CLIMATE-RELATED FINANCIAL DISCLOSURE OF THE MAGYAR NEMZETI BANK

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Climate-related Financial Disclosure of the Magyar Nemzeti Bank

Analysis of Environmental Sustainability Risks and Impacts

2025

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Executive Summary

The MNB's strategy on environmental sustainability has been developed in line with its mandates and organisational structure as defined by the Central Bank Act. In the Green Monetary Policy Toolkit Strategy, the MNB established a framework for the implementation of sustainability considerations in the use of monetary policy instruments; the Charter of Sustainable and Responsible Investment (SRI) expresses the central bank's commitment to integrating sustainability considerations into reserve management; and the Green Programme defines the MNB's supervisory strategy to support the stability of the financial intermediary system. The MNB operates an environmental management system to green its own operational activities.

This report provides an analysis in relation to the MNB's balance sheet and its own operations, while the Green Finance Report provides information on the Hungarian financial sector's risk exposure to environmental sustainability and covers the MNB's regulatory activities for promoting sustainability, as well as the related MNB programmes.

The MNB analyses the climate-related risk exposure of its financial assets according to the two main risk categories (transition and physical risks), broken down by portfolios, but – in accordance with the principle of double materiality – emphasis is also placed on examining the environmental impact of the financed instruments. The analytical framework for this year's report has been expanded to encompass an analysis of broader nature-related risks, given that ecosystem services, the erosion of biodiversity and climate change are closely interrelated.

The carbon intensity of sovereign exposures, which account for the largest share of foreign exchange reserves, decreased in 2024, due to the general reduction in the GHG intensity of the issuer countries; however, it is also clear that the combined emissions trajectories of the countries in question are still not aligned with the targets set out in the Paris Climate Agreement. Despite this, the portfolio is largely protected against the potential negative financial effects of climate change, mainly due to the relatively short maturities and the considerable adaptive capacity of the countries. For the countries related to the sovereign exposures in the reserves, rising sea levels and floods are the main physical risk factors, while in terms of nature-related risks, the risks are at a low to medium level, meaning that there are no acute threats to the economy as a whole from the deterioration of nature and ecosystem services; however, in terms of pressure on biodiversity, the combined economic activity of the countries in question can be classified as higher.

Regarding the corporate portfolio within foreign exchange reserves, the exposure to transition risks is relatively moderate, and negative screening indicators suggest that there is no material risk.

At the end of 2023, the MNB decided to double the size of the dedicated green bond portfolio within its foreign exchange reserves to EUR 500 million; this exposure reached the targeted level by the end of 2024. The green bond portfolio has a significant environmental impact: 117,000 tonnes of GHG emissions are being avoided annually, which is equivalent to the carbon footprint of a Hungarian settlement with a population of approximately 20,000.

Climate change may have negative social and economic consequences that can increase the importance of safe-haven assets in general. Gold plays a prominent role in the central bank's reserves, and for the first time this year's report also covers the climate risk assessment of this asset category. In existing climate risk analyses, a best practice seems to be emerging for traditional reserve assets. For gold, however, due to its special properties, there is still no widely accepted methodology, and thus its comparability with conventional investment instruments is quite limited. It can be stated that gold is practically indestructible and will not be damaged even in the event of (climate) disasters. Consequently, its physical risk exposure is negligible, but its transition risk cannot be clearly identified.

The report also covers portfolios held for monetary policy purposes. The MNB supports the reduction of GHG emissions not only via its green bond portfolio, but also via the Green Home Programme and the Green Mortgage Bond Purchase Programme. The combined positive environmental impact of these programmes is approximately 67,000 to 92,000 tonnes

of avoided GHG emissions annually. No new exposure is generated under these programmes, and the outstanding portfolio is continuously decreasing as a result of repayments.

In terms of greening its operational activities, the MNB exceeded its previous target: relative to the baseline (2019), the carbon footprint per employee had declined by 60 percent by the end of 2022, instead of the 30 percent commitment. A further reduction is targeted for 2023–2025: by the end of 2025, the carbon footprint per employee is to be cut by 75 percent versus the baseline. Based on preliminary data, the carbon footprint of the MNB's operations decreased by 3,800 tonnes by the end of 2024, representing a **decline of 68.1 percent relative to the baseline.** The MNB's carbon footprint related to energy consumption decreased to one-quarter of its original level, while the carbon footprint related to business travel fell by nearly 20 percent. The declines were driven by an actual decline in volume and the increasing use of renewable energy in buildings. To compensate for emissions that could not be reduced any further, the MNB continued to finance habitat restoration projects.

The MNB remains among the leading central banks in terms of supporting environmental sustainability. Using the publicly available methodology of the Green Central Banking Scorecard, the MNB once again voluntarily assessed its environmental sustainability initiatives in 2024, boosting its score to 81 on a scale of 130, compared to 79 in the previous year. The self-assessment was validated by PositiveMoney, the publisher of the Scorecard.

Introduction

In 2015, the G20 Financial Stability Board (FSB[1]) established the Task Force on Climate-related Financial Disclosures (TCFD[2]) to provide recommendations on climate-related disclosure reports. This facilitates more informed investment, lending and insurance decisions and allows market participants to better understand the concentration of GHG-intensive assets in the financial sector and the exposure of the financial system to climate-related and environmental risks.

In addition to the TCFD recommendations, binding regulations coming into force gradually will also improve environmental transparency and comparability. The European Union has established a framework for sustainable finance, through which it has sought to promote transparency on the European financial markets using a number of regulations in recent years. The EU Taxonomy Regulation, which introduced the classification system for environmentally sustainable economic activities, serves as the basis for the framework. Other important pillars are the SFDR,[3] which regulates sustainability-related disclosures in the financial services sector, and the CSRD,[4] which sets out rules for companies' sustainability-related reporting obligations.[5] The framework also describes the investment instruments promoting environmental sustainability; in this regard, the European Green Bond Standard is of particular importance: it aims to innovate the green bond market through the creation of high-quality sustainable investment opportunities, subject to strict regulation.

In 2024, the EU continued to expand the regulatory framework to ensure sustainable financing with the promulgation of new legislation on the transparency and integrity of Environmental, Social and Governance (ESG) rating activities as well as the Corporate Sustainability Due Diligence Directive (CSDDD[6]). The CSDDD, which entered into force on 25 July 2024, obliges the companies falling under its scope to identify and manage the adverse effects of their activities, thus promoting sustainable and responsible corporate behaviour in their operations and global value chains. The regulation on ESG rating activities establishes the need for ESMA for entities falling under the scope of the regulation to be authorised and supervised by ESMA and seeks to make ESG rating activities more transparent and comparable by requiring the disclosure of the rating methodologies, and separate rating of the pillars E, S and G, thereby promoting investor confidence.

It is important to note that a growing number of central banks have recently recognised the need to interpret climate risks in the context of broader environmental risks. Similar to other central banks, and market and regulatory organisations, the MNB has primarily focused on the analysis of climate risks over the past few years. In this area, transparency, standardisation, the unification of methodologies and the development of best market practices have improved quite significantly, facilitated by the analyses published by the MNB in recent years. Nonetheless, a new approach has also emerged recently, suggesting that other nature-related risks should also be assessed in addition to traditional climate risk aspects, since the stability of the ecosystem and the services it provides, biodiversity and climate change are interrelated, and the related impacts may affect the entities in the form of physical or transition risks. In 2022, at the COP15 Biodiversity Conference, the participating countries adopted the Kunming-Montréal Global Biodiversity Framework (GBF), which aims to halt biodiversity loss and restore ecosystems. Similar to the TCFD, the Taskforce on Nature-related Financial Disclosures (TNFD[7]) was also established, which developed a framework for reporting the related risks.

In 2024, the MNB remained among the leading central banks in terms of supporting environmental sustainability. PositiveMoney, an independent London-based nonprofit research organisation, annually publishes the Green Central

[1] Financial Stability Board
[2] Task Force on Climate-related Financial Disclosures
[3] Sustainable Finance Disclosure Regulation
[4] Corporate Sustainability Reporting Directive
[5] In addition to the above, the European Sustainability Reporting Standards (ESRS), which unify the sustainability reporting obligation required under the CSRD, were also published in 2023.
[6] Corporate Sustainability Due Diligence Directive
[7] Taskforce on Nature-related Financial Disclosures

Banking Scorecard,[8] which assesses the environmental sustainability initiatives of the G20 central banks and financial supervisory authorities. The assessment focuses on the steps taken in the field of monetary policy and prudential supervision, but achievements in the categories of research, advocacy and leading-by-example categories are also taken into account. Since Hungary is not a member of the G20, the MNB is not part of the GCB Scorecard, but it has prepared a self-assessment based on the publicly available methodology, which was validated[9] by PositiveMoney. In the spring of 2024, the MNB achieved a score of 79 out of a possible 130, ranking higher than all of the G20 central banks. In 2025, based on the re-performed and validated assessment, the MNB's overall score further increased from the previous level of 79 to 81 points, thus remaining among top performers.

