technologies or output types.



The figure above shows the high and low-carbon technology mix for the power sector in a sample portfolio:

- Portfolio 2021: reflects the current technology mix of the power sector in the analyzed portfolio.
- Portfolio 2026: reflects the future technology mix of the power sector in the analyzed portfolio.
- Scenario 2026: shows the projected technology mix of the portfolio in 2026 based on the SDS scenario.
- Benchmark 2021: reflects the current technology mix of the power sector based on the current production plans of companies comprised at a market index benchmark.
- Benchmark 2026: reflects the future technology mix of the power sector based on the capital plans for the next five years of companies at a market index benchmark.

PACTA assumes a static balance sheet. As such, the difference in the technology mix between Portfolio 2021 and Portfolio 2026 is solely a result of the production plans of the companies the investor is currently financing and not a result of any change in the portfolio composition.

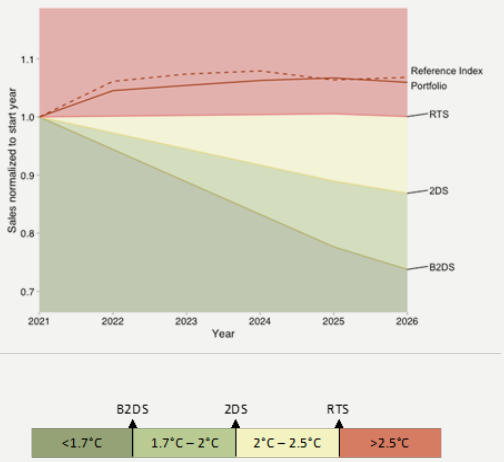
II) Alignment: production volume trajectory and emission intensities

A) Production volume trajectory

The production volume trajectory metric aims to measure the forward-looking alignment of a portfolio's projected production volumes, based on the five-year capital plans of companies, to the production volume ranges set as targets in different climate scenarios.

Changes in production volume result either from the transfer of production from one technology to another (e.g., internal combustion engines to electric vehicles) or from the sheer expansion or contraction in production coming from the technology/fuel (e.g., a company brings a new coal-fired power plant to operation). The Figure below shows an example of the production volume trajectory metric for internal combustion engine (ICE) vehicles.

Amount of ICE cars allocated to the investment portfolio. This is the "planned production profile" of the companies that are part of the portfolio.



Colored areas denote the production volume ranges that are compatible with different climate scenarios.

Amount of ICE cars produced by companies in a specific benchmark.

Misalignment with a <2°C scenario.

The Y-axis of the figure shows the normalized production, in this case, sales planned for the next five years with the current capacity represented as 1. The chart shows that the portfolios' ICE vehicles' production trajectory falls within the red area and increases between 2020 and 2026. This means that the portfolio companies' production plans for ICE vehicles for the next five years are not compatible with the Beyond 2° Scenario (B2DS) and perform worse than the 2° Scenario (2DS) and the (Reference Technology Scenario (RTS), but similar to the selected benchmark (please note that these are just example scenarios – the scenarios change every year according to data availability).

Interpreting the technology share mix metric and the production volume trajectory metric altogether

The technology mix metric and the production volume trajectory metric both provide an indication of the alignment of portfolio companies with the Paris Agreement goals. However, they differ in that the technology mix metric is a measure of the relative amounts invested in different climate-relevant technologies within the portfolio, while the production volume trajectory measures whether the rate of change in the production amount is sufficient to meet the benchmark scenario that is in line with Paris Agreement goals. For example, it is possible that renewable power generation makes up a large portion of a credit portfolio relative to carbon-intensive power generation, resulting in a portfolio that is aligned with the Sustainable Development Scenario (Paris Agreement aligned) from a technology mix perspective. Yet the rate of increase of renewable power generation may be too small to meet the same scenario from a production volume trajectory perspective, because companies in the portfolio might not be planning an increase in their production plans in the next five years.

