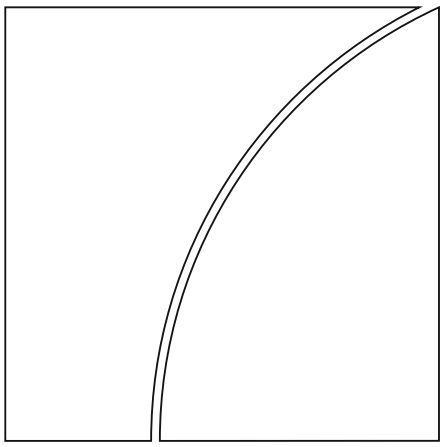

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Climate-aware investing

by Anandakumar Jegarasasingam

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Keywords: central banks, sustainability, carbon footprints, investing.

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Climate-aware investing[1]

A primer for central bankers

Anandakumar Jegarasasingam[2]

Abstract

Since the signing of the 2015 Paris Agreement, investment strategies focused on managing climate risks and pursuing climate impact have garnered considerable interest. Financial institutions, including some central banks, have started to decarbonise and align their investment portfolios with net zero emissions targets, and many have started to lower the greenhouse gas (GHG) emissions generated from their investments. This paper explores the key concepts, norms and strategies behind such an investment approach, which for easy reference is referred to as climate-aware investing. It also introduces some of the most common investment strategies, such as exclusionary screening and thematic investments, as well as portfolio management techniques such as temperature alignment. The paper also addresses the unique challenges faced by central bank investors in pursuing climate-aware investments. By examining the opportunities and limitations, this study contributes to the broader understanding of climate-aware investing from the perspective of central bank investors.

Keywords: central banks, sustainability, carbon footprints, investing.

JEL classification: E58, G11, Q56.

[1] This paper reflects the views of the author and not necessarily the views of the BIS. The author would like to thank Benoit Mojon for research guidance; Cornelius Nicolay for research assistance; and Corrinne Ho, Frank Packer and Torsten Ehlers for substantive comments.

[2] Bank for International Settlements (BIS), kumar.jegarasasingam@bis.org.

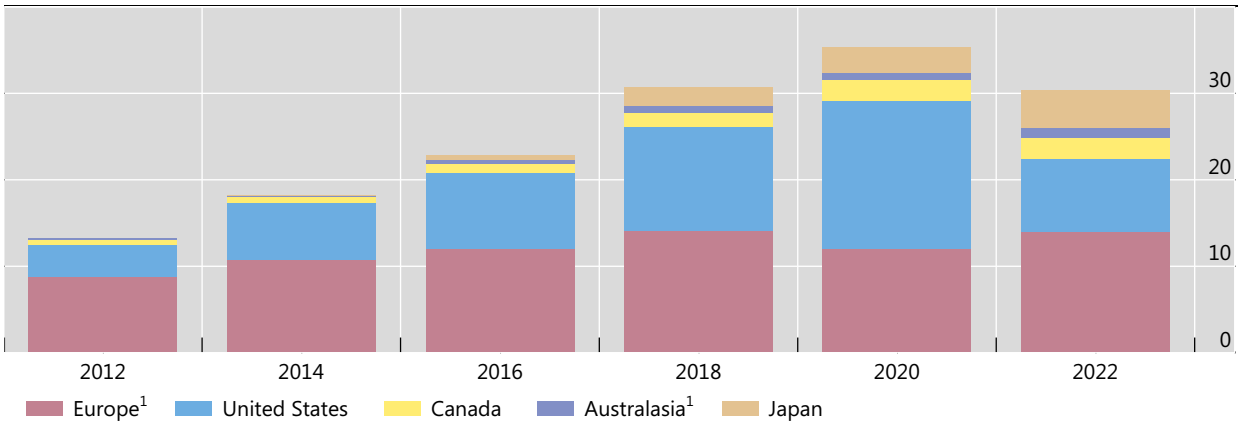
1. Introduction

Arguably the most significant investment trend of the past decade has been the interest in sustainable investing. Assets managed under sustainable investment principles are estimated to have reached USD 30 trillion by end-2022, from USD 18 trillion at end-2014 (GSIA (2023)). One of the most salient developments has been the growth of climate-focused investments since the signing of the 2015 Paris Agreement. This is demonstrated by the growing popularity of initiatives of like-minded organisations such as the Principles for Responsible Investment (PRI) and the Network for Greening the Financial System (NGFS), seeking to help organisations enhance the climate-friendliness of their investment portfolios.

Global sustainable investments

In USD trillions

Graph 1



[1] Europe and Australasia have enacted significant changes in the way sustainable investment is defined in these regions, so direct comparisons between regions and with data from previous versions of GSIA reports (data points for 2012 and 2014) are not easily made.

Source: Global Sustainable Investment Alliance (GSIA), 2023.

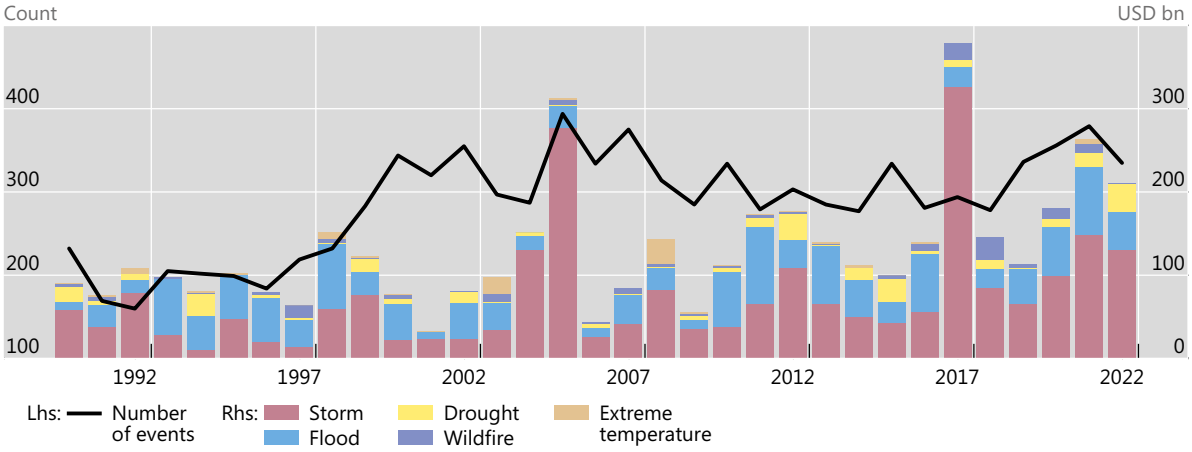
Against this backdrop, the intention of this paper is to introduce climate-aware investing as a high-level concept, specifically tailored for central bank investors. Positioned within the broader literature on sustainable finance and building on recent work of the NGFS, this paper aims to offer insights and guidance on integrating climate considerations into investment decisions. By doing so, it provides an introduction to how central banks can either hedge their investments against carbon risk or gear their investments to finance the transition to a sustainable, low-carbon economy.

Climate-aware investing can be approached through two lenses: a risk angle and an impact angle. Given the broad-ranging socio-economic impact of climate change and its impact on the financial performance of entities, climate-related risks have started to garner greater attention. The evidence has been tangible. For instance, global temperatures have risen well above the historical average, and the warmest seven years on record have all been after 2015 (World Meteorological Organization (2023)). Moreover, significant natural hazards such as tropical storms, floods and droughts have all increased in number and generated significant

socio-economic impacts (see Graph 2). Actions by households, businesses and governments to address climate change-related challenges have also inevitably increased the global economy's climate transition risk profile.

Investors can therefore be exposed to either the physical risks or transition risks associated with climate change, and they may want to hedge against such risks. However, the recognition that the current trajectory of actions is not sufficient to limit global warming to well below 2˚C by 2050, as envisioned by the Paris Agreement, has catalysed efforts to pivot towards climate-aware investments as a tool to pursue global climate ambitions. Investors may also channel their portfolios to fund the transition to relying less on fossil fuels and more on either saving energy or promoting the commercialisation of energies that do not foster global warming, ranging from solar- or wind-powered electricity generation to sustainable aviation fuel.

Economic costs and frequency of physical risk events[1] Graph 2



[1] Physical risk events comprise droughts, extreme temperatures, floods, storms and wildfires.

Sources: EM-DAT, CRED/UCLouvain, 2023, Brussels, Belgium; author's calculations.

While interest in climate-aware investing has grown significantly, it is still a new discipline with an evolving body of knowledge. This presents its own challenges and complexities. For example, the value chain perimeter for emissions assessments (ie with or without scope 3 emissions)[3] remains a key challenge due to data gaps. Similarly, the ability to meaningfully forecast entities' future climate performance for investment decision-making is another key hurdle (Institut Louis Bachelier (2020)). Existing approaches to overcoming these challenges include portfolio management techniques such as temperature alignment assessments are heavily dependent on assumptions with regards to an entity's or sector's decarbonisation trajectory, limiting their comparability and even usefulness across other entities and sectors.

[3] Scope 1 emissions are direct emissions from owned or controlled sources. Scope 2 emissions are indirect emissions from the generation of purchased energy. Scope 3 emissions are all indirect emissions (not included in scope 2) that occur in the value chain of the reporting company, including both upstream and downstream emissions.

Against this backdrop, an introduction to climate-aware investing is particularly relevant for central banks. This is because central banks have a distinct investor profile characterised by an unconventional balance sheet structure primarily designed to fulfil public policy obligations, serving the diverse needs of the government, the financial system and the public (BIS (2009)). Consequently, central banks often operate with limited flexibility compared with private sector investors, which presents certain challenges when it comes to hedging against climate risks or embracing climate-aware investment strategies. For example, foreign exchange (FX) reserve management is a common core function of many central banks. The main motivation for managing FX reserves rests on the desire to assure markets that the country's authorities can meet their external financial obligations and, more generally, to instil confidence in the domestic economy. As such, the focus has been on balancing a triad of objectives – liquidity, safety and return – and the associated trade-offs (Fender et al (2020)).