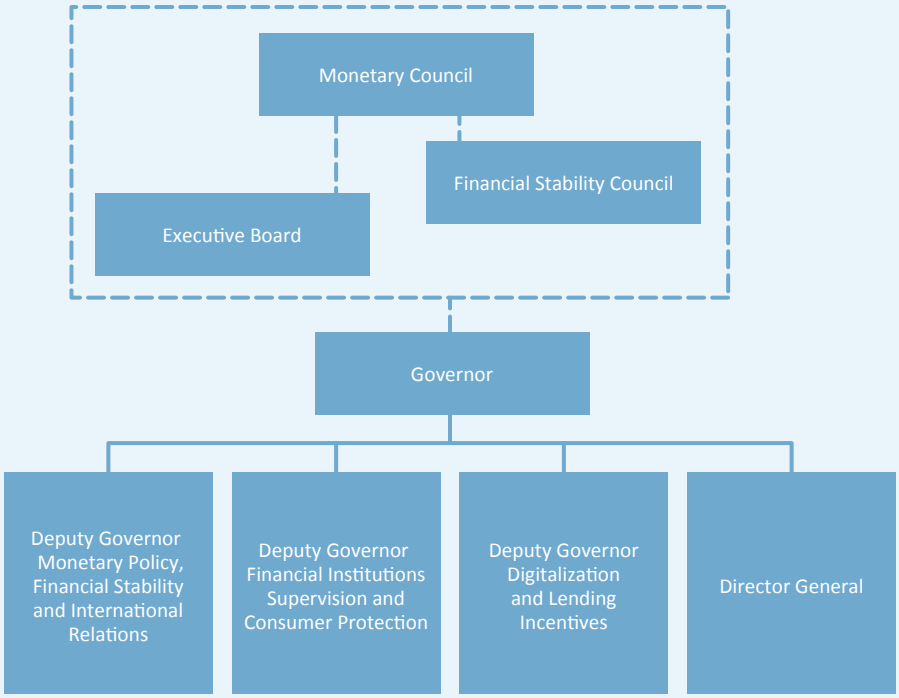
As a central bank, the MNB is not subject to mandatory disclosure requirements for climate risks, but it wishes to set an example by publishing a report in alignment with the TCFD recommendations every year, in order to present the risks and environmental impacts, according to the double materiality principle. For the first time this year, the assessment also includes broader nature-related risks and impacts.

[8] Green Central Banking Scorecard
[9] https://positivemoney.org/uk/archive/positive-moneys-green-central-banking-analysis-of-the-central-bank-of-hungary/

1 Corporate Governance

According to the 2024 year-end organisational structure, the MNB's decision-making bodies are the Monetary Council (MC), the Financial Stability Council (FSC) and the Executive Board (EB). The senior management of the MNB are the Governor, the Deputy Governors, and the Director General. Decision-making bodies and senior MNB executives are regularly informed on the impact of climate change and other environmental risks on the financial intermediation system and the MNB's own operations.

Chart 1
Organisational structure of the MNB (at 2024 year-end)



The main decision-making body of the MNB is the Monetary Council. The MC's responsibilities include, inter alia, strategic decisions relating to monetary policy, the issuance of legal tender, the management of foreign exchange and gold reserves and the execution of foreign exchange operations in the context of the implementation of exchange rate policy, as well as statistical tasks. The MC is also entitled to make decisions on macroprudential tasks, the oversight of payment and settlement and securities settlement systems, the oversight of the financial intermediary system and the functioning as resolution authority. The members of the MC are the Governor, the Deputy Governors, and members elected by Parliament. The MC monitors the impact of climate change and other ecological risks on the financial system on a regular basis and supports adaptation to environmental risks through its strategic decisions.

Within the strategic framework defined by the MC, the Financial Stability Council (FSC) acts on behalf of the MNB in decision-making related to the oversight of payments and settlement and securities settlement systems, macroprudential and resolution authority tasks, and the supervision of the financial intermediary system. The FSC is composed of the Governor and Deputy Governors of the MNB, the executives appointed by the Governor of the MNB, and the Director General. The FSC regularly monitors the impact of climate change and other ecological risks on the financial system

and financial stability and takes measures to support the financial system's adaptation to climate change and Hungary's transition to a climate-friendly and ecologically sustainable economy.

As the MNB's executive body, the EB is responsible for implementing the decisions of the MC and the FSC, and for managing the MNB's operations. The members of the EB are the Governor and the Deputy Governors of the MNB. The EB is regularly informed about the impact of climate change and environmental risks on the financial system and the MNB's operations, while through its actions, it contributes to the implementation of the decisions of the MC and the FSC in support of environmental sustainability. The EB, responsible for managing the MNB's operations, is empowered to decide on the identification, management and measurement of major environmental risks and the implementation of its investments in support of environmental sustainability.

The organisational units under the direction of the **Deputy Governor responsible for monetary policy, financial stability and international relations** are responsible for formulating the central bank's proposals for structural reforms designed to ensure sustainable development in Hungary; conducting research on sustainable economic growth; monitoring Hungarian and international macroeconomic topics and economic policies that support sustainable growth; and assessing the function of the financial system in supporting sustainable economic growth. This area is responsible for exploring opportunities for the development of the domestic green loan and green bond markets, developing the Green Monetary Policy Toolkit Strategy, and supporting and coordinating the MNB's international sustainability-related tasks.

The departments under the direction of **the Deputy Governor responsible for financial supervision and consumer protection** are responsible for conducting analyses and research on financial services and products that support environmental and social sustainability; identifying the prudential implications and risks of climate change and other ecological anomalies and conducting supervisory activities related to such and to sustainable financial regulations; for developing the MNB's position and proposals on sustainable finance; and contributing to the MNB's educational, training, awareness-raising, research and international relations-related tasks in the field of sustainable finance. The activities of the Deputy Governor regarding sustainability are supported by a dedicated organisational unit, the Sustainable Finance Department.

The organisational units reporting to **the Deputy Governor responsible for digitalisation and lending incentives** are responsible for exploring and implementing opportunities for the development of the domestic green credit market.

The departments under the direction of the **Director General** are responsible for reducing the MNB's carbon footprint from its own operations; for the greening of cash logistics processes; for operating the MNB's Environmental Management and Verification System; for monitoring the MNB's waste management processes; for developing and implementing the MNB's Corporate Social Responsibility Strategy; and disseminating an environmentally sustainable financial culture and awareness in broad segments of society.

In addition to ad-hoc collaborations and multi-disciplinary projects, the areas of expertise dealing with sustainability and environmental risk topics also report on their activities to each other at regular **Green Workshop** meetings at the middle management and expert level; this forum is responsible for coordinating climate risk tasks and projects within the MNB.

2 Strategies

The core duties and operational framework of the MNB are set out in the Central Bank Act.[10] The MNB's primary objective is to achieve and maintain price stability. Without compromising its primary objective, the MNB also supports the maintenance of the stability and the improvement of the resilience of the financial system, its sustainable contribution to economic growth and the economic policies of the government, using the instruments at its disposal.

An amendment to the law, which entered into force on 2 August 2021, extended the MNB's mandate to support government policy on environmental sustainability. With this amendment, the MNB is legally obliged to integrate environmental sustainability considerations into its activities without compromising its primary objective.

2.1 THE MNB'S GREEN MONETARY POLICY TOOLKIT STRATEGY

The MNB identifies a number of risks stemming from climate change that could have an impact on price stability and financial stability. Accordingly, environmental sustainability considerations must be taken into account in the design of the toolkit in the context of the feasibility of the primary mandate. In July 2021, the document "*Sustainability and central bank policy – Green aspects in the MNB's monetary policy toolkit*"[11] was published, which elaborates the strategic orientation to mainstream long-term environmental sustainability considerations through central bank instruments. In line with this, the MNB introduced the following measures:

- **Green Mortgage Bond Purchase Programme (GMBPP):** This was the MNB's first asset purchase programme with a focus on sustainability, aiming to establish a green mortgage market in Hungary, thereby creating a green housing loan market and expanding the energy-efficient housing portfolio. In line with the tightening of the monetary policy stance, the MNB suspended purchases under this programme in 2022.

- **Green Home Programme (GHP):** Launched as part of the Funding for Growth Scheme, this programme promoted the creation of a green housing loan market and helped to mainstream environmental sustainability considerations in the domestic housing market by providing low-interest financing from the central bank. With an overall allocation of HUF 300 billion, the programme enabled around 8,600 households to build or buy energy-efficient new homes. The programme was closed at the end of September 2022.

- **Green collateral management:** In its monetary policy-related collateral management activities, the MNB assumes risks via the assets it accepts as collateral. For this reason, the Bank explored opportunities for green collateral management, which can have an impact on greening bank exposures via liquidity management at commercial banks and foster the growth of the market for green bonds. The MNB supports the issuance of green securities by applying preferential haircuts and promotes standardisation and transparency through green reporting requirements.

- **Integrating macroprudential measures into the green monetary policy toolkit:** Since July 2021, the rules for the Mortgage Funding Adequacy Ratio (MFAR) have given preferential treatment to stable mortgage funding for energy-efficient properties. This measure supports the development of banking frameworks for the uptake of green capital market instruments, an increase in the share of mortgage loans that finance energy-efficient real estate and diversification of the range of mortgage bond investors, in support of financial stability.

[10] Act CXXXIX of 2013 on the Magyar Nemzeti Bank
[11] The MNB's Green Monetary Policy Toolkit Strategy

2.2 GREEN FOREIGN EXCHANGE RESERVES STRATEGY

As stipulated by law, the MNB's statutory tasks include the management of Hungary's foreign exchange reserves. The purpose of holding foreign exchange reserves is to support monetary and exchange rate policy; to ensure the necessary foreign currency liquidity; to maintain investor confidence; and to ensure state's needs of transactional foreign currency. When investing foreign exchange reserves, the central bank follows a threefold objective of safety-liquidity-return: it strives to achieve the highest possible return level, while keeping risks low and ensuring the necessary liquidity. In line with conservative portfolio management, the exposures of the foreign exchange reserves are well-diversified, with a significant proportion of government securities with high ratings, which are considered to be free of credit risk, but also including highly rated supranational, corporate and banking issuances.

In addition to fulfilling the primary objectives of reserve holdings, central banks can play an important role in supporting the green transition of economies, for example by supporting green bond markets ("supportive approach"). In addition, the value of foreign exchange reserves may be severely affected by the realisation of climate risks associated with financed emissions ("defensive approach"). Although the likelihood of risks materialising only appears significant in the longer term, even in the short term it is essential to examine the issue and assess the investment strategy from a climate risk perspective.