B) Emission intensities

The emission intensity metric measures the average CO_2 intensity of the portfolio in the steel, cement, and aviation sectors. This emission intensity is given as CO_2/economic unit of output (for example, CO_2/ per ton of steel produced). This is then compared to an emission intensity reference point set by a climate scenario.

While this is not the main metric of choice for the largest sectors tackled in this methodology, the emission intensity of the activities financed by the portfolio is nonetheless the first metric in sectors for which no clear technology pathways have been set out (namely, steel, cement, and aviation). Put differently, for these sectors, no zero-carbon alternative yet exists. As such, it is not possible to use the technology mix metric or the volume production volume trajectory metric to measure alignment. However, it is still imperative to steer capital in a way that aims to decrease carbon emissions in these sectors – hence the emission intensity metric is used.

Annex II: Scenarios – what are climate-related scenarios and decarbonization pathways?

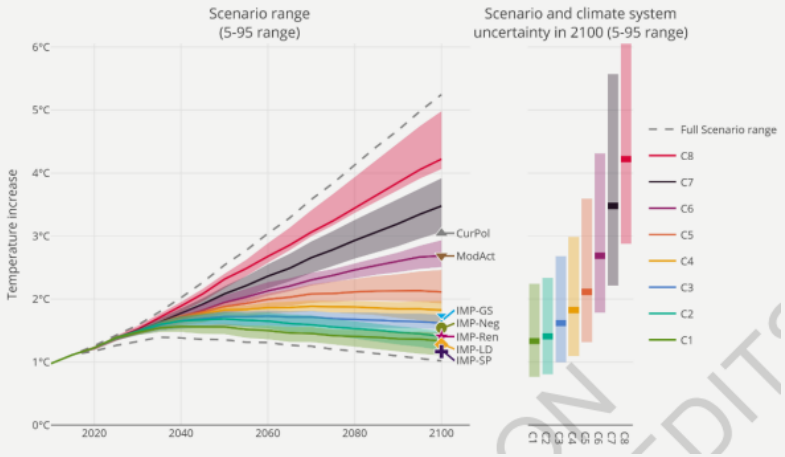
In the efforts to tackle climate change, it is critical to understand what can happen and what should happen in the future that, although uncertain, can be planned for with the aid of the foresight provided by scenarios. Climate-related scenarios have been defined as being:

"A plausible description of how the future may develop based on a coherent and internally consistent set of assumptions about key driving forces (e.g., rate of technological change, prices) and relationships" IPCC (2021).

Climate-related scenarios are therefore depictions of possible futures that incorporate scientific, technical, and socio-economic assumptions in order to describe a range of potential pathways to the future. They constitute a powerful tool that allows society to understand the consequences of not taking action today and, importantly going forward, the scale and pace of technological change and investment that is likely to be required in order to mitigate climate change.

A) Understanding scenarios and their sectoral pathways

A common reference point for understanding scenarios is the indicative pathways developed by the United Nation's Intergovernmental Panel on Climate Change (IPCC), whose regular reviews and updates of the latest climate science form the basis for international policymaking. The IPCC maintains a global database of models and scenarios that it reviews in order to create a set of indicative pathways to different average global mean temperature rises in 2100, together with their associated probability and what they imply in terms of the techno-economic and social change required. Their latest and 6th review, published in October 2021 in advance of COP26, presented eight pathways for policymakers to consider at the global level (see figure below).



Whilst useful to understand the headline scale of change and investment required, the IPCC pathways are in general not granular enough to use at the sector level in PACTA. To measure alignment, scenarios based on Integrated Assessment Models (IAM) are required. They tend to be built-up from much more granular information on what needs to happen at the sectoral level in order to contribute to achieving an overall climate goal, such as limiting the global average mean temperature rise to 1.5°C.