Introducing climate considerations would add an additional layer of complexity into the mix. Therefore, arguably, central banks must assess the means to hedge their portfolio against climate risk and, depending on their mandate, to tilt their investments to support the green transition. As public institutions, central banks attract significant scrutiny of their actions from politicians, market observers and interested members of the public. Hence, irrespective of the stand that a central bank may take regarding climate investing, it is likely to come under scrutiny for doing either too much or too little. This is clearly illustrated by the fact that central banks consistently rank reputational risk as a key motivation in periodic NGFS surveys on sustainable investment practices (NGFS (2024)).

This paper uses the term "climate-aware investing" to encompass elements of both climate-aligned investing and climate change investing. Climate-aligned investing aims to align investment portfolios with the Paris Agreement goals by reducing carbon footprints, supporting investees with credible low-carbon transition plans and engaging in stewardship activities. In contrast, climate change investing encompasses a broader range of strategies, including managing climate-related risks on the portfolio and helping build resilience to adapt to climate impacts through investments such as green bonds. While climate-aligned investing is specifically aimed at meeting climate targets and often involves exclusionary practices, climate change investing addresses a wider array of issues related to climate change through diverse investment strategies.

In section 2, the paper introduces the concepts related to climate-aware investing and the considerations specific to central banks as institutional investors. In section 3, it discusses the differing objectives of central banks and the financial instruments available to them to pursue climate-aware investing. In section 4, the paper introduces the most common investment strategies such as exclusionary screening and thematic investments, as well as portfolio management techniques such as carbon footprinting. Section 5 concludes.

2. Climate-aware investing: initiatives, definitions and challenges

The definitions and concepts underpinning climate-aware investing have evolved in recent years thanks to various public, private and joint public-private initiatives. This section introduces the main global initiatives that are relevant for central banks and provides an overview of key decision-relevant definitions and concepts.

2.1 Global reporting initiatives

Climate-related financial reporting is crucial for promoting climate investing as it encourages transparency, accountability and informed decision-making among investors. By mandating disclosures on greenhouse gas (GHG) emissions and climate-related risks and opportunities, investors are better placed to assess the environmental impact and sustainability of their investments. This, in turn, supports the alignment of investment portfolios with climate goals, such as those set by the Paris Agreement, and helps combat greenwashing.[4] Furthermore, consistent and comprehensive climate-related reporting fosters a level playing field, encouraging all market participants to adopt sustainable practices and contribute to the transition towards a low-carbon economy. As more jurisdictions adopt or align with these standards, the global financial system becomes more resilient to climate risks, driving the mainstream adoption of climate-aware investing.

Climate-aware investing is supported by a growing set of standards, norms and concepts produced by the official sector, standard-setting bodies, non-governmental organisations, the private sector and public-private partnerships. While some have a climate focus, including supporting the ambitions of the Paris Agreement, others have a wider environmental and sustainability focus. A notable initiative is the Task Force on Climate-Related Financial Disclosures (TCFD), founded in 2015. The TCFD has helped bring climate-related financial disclosures to the mainstream. The UN-sponsored Principles for Responsible Investments (PRI), which was one of the first initiatives to be established in 2005, has issued guidance that helps investors incorporate sustainability considerations into their investment decision-making. These initiatives play a crucial role in climate-aware investing by promoting transparency and accountability through the disclosure of climate-related risks and opportunities. A non-exhaustive list of some of the more widely known initiatives can be found in Annex 1.

Despite being asset owners and asset managers, central banks are atypical as financial institutions due to their role as official sector institutions and their public policy mandate. Therefore, some initiatives do not apply to central banks, while others are less suited to central banks due to the nature of their operations. For example, the Principles for Responsible Banking (PRB) are less suited to central banks as they

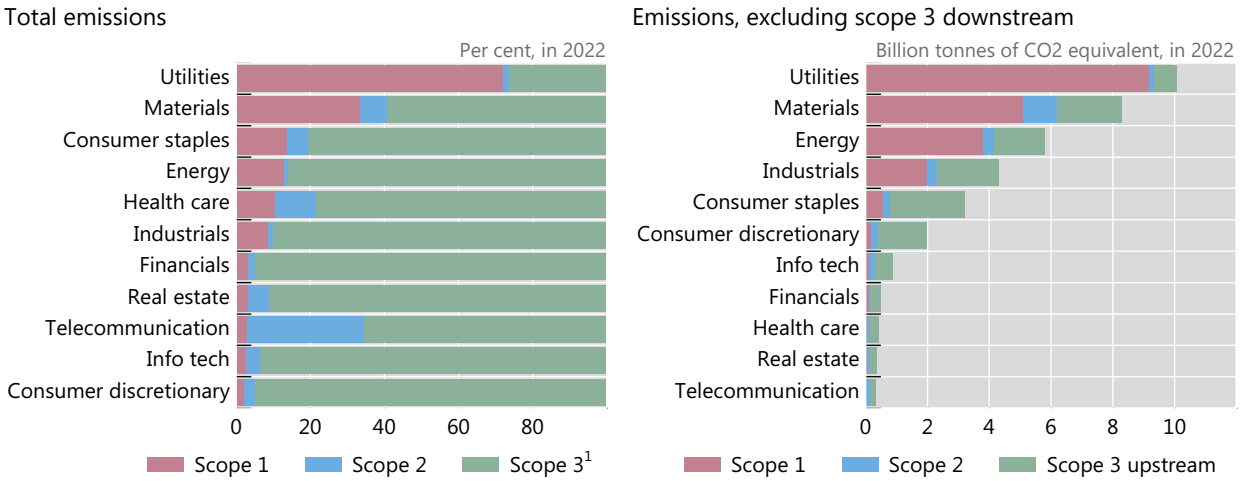
[4] The Merriam-Webster dictionary defines greenwashing as "the act or practice of making a product, policy, activity etc appear to be more environmentally friendly or less environmentally damaging than it really is".

have been tailored to commercial banks' business activities and decision-making processes. Similarly, the European Union's Sustainable Finance Disclosures Regulation is primarily directed towards private sector financial market participants and financial advisors and aims to enhance transparency and combat greenwashing. The most notable recent development is the creation of the International Sustainability Standards Board (ISSB) under the IFRS Foundation in 2021. The ISSB seeks to develop a global baseline for sustainability-related financial reporting, building closely upon the work already done by the TCFD. Following the creation of the ISSB, the Financial Stability Board (FSB) formally transferred its responsibilities for monitoring the progress of climate-related disclosure to the IFRS Foundation (FSB (2024)).

The ISSB has since issued its first two standards. The new ISSB S2 standard that came into effect in January 2024 mandates entities to disclose scope 1, 2 and 3 emissions (including financed emissions) following the Greenhouse Gas Protocol, unless a jurisdiction specifies an alternative accounting system. Currently, the ISSB standards are not mandatory in all jurisdictions. However, there is significant consensus emerging towards adopting the standards. As of September 2024, 16 jurisdictions have finalised decisions on adoption or other uses of ISSB standards, while another 14 jurisdictions are making progress to adopt or otherwise use ISSB standards. Collectively, these 30 jurisdictions represent almost 57% of global GDP and more than half of global GHG emissions (IFRS Foundation (2024)).

2.2 Greenhouse gas emissions

Emissions breakdown by sector — Graph 3



[1] Scope 3 emissions comprise upstream as well as downstream emissions.

Sources: S&P Global Trucost; author's calculations.

The environmental significance of any single GHG is determined by its global warming potential, atmospheric lifetime (ie how long it lingers) and the relative intensity with which it is emitted into the atmosphere. Due to a combination of its long atmospheric lifetime of around 500 years and increased abundance since the industrial era, carbon has the greatest impact on global warming (IPCC (2013)). GHG

emissions are quantified in units equivalent to carbon dioxide (CO_2) because CO_2 is the predominant greenhouse gas. By expressing GHG emissions in CO_2-equivalent units, one can compare the emissions of different gases and get a better understanding of their overall impact on the climate.

The terms "carbon emissions" and "GHG emissions" are at times used interchangeably. However, there is a major distinction between the two. Carbon dioxide is one of the gases that come under the umbrella term "greenhouse gases". The other GHGs are methane, nitrous oxide, fluorinated gases and halocarbons.

The GHG emissions of any entity could be viewed through three distinct categories based on the degree of perceived control of the entity over such emissions, as shown below (Greenhouse Gas Protocol (2004)):

- Scope 1 refers to direct GHG emissions that occur from sources that are owned or controlled by an entity, for example emissions from the operations of owned or controlled machinery such as boilers and furnaces.
- Scope 2 refers to GHG emissions from the generation of electricity purchased and consumed by an entity. While an entity can typically control the amount of electricity it consumes, it has little or no control over the production methods of its electricity supplier.
- Scope 3 refers to other indirect GHG emissions. Scope 3 emissions are the consequence of an entity's activities but occur at sources that are not owned or controlled by the entity. Scope 3 emissions could be subdivided into two categories: upstream emissions and downstream emissions.

  Upstream emissions are those that occur during the production of a product or delivery of a service. These emissions are often associated with various processes and activities. For instance, businesses may generate upstream emissions through their supply chains. This includes emissions tied to the manufacturing and transportation of goods they purchase, as well as emissions from employee business travel.

  Downstream emissions, on the other hand, pertain to the emissions produced during the use or disposal of a product. A typical illustration of this concept would be the emissions generated from driving conventional gasoline-powered automobiles. These vehicles burn gasoline, releasing CO_2 and other GHGs into the air as part of their regular operation. Conversely, electric cars represent a greener alternative, as they produce no emissions during operation, if the electricity is generated from renewable sources, thus resulting in significantly lower downstream emissions compared with traditional gasoline-powered vehicles.

The scope of emissions varies across industries. Generally, scope 1 and 2 emissions make up a very small part of overall emissions for service-oriented sectors, while the opposite holds for manufacturing-oriented sectors, as shown in Graph 3.

2.3 Financed emissions

2.3.1 An introduction to financed emissions

The absolute operational emissions of financial institutions (including central banks) are lower than those of industrial corporates when measured using the three-scope categorisation as shown in Graph 3. However, by virtue of its intermediary function, the financial sector also plays a key role in financing climate problems and solutions (Weber et al (2018)). In this context, financed emissions are defined as absolute GHG emissions that are financed by all types of financial institution through their loans and investments.[5] For financial institutions, scope 3 GHG emissions are the largest component of their total GHG emissions footprint (ISSB (2022)).