In 2019, the MNB decided to establish a dedicated green bond portfolio within the foreign exchange reserves, the level of which was doubled in 2024, increasing it to EUR 500 million. The portfolio may include so-called "green-labelled" bonds (green bonds) that comply with international green standards and the general rules for reserve management, in which case the funds raised are used by the issuer for a specific, environmentally beneficial, "green" investment.

In order to integrate sustainability considerations into foreign exchange reserve management as broadly as possible, at the end of 2023 the MNB published its Charter of Sustainable and Responsible Investment,[12] which sets out the medium- and long-term objectives. In addition to serving as a compass for the foreign exchange reserves investment strategy in terms of integrating green aspects, the document can also be an example to follow for financial market participants.

2.3 SUPERVISORY GREEN STRATEGY

The management of environmental risks also features prominently in the supervisory strategy. As a financial supervisory authority, the MNB considers its mission to strengthen, preserve and develop the stability of the financial system, with a particular focus on consumer protection, digitalisation and sustainability. The supervisory objectives of the MNB are summarised in the document "*Stability and Confidence 2.1*".[13]

The MNB launched the Green Programme[14] in February 2019, which consisted of several measures concerning the financial system, including analyses aimed at identifying environmental risks, fostering the resilience of the financial system and the environment for green financing, and developing social and international relations (education, research, domestic and international professional relations).

The role of banks is crucial in the carbon neutral transition of the entire Hungarian economy, and accordingly it is a fundamental expectation that they are able to make informed strategic and business decisions in this regard. In 2022, the MNB published a Green Recommendation[15] for credit institutions with the aim of transitioning to green operations by 2025, i.e. to identify, measure, manage, monitor and disclose climate and environmental risks. In 2024, the MNB issued another Recommendation[16] to institutions, aimed at strengthening the assessment and application of ESG information when undertaking, measuring, managing and controlling credit risks.

[12] The MNB's Charter of Sustainable and Responsible Investment
[13] The MNB's supervisory and consumer protection strategy
[14] Green Programme of the MNB
[15] The MNB's Green Recommendation for credit institutions
[16] ESG recommendation

Participants of the insurance market are exposed to environmental risks in many ways (e.g. drought insurance, liability claims, revaluation of investments), and thus the need for a green transition is an important aspect for these entities as well. As a first step, in 2022 the MNB conducted a survey on the preparedness of the insurance sector for climate change, and at the end of 2023 it published a Green Insurance Recommendation.[17] The requirements of the Recommendation came into effect on 1 January 2025, with 2024 as a year for preparation.

Due to the prominent role of the financial intermediary system in capital allocation, it is important to mobilise financial services towards financing sustainable economic activities. The MNB has therefore launched a preferential capital requirement programme for banks in both the retail, corporate and municipal lending segments, including green bonds in the latter.

In one of the most immature, yet increasingly important segments of green finance – the so-called voluntary carbon market – the report "*Nature-based Carbon Neutralisation 2023: a Roadmap for Companies*"[18] serves as a guide for Hungarian companies in setting environmental sustainability targets.

2.4 SUSTAINABILITY STRATEGY FOR THE MNB'S OWN OPERATIONAL ACTIVITIES

The MNB operates an environmental management system (EMS), in order to reduce the environmental impact of its operations. The system was introduced in 2011 following an assessment of significant environmental risks. Accordingly, the two main approaches in the Bank's long-term environmental strategy are: (i) reducing the environmental impact of the buildings necessary for its operations; and (ii) reducing the carbon footprint of the cash supply chain.

- **In recent years, the MNB has sought to increasingly rely on renewable sources in its energy usage.** Today, all of its electricity purchases come from renewable sources. The MNB aims to further reduce the carbon footprint from operational activities, but it cannot be eliminated completely. To compensate for emissions that cannot be further reduced, the MNB finances habitat restoration projects that can absorb all of the remaining emissions in the coming years.

- **Reducing the carbon footprint of the cash supply chain is one of the key priorities in the MNB's long-term environmental strategy.** Ensuring the smooth flow of cash is one of the MNB's core tasks. It is important for the MNB to maintain guarantees of fair access to cash in the long term; therefore, in aiming to reduce the carbon footprint of the supply chain, it only considers solutions that do not jeopardise the continuous, reliable satisfaction of the cash needs of households, businesses and credit institutions.[19]

The environmental impact of the cash supply chain has three main components: i) cash production and the activities of the subsidiaries involved in production; ii) cash logistics activities within the MNB (distribution, processing); and iii) the activities of cash logistics service providers (suppliers).

One important consideration when setting expectations for the MNB's partners regarding environmental protection is that the MNB has no legal instruments at its disposal to demand that credit institutions, post offices and cash processors operate in an environmentally responsible manner. Nevertheless, the MNB orients the actors in this direction in a consultative manner, in the form of "soft" recommendations.

[17] The MNB's Green Recommendation for insurers
[18] Nature-based carbon neutralisation 2023 - a market guide for companies
[19] Despite the continuous development of electronic payment solutions, cash remains the most commonly used means of payment in Hungary.

The MNB's environmental management system operates in 3-year cycles, with the current cycle covering the period 2023–2025. The strategic objectives are as follows:

- **Maintaining carbon neutral operations:**

– The MNB is further reducing the carbon footprint of its operations to the extent possible: the goal is to reduce the per-employee carbon footprint by 75 percent by the end of 2025 relative to the 2019 base year.

– The electricity consumption of the office buildings used for MNB operations will continue to be provided entirely from energy from renewable sources.
  ○ *Construction on the solar energy investment at the MNB Logistics Centre started at the end of 2024. With its implementation it is expected that approximately 20 percent of the electricity demand of the logistics processes related to cash supply will be provided from self-generated renewable sources.*

– Carbon emissions from operations that cannot be further reduced will be neutralised with offsets.

- **Further improving the environmental performance of the buildings used by the MNB in its day-to-day operations:**

– The MNB will pre-certify its Buda Centre building according to the requirements of the "BREEAM In-Use" standard and use the pre-certification results to identify any areas for improvement.
  ○ *In addition to the pre-certification, actual certification was completed in 2024; the "Excellent" rating level can be achieved by implementing a few minor measures.*

– The MNB will ensure that the Logistics Centre building will retain its Excellent performance rating.

- **Exploring the possibility of introducing new environmentally friendly technologies as a way of improving internal processes related to operational activities:**

– The MNB will conduct a technology test to introduce chemical-free office cleaning and workplace composting practices and, depending on the results, propose the introduction of such.
  ○ *Both tests were carried out successfully in 2024. The new (currently ongoing) tender for the maintenance of the buildings includes the requirement for chemical-free cleaning services. The office composting process is more of an awareness-raising activity; its environmental benefits in terms of carbon footprint are minimal, but it is ecologically beneficial.*

- **Further reducing the carbon footprint of the cash supply chain:**

– In order to promote an increase in the local reuse of banknotes and coins by credit institutions, as well as a reduction in the transportation tasks of cash processing entities in the supply chain and a reduction in packaging materials, the central bank assumes a consultative role and guides stakeholders towards environmentally conscious operations. In 2023, the MNB issued a recommendation on the enforcement of environmental sustainability considerations.[20]

– The Hungarian Mint Ltd. obtained the ISO 14001 environmental certification in 2023. This means that all subsidiaries involved in cash production[21] operate in accordance with high environmental standards

[20] The MNB's green recommendation for cash processors
[21] DIPA Diósgyőri Papírgyár Zrt., Hungarian Banknote Printing Company, Hungarian Mint Ltd.

2.5 DOMESTIC AND INTERNATIONAL COLLABORATION

The MNB is building up domestic and international professional relationships in order to effectively implement its green programmes and learn about good practices. The Bank intends to work in partnership with domestic government, market and social actors with knowledge and capacity relevant to climate change and green finance, taking advantage of synergies arising from the cooperation.

In addition to domestic actors, the MNB is also seeking to develop international relations in the field of climate risks and green finance initiatives. Since 2019, the MNB has been an active member of the Network for Greening the Financial System (NGFS), a global central bank and supervisory initiative. The MNB also joined the Advisory Council of the Energy Efficient Mortgages Initiative (EEMI), which aims to promote preferential loans for energy efficiency investments. Additionally, the MNB actively participates in the development of related regulations by the European supervisory authorities.[22]

The MNB plays an active role in promoting sustainability awareness. Through its social relations, the MNB intends to support awareness-raising and educational activities on green finance. To increase the knowledge base on green finance, in cooperation with universities in Hungary, green finance courses, advanced college events and adult education courses are offered.

Starting in 2019, the MNB hosts an annual international green finance conference in Budapest, with the participation of renowned international experts, market participants and policymakers. These occasions are also used to reward academics, research teams and financial institution for outstanding performance in environmental issues and green finance. Specialist articles and studies on sustainability by MNB experts also help to raise awareness, deepen scientific discourse and develop best practices.

The MNB actively participated in the COP16 Biodiversity Summit held in Colombia in October 2024, and played a pioneering role in presenting the financial aspects of nature-related risks. The MNB presented the results of a project carried out jointly with the OECD and supported by the European Commission, which aimed to map financial risks arising from biodiversity loss. In addition to the development of the general supervisory framework, the MNB also prepared the domestic implementation of the framework, on the basis of the exposure of the Hungarian banking sector. The programme was presented as part of the official COP16 programme calendar, with the Ministry of Agriculture and several international organisations also joining in.

[22] EBA, ESMA, EIOPA

3 Risk Management

3.1 CHARACTERISTICS OF ENVIRONMENTAL SUSTAINABILITY RISKS

In analysing environmental sustainability risks, the principle of double materiality is important. Double materiality means that the consequences of climate change may appear as a financial risk factor for an institution, while the institution itself may also have an impact on the environment through its activities and investments. In its risk analysis, the MNB considers both transition and physical risk channels.

- **Transition risks arise from the difficulties of transitioning to a low-carbon, climate-resilient economy.** Changes in policy or technology, or rapid shifts in consumer attitudes can all cause a sudden revaluation in the prices of financial instruments. As a consequence, credit and market risks may increase and, in certain scenarios, the resulting losses may even pose financial stability risks.