Scenarios with decarbonization pathways that can be used by PACTA have been developed by the International Energy Agency (IEA), the European Commission, and on behalf of other organizations such as United Nations Principles for Responsible Investment (PRI), the Network for Greening the Financial System (NGFS) and the Net Zero Asset Owners Alliance (NZAOA). The scenarios selected for use with PACTA generally have two main features that lend themselves to alignment measurement:

- A set of scenarios: They come as a set, reflecting different possible political, social, and economic futures as well as different climate outcomes. This is important because it allows internally consistent comparisons to be made between a baseline that represents what may happen if the transition occurs according to current policies that are modeled to be on track to limit global warming to 2.7°C and what will need to happen in order to accelerate the pace of change in order to limit global warming to below 2.0°C or, ideally, 1.5°C.

- Sector decarbonization pathways: They provide sectoral decarbonization pathways against which progress and in particular alignment can be measured. Decarbonization pathways have been defined as being: *"A temporal evolution of a set of mitigation scenario features, such as greenhouse gas emissions and socio-economic development, towards a future state. Pathways can include narratives of potential futures and solution-oriented decision-making processes to achieve desirable societal goals."* (IPCC 2021).

Pathways tell us how the different technologies will shift within a sector or how the emissions intensity will change as a result of implementing different measures over time.

These selected scenarios and their pathways are built up from a range of socio-economic and technical assumptions, as well as expert judgments. It is therefore important when using them to be aware of some of the main differences between them and the drivers for different climate outcomes. Some of the factors to bear in mind that can differ from the modelling of one scenario to the other can include:

- The speed at which decarbonization occurs;

- Availability and maturity of technologies, their scalability, and cost;

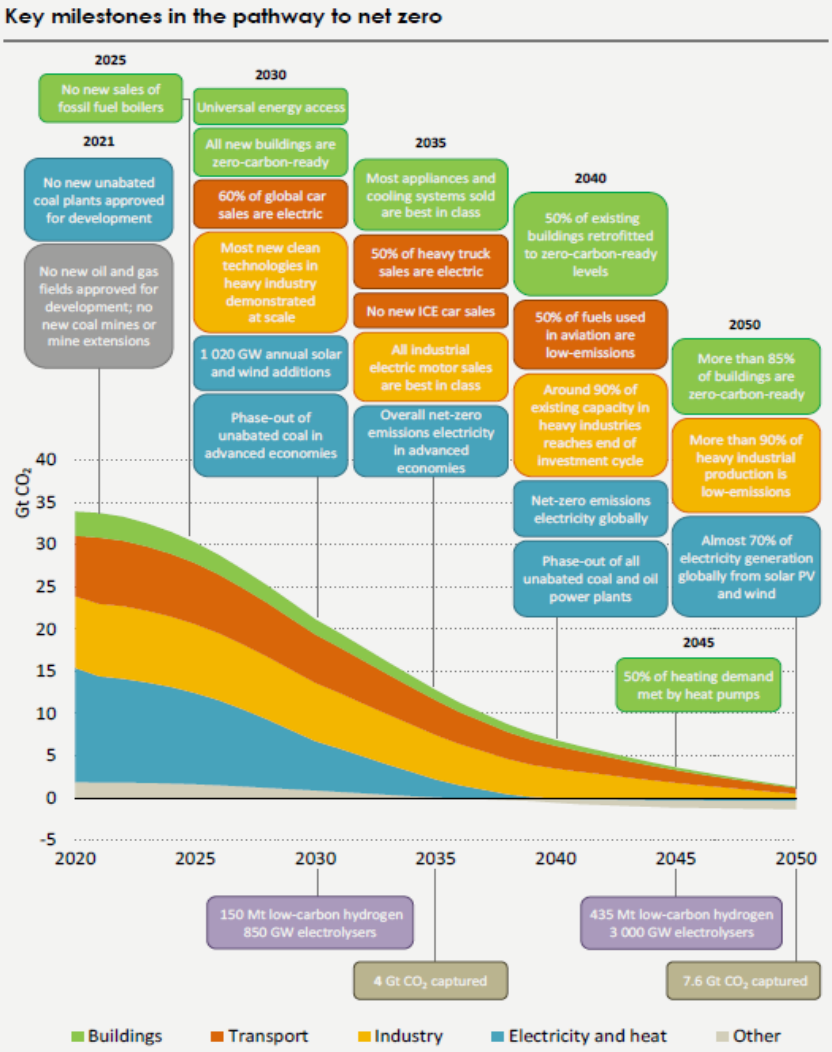
- Favoring or ruling out different technologies (e.g., reduced role for nuclear power, more prominent use of carbon capture technologies);

- Level of ambition for decarbonization, resulting in varying probabilities of limiting the global average global rise in temperature to <2°C;

- Levels of granularity (time, geography, etc.).