Financed emissions are considered indirect downstream scope 3 emissions under Category 15 of the Greenhouse Gas Protocol Corporate Value Chain Standard (Greenhouse Gas Protocol (2013)). The standard classifies financial investments into four categories: equity investments, debt investments, project finance, and managed investments and client services. The most pertinent for central bank investors is the guidance on debt investments. Emissions from debt with unknown use of proceeds (ie general corporate purposes) are computed based on the investee's firm-wide emissions. However, emissions from debt with known use of proceeds (such as green bonds and sustainability-linked bonds) are computed based on emissions attributable to the financed activity.

According to the Greenhouse Gas Protocol,[6] although the standard is designed primarily for private financial institutions such as commercial banks, it is also relevant for public financial institutions such as multilateral development banks and central banks given their intermediary role, which in the case of some central banks was also magnified in recent years due to their large asset purchase programmes.

Currently, the disclosure of financed emissions by financial institutions is limited. This is attributed to challenges related to data sourcing and uncertainties around evolving taxonomies, among others. Researchers at the Federal Reserve have found that only eight out of the 30 global systemically important banks made some disclosures on their scope 3 emissions (Beltran et al (2023)). However, banks and other financial institutions are increasingly being assessed on their carbon footprint.

As discussed earlier, the recently introduced ISSB sustainability standards require the disclosure of financed emissions for asset management firms, commercial banks and insurance companies. The proposed standards require these entities to disclose the total amount of financed emissions associated with their loans and investments, the methodology used to calculate financed emissions, the sectors and activities that

[5] An additional classification known as "facilitated emissions" is used to refer to off-balance sheet activities performed by financial institutions, such as underwriting, securitisation and advisory services. Given that data and methodologies to measure facilitated emissions are still evolving and the off-balance sheet activities of central banks are limited compared with those of commercial financial institutions, this paper focuses on financed emissions.

[6] The Greenhouse Gas Protocol is a set of standards and tools developed by the World Resources Institute and the World Business Council for Sustainable Development. It provides ways to measure and manage GHG emissions through a framework for accounting and reporting GHG emissions.

contribute the most to financed emissions and the steps they are taking to manage financed emissions (ISSB (2023)).

2.3.2 Measuring financed emissions in investment portfolios

The measurement of financed emissions is a key first step for any financial institution seeking to assess its exposure to climate-related risks. Moreover, it is also a prerequisite for setting targets to meet the aspirations of the Paris Agreement. Financed emissions could be viewed in both absolute and normalised terms. Normalised emissions indicators are more common in the financial sector and are widely used for climate transition risk assessments. The common normalised emission indicators are as follows (PCAF (2022)):

a. Physical emissions intensity measures the absolute emissions attributable to a financing activity relative to any physical unit of measure relevant to the entity receiving the financing. Examples of physical units of measure include megawatts of electricity produced, units of production such as tonnes of steel produced, or units of consumption such as kilometres driven. Physical emissions intensity measures are useful to assess the relative efficiency of firms operating in the same industry.

b. Economic emissions intensity measures GHG emissions expressed in tonnes of carbon dioxide equivalent (tCO_2e) per million currency units of investments. The TCFD provides useful guidance as to possible exposure metrics that could be used by financial institutions.

   When computed at the sub-portfolio level (such as for sectors and regions), this metric is useful for financial institutions to assess the climate impact of their various financing activities and to identify the sectors and entities that are most exposed to climate transition risk.

c. Weighted average carbon intensity measures a portfolio's exposure to GHG-intensive companies. The metric is expressed in tCO_2e per million revenues, which is then weighted relative to the value of the investment in the portfolio. This is a TCFD-recommended metric and is useful as it could be applied across asset classes.

Although normalised intensity measures are widely used and are intuitive for many investors, there are some limitations. For instance, GHG intensity measured in relative terms does not provide any indication as to the operational efficiency of an entity in lowering its emissions, as higher revenues (through financial consolidation or foreign exchange translation effects) could result in a lower intensity level. Similarly, in the case of the weighted GHG intensity metric, using revenues to normalise the data favours firms with higher pricing levels relative to competitors and the metric is therefore distorted by pricing strategies. Moreover, financial market valuation changes could have an impact on the metric without there being any underlying change in operational emissions (Sustainable Finance Platform (2022)). Despite these shortcomings, as anecdotally observed from sustainability reporting by financial institutions, these ratios are widely used as they are a good starting point for understanding the emissions dynamics of portfolios.

2.4 Climate-aware investment terminologies

Often used interchangeably, the terms "net zero portfolio" and "low-carbon portfolio" achieve different outcomes, while the broader objective of lowering financed emissions remains the same.

Low-carbon investing focuses on reducing GHG emissions by investing in companies and technologies that produce lower emissions compared with their traditional counterparts. This approach prioritises sectors like renewable energy and the pursuit of energy efficiency in operations, aiming to minimise a portfolio's carbon footprint without necessarily achieving zero emissions.

The term "net zero", in an environmental context, is defined as a state in which anthropogenic emissions of GHG are balanced by anthropogenic removals. Entities (with physical operations) that produce GHG emissions are considered to have reached a state of net zero when they reduce their GHG emissions following science-based pathways, with any remaining GHG emissions attributable to the firm being neutralised either within the value chain or through the purchase of valid offset credits (Simmons et al (2022)).

In net zero investing, the aim is to balance the total amount of GHGs emitted with an equivalent amount removed from the atmosphere. Therefore, the starting point is the absolute level of emissions. This approach entails implementing a pathway to decarbonise a portfolio in order to achieve a 1.5˚C temperature scenario, typically by reaching net zero emissions by 2050. The operational mechanics in this case are similar to those of the low-carbon approach and would include a mixture of divestment, tilts and portfolio optimisation exercises to lower the portfolio's footprint and bring it closer to the 1.5˚C target. De facto, this means that the financed carbon emissions of the portfolio reach zero at a chosen horizon (eg 2050) as specified in the 2015 Paris Agreement.

However, in addition to the focus on the absolute level of emissions, the key difference between low-carbon investing and net zero investing is that, in net zero investing, carbon offsets[7] can be used to neutralise unavoidable residual portfolio emissions (MSCI (2022)). This is particularly useful for certain hard-to-abate sectors, such as transportation, where emissions cannot be fully avoided (WWF France (2021)).

An illustrative application of normalised intensity measures can be found in the research conducted by Jondeau et al (2021). In their paper, the authors focused on assessing the carbon intensity of firms, measured by the amount of carbon emitted per million dollars of revenues. The objective was to devise a divestment strategy that would construct a portfolio with progressively decreasing carbon footprints. The underlying premise of this strategy was rooted in the observation that the distribution of firms' carbon intensity is highly skewed. Consequently, excluding a small fraction of highly polluting firms from the portfolio could lead to significant reductions in the carbon footprint of the overall equity portfolio. The authors demonstrated with historical data that excluding firms with the highest carbon intensity, representing

[7] Carbon offsets have become a popular choice for firms seeking to offset their unavoidable emissions against the backdrop of accelerating net zero ambitions. However, controversies linked to certain carbon offset providers have cast a doubt over the overall credibility of carbon offsets.

6% of the market value of a worldwide passive portfolio, led to a remarkable 50% reduction in the carbon emissions of the resulting portfolio (Jondeau et al (2021)).

Approaching the challenge from a different angle, Bolton et al (2022) conducted research on the importance of targeting absolute emissions in climate-aware portfolios. Their approach to the low-carbon portfolio was based on constructing low-carbon indices that reduced the weight of carbon-intensive companies in the reference index. The researchers aimed to minimise the tracking error of the low-carbon index with respect to the reference market index while adhering to the overall carbon budget constraint of 1.5°C. To calculate the carbon budget, Bolton et al considered scope 1, scope 2, and scope 3 upstream emissions, covering the direct supply chain. Based on data from the Intergovernmental Panel on Climate Change (IPCC) and the International Energy Agency, they estimated the global carbon budget for 2021 at 268.5 Gt of CO_2, with annual emissions estimated at a constant rate of 31.5 Gt of CO_2. Consequently, approximately 8.5 years' worth of carbon budget (268.5/31.5) was available for allocation. The key takeaway here is that from a risk management perspective, initiating portfolio emissions reductions sooner offers greater flexibility for investors. If the process were delayed by five years, according to the authors' calculations, emissions reductions would need to rise from the current 10% rate to 18%. Such steep reductions could inevitably result in the accumulation of more tracking error into the strategy (Bolton et al (2022)).

2.5 Challenges and limitations

Investors aiming either to hedge against climate risk or to foster the energy transition in the real world often structure their portfolios to encourage investees to lower their GHG emissions in both production and consumption. However, the methodologies for achieving this goal are the subject of ongoing debate and present significant challenges.

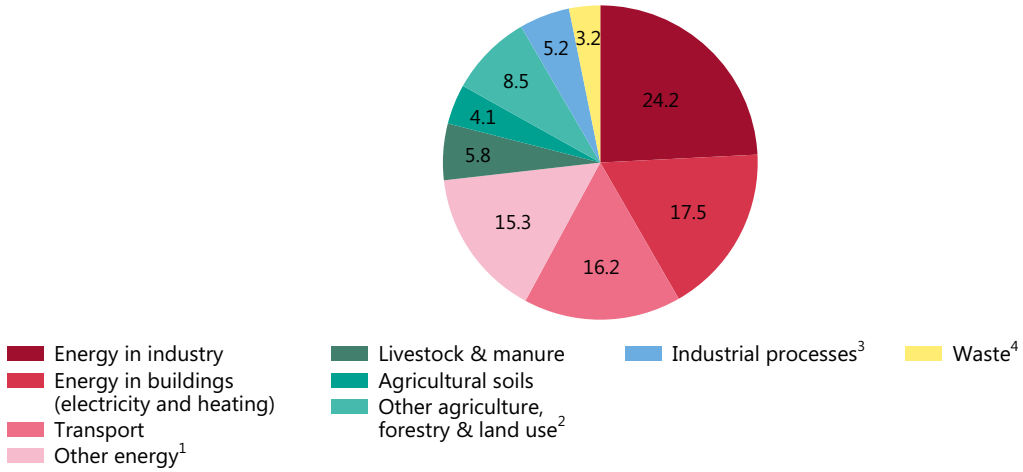
First, the attribution of emissions and potential double-counting is a key issue. For example, the same CO_2 emissions from aluminium produced for a can of soft drink would go into the emissions calculation for the aluminium smelter (direct), the can manufacturer, the soft drink bottler and the retailer (all indirect) (Demine and De Silva (2021)). That said, the ISSB standards seek to improve the measurement and disclosure of scope 3 emissions. The new ISSB standards introduced in 2024 should help address concerns about data gaps and improve disclosure practices over the medium term.