- **Physical risks arise from the physical impacts of climate change, including the increase in the severity and frequency of extreme weather events.** Physical risks include not only the risk of losses resulting from the deterioration of physical assets and infrastructure, but also the disruption of value chains, loss of biodiversity and negative impacts on human health and well-being, which in extreme cases can lead to increased geopolitical tensions, conflicts and migration. This may have an impact on the productivity of certain companies or the value of physical and financial assets, which may also affect financial stability.

It is important to recognise that the operation and stability of economic and social systems also depend on a number of vital natural services (collectively referred to as biodiversity and ecosystem services). These include: (i) provisioning services (e.g. food supply, timber, dietary fibre, freshwater), (ii) regulating services (climate regulation, CO_2 capture and storage, water quality regulation, pest control), (iii) supporting services (soil formation, pollination, nutrient and water cycling, photosynthesis), and (iv) cultural services (e.g. recreation). Degradation of these systems (e.g. deforestation, water pollution, soil erosion, loss of pollinators) all contribute to the deterioration of the natural environment, which feeds back into the climate change process, and can lead to a mutually reinforcing negative spiral, that can also feed into the economic-financial system through various transmission channels. Risk exposure depends on the extent of reliance of the given economic activity on these ecosystem services; the impact is the function of the direct or indirect pollution or erosion of the service systems, which the activity causes. Due to the complexity of the processes, it is therefore worthwhile to extend the analyses to nature-related risks in a broader sense, in addition to climate risks.

The specific nature of environmental sustainability risks requires an extension of traditional risk management frameworks. Climate change generates changes characterised by a high degree of uncertainty, determined not only by the interaction of economic-financial impacts, but also by environmental, technological and cultural impacts, amongst other things. These processes also affect each other and thus generate unpredictable impacts that can be wide-ranging and potentially very severe. The related risks are non-linear, irreversible and characterised by a fat-tailed distribution pattern.

A significant part of the impacts will occur over a longer period of time and will be reflected as financial and economic risks, but these can only be mitigated by actions taken today. Long time horizons are difficult to reconcile with traditional business planning and risk-taking. In addition, the lack of necessary data is also a frequently cited problem. High-quality, abundant, robust data are essential to understand and assess risks accurately and to develop reliable models. Since models based on historical data are not always sufficient, forward-looking estimates are also required, for example, through scenario analysis or stress tests.

Unlike traditional financial risks (e.g. market, liquidity and credit), one special characteristic of environmental sustainability risks is that, although the details of the occurrence of the risks are unknown, it can be stated with complete certainty that the materialisation of transition and physical risks – in some combination – is inevitable. Their

timing, severity and subsequent manageability depend on how we respond to them; if the targets of the Paris Agreement are met globally, we will face higher transition risks, otherwise the future will be determined by the occurrence of physical risks.

The process of risk management can be divided into distinct, interdependent phases. The first step is to identify the risks that threaten the operation and business activities of the given institution. Risk assessment involves determining their materiality and magnitude. The active management of risks comes after these steps. From the perspective of the MNB, there are some risks that it only monitors, while others it seeks to purposefully mitigate. Each central bank function – taking into account its objective – has different risk characteristics, and thus risks are presented broken down by central bank functions.

3.2 MONETARY POLICY

Through its monetary policy instruments and reserve management, the MNB takes on Hungarian and foreign exposures, typically bonds or loans, on its own balance sheet. The financial risks of these exposures are identified and analysed, and – in addition to monetary policy considerations – risk management aspects are also taken into account in the related decision-making processes. At the MNB, the tasks of identifying, measuring and managing risks related to the central bank's balance sheet, preparing decisions and monitoring risks are carried out by a dedicated organisational unit. The management of environmental sustainability risks should also be integrated into this conventional framework.

3.2.1 Central Bank Asset Purchases

In its asset purchase programmes, the MNB mainly acquired government securities, mortgage bonds and corporate bonds. During the period of monetary easing, the primary objectives of these instruments included ensuring the achievement of the inflation target and supporting companies' access to long-term, affordable funding and developing certain markets. The introduction of these instruments expanded the MNB's balance sheet and risk exposure. Prior to the launch of the programmes, the MNB assessed the key parameters (e.g. amount, maturity) and their impact and risks (credit risk, market risk) on its balance sheet. In line with the tightening of the monetary policy orientation and utilisation of the allocations, the MNB gradually suspended or discontinued its asset purchase programmes between December 2021 and May 2022.

It is also true for the asset purchase programmes that the MNB can more effectively support the green transition of the economy and the government's economic policy and environmental sustainability objectives by taking into account climate risk considerations. The green transition of the Hungarian economy may also improve the MNB's bond exposures from a climate risk perspective.

3.2.2 Central Bank Loans/Collateral Management

The lending activities of central banks serve a range of purposes. Traditional central bank lending is a short-term availability (e.g. overnight, one week), which plays a key role in the liquidity management of the banking system when necessary. In recent years, however, central banks have also applied longer-term, targeted lending programmes. In accordance with the provisions of the Central Bank Act, the MNB does not assume credit risk in connection with its lending activities, i.e. it provides loans to financial market clients only in a secured form.

The MNB also evaluates the climate-related risks in the context of lending and collateral management. By designing these programmes in a targeted manner, central banks can encourage the green transition in the economy and green lending in the banking system. They can influence market participants through the collateral management framework, via their exposure to bank funding and liquidity management, for example, by giving preferential treatment to certain asset classes in order to influence the spreads of certain issuances.

In addition to the aforementioned policy considerations, the MNB also takes into account the financial risks of climate exposures associated with collateral. By amending the framework, climate risk exposures can also be reduced in relation to securities accepted for collateral management (it should be noted, however, that the exposure of a central bank during

collateral management is only indirect, as the primary obligor of the lending activity is the lending bank, and collateral is included in the central bank balance sheet only in the event of a bank default). Overall, a greener collateral pool may be preferable for the central bank, due to the potentially lower default risk or higher recovery and lower price volatility.

3.2.3 Foreign exchange reserves

In the course of its reserve management activities, the MNB determines its investment policy taking into account central banking objectives and considering the three criteria of risk, liquidity and return. The Bank is considered to be a fundamentally conservative investor, in line with international central banking practice. The MNB mitigates the risks arising (credit risk, market risk, liquidity risk) by applying a strict limit system.

The portfolio should be analysed from a policy perspective on the one hand and from a financial risk perspective on the other. An example of the former is that the MNB supports green bond markets and, in general, issuers' access to the market by creating demand, while giving priority to the above reserve management objectives. With these considerations in mind, the MNB is among the first central banks to have established a dedicated portfolio of green bonds, which it monitors for their positive environmental impacts.

Financial risk effects appear in portfolios in such a way that physical or transition risks can represent market and credit risks through increased spreads or the deterioration of default probabilities. In this context, it is worth distinguishing between the two approaches.

- **Short term:** The MNB essentially has a short-term investment horizon; the portfolio is protected against the potential financial impacts of climate risks over this time horizon. One reason for this is that climate risks will have an increasingly significant impact over a time horizon of several decades, and, secondly, the MNB mainly holds sovereign debt securities of developed, highly rated countries, and the exposures are well diversified. On the one hand, this means that the risk of default is low, and, on the other hand, repricing risk is also low because of the short-term exposures.

- **Long term:** The current structure of the reserves allows the MNB to develop its long-term strategy without a rapid and drastic rearrangement of the portfolio. As time passes, it will become increasingly important to take appropriate, gradual steps in the reserves as well. Climate risk exposure can be managed with simpler limits (e.g. concentration limits, exclusions), but more complex models can also be implemented (climate risk budget, VaR, green benchmark). As the market evolves and international best practices become more established, the range and reliability of the data available may improve, which is a prerequisite for taking further steps.

The traditional risk management framework includes daily limit monitoring and monthly, quarterly and semi-annual reporting, which supports the work of the decision-making bodies. The integration of climate risks into this framework is ongoing. As a first step, the carbon intensity of sovereign exposures in the foreign exchange reserves was regularly reported to decision-makers, and this was expanded from 2023 to include the environmental sustainability risks of the reserve's corporate exposures.

3.3 FINANCIAL STABILITY

Environmental sustainability risks do not only affect the MNB through its balance sheet. Effects of climate change may spill over into the financial intermediation system through the real economy and cause losses first for economic actors and then for investors and creditors. For example, losses of credit institutions, whether concentrated at one institution or affecting the entire banking system at once, can have serious consequences. Therefore, the MNB, as the authority responsible for the stability of the financial intermediary system, monitors these developments closely.

The MNB measures the sustainability risks of the financial system using a number of methodologies and processes. For example, the Bank Carbon Risk Index can be used to monitor the evolution of the transition risks of the entire banking system (or individual institutions) on a quarterly basis. This process is supported by various climate stress tests, including a short-term climate stress test carried out by the MNB following the long-term climate stress test conducted in 2021.

The individual assessment of financial institutions is gradually being integrated into micro-prudential supervisory activity. Starting from 2021, since the first edition of the Green Recommendation, the MNB has been monitoring and analysing the preparedness and attitudes of domestic credit institutions in relation to environmental sustainability aspects at the institutional level (by means of self-assessments, own action plans and prudential discussions). If the degree of compliance with these recommendations improves in the Hungarian banking sector, the extent of climate risk to the financial system may also decrease, as well as the probability of a shock-like reaction to new, stricter regulations.