Based on the IEA´s Net Zero Energy by 2050 scenario, the figure below illustrates the types of assumptions

and technological changes that may inform different sectoral pathways within a scenario (as indicated by the different colors) and on what timescale.



B) Limitations and assumptions of the scenarios used in the present study

As has already been emphasized, scenarios and their sectoral pathways are depictions and models of possible futures, they are not forecasts of what will happen. When reading the PACTA results for meta, peer group, and individual financial institution portfolios, it is therefore important to understand the underlying limitations and assumptions behind the scenarios used as the basis for the analysis.

C) Probability of achieving the stated climate outcomes

Probability is a significant factor to bear in mind. In general, the climate outcome or target of stabilizing global warming at the 2°C target above pre-industrial levels by 2100 should be accompanied by a percentage probability. Thus, based on the table below for the IEA WEO scenario set, aligning with a 2°C scenario may represent, for example, only a 50% chance and thus will not necessarily lead to the limiting of global warming to 2°C and in fact, the probability of falling below 2°C falls to 33%.

Temperature rise in the WEO 2021 scenarios (°C)

Scenario	2030		2050		2100	
Confidence level:	50%	33% – 67%	50%	33% – 67%	50%	33% – 67%
Stated Policies	1.5	1.4 – 1.6	2.0	1.8 – 2.1	2.6	2.4 – 2.8
Announced Pledges	1.5	1.4 – 1.6	1.8	1.7 – 2.0	2.1	1.9 – 2.3
Sustainable Development	1.5	1.4 – 1.6	1.7	1.5 – 1.8	1.6	1.4 – 1.7
Net Zero Emissions by 2050	1.5	1.4 – 1.5	1.5	1.4 – 1.7	1.4	1.3 – 1.5

Note: Shows the maximum temperature rises with 33%, 50% and 67% confidence levels. Source: IEA analysis based on outputs of MAGICC 7.5.3.

The second table below compares the overall global warming goals and probabilities of four ambitious scenarios analyzed using PACTA. The use of a given scenario from within a set (e.g., from with WEO 2021 – NZE, SDS, NPS, CPS) does not constitute an assumption that this scenario is more likely to prevail than others, but the assumptions made about the market maturity of the different technologies in the pathways can provide an overall indication of the degree of uncertainty It is also important to note that the choice of IEA scenarios or other providers should not be interpreted as an endorsement of the underlying assumptions by RMI.

Scenario parameters	**IEA** **WEO 2021 SDS scenario**	**IEA** **Net Zero by 2050 scenario**	**ISF (NZAOA)** **Net Zero scenario**	**JRC** **GECO 1.5oC Unified scenario**
Average global temperature target in 2100	1.6°C	1.4°C	1.5°C	1.5°C
Probability of achieving warming goal by 2100	50%	50%	66%	50%

D) The assumptions and judgments related to technological maturity

Most ambitious scenarios rely on assumptions about the implementation of technologies, some of which are still in the early stages of development and hence may not be available at the speed and scale that the scenario requires. For example, one criticism of the IEA 2°C and SDS scenarios is that it relies on a significant portion of BECCS (Bioenergy with Carbon Storage) up to 2050, which might not be technically feasible. The table below summarizes the main assumptions and expert judgments about the technological maturity of solutions.