Second, the available emissions disclosures, while improved compared with those available a few years ago, still only paint a partial picture, especially since data related to scope 3 emissions, especially downstream emissions, remain deficient. As such, initial guidance from TCFD focused on scopes 1 and 2, where a higher degree of confidence could be assigned for data accuracy. For example, while emissions generated in the operation of a combustion engine vehicle could be attributed as scope 3 emissions for an automobile manufacturer, the extent of such emissions would realistically depend on the usage patterns. For example, a car used as an airport taxi would generate considerably more emissions than a family car due to their vastly different usage patterns.

Moreover, the source of GHG emissions is multidimensional, as emissions are generated by economic agents across many sectors and regions (see Graph 4) with varying degrees of control over their own emissions as well as diverging levels of ability and willingness to green their activities and lower their emissions. For example, energy consumption in buildings (17.5% of global emissions) is a major source of GHG emissions. However, tackling these emissions is a complex endeavour requiring a multifaceted approach across energy efficiency improvements, switching to renewable energy, using energy-efficient appliances and designing climate-friendly buildings (with features such as green roofs and rainwater harvesting systems).

Global greenhouse gas emissions by sector

In per cent — Graph 4



[1] "Other energy" comprises energy-related emissions from unallocated fuel combustion, fugitive emissions from energy production and energy use in agriculture and fishing. [2] "Other agriculture, forestry & land use" comprises emissions from crop burning, deforestation, rice cultivation, cropland and grassland. [3] "Industrial processes" comprises emissions from the production of cement and emissions as a by-product of chemical and petrochemical manufacturing. [4] "Waste" comprises emissions from wastewater and landfills.

Source: Climate Watch Historical GHG Emissions; author's calculations.

At the same time, several activities such as transportation and agriculture are determined by economic actors in the public and informal sectors rather than by listed firms. While a focus on listed firms and bond issuers would help accelerate the transition to a low-carbon economy, the important caveat is that it is still only one part of the overall solution. This is because there are also emissions generated by those who do not issue stocks or bonds. Public transit networks are a good example. In some advanced economies such as France, certain state-owned public transit networks have sought to enhance their green credentials through fleet replacements financed by green and sustainable bonds. However, the same is not true for many other economies, especially emerging economies, where local public transit operators continue to operate environmentally inefficient modes of public transit, primarily due to their limited financial resources.

3. The differing objectives, investment portfolios and financial instruments of central banks

Central banks interested in climate-aware investments must address three key questions:

a. What is the main purpose of pursuing climate-aware investments and what is the ambition level vis-à-vis the policy and institutional environment? Is it to manage climate-related financial risks in investments, seek climate impact through investments or concurrently pursue both objectives?

b. What is the flexibility available in the various investment portfolios managed by central banks to pursue climate-aware investing vis-à-vis the traditional investment management objectives of liquidity, safety and return?

c. What are the portfolios and instruments that are the most suitable in the pursuit of climate-aware investments?

3.1 High-level objectives

Central banks may, like other investors, aim either to hedge against climate risk or foster the decarbonisation of the economy. While hedging is a standard aspect of the fiduciary objectives of all central banks, only a small minority of central banks have a mandate for impact investing.

How far central banks can go in playing a role as an overall catalyst for mainstreaming green finance, both through their investment management activities and through the creation of a supportive policy environment, depends on their mandates (Dikau and Volz (2021)). Explicit mandates may provide the strongest basis for proactive action to address climate change, though such cases are very rare. In a study of 135 central bank mandates, Dikau and Volz have found that 16 operate under a mandate that explicitly includes the promotion of sustainable growth or development as an objective, while another 54 are tasked with supporting their governments' national policy objectives. A good example is the Bank of France, which integrates climate considerations across a broad range of investment management activities (see Section 4), including to seek climate impact through investments. Even in the absence of a mandate, central banks whose national governments have formally committed to net zero targets are typically expected to act as a partner in this effort.

In the above-mentioned assessment of central bank mandates, the authors have identified that 33 central banks do take initiatives to address climate-related risks and sustainability challenges even though their mandates do not mention sustainability or set a requirement to support government policy. The Bank of England's approach to addressing climate risks illustrates how central banks can incorporate environmental considerations into their operations. Despite lacking an explicit sustainability mandate, the Bank of England supports the government's economic policy of sustainable and balanced growth. This approach has led to the integration of sustainability considerations into its core operations. Similarly, De Nederlandsche Bank, despite the absence of specific sustainability references in its mandate, has

undertaken initiatives to promote sustainability by incorporating sustainability considerations into its mission statement (Dikau and Volz (2021)).

Irrespective of considerations related to a climate mandate, hedging financial risks posed by climate change is an active consideration for most central banks, including those without an explicit or an implicit mandate. The hedging objective appears particularly strong for central banks with long-dated portfolios with diverse asset classes, as they are likely to have a higher intrinsic exposure to climate-related risks. Indeed, according to the IPCC, the materiality of climate risk, and in particular physical risk, will be an order of magnitude larger from 2035 to 2050 than in the next few years.

However, in this pursuit, central banks must strike a delicate balance. On one hand, abstaining from active involvement in climate financing may expose central banks to criticism, as it might be seen as reinforcing the market's carbon bias and overlooking the systemic risks posed by climate change. On the other hand, a concentrated push to support the green transition may raise concerns that central banks are overstepping their traditional remit, potentially distorting market neutrality.

The concept of market neutrality is based on the idea that central banks should not interfere in the market, with the underlying assumption that the market is correctly allocating resources across the economy. However, this concept has been challenged in recent years by a growing recognition of the risks posed by climate change. An important school of thought is that markets do not adequately consider the long-term risks posed by climate change. Therefore, central banks have a responsibility to act to mitigate these risks, even if it means going beyond their traditional mandate (Schnabel (2021)). Moreover, this re-evaluation of central banks' role in climate-aware investing aligns with an emerging global consensus that addressing climate change is not merely a matter of ethical or social responsibility but is also integral to safeguarding the stability of the financial system.

3.2 Investment portfolios

Another challenge for central banks is that the original purpose of holding assets can conflict with the application of climate-aware or sustainable investment practices (Fender et al (2022)). Therefore, a pragmatic starting point for understanding investment flexibility is to map it out across the distinct investment portfolios managed by central banks. In general, the investment portfolios managed by central banks could be categorised into four groups (NGFS (2020)):

a. Policy portfolios: These relate to portfolios maintained for FX interventions, the execution of asset purchase programmes and other related monetary policy objectives such as targeting economic activity in particular sectors of the economy.

   For example, in the FX reserves portfolio, liquidity is a primary consideration as the need for reserves may arise suddenly. Another key concern is the balance between safety and return. While investments in corporate bonds could generate higher returns relative to sovereign bonds, they could also expose the portfolio to higher default risk. As such, the asset composition for FX intervention portfolios typically tends to be high-grade government and supranational debt. On the other hand, the asset mix of the asset purchase

programmes is determined by the economic priorities of the authorities and can include sovereign, sub-sovereign and corporate bonds.

The degree of flexibility to pursue climate-aware investment strategies in the policy portfolio is determined by the main motivation for maintaining such a portfolio. For example, FX intervention portfolios would prioritise liquidity and hence have less scope for including a climate focus. At the same time, the European Central Bank (ECB) explicitly factors climate risk considerations into its corporate sector purchase programme (CSPP) by tilting bond purchases towards issuers with a better climate performance (Aubrechtová et al (2023)). The CSPP portfolio is arguably the opposite of an FX intervention portfolio as it is not expected to be sold on short notice. Also notable is that tilting began only in the reinvestment phase. During the purchase phase, when the prime objective was to add liquidity to the system and keep rates low, climate performance was not a key priority.

b. Own portfolios: These portfolios are typically not related to a policy objective and aim to generate returns within a certain risk tolerance level. The asset mix tends to be more diversified and can also include equities. Own portfolios are typically a good starting point as they have fewer constraints than policy portfolios as they largely pertain to the management of a central bank's own capital reserves. Please see Box 1 for an overview of current practices.

c. Pension portfolio: Given its inherent long-term nature, the pension portfolio tends to focus on a longer time horizon and is more diversified in terms of asset classes and invested geographies. This generally renders it well suited for deploying climate-aware investment strategies.

d. Third-party portfolios: Some central banks manage third-party portfolios where the portfolio attributes are determined by the third party. A pertinent example is the Deutsche Bundesbank, which manages the pension funds for the German federal states. However, since the investment parameters are typically set by the asset owners, the flexibility to have a climate focus is limited unless it has been agreed upon with the asset owner.