Between 2022 and 2024, within the framework of the Green Programme, the MNB launched a research and methodology project to assess financial risks arising from biodiversity loss. The project was funded by the European Union through the Technical Support Instrument (TSI), with the OECD participating in the process as an implementation advisory partner, in cooperation with the European Commission's Directorate General for Structural Reform Support. In 2024, the outcome of the project was the implementation of the supervisory methodology framework in Hungary.[23]

3.4 THE MNB'S OWN OPERATIONS

Climate risks affect the operational risk profile of the MNB. Both transition and physical risks are relevant for the MNB and need to be considered when developing and operating the operational risk management framework. Activities related to operational risk management and business continuity management are decentralised within the MNB, where a dedicated organisational unit plays a coordinating role and provides methodological guidance.

International best practices are applied in the management of operational risks: operational risks are assessed in the context of processes, and a bank-wide risk map is prepared on that basis. This is supported by the so-called event register of the relevant losses, on which an annual summary report is provided to senior management. Where climate risks become relevant for a given workflow, they are analysed as part of the normal operational risk management process.

One key area of operational risk management is business continuity, which can be severely impacted by physical risks. Chance and unavoidable external circumstances also play a role in the occurrence of risk events, which can cause uncertainty in the operation of the MNB. The aim of operational risk management is to effectively manage this uncertainty and provide decision-making processes with the widest possible range of information. The direct risks arising from the MNB's operations may be affected by the effects of climate change and environmental degradation, such as the negative impact on the MNB's buildings, for example, of high summer temperatures, which can damage the operational infrastructure, impairing business continuity.

The operations of the MNB involve GHG emissions and other environmental impacts, which may have a negative impact on the environment and thus pose a potential reputational risk to the Bank. The MNB seeks to manage its impact on the environment primarily by measuring and reducing its carbon footprint.

Transition risks can affect the price of energy used or business travel, which can lead to higher operating costs. This type of materialisation of climate risks needs to be taken into account when planning costs.

[23] The joint biodiversity Project of the MNB and OECD, with the support of the European Commission

4 Indicators

This report presents a quantitative and qualitative assessment of the environmental sustainability risks and impacts associated with the MNB's balance sheet and its own operations. An analysis of climate risks in the financial system is contained in the Green Finance Report.[24]

4.1 COVERAGE OF THE FINANCIAL ASSETS SUBJECT TO ANALYSIS

The MNB aims to include the widest possible range of its assets in its analyses. Regarding foreign exchange reserves, the focus of the analysis is on sovereign exposures, representing the core of the reserves, but the assessment also covers other positions, such as corporate portfolios, gold and monetary policy instruments.

- **Foreign exchange reserves:** A substantial part of the reserve portfolios consists of sovereign exposures, but also includes issuances by international (supranational) institutions, highly rated corporate and bank issuances and covered securities. The portfolio also includes gold reserves; for which this year's report is the first to include an assessment of climate risks and impacts.[25]

- **Funding for Growth Scheme (FGS):** Launched in 2013 to restore the functioning of the SME lending market. Under the programme, the MNB provided funds to participating credit institutions at an interest rate of 0 percent, which they could lend on to micro, small and medium-sized enterprises at a maximum interest rate of 2.5 percent, until 2021.

- **Bond Funding for Growth Scheme (BGS):** Launched in 2019 by the MNB based on a strategic decision to develop the capital market and boost liquidity in the corporate bond market. Under the programme, the MNB purchased bonds issued by non-financial corporates with good credit ratings until 2021.

- **Government Securities Purchase Programme (GSPP):** The MNB purchased Hungarian government securities on the secondary market starting from 2020 to address the adverse effects of financial market turbulence on the domestic markets. While the MNB ended these purchases in December 2021, it continues to hold long-term government securities on its balance sheet.

- **Mortgage Bond Purchase Programme (MBPP):** First launched in 2018. Under this programme, the MNB purchased HUF-denominated, fixed-rate mortgage bonds from Hungarian mortgage institutions. The Green Mortgage Bond Purchase Programme (GMBPP) was launched in 2021 and closed in May 2022, due to the tightening measures taken by the central bank.

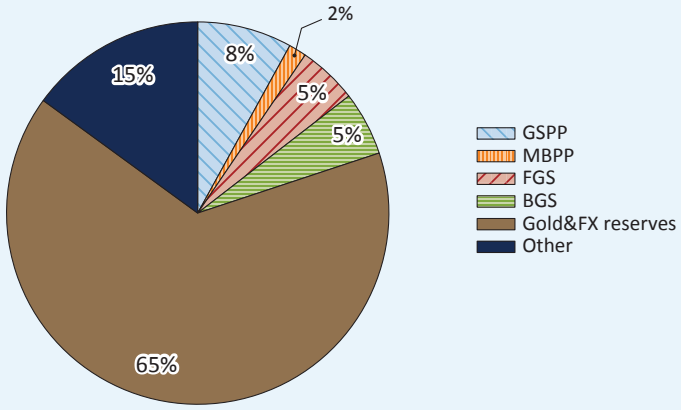
- **Green Home Programme (GHP):** Launched as part of the FGS scheme, this programme promoted the establishment of a green housing loan market and helped to mainstream environmental sustainability considerations in the Hungarian housing market by providing low-interest central bank funding. The programme, with a budget of HUF 300 billion, closed at the end of September 2022.

- **The MNB also assumes indirect risks in the course of collateral management.** The MNB essentially accepts issuances from the entire Hungarian bond market as collateral, in addition to large corporate loans, where – due to the structure of the market – government securities dominate the pledged collateral. The range of eligible securities is relatively wide, with government, corporate and bank securities (including mortgage bonds) included in the eligible portfolio.

[24] The MNB's Green Finance Report

[25] A detailed analysis on this topic will be published in the near future in the Financial and Economic Review: *Sustainability and Climate Risk Analysis of Gold as a Central Bank Reserve Asset* (Marczis, D. –Karácsony, T. – Straubinger, A).

Chart 2
Asset side of the MNB's balance sheet



Note: Based on preliminary 2024 year-end balance sheet data.
Source: MNB

4.2 METHODOLOGY AND DATA SOURCES

The MNB analyses the climate risk exposure of its financial asset portfolios in terms of transition risks and physical risks.

- The primary indicator used by the MNB for measuring **transition risks** is Weighted Average Carbon Intensity (WACI), in a production and consumption approach, and the Bank aims to align this as closely as possible with the ECB's unified methodology,[26] which was published in 2023. It is important to note that, based on the principle of double materiality, the WACI indicator can be considered as an "impact"-type indicator, reflecting the environmental impact of the MNB's financed portfolio, and at the same time, it can also be used as a proxy for transition risks. The advantage of this indicator is that it is relatively easy to calculate and does not require a complex methodological background. However, its disadvantage is that it relies mainly on historical data, i.e. it does not take into account possible future decarbonisation paths, nor does it provide answers as to how a given industry or company can adapt; for example, to what extent it can pass on the cost shock to other actors in the value chain. The analysis was thus supplemented with forward-looking indicators such as the Implied Temperature Rise (ITR), the Bloomberg Government Climate Risk Scores, the MSCI Sovereign CVaR, and the ND-GAIN index, which shows both the vulnerability and adaptive capacity of countries.

- Assessing **physical risks** entails significant technical and methodological challenges, including the need for detailed geographical data to determine the severity of potential weather events occurring at different locations. Another difficulty in the calculations is the aggregation of data, for example, when assessing the risk exposure of various countries.

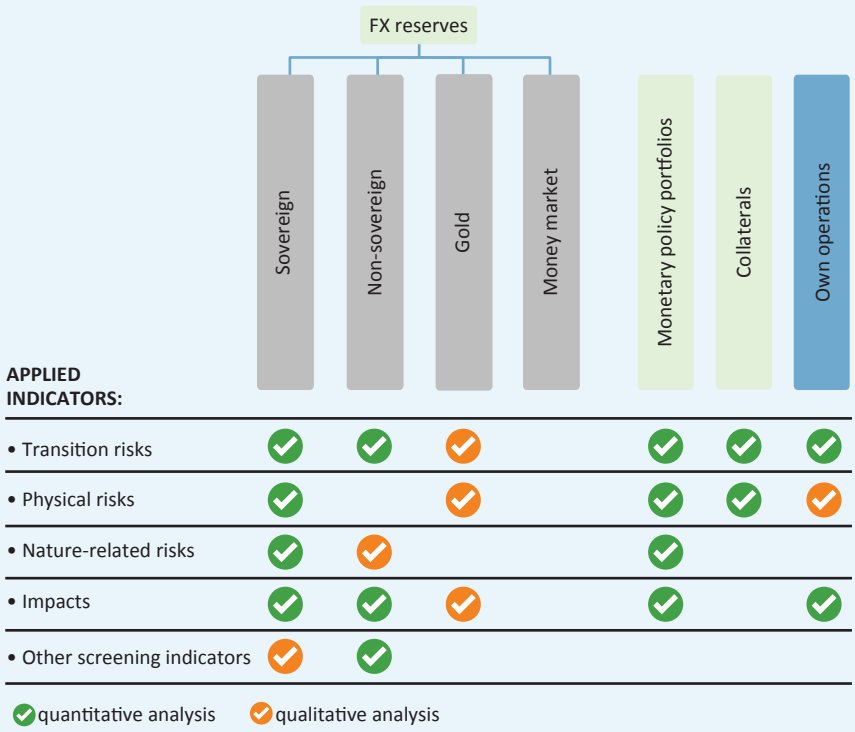
Nature-related risks in a broader sense affect the economy in the form of transition and physical risks, similar to climate risks, but due to their specific nature, the report treats them separately. Best practices are beginning to emerge in climate risk assessment, while biodiversity and nature-related risks are location-specific and their measurement is much more complex, and accordingly there is still no widely accepted methodology.

Although most of the indicators used are based on a number of complex methodological assumptions, the results still serve as a useful compass for gaining a broader perspective on the trends and processes, and for better understanding which parts of the asset side of the balance sheet are most exposed to risk.

The analyses were prepared based on the preliminary balance sheet data as of the end of 2024 and the latest data available from the data providers. The methodological description related to each indicator can be found in the Annex.