Scenario parameters	IEA WEO 2021 SDS scenario	IEA Net Zero by 2050 scenario	ISF Net Zero scenario	JRC GECO 1.5°C Unified scenario
Main identified sources of model uncertainty	Covid uncertainties, behavioral changes, CCUS for fossil fuels	Behavioral change, bioenergy, CCUS for fossil fuels	Behavioral change, large-scale deployment of renewables 4	Carbon price and mitigation policies
Main assumptions on technology maturity	60-65% of required CO_2 reductions are from technologies currently commercially deployed.	50-60% of required CO_2 reductions are from technologies currently at demonstration or prototype stage.	Only considers theoretical technologies that have demonstrated proof of concept.	A technology learning-curve approach is applied.

E) The role of different technologies in each scenario

Underpinning the four selected scenarios are major technology shifts. In the past, IEA scenarios have been quite conservative and have underestimated both energy efficiency developments and renewable deployment rates. This is because technology learning rates and cost reductions turned out to be faster than predicted. This means that the scenarios might not be ambitious enough (compared to what is feasible) and that there is a need for more ambitious scenarios that lead to higher probabilities of limiting global warming to well below 2°C, one of the main goals of the Paris agreement. The table below compares and contrasts the role a number of key high and low-carbon technologies are earmarked to play in the selected scenarios – including energy demand, fossil fuel use, renewable energy, and carbon capture.

Scenario parameters	IEA WEO 2021 SDS scenario	IEA Net Zero by 2050 scenario	ISF Net Zero scenario	JRC GECO 1.5oC Unified scenario
Primary Energy demand reduction	17% less in 2030 compared to 2019	7% less in 2050 compared to 2020	8% less in 2050 compared to 2020	7% less in 2050 compared to 2020

Fossil fuel use and exploitation	Fossil fuel share in the primary energy mix falls around 70% by 2030	No new development or exploitation from 2020 onwards	Emissions from fossil fuel must decline by more than half by 2030	Fossil fuel share in the primary energy mix falls around 70% by 2050
The role of renewable energy	Renewable energy generation share increases from 30% in 2019 to 40% in 2030	Renewable energy generation is 60% of global power generation by 2030	Renewable energy generation share increases from 30% in 2019 to 40% in 2025	Renewable energy accounts for 78% of global power generation in 2050
The role of nuclear energy	36% growth in nuclear capacity by 2040	76% growth in nuclear capacity by 2040	No new nuclear power stations	337% growth in nuclear capacity by 2040.
The role of carbon capture utilization and storage	2.9 Gt CO_2 after 2050	7.6 Gt CO_2 in 2050	No use of the technology	4.6 Gt CO_2 in 2050
Use of nature-based solutions as offsets	80-240 Gt CO_2 in 2050	No offsets assumed	152 Gt CO_2 in 2050	Use of forest management to mitigate emissions

F) Summary descriptions of the scenarios used in is study

In this section, an overview of the main scenarios used to measure the climate-related alignment and exposure of the meta and peer group portfolios is provided. The scenarios summarized have been developed by the IEA, and the European Commission. The individual scenarios within each set are described, allowing the reader to compare and contrast their rationale and basic assumptions.

I) International Energy Agency (IEA), WEO 2021 and ETP 2020

The IEA scenarios form part of two linked but separate energy models and publications, the World Energy Outlook (WEO) and Energy Technology Perspectives (ETP). Both are based on the IEA World Energy Model (WEM). The Net Zero 2050 scenario forms an extension of the WEO and has its own supporting documentation.

The WEO and ETP each provide sets of scenarios, providing depictions of potential future outcomes from current stated policies, orderly policy transitions in response to the Paris Agreement, as well as ambitious sustainable development and net zero transitions towards meeting specific climate goals. The IEA scenarios, therefore, allow for a scenario selection to be based on the overall strategic objectives for climate mitigation and the extent to which each scenario deviates from current climate change policies.