3.3 Financial instruments

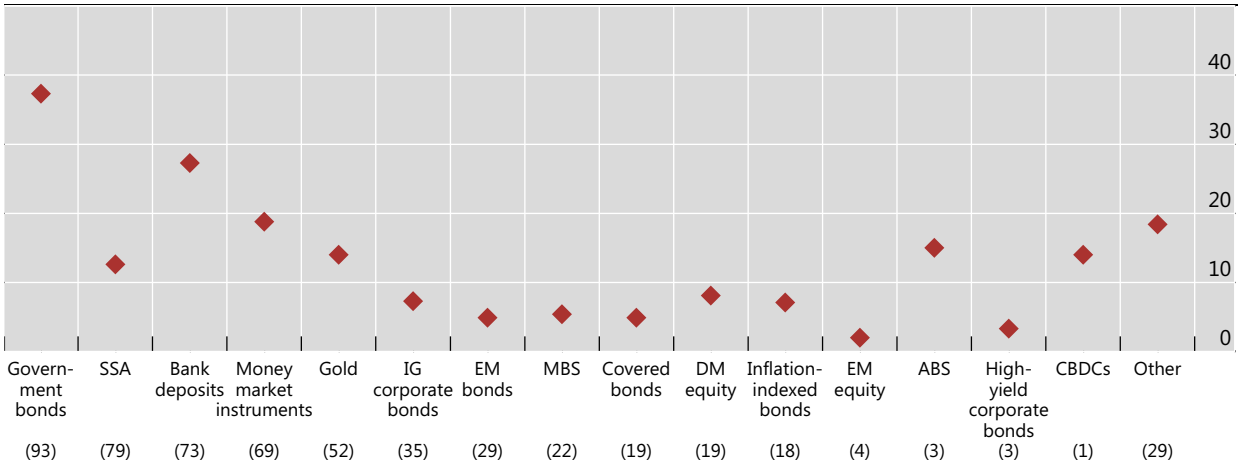
While investment portfolios are a first layer, the second layer is financial instruments within those portfolios. Instruments managed by central banks are structurally different to those managed by private sector investors in terms of their asset composition, investment constraints (ie asset classes, currencies, maturities etc) and underlying objectives. The World Bank's survey of asset allocation practices among central bank reserve managers (see Graph 5) is a good starting point for understanding the asset class preferences of central bank investors, even if it is only limited to their reserve management activities.

Unsurprisingly, as can be seen from Graph 5, government bonds, bank deposits, money market instruments, asset-backed securities, gold and SSA bonds are the most popular. In contrast, the relatively riskier asset classes, such as equities and corporate bonds, account for a smaller portion.

Distribution of central banks' average allocation to individual asset classes

In per cent

Graph 5



Numbers in brackets indicate the number of respondents with exposure from a pool of 104 respondents. The data points for each asset class represent the average for all institutions that reported exposure to the specific asset class.

ABS = asset-backed securities; CBDCs = central bank digital currencies; DM = developed markets; EM = emerging markets, IG = investment-grade, MBS = mortgage-backed securities; SSA = supranational, sovereign and agency bonds.

Source: World Bank (2023).

The suitability of various asset classes for climate-aware investments could be evaluated using the following assessment factors:

a. **Core investment objectives** could be viewed through the traditional triad of liquidity, safety and return. The objective – outside of recent stimulus-related purchase programmes – has been to balance liquidity and safety. This preference is clear in the asset allocation strategies that have tended to focus more on government and SSA sector bonds and bank deposits. Return considerations have been less pronounced but have gained importance during the low interest rate environment, especially in the own and pension fund portfolios. A preference for liquidity and the resulting focus on sovereign securities could presumably constrain the ability to pursue climate-aware investing. This is because the number of bond-issuing sovereigns is limited compared with that of corporates. In fact, only about a dozen sovereigns issue bonds that are liquid in global financial markets.

b. **Maturity:** Unlike the private sector, central banks are predominantly short- to medium-term investors. All else equal, assets with longer maturities are generally better suited for climate-aware investments. This is because an investor is better able to monitor and adjust investments (see Section 4) into a climate-aware trajectory in the long term. Moreover, certain short-term investments such as bank deposits and short-term sovereign notes are influenced by liquidity management considerations where the computation of financed emissions or tilting towards or away from counterparties may not be feasible.

c. **The investable universe and the number of counterparties** are often limited for central banks compared with the private sector. At least partially, this is because central banks have a lower risk appetite stemming from their need to maintain liquidity for intervention for exchange rate stabilisation (Castelli and Gerlach (2019)), as well as their policy mandate emphasising conservatism. Typically, the larger the investable universe and the number of available counterparties, the greater the flexibility as it allows for differentiation.

The following table shows the assessment of the most common asset classes of interest for central bank investors across the assessment factors discussed above.

Climate exposure and impact potential of investments — Table 1

Asset class	Core investment objective	Maturity	Available number of counterparties	Climate risk exposure potential	Climate impact potential
	Liquidity; return; safety	Short (< 1 yr); medium (1–5 yrs); long (> 5 yrs)	Low (< 50), medium (50–100); high (> 100)	Low; medium; high	Low; medium; high
Government bonds	Safety and liquidity	Medium to long	Low	Medium	Medium
Bank deposits	Liquidity	Short	Low	Low	Low
SSA bonds	Safety and return	Medium to long	Medium	Medium	Medium
Money market instruments	Liquidity	Short	Low	Low	Low
Gold	Safety	Short (technically)	Low	Low	Low
Covered bonds and other securitised assets	Return and safety	Medium	Medium	Low-medium	Medium
Corporate bonds	Return	Medium to long	High	Medium	Medium
Equities	Return	NA	High	High	High

Source: Author's assessment.

Due to the long-term nature of climate change, long-dated assets inevitably have a greater intrinsic exposure to climate risk. While short-term assets could arguably also be affected by a sudden risk event, especially a physical risk event, in general the probability of occurrence is lower than that for long-dated assets. As such, as described in the next section, most climate-aware investment methodologies have been developed with a focus on corporate bonds and equities. The methodologies for assessing other asset classes such as sovereign and SSA bonds are still evolving.

The potential for seeking climate impact requires a clear investment positioning towards industry sectors/geographies and asset classes. This is because, in climate

Box 1

Central banks and climate-aware investments

Many central banks are exploring climate-aware investments to manage climate-related financial risks and to a lesser degree, achieve climate impact. The NGFS, launched in 2017, recommends integrating sustainability factors into portfolio management. However, practices vary based on institutional mandates and interpretations.

Purpose and ambition levels

Most central banks pursue climate-aware investments through pension and own fund portfolios to manage climate-related financial risks and sometimes generate climate impact. For example, the Bank of Italy integrates ESG criteria into the management of its equity and corporate bond investments in its non monetary policy portfolios (Bank of Italy (2022)). Similarly, the Central Bank of Malaysia has integrated ESG considerations into its strategic asset allocation exercise (NGFS (2024)). De Nederlandsche Bank has increased its green bond investment target to EUR 1 billion (Central Banking (2023)). The Bank of France buys green and social bonds and invests in thematic funds for energy and ecological transition (Bank of France (2022)). The Bank of Finland is aiming for a carbon-neutral investment portfolio by 2050 (Bank of Finland (2022)). Similarly, the Hong Kong Monetary Authority (HKMA) has set a target of net zero GHG emissions by 2050 for the Investment Portfolio of its Exchange Fund (NGFS (2024)).

Flexibility and trade-offs

The ECB uses a climate score to tilt corporate bond holdings under its quantitative easing programme, assessing issuers' climate performance through metrics and disclosure quality (ECB (2022)). Similarly, the Bank of England employs a comparable approach for its corporate bond purchase scheme and monitors climate risk exposures in other asset classes (Bank of England (2022)). The political, institutional and economic environments have supported these initiatives. However, central banks face limitations when extending climate-aware investments to government and supranational securities due to the limited number of issuers. Pursuing climate aware investments depends on central banks' motivation, ambition and tolerance for trade-offs. Incorporating climate considerations can generate trade offs with objectives of safety, liquidity and return. For instance, purchasing large quantities of green bonds can lengthen portfolio duration (Fender et al (2022)).

Suitable portfolios and instruments

Pension fund and own fund portfolios appear most suitable for climate-aware investments, with green bonds, environmentally focused equities and thematic funds being effective choices. Central banks' flexibility in these portfolios allows them to balance climate objectives with traditional investment goals, paving the way for more sustainable investment portfolios.

risk management, the focus is relatively well defined in that it seeks to avoid any investment losses attributed to climate risk events. In climate impact investing, the focus can be on enabling the progressive reduction of emissions or on avoiding emissions. Both require expenditure to change processes and practices and hence require long-term financing. As such, climate impact-seeking requires long-dated investments such as equities and bond financing. In recent years, green bonds have emerged as an impact-seeking tool, as their focus on positive environmental outcomes would generally help qualify them as impact investments.

Arguably, fixed income securities and equities make up only one part of a central bank's balance sheet. This raises the question as to the application of climate filters for other assets such as deposits, repos and derivatives. From a theoretical standpoint, one could, for instance, compute the carbon emissions attributed to a deposit placement with a commercial bank counterparty if it is treated as a source of funding

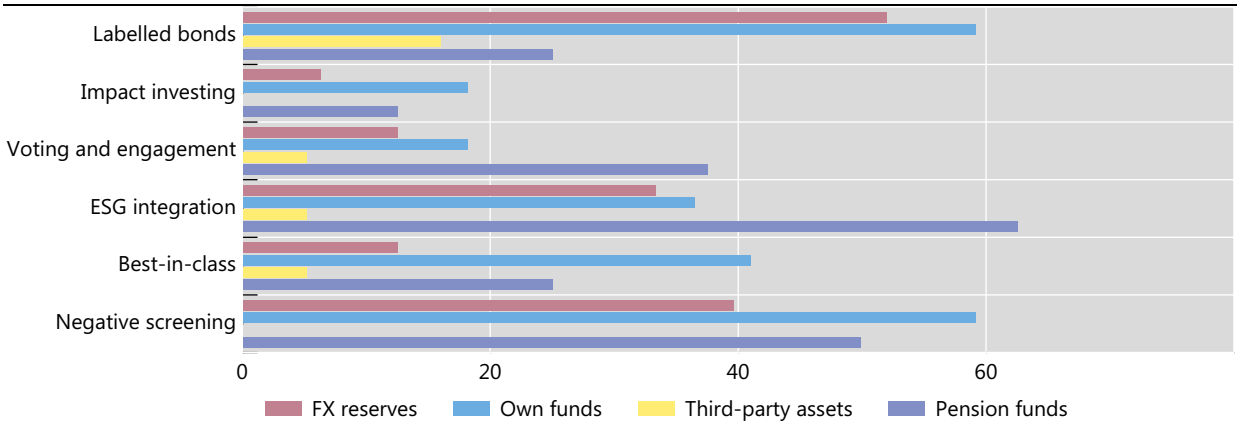
like debt and equity. It is important to note that the carbon footprint of deposits can still be significant, and central banks can consider assessing this footprint[8] as part of their overall climate risk management efforts. However, as the level of disclosure of financed emissions is currently in a state of evolution, there is reluctance to use the available information. Nonetheless, it is important to acknowledge that in the pursuit of perfection, the quest for better data should not impede the utilisation of available information.