[26] Overview of Eurosystem climate-related financial disclosures

Chart 3
Asset categories covered in the report



4.3 ANALYSIS OF ENVIRONMENTAL SUSTAINABILITY RISKS AND IMPACTS

4.3.1 Transition Risks

4.3.1.1 Foreign Exchange Reserves

Sovereign Exposures

In line with the uniform methodology applied by euro area central banks, in respect of sovereign portfolios, in addition to the WACI, the total carbon emissions and carbon footprint are also presented, both in the production and consumption approaches. In 2024, the carbon intensity of the portfolios was 192 tCO_2e/*million EUR GDP in the production approach*, which decreased relative to the previous year partly due to changes in composition and the reduction of GHG intensity in some countries (Table 1).

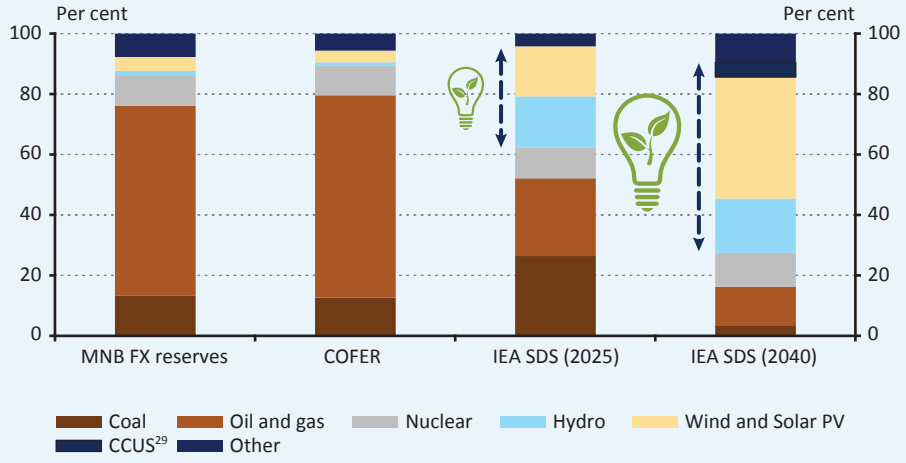
Table 1
Emissions indicators for the sovereign exposure of foreign exchange reserves

Consumption approach	2023	2024	Production approach	2023	2024
WACI *(tCO_2e/capita)*	13	14	**WACI** *(tCO_2e/capita)*	247	192
Total Carbon Emission *(tCO_2e)*	3,086,323	*2,649,673*	**Total Carbon Emission** *(tCO_2e)*	2,742,124	2,352,678
Carbon Footprint *(tCO_2e/ m€ GDP)*	279	*216*	**Carbon Footprint** *(tCO_2e/ m€ GDP)*	247	192

Source: MNB calculations, based on data from the World Bank, MSCI

The analysis also examined the energy mix of issuers of sovereign securities included in the foreign exchange reserves. We consider the IMF COFER[27] and the Sustainable Development Scenario (SDS)[28] published by the International Energy Agency (IEA) as a basis for comparison. The latter represents the profile of the global aggregate energy composition that is necessary to achieve a sustainable transition. The current energy mix of the countries in the portfolio is almost identical to that of the IMF COFER which approximates the world's foreign exchange reserves, but at the same time it differs substantially from the composition deemed necessary in the IEA sustainability scenario, due to the dominance of natural gas and oil (Chart 4).

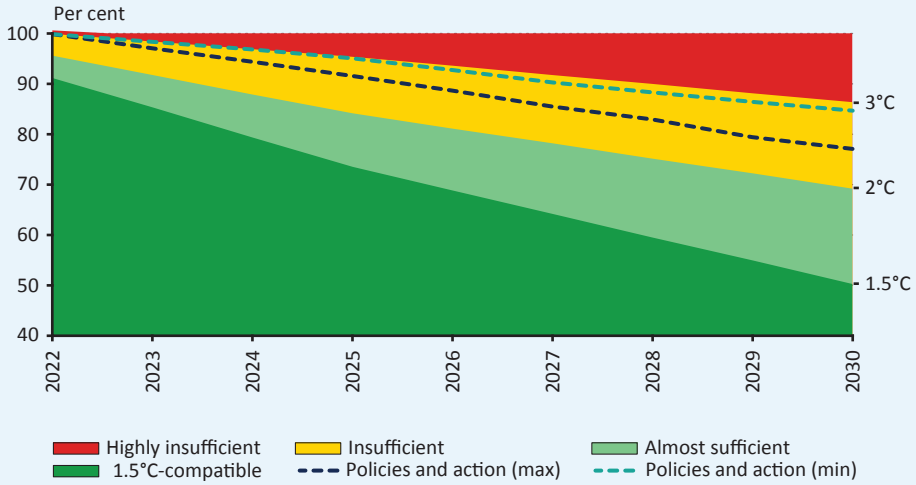
Chart 4
Energy mix of sovereign issuers of foreign exchange reserves[29]



Source: MNB calculations, based on 2023 energy production data from the IEA

A similar picture emerges from the calculations based on the Climate Action Tracker (CAT) data: the combined weighted emissions trajectories of the countries in the reserve do not meet the pro-rata Paris climate targets in either scenario (full or partial fulfilment of national commitments). It is important to note, however, that according to CAT none of the countries in the investment universe relevant for reserve management meet the climate targets over the examined time horizon.

Chart 5
Emissions trajectories of the sovereign portfolio and pro-rata compliance with the Paris climate targets



Note: 2022 emissions =100 percent
Source: MNB calculations, based on Climate Action Tracker 2024 climate scenario data

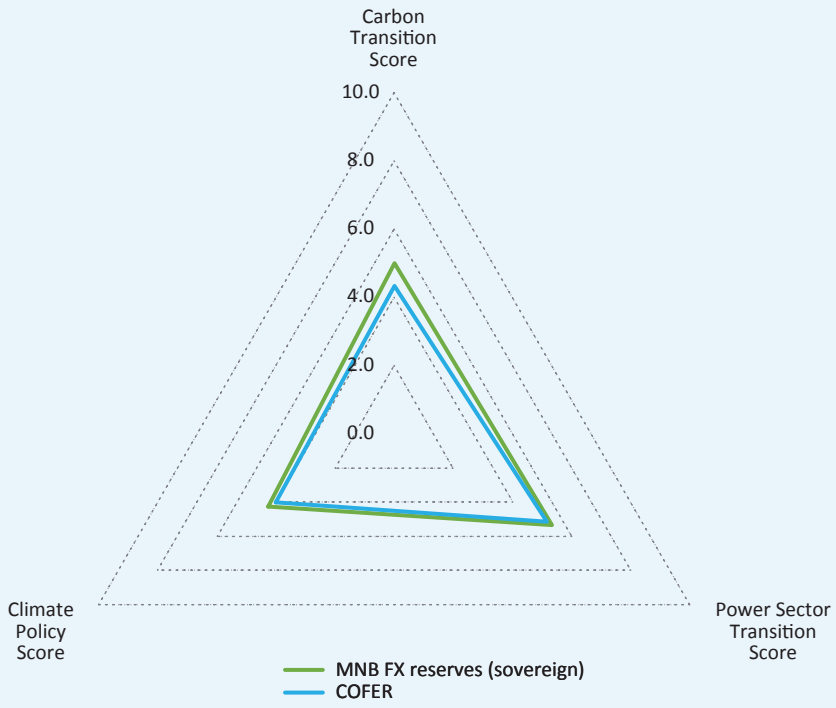
[27] Composition of Official Foreign Exchange Reserves (COFER): a portfolio representing the currency composition of the IMF's official foreign exchange reserves
[28] Sustainable Development Scenario
[29] CCUS: innovative technologies for reducing GHG emissions (CO_2-capture, utilisation and storage)

Based on the *Bloomberg Government Climate Risk Scores*, the countries of the sovereign exposures of the foreign exchange reserves are relatively better prepared in the climate transition process (Aggregate Climate Risk Score: 4.8/10) than the COFER (4.5/10), but at the same time there is a lag compared to the theoretical best values according to the methodology.

The methodology evaluates the transition risks of individual countries related to climate change in three dimensions, on a scale of 0–10 (10 being the best value).

- *Carbon Transition Score:* assesses a country's past, current and projected GHG emissions.
- *Power Sector Transition Score:* assesses a country's progress and future efforts to decarbonise its energy sector, taking into account the current share of fossil fuel and renewable generation and the level of clean energy investments.
- *Climate Policy Score:* evaluates a country's progress in achieving net-zero goals and in developing frameworks related to green debt issuance and renewable energy policies.

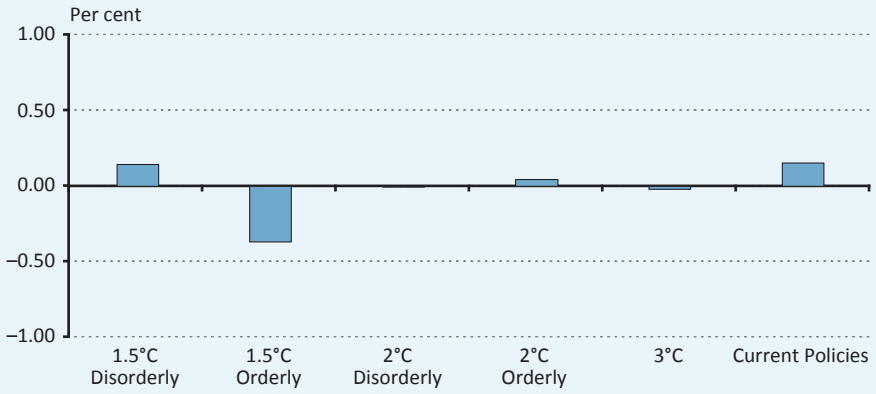
Chart 6
Bloomberg Government Climate Risk Scores of the sovereign portfolio and the COFER



Source: MNB calculations, based on Bloomberg Finance L.P. data for 2024

***The Sovereign Climate Value-at-Risk (CVaR)* methodology developed by MSCI ESG Research examines the financial impact of different NGFS climate stress scenarios on the valuation of the sovereign portfolio.** Depending on how the transition to a sustainable economy occurs, each scenario assumes different changes in the dynamics of macroeconomic variables (e.g. interest rates), which affect the pricing of financial instruments. "Orderly" scenarios assume that climate policies are introduced early and gradually tightened; both physical and transition risks are relatively contained. "Disorderly" scenarios assume higher transition risk due to delayed or divergent climate policies across countries and sectors. Long-term interest rates tend to rise in transition-based scenarios, reflecting higher carbon prices and a higher inflationary environment resulting from the increased investment required for the green transition.