The WEO provides insight into the energy sector, with a focus on pathways for the fossil fuel and power generation sectors. The ETP covers the buildings, transport, and heavy industrial sectors. In PACTA, it is used for industry and transport, namely the steel, cement, and automotive sectors. It provides pathways

with a time horizon from 2017 to 2070. In contrast, the WEO only extends until 2050. The WEO and ETP scenario set comprises:

- Stated Policies Scenario (STEPS): This scenario incorporates policies declared today. The goal of this is to assess what the world may look like in the future based on policies that have currently been announced. Energy demand rises by 1% per year until 2040. More than half of this growth in demand is met by solar photovoltaics (PV) while natural gas enabled by trade in liquefied natural gas (LNG) accounts for a third. Oil demand plateaus in 2030. Despite this, the global economic and population growth means that there is no peak in global emissions ahead of 2040 and hence globally shared sustainability goals (like those set out in the Paris Agreement) are missed. If all the targets are achieved as set out by this scenario there would be at least a 50% chance of limiting global temperature rise to 2.7°C by 2100.

- Sustainable Development Scenario (SDS): This scenario aims to meet stricter sustainable development goals. This requires rapid and widespread changes across all parts of the energy system. It is aligned with the goals set out in the Paris Agreement, with a 50% chance of limiting global temperature rise to below 1.65°C by the end of the century, as well as objectives related to universal energy access and cleaner air. These efforts are shared amongst multiple fuels and technologies.

In addition, the WEO in 2021 started to include an ambitious 1.5°C, ´net zero´ scenario:

- Net Zero Emissions by 2050 (NZE) This scenario extends the SDS scenario in order to target net zero emissions. The scenario responds to the increasing number of countries and companies that have made commitments to reach net zero emissions earlier combined with the aim of limiting the rise in global temperatures to 1.5°C by the end of the century (with a 50% probability). In particular, it explores the actions needed in the period to 2030 in order to be on track to achieve net zero emissions by 2050, including the need to end new fossil fuel exploitation from 2021 onwards and to avoid stranded assets across sectors. The original May 2021 documentation is provided below, as many of the scenario and sectoral pathway assumptions remain unchanged.

IEA, Energy Technology Perspectives (2020)

IEA, World Energy Outlook (2021)

IEA, Net Zero by 2050 (2021)

II) European Commission Joint Research Centre (JRC), GECO 2021

The Global Energy and Climate Outlook (GECO) scenario set has a basis in the energy-economic models that are used by the Joint Research Centre (JRC) to inform policymaking by the European Commission, combining the use of a global energy model (POLES) and a global economic model (GEM-E3). It provides pathways for all PACTA sectors, with the exception of cement. The time horizon extends to 2070. The 2021 edition of GECO comprises three main scenarios:

- Current Policy (CurPol) This scenario models at a macroeconomic level the effect

of enacting current policies that have already been adopted up until 2019. If there are Nationally Determined Contributions (NDC) targets at the national level but no policies, then these are not taken into account. Macroeconomic projections for GDP and population growth are combined with the modelled effects of policies on energy prices and technology development and deployment in order to then make projections for changes in energy systems and CO_2 emissions. The effects of the Covid-19 pandemic on the energy system are factored into the modelling of growth and in particular in the transport sector. The global temperature outcome of the scenario is not specifically stated in the scenario literature, but the charts indicate greater than 3°C.

- NDC and Long-term Strategies (NDC-LTS) This scenario uses the Current Policy as its starting point and adds the potential effect of NDC policies in the short term and in the longer-term policy measures that may be implemented post-2030. This scenario results in a 50% chance of limiting global temperature rise to 1.8°C by 2100.

- 1.5°C Unified (Unif): This scenario represents an economically efficient pathway to achieving 1.5°C. The scenario assumes a low overshoot by 2050 (1.7°C) with global net zero GHG emissions reached before 2070. It assumes the application of a single global carbon price from 2021 onwards and that this functions as the main policy driver. It has limited reliance on carbon capture and storage technologies and does not consider financial transfers between countries to implement mitigation measures. If all the targets are achieved as set out by this scenario there would be at least a 50% chance of limiting global temperature rise to 1.5°C by 2100.

A second version of the 1.5°C scenario has also been developed, a ´differentiated´ scenario in which the carbon price is varied on a regional basis. This scenario is not currently available as part of the GECO 2021 scenario set prepared for use with PACTA.

JRC, Global Energy and Climate Outlook (2021)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