4. Overview of potential investment strategies

Climate-aware investing is a broad, forward-looking exercise with varying levels of complexity and effectiveness, both for risk management and for impact generation. Central banks have been increasingly exploring these strategies, driven by the dual objectives of managing climate-related financial risks and achieving climate impact through their investments. This section categorises climate-aware investing approaches into five main types, illustrating how central banks employ multiple strategies concurrently across different portfolios to align with their institutional mandates and climate ambitions. It should be noted that in practice multiple strategies could be concurrently deployed to different portfolios or, at times, to the same portfolio, as illustrated in Graph 6 (NGFS (2024)).

Most applied SRI strategies per central bank portfolio[1]

In per cent — Graph 6



[1] Percentages of central banks responding to the SRI survey that apply SRI strategies per portfolio type. Percentages were calculated using the number of central banks managing the portfolio type: 48 central banks manage FX reserves, 22 own funds, 19 third-party assets, and 8 pension funds.

Source: NGFS (2024).

[8] A more direct practical limitation for central banks is that the universe of eligible commercial banking counterparties is often limited to highly rated major global banks and national champions owing to stringent internal risk management guidelines. Given that the starting list is relatively short, exclusions for climate reasons may result in a further shortening and generate an undesirable increase in counterparty concentration.

4.1 Negative screening, divestments and portfolio tilting

Negative screening or exclusion is a common investment practice in which investments in companies and sectors deemed "socially harmful", such as tobacco and cluster munition, are excluded. Historically, such exclusions were primarily driven by investor convictions and a desire to manage reputational risks arising from investments rather than financial risk concerns. In the context of climate change, the focus has been on screening fossil fuels and sectors with high emissions. The financial risk dimension stems from the impact of climate change on entities' financial performance (Basel Committee on Banking Supervision (2021)). At the same time, there is also a reputational risk dimension underpinning exclusionary strategies, as such strategies galvanise global social awareness and action against economic actors contributing to global warming (with "at-risk" sectors being the most prominent).

Given their relatively simple implementation, exclusions are often a first step. While some investors avoid at-risk sectors altogether, others tolerate a certain level of exposure and apply minimum thresholds for revenues generated from high-emissions activities and exclude entities that generate revenues above a given threshold. An example in the official sector is the Bank of France, which has committed to excluding thermal coal from its investments by 2024, having previously set a minimum revenue threshold of 20% for thermal coal revenues in 2018 (Bank of France (2022)).

When a negative screening strategy is applied, it precludes future investments and at the same time may also require the divestment of existing investments in entities falling within the ambit of the screen. Given the concentration of emissions in certain industrial segments, divestments can help generate an immediate improvement to a portfolio's post-divestment carbon footprint and reduce the risk of carrying stranded assets in the portfolio (NGFS (2024)). An example in the official sector is the Sveriges Riksbank, the Swedish central bank, which in 2019 sold its holdings of bonds issued by the Australian states of Queensland and Western Australia and the Canadian province of Alberta, premised on a new investment policy that precluded investments in entities with a high carbon footprint (Stubbington (2021)). However, it's worth noting that the divestment strategy may not always yield consistent results. Over time, the initial substantial improvements to the portfolio's carbon footprint might potentially taper off once the major emitters are excluded.

Arguably, exclusions and divestments work for equity and corporate bond portfolios, as a typical portfolio would have several individual entities. However, they may not have the same degree of effectiveness for sovereign bond portfolios. As already discussed, the number of bond-issuing sovereigns is limited, and those that would be of interest for central bank investors (typically issuers rated investment grade) would at best amount to around a dozen sovereigns. Therefore, any exclusions or divestments may result in higher portfolio concentration to existing names. Moreover, given the underlying structure of global economies and the dominance of major currencies, bonds issued by certain sovereigns (notwithstanding their own climate credentials) are an inevitable part of any portfolio, particularly so for central banks' reserve management portfolios.

A key limitation of the exclusion strategy is that it has a very limited role in influencing the achievement of global climate ambitions. This is because the focus of

the screening strategy is to minimise an investor's exposure to at-risk entities, with no concomitant effort to address the investee's role in global emissions.

Another potential consideration is that an exclusion strategy requires a clear formulation of exclusion policies if central banks are not to be accused of making politicised investment decisions (NGFS (2024)). As such, there is typically due consideration for exclusionary filters premised on national and international laws, conventions, principles and standards, such as the international treaties on controversial weapons and the United Nations Global Compact. Exclusions based on climate change considerations are well founded thanks to the aspirations of the Paris Agreement.

4.2 Voting and engagement

Voting in invested firms and engaging with investees has become increasingly popular in the asset management industry. This is because these activities allow investors to have a public voice and generate positive stakeholder perceptions when they are successful. Moreover, when the majority of investors are even slightly socially responsible, engagement helps achieve socially desirable outcomes (Broccardo et al (2022)). Unlike in the case of exclusions and divestments, voting and engagement also allows the investor to remain invested and influence (typically alongside other like-minded investors or investor consortia) an entity as it transitions to a more climate-aware path. Many asset owners and asset managers publicly disclose their engagement priorities.

A survey done by the NGFS (see Graph 6) suggests that voting and engagement is not widely used by central banks at present. In part, this is because its application is often limited to equity investments, which are only pursued by a small subset of central banks. Even among those central banks that invest in equities, barring a few, the relative proportion of equity investments in their overall asset allocation is small, and these investments are typically confined to own and pension fund portfolios.

Voting and engagement initiatives require the establishment of clear policies, which can be onerous on resources. Another key challenge is structuring interactions in a constructive manner, focusing on the risks the investor is seeking to avoid. Given the rule and policymaking powers vested with central banks, engaging with private sector firms can generate the perception of conflict of interest. As such, those central banks that use engagement typically tend to structure their engagement efforts indirectly through external asset managers or third-party proxy managers (NGFS (2024)).

For example, the Swiss National Bank (SNB) has exercised its voting rights at annual and extraordinary general meetings since 2015, with a focus on good corporate governance practices. However, the SNB has refrained from actively engaging with companies to influence business developments or from submitting shareholder proposals (NGFS (2019)).

Although voting and engagement is highly effective in influencing global climate ambitions, it creates additional practical and political complications for central bank investors without a well-defined organisational mandate for climate impact. Taken in the context of the relative size of equity portfolios held by central banks and the

associated challenges of implementing a voting and engagement strategy, it appears to be less suited to central banks.

4.3 Best-in-class investing

Best-in-class investing focuses on actively selecting only those entities that meet a defined ranking hurdle based on both a financial filter (ie return potential) and an environmental filter. In the context of climate-aware investing, this latter filter could be linked to a physical or economic emissions intensity measure. Due to the relative ease of obtaining and comparing it across sectors, the revenue intensity of emissions is often used as a screening hurdle, the underlying rationale being that entities that are above the threshold are better positioned to face climate-related challenges compared with those that fall below the threshold.

Best-in-class portfolios have gained popularity, particularly among ESG-focused investors, as they can be used for passive index investment approaches (Cambridge Institute for Sustainability Leadership (2014)). Outside an index-based strategy, a best-in-class strategy could also be applied as a thematic strategy when an investor seeks to expand the current investable universe to include new sectors and geographies. Another advantage of a best-in-class approach for a diversified portfolio is that it makes it possible to preserve sectoral and country exposures while channelling funds to the best performers in terms of carbon emissions within sectors and countries (Jondeau et al (2021)).

However, a potential drawback of this strategy is that the initial threshold is often based on backward-looking data such as the revenue intensity of emissions. Therefore, by construct, this approach would exclude entities that may potentially improve their climate performance over time. This limitation could be overcome with the application of a sequence of filters that can include forward-looking assessment of emissions abatement or updating previous backward-looking criteria with up-to-date information.

4.4 Transition financing and impact investing

Transition financing relates to investments made in entities to help implement their net zero transition, in line with the temperature goal of the Paris Agreement and based on a credible corporate climate transition plan (OECD (2022)). Although transition bonds have existed as an asset class since 2017, they have not gained widespread acceptance due to a lack of universal consensus on definitions (Olszowka (2023)). While there are also more complex arrangements such as project financing, mezzanine financing and blended financing, these are less commonly used, especially by central bank investors, who have a much narrower remit of authorised investment outlets compared with institutional investors in the private sector. As such, the most used investment tool for transition financing have been green and sustainability-linked bonds.

Transition financing is a proactive choice for an investor and signals the investor's climate focus. A case in point is the BIS's green bonds investment pool (green BISIP) launched in USD and EUR tranches in 2019 and 2021, respectively. As of end-September 2021 and per USD 100 million invested, the BIS's two green BISIPs

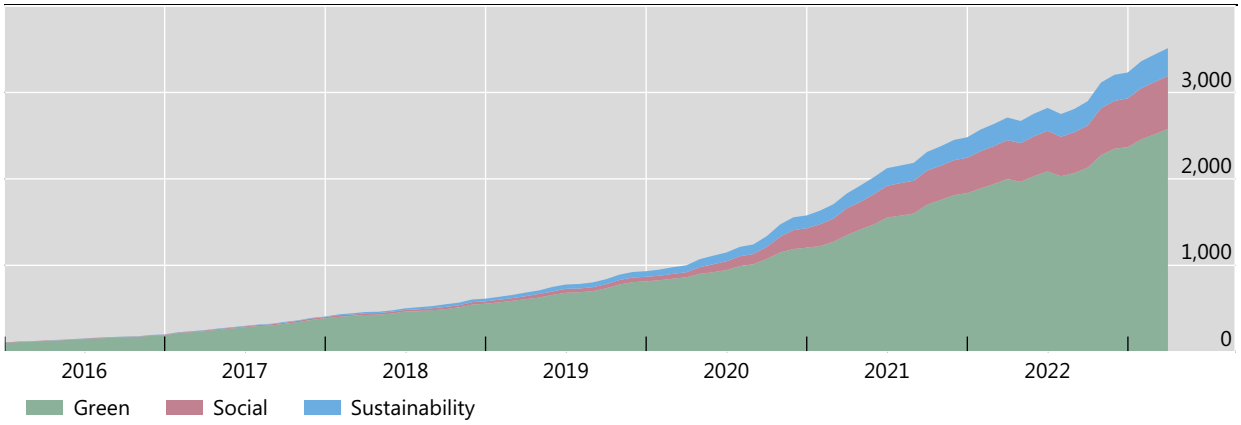
together were estimated to have an annual expected impact equivalent to 66,235 tonnes of CO_2 emissions prevented across a range of categories (BIS (2022)).