Chart 7
Impact of NGFS interest rate scenarios on the value of sovereign exposures in the foreign exchange reserves



Source: MNB calculations, based on MSCI data

Overall, despite the fact that the emissions trajectories of the countries in the sovereign portfolio do not meet the Paris climate targets, the portfolio is largely protected from climate risks, mainly due to its short maturity. At the same time, it can also be stated that the countries in the reserve are the world's leading economies, with high credit ratings and considerable capacity for adaptation to the negative effects of climate change.

This is also supported by the University of Notre Dame's ND-GAIN country index, which identifies four main groups of countries, based on 45 indicators, according to each country's vulnerability to climate change and other global challenges, as well as their readiness to improve their resilience:

A. These countries face the greatest challenges and need significant investment and innovation to improve their adaptive capacity.

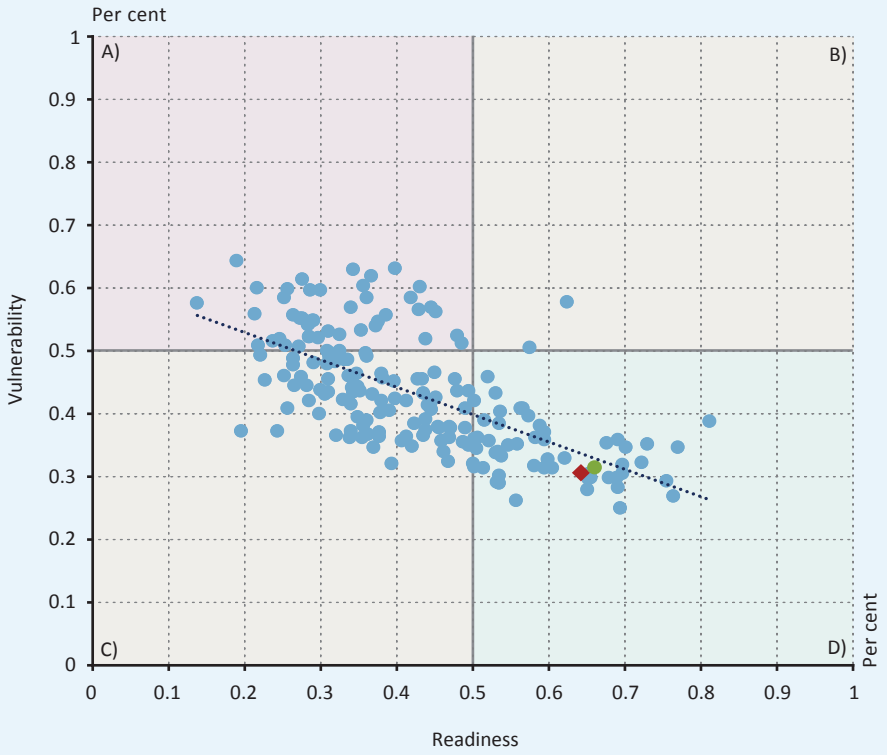
B. These countries are more prepared to respond to the challenges of climate change, but they also have high adaptation needs.

C. These countries currently face relatively moderate challenges from climate change, but their adaptive capacity is also low.

D. These countries are less vulnerable, and their capacity to adapt is relatively good.

The reserve portfolio is shown in the "lower right" quadrant, where countries that are less vulnerable and have relatively high adaptive capacity are positioned.

Chart 8
Values of all countries (blue), the sovereign portfolio (green) and the COFER (red), based on the ND-GAIN Index



Source: MNB calculations, based on Notre Dame Global Adaptation Initiative Country Index (ND-GAIN) data

Corporate Exposures

Since 2023, the environmental sustainability risk analysis framework also covers the corporate exposures of the reserves. For this portfolio, the carbon intensity indicator is expressed as the ratio of financed GHG emissions to the revenue generated by the companies or to the enterprise value.[30] At the end of 2024, the carbon intensity, taking into account direct emissions, was 19.2 *tCO_2e/million EUR revenue* (91 percent coverage) and 5.8 *tCO_2e/million EUR EVIC* (89-percent coverage).[31]

According to MSCI's methodology, the proportion of issuers with significant transition risk in corporate portfolios is marginal. The data provider classifies companies into different categories based on their current emissions profiles. According to the methodology, these categories are: companies whose assets are potentially "stranded assets", companies that need to take further steps in the transition of their operating processes (operational transition), and companies that need to take further steps due to a decline in the demand for GHG-intensive products (product transition). The vast majority of the portfolio falls into the "Neutral" category, with limited exposure to transition risks (Chart 9).

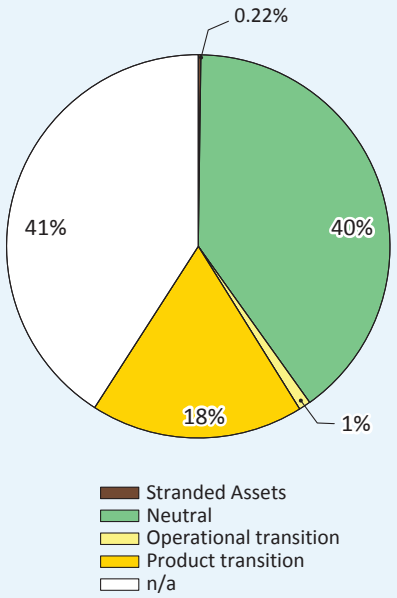
Based on the MSCI Implied Temperature Rise (ITR) indicator, 23 percent of the corporate portfolio is on track to meet its climate targets. ITR is a forward-looking measure, expressed in degrees Celsius, that shows the alignment of companies' emissions profiles with the targets set out in the Paris Climate Agreement. Although some of the issuers in the portfolio are meeting their targets, 19 percent need to take further action to reduce their emissions. The weighted average ITR of the portfolio is 2.1°C; the coverage of the indicator is 42 percent (Chart 10).[32]

[30] Enterprise Value Including Cash, EVIC

[31] MNB calculations, based on Bloomberg Finance LP. The data provider uses the emissions data reported by the companies where available, otherwise it uses estimates based on its own methodology. The weighted average reliability index of the data is 8.2, based on the *Bloomberg GHG Estimate Confidence Score*, which indicates relatively high reliability on a scale of 10.

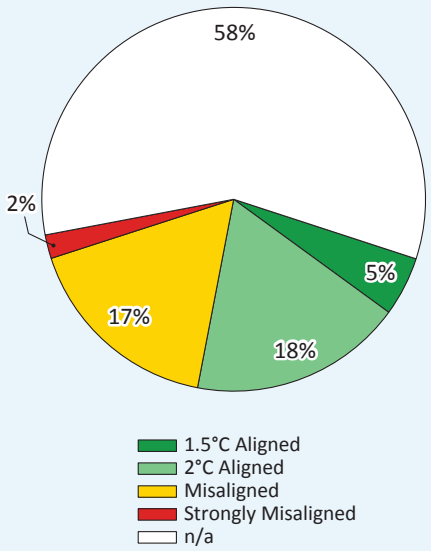
[32] The decrease in the coverage was related to portfolio restructuring and data revision.

Chart 9
Transition risk categories



Source: MSCI

Chart 10
Implied temperature rise



Source: MSCI

Based on the international examples for central banks, the sustainability risk analysis framework also includes the examination of certain "positive and negative screening" type indicators. The *"positive screening"* indicators show that some of the issuers in the corporate portfolio of the foreign exchange reserves are already making some sort of environmental sustainability-related commitments. These metrices look for indications of whether the given company is positively contributing to the promotion of sustainable development. Examples include being signatory to the UN Global Compact,[33] which is positive for 30 percent of the portfolio. 96 percent of the portfolio have an ESG rating from at least one leading ESG rating agency; the portfolio has no exposure in a high-risk category.

The "*negative screening*" indicators do not indicate problematic entities. These indicators may capture a company's negative involvement in sustainability-related issues. Based on the available sources of data, we are not aware of any information suggesting that any particular company is involved in significant environmentally harmful activities[34] or in serious violation of the UN Global Compact guidelines.

The MNB also monitors various exclusion indicators (for informational purposes). Based on these indicators, the involvement of corporate exposures of the foreign exchange reserves is marginal and no substantial risk exposure arises. Such indicators include, for example, the *"Exclusion from Paris-aligned benchmark"* indicator by MSCI, which indicates whether a company's activities fall within the exclusion criteria defined in the EU Paris-aligned Benchmark Regulation,[35] and a list of companies published by Norges Bank Investment Management, that are excluded from their investment universe for some reason.[36]

[33] United Nations Global Compact participants

[34] The MSCI Environmental Controversy indicator identifies companies that are involved in serious violations of any of the environmental objectives set out in Article 9 of EU Regulation 2020/852.

[35] In 2020, the European Commission set the criteria for the EU Climate Transition Benchmark and the EU Paris-aligned Benchmark. The decarbonisation trajectories of the indices labelled CTB and PAB are close to the path that would enable the index to align with the Paris Agreement's 1.5°C target, compared to the index's initial baseline. Article 12 of the Regulation lists the criteria under which a company must not be included in indices so designated.