Implementation considerations here include a concentrated issuer pool and low liquidity. While the issuance volume of green and sustainability bonds has expanded as shown in Graph 7, the number of issuers is rather concentrated.

Total amounts outstanding of green, social and sustainability bonds

In billions of US dollars

Graph 7



Sources: Climate Bonds Initiative; Dealogic; Environmental Finance Bond Database; BIS calculations.

Green and sustainability bonds tend to be oversubscribed during initial issuance. Moreover, given investors' desire to hold them in their portfolios to maturity, they are less liquid than conventional bonds. As such, accessing bonds that also match the central bank investor's investment criteria (eg minimum credit rating, minimum return threshold etc) can at times be challenging.

Another concern is whether the issuance of green bonds leads to actual emissions reduction at the issuer level (Ehlers et al (2020)). While this is indeed a valid concern, it should not be overlooked that the benefits from a green bond-funded project may only generate a positive climate outcome after a gestation period, as emissions reductions may not be immediate.

Impact investing focuses on generating positive environmental impact through intention, measuring impact to assess progress and using those impact data to manage investment performance from strategy to exit (Hand et al (2021a)). In the context of climate-aware investing, this is broadly similar to transition financing, but a key difference between the two is that the targeted investment returns of impact investments could potentially be below market rates (Bouyé et al (2021)).

While impact investing is still a niche space, it has increasingly caught the attention of the investor community. This is because impact themes such as renewable energy, sustainable agriculture and forestry are viewed as justifiable from both financial and risk perspectives (Hand et al (2021b)).

Impact investing by central banks – beyond the transition financing initiatives outlined above – may require a clear organisational mandate to facilitate a climate impact, which very few central banks have. Additional research is also needed to ascertain how certain features of impact investing, such as longer investment holding

periods and the less predictable nature of returns, would affect core investment considerations related to safety and liquidity desired by central bank investors.

An example within the central banking community is that of the Bank of France, which has invested in unlisted green infrastructure funds that focus on financing infrastructure for electricity generation using renewable energy – solar, wind or biomass – and infrastructure dedicated to sustainable mobility (NGFS (2019)).

4.5 Index investing

Decarbonisation indices are a type of investment index that tracks the performance of entities that are taking steps to reduce their carbon emissions. De facto, these indices are constructed using exclusion, tilting or best-in-class criteria, implemented in the composition of diversified portfolios. These indices can be used by investors who want to invest in entities that are aligned with the Paris Agreement goal of limiting global warming to well below 2.0°C. Firms such as MSCI, S&P and FTSE Russell have played a role in developing and maintaining these indices, each with their own methodology. Some indices focus on entities that have set ambitious emission reduction targets, while others focus on entities that are actively investing in low-carbon technologies (PRI (2018)).

The main advantage of decarbonisation indices is that they can be a relatively easy entry point for investors to invest in climate-aware assets and thereby support the transition to a low-carbon economy. Moreover, given the concentration of GHG emissions among a minority of corporates, a broad index that aims to be on or tend towards a net zero carbon trajectory is unlikely to substantially differ from a traditional broad-based index. For instance, Jondeau et al (2021) show that the carbon footprint of a global stock portfolio can be reduced by 50% by reallocating only 5% of the assets under management. While reducing exposure to carbon-intensive sectors may in principle lead to short-term underperformance (as climate risks may not have materialised) compared with traditional indices, especially during periods when high-carbon sectors outperform the market, in practice, the composition and return of a decarbonised portfolio will be nearly identical to that of the benchmark. While there may be short-term performance trade-offs, central banks can potentially view decarbonisation indices as a strategy for securing long-term value by mitigating climate risks.

Decarbonisation indices based on equities are more common than those based on fixed income securities. Moreover, while decarbonisation indices for sovereign securities are available, they may not meet the investment needs of central banks as certain sovereign issuers, by virtue of their dominant role in the global economy, are inevitable components of any investment portfolio (at least for the foreseeable future) irrespective of their climate credentials. This concern is particularly pronounced in reserve management portfolios where the portfolio's currency composition is a key consideration.

The potential applicability of decarbonisation indices for central bank investors is still being debated. Some central banks are already investing in decarbonisation indices, while others are still considering the issue. The decision of whether to invest in decarbonisation indices will depend on factors such as the alignment of decarbonisation indices with the central bank's investment mandate, the availability

of data and research on decarbonisation indices, and the cost of investing in decarbonisation indices.

4.6 Portfolio alignment

"Portfolio alignment" is a broad term related to the positioning of a portfolio on the transition path typically relative to a benchmark or an emissions target, most commonly the Paris Agreement aspiration of under 1.5°C of warming. There are four major approaches to portfolio alignment, with varying levels of complexity (Glasgow Financial Alliance for Net Zero (2022)).

Binary target measurements capture the alignment with a chosen climate outcome based on the proportion of investments (or firms) in the portfolio with declared net zero targets. An example of a binary target could be that 50% of firms in the portfolio should have emissions reduction targets validated by an independent third party in line with the latest climate science. Although simple to use, this approach cannot be used for firms without emissions reduction targets, and the binary measurement approach does not imply that the credibility of transition plans has been scrutinised and validated. Moreover, an investee firm could align itself with a "consolidated firm-level" target through mergers and acquisitions. In such cases, although the firm would be aligned in theory, in practice there would be no direct contribution to global net zero efforts as assets would only change ownership.

Maturity scale alignment metrics group firms in the portfolio based on their temperature alignment efforts. This is done, for example, based on assessments such as "aligned", "aligning", "committed to aligning" or "not aligned". Compared with the simple binary measurement, a key advantage of this approach is that it might help to provide a more comprehensive picture of the portfolio's trajectory, and targets could be set to increase these percentages over time.

An example within the central banking community is the Bank of England, which has disclosed the temperature alignment efforts of investee firms in its corporate bond purchase programme. The proportion of firms with a set target under the Science Based Targets initiative (SBTi) has increased to 59% in 2022 from 39% a year earlier. Here, the SBTi assesses the firm's targets against three categories: 1.5°C-aligned, "well below" 2.0°C-aligned and 2.0°C-aligned. Of the firms that have SBTi targets, 70% are said to be aligned with the 1.5°C pathway, 17% with the "well below" 2.0°C pathway and 14% with the 2.0°C pathway (Bank of England (2022)). This approach helps investors set targets to increase the percentage of firms in the portfolio that are aligned with their climate goals. This, in turn, can help investors make progress towards their climate goals and ensure that their portfolios are becoming more sustainable.

Benchmark divergence models compare a firm's emissions against a normative benchmark that uses forward-looking climate scenarios to map the emissions pathways required to achieve a given warming target (such as 1.5˚C). The resulting metric shows the level of compliance of the firm's emissions vis-à-vis the benchmark (ie over- or undershooting the benchmark). However, the main drawback of this approach is that it is not clear whether a certain percentage of misalignment corresponds to an average or significant misalignment. That said, this approach might be a suitable tool when used in a sector-specific context and to identify

climate-specific sector hotspots in order to flag potential transition risks inherent in portfolios. The EU Climate Transition and Paris-Aligned Benchmarks introduced by the European Commission are good examples (Leale-Green et al (2021)).

Implied temperature rise (ITR) models are an extension of benchmark divergence models. They translate an assessment of alignment/misalignment with a benchmark into a temperature score that describes the most likely global warming outcome. While the results from ITR models are intuitive to communicate, their underlying complexity is a key hurdle to overcome and may lead to compromised decision usefulness.

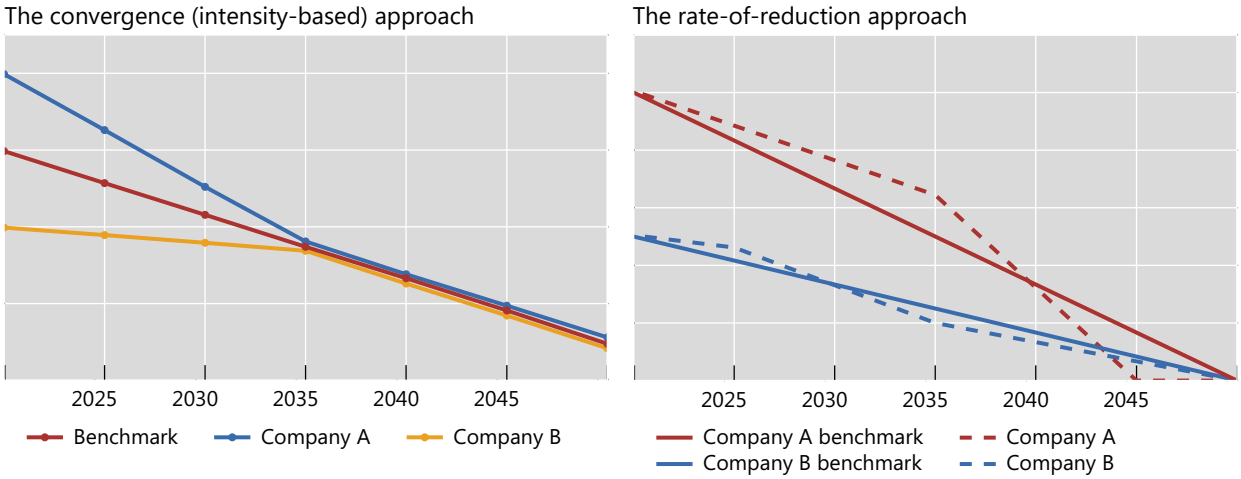
Notwithstanding the computational challenges, ITR models are gaining popularity due to their relative ease of interpretation and communication to non-technical audiences. For example, a portfolio aligned with a 1.5°C target is typically deemed consistent with the aspirations of the Paris Agreement. A key point here is that ITR is a forward-looking assessment that can aid investment decision-making, compared with the focus on historical emissions. Moreover, evaluating a firm's alignment with ITR places the focus on its transition trajectory rather than the current scale of emissions (Lombard Odier (2022)). Such an approach helps enable real-world outcomes by financing the energy transition in high-emitting industries that are essential for the global economy, while concurrently avoiding climate laggards.

There are two main approaches to ITR analysis: a convergence approach and a contraction approach (also known as the rate-of-reduction approach). Under the **convergence approach** (see left-hand panel in Graph 8), firms are compared against a benchmark defined in terms of emission intensity (ie the amount of emissions per unit of output, defined in physical or economic terms). Firms with worse than average emissions intensity will need to lower their emissions at a greater pace than the intensity improvement rate of the benchmark. In contrast, firms with better than average emissions may pursue further intensity improvements at a slower pace.

The main problem with the convergence approach is that it might unfairly punish companies in sectors that find it hard to reduce their emissions, while also reducing the motivation for companies with lower emissions to keep working on reducing their emission footprint. Also, because this approach depends on measures of physical or economic emissions intensity (like revenue in monetary terms), it doesn't work well with the global carbon budget (Hohne-Sparborth et al (2021)).

Convergence and rate-of-reduction approach

Absolute emissions/emissions intensity Graph 8



Illustrative representation.

Source: Hohne-Sparborth et al (2021).

The focus of the **contraction or rate-of-reduction approach** (see right-hand panel in Graph 8) is on absolute emissions. This has a number of advantages, as there is a direct link to carbon budgets, the availability to assess changes in firm alignment given the reduced need to correct benchmarks for unexpected changes in industry growth trends, lack of exposure to price volatility and the ability to assess the full spectrum of decarbonisation strategies that may have an impact on a firm's emissions, such as strategies linked to the circular economy (Lombard Odier (2022)). However, a key shortcoming of this approach is that as firms of different sizes and, potentially, of different business models will face the same year-over-year reduction rates, it has the potential to penalise better-performing firms relative to poor-performing firms, which may lead to perverse incentives when calculating alignment (Hohne-Sparborth et al (2021)).

Among central banks, the Bank of England has disclosed the ITR for its corporate bond purchase programme. The Bank of England has estimated an implied temperature rise of 2.4°C in 2022 compared with 3.0°C a year earlier. This improvement is attributed almost entirely to the improvements made to the computational methodology, including improved portfolio coverage, reflecting greater data availability (Bank of England (2022)).

5. Conclusion

The journey towards integrating climate-aware investing into central bank portfolios is both complex and important. The exploration into this evolving discipline reveals that central banks, given their unique institutional mandates and balance sheet structures, face distinct challenges and opportunities in aligning their investments with climate goals.

It is evident that climate-aware investing is not merely a trend but a critical component of contemporary investment management practices. The dual lenses of risk mitigation and impact generation offer an entry point for central banks to navigate the intricate landscape of climate-related risks and opportunities. The growing body of standards and global initiatives, such as the TCFD and ISSB, provide a foundation for enhancing transparency and accountability in climate-related financial disclosures.

The path forward, however, has challenges. Data gaps – particularly concerning scope 3 emissions – and the evolving nature of climate performance forecasting underscore the need for continuous improvement in methodologies and reporting standards. Moreover, the inherent complexities of balancing liquidity, safety and return objectives with climate considerations necessitate a nuanced approach tailored to the specific portfolios managed by central banks. These considerations aside, from a practical standpoint, the ambition to support climate-aware investing can also be influenced by factors such as staffing levels and the availability of financial resources for procuring and integrating climate data into the investment process.

Despite these challenges, the increasing adoption of climate-aware strategies such as exclusionary screening, thematic investments and portfolio alignment demonstrates a growing recognition of the importance of sustainable investing. Central banks' efforts in incorporating climate considerations into their investment decisions, while still in nascent stages, can both help improve the hedging of their portfolio with respect to climate risk and support, at the margin, the funding of the transition to a low-carbon economy.

In conclusion, climate-aware investing represents a pivotal opportunity for central banks to align investment portfolios under their management with the broader goals of sustainability and climate resilience. By embracing this shift, central banks can play a crucial role in balancing their traditional objectives with the imperative of addressing climate change.

Annex 1: Global initiatives

Global initiatives for climate-aware investing — Annex 1

Initiative	Focus group	Description	Relevance for central banks
Task Force on Climate-Related Financial Disclosures (TCFD)	All corporates	Private sector-led initiative founded in 2015 by the FSB. Develops guidance for the creation of consistent climate-related financial risk disclosures by companies, banks and investors to enable the assessment of climate-related risks and opportunities.	Highly relevant, as it not only helps create a structured approach to climate risk management but also helps guide organisational awareness around climate investing.
Network for Greening the Financial System (NGFS)	Central banks and financial supervisors	Founded in 2017. Gathers 138 central banks and supervisors and 21 observers, including the BIS. Defines and promotes best practices to be implemented within and outside of the membership of the NGFS and conducts or commissions analytical work on green finance. Members are encouraged to integrate sustainability factors into own portfolio management.	Highly relevant due to the peer-driven guidance and insights on implementation considerations and support.
International Sustainability Standards Board (ISSB)	All corporates	Founded in 2021. Aims to be a standard setter providing disclosure standards that provide investors and other capital market participants with information about companies' sustainability risks and opportunities.	Highly relevant as it helps create a structured approach to climate disclosures.
UN Environment Programme Finance Initiative (UNEP FI)	Banks and insurers	Founded in 1992. Gathers nearly 540 banks and insurers with more than USD 100 trillion of assets to facilitate the implementation of the Principles for Responsible Banking (PRB) and Principles for Sustainable Insurance (PSI). The PRB principles respectively seek to align the signatories' core strategy, decision-making, lending and investment with the UN Sustainable Development Goals and international agreements such as the Paris Agreement. Similarly, the PSI principles serve as a global framework for the insurance industry to address ESG risks and opportunities.	Less relevant for central bank investors as the implementation principles apply primarily for commercial banks and insurers.
Principles for Responsible Investment (PRI)	Asset owners and asset managers	Founded in 2005. A UN-supported entity that advocates for responsible investment practices by promoting understanding of the investment implications of ESG factors. More than 5,000 signatories, including some asset-owning central banks, have committed to implementing the PRI's six responsible investment principles.	Moderate relevance as climate change falls under the broad ambit of responsible investments. However, some are not directly applicable for central banks.
UN Global Compact	All corporate entities (including financial sector firms)	Founded in 2000. One of the largest sustainability initiatives globally, with nearly 25,000 corporate signatories from 160 countries. Signatory firms commit to meeting fundamental responsibilities in four areas: human rights, labour, environment and anti-corruption practices.	Moderate relevance for central bank investors. As governmental institutions, central banks (irrespective of differences in the national context) are expected to uphold the highest standards.

Initiative	Focus group	Description	Relevance for central banks
Glasgow Financial Alliance for Net Zero (GFANZ)	Financial sector firms	Founded in 2021. Global coalition of more than 675 financial institutions committed to reaching net zero by 2050. Focuses on addressing sector-wide challenges associated with the net zero transition through a forum of peer institutions. This is done through sector-specific alliances such as the Net Zero Asset Managers initiative, the Net Zero Asset Owners initiative and the Net Zero Banking Alliance. The signatories commit to reducing emissions across all scopes swiftly and fairly in line with the Paris Agreement, with transparent action plans and robust near-term targets.	Moderate relevance. While the technical guidance can be used by central banks with net zero ambitions, they are not part of the envisaged target group.
Greenhouse Gas Protocol	All corporates	Founded in 1998 by the World Business Council for Sustainable Development and World Resources Institute. Provides standards for measuring and reporting GHG emissions from operations and value chains. Instrumental in defining emissions into scope 1, 2 and 3 categories.	The work of the GHG Protocol is generally relevant for all sectors, including central banks.
Partnership for Carbon Accounting Financials (PCAF)	Financial institutions	Founded in 2015 as an initiative among Dutch banks to enable the shift to a low-carbon economy. Has since expanded to cover 485 financial institutions globally, each disclosing or committing to disclosing their financed emissions.	While the partnership is targeted towards financial institutions, the concepts related to the computation of financed emissions could also broadly apply to central banks.
CDP (formerly known as the Carbon Disclosure Project)	Cross-sectoral	Founded in 2000. CDP is a not-for-profit charity that runs the global disclosure system for investors, companies, cities, states and regions to manage their environmental impacts. A CDP score provides a snapshot of a company's disclosure and environmental performance.	The CDP score is useful as a stakeholder communication tool. Given central banks' unique role, it may not have the same degree of relevance for them as for private financial institutions.
The Science Based Targets initiative (SBTi)	All corporates	Founded in 2015. Promotes corporate emissions reduction target-setting for both corporates and financial institutions in line with climate science. More than 5,400 corporates have approved emissions reduction targets or commitments with the SBTi.	Less relevant for central banks given the size and composition of their balance sheets and the unique nature of their operations.
Transition Pathway Initiative (TPI)	All corporates	Founded in 2017. Evaluates companies' alignment with the 1.5°C ambition through sector-specific decarbonisation pathways.	Less relevant for central banks.
EU's Sustainable Finance Disclosures Regulation (SFDR)	Financial services providers in the EU	Introduced in 2021. A European regulation seeking to improve the transparency of sustainable investment products, prevent greenwashing and increase sustainability claims made by financial market participants.	Central banks are not subject to this regulation.

Sources: Website of initiatives listed above; author's assessment.

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