[36] The exclusion criteria are determined by the Council on Ethics of the Norwegian Ministry of Finance.

Gold Reserves

Gold plays a prominent role in central bank reserves, primarily due to its safe-haven and diversification characteristics. In 2024, in line with its long-term national and economic strategic objectives, the MNB decided to increase its gold reserves from 94.5 tonnes to 110 tonnes.

Climate change can have negative social and economic consequences, such as increased geopolitical tensions and rising inflation, which can increase demand for safe-haven assets, including gold. In order to understand the impact of gold as an investment product on climate change and its climate risk exposure, it is first necessary to examine the emissions profile of the gold industry's value chain. The separation of gold from ore accounts for a large part of the value chain's energy demand, the vast majority of which is related to the use or on-site generation of electricity (see Annex). Estimates on emissions per tonne of gold vary widely in the literature, mainly due to differences in the energy mix of the regional electricity grids.

Gold mining can be considered as an emissions-intensive industry in terms of the amount of GHG emissions per tonne of gold produced.[37] However, in analysing the environmental impact and climate risks of financial investments, it is necessary to examine the extent to which the investment contributes to financing emissions. When analysing bond investments, the carbon intensity indicator, calculated as the ratio of the annual revenue or the value added generated by a given sector or company, and the annual GHG emissions resulting from the production, should be examined.[38] Using this logic, it can be concluded that the carbon intensity of the gold industry is relatively favourable, primarily due to the high value of gold.

However, this methodology cannot be applied to physical gold, as the gold bars purchased had a GHG impact only once (during their production), and no significant recurring emissions arise during storage. For this reason, it is preferable to focus on absolute emissions (TCE – Total Carbon Emissions) rather than intensity ratios, as these can be used to compare different asset classes. For example, in the case of companies, the annual nominal GHG emissions (tCO_2e) can be determined, and where applicable, it can also be established how much tree planting or annual carbon credit purchases are required to offset this. The amount of GHG emissions generated during production can also be estimated for physical gold (approx. 11,500–55,000 tCO_2e for 1 tonne of gold). Given the one-off emissions associated with gold, if offsetting is used, it is necessary to determine the period over which such neutralisation is to be provided. It can be concluded that the longer the time horizon over which the one-off GHG emissions of gold can be dispersed, the lower the annualised value of the indicator, and thus its climate impact may be more favourable than that of other investment instruments, depending on the expected holding period.[39]

When conducting climate risk analyses related to gold, it is also important to consider the position of the given investor: before making new investments, a number of ESG factors can be examined (screening), including the emissions impact of the purchase compared to other assets. However, in the case of the existing portfolio assets, alternative questions need to be asked, as the environmental impact of gold accumulated in the past is a historical factor.

When analysing transition risks, it can generally be said that potential regulatory changes to promote the green transition will have a negative impact on companies engaged in carbon-intensive activities. In the case of gold, however, this relationship is not clear-cut. It can be stated with certainty that there will be no direct effects (e.g. carbon tax) on physical gold already held in the investment portfolios, and accordingly the direct effects of transition risks can be deemed marginal. However, considering that the value of the existing gold investments is determined by the price established by the prevailing market supply and demand conditions, indirect impacts may also play a role. Estimating indirect impacts poses a number of challenges, as it is unclear how regulatory changes or consumer preferences affect supply and demand conditions. In some cases, the price of gold may even rise, thereby improving investors' existing positions.

[37] According to estimates, the industry's total annual emissions are approximately 120–130 million tCO_2e (WGC).
[38] By purchasing bonds or shares, investors finance the current and future activities of the given company and the related emission.
[39] For details on the methodology, please see: Baur, D.G. - Oll, J. (2017): The Role of Gold and the VIX in Investment Portfolios – A Financial and Sustainability Perspective.

4.3.1.2 Portfolios Held for Monetary Policy Purposes

Government Securities Purchase Programme

In the analysis of the transition risks and impacts of the portfolio, we used Hungary's emissions profile as a basis. Hungary's WACI indicator in a production approach is 168 *tCO_2e/million EUR GDP*, which decreased compared to the previous year.[40] WACI as per the consumption approach did not change significantly, with a value of 6 *tCO_2e/capita*. The reduction in total carbon emissions can be attributed to the decline in the portfolio size[41] (Table 2).

Table 2
Carbon intensity indicators for Hungary

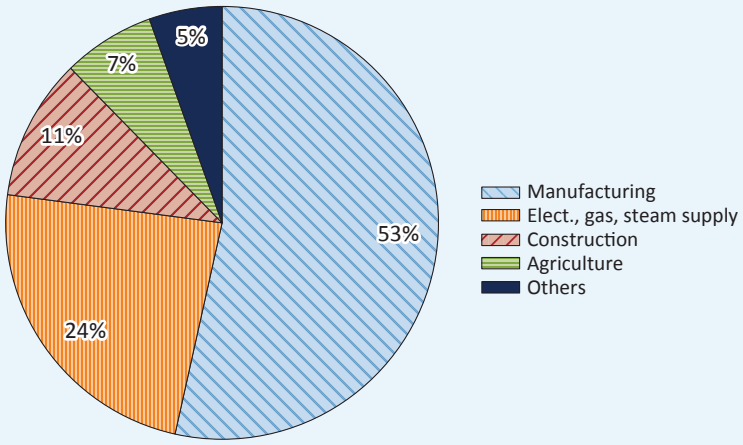
Consumption approach	2023	2024	Production approach	2023	2024
WACI *(tCO_2e/capita)*	6	6	**WACI** *(tCO_2e/capita)*	213	168
Total Carbon Emission *(tCO_2e)*	1,727,098	827,671	**Total Carbon Emission** *(tCO_2e)*	1,839,484	917,878
Carbon Footprint *(tCO_2e/ m€ GDP)*	200	151	**Carbon Footprint** *(tCO_2e/ m€ GDP)*	213	168

Source: MNB calculations, based on MSCI and World Bank data

Bond Funding for Growth Scheme

For the BGS portfolio, the weighted average carbon intensity calculated from sectoral data is 294 *tCO_2e/million EUR value added.* The indicator changed compared to the previous year mainly due to the decrease in GHG intensity in the electricity, gas, steam supply and air conditioning sectors. Nearly 90 percent of the portfolio's WACI was contributed by just three sectors (Chart 11). The high value of electricity sector is mainly explained by its high GHG intensity, while for manufacturing and construction by their high weight in the portfolio.

Chart 11
Contribution of main sectors to the GHG intensity of the BGS portfolio



Source: Eurostat, MNB

[40] Several factors influence the development of the WACI of the government securities portfolio. Based on the data available for the reference period, although the value in the numerator of the production-based WACI (Hungary's GHG emissions) increased in 2022, the value in the denominator (Hungary's PPP-adjusted GDP expressed in euros) increased to a greater extent during the period.

[41] https://www.mnb.hu/sajtoszoba/sajtokozlemenyek/2024-evi-sajtokozlemenyek/allamkotvenyeket-vasarol-vissza-az-allam-a-jegybanki-portfoliobol

The ratio of carbon-intensive assets (brown share) in the BGS portfolio was 14 percent at the end of the year. It is also important to note that, while this was not a stated objective of the BGS, the MNB also purchased green corporate bonds within the framework of the programme. The proportion of green bonds (green share) in the BGS portfolio exceeds 20 percent. The most significant issuers were companies in the construction, manufacturing and real estate sectors.

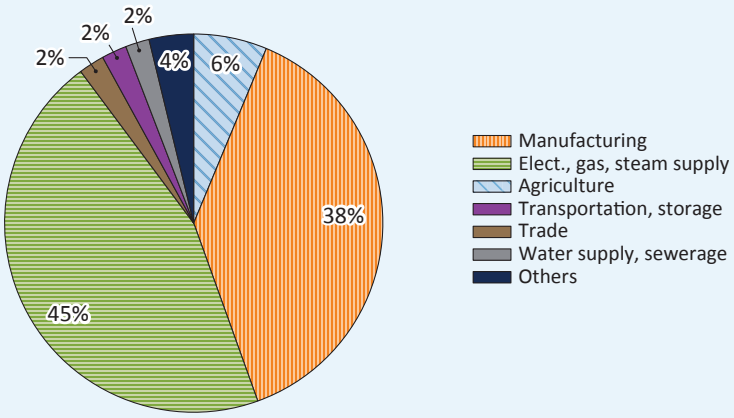
Government securities dominate among the collaterals pledged in favour of the MNB, but the MNB also accepts BGS securities (approximately 12 percent). The average carbon intensity of the pledged BGS exposure at year-end was 254 *tCO_2e/million EUR value added*.

Funding for Growth Scheme

The WACI of the FGS portfolio is *439 tCO_2e/million EUR value added.* The change in the indicator versus the previous year is explained by the changes in composition due to repayments and a general decline in the carbon intensity of certain sectors (e.g. electricity). Among the loans provided under the FGS, the ratio of sectors with high carbon intensity can be considered low: at the end of the year, 7.26 percent of the portfolio of investment loans and 8.63 percent of the working capital and refinancing loans were related to these sectors.

94 percent of the FGS's carbon intensity was the result of only five sectors (Chart 12). The high contribution of agriculture and electricity generation, transportation and storage is mainly due to the high GHG intensity of these sectors, while in the manufacturing and trade sectors, it is due to the high portfolio value.

Chart 12
Contribution of the main sectors to the carbon intensity of the FGS portfolio



Source: Eurostat, MNB

4.3.2 Physical Risks

4.3.2.1 Foreign Exchange Reserves

Sovereign Exposures

The sovereign portfolio of foreign exchange reserves consists primarily of securities issued by developed countries, and thus the physical risk profile is determined by data typical of the world's leading economies. The risk profile of the countries (or regions within the given countries) may vary significantly. Bearing this in mind, instead of an aggregated, portfolio-level weighted average risk index, it is worth examining the distribution of risks and exposure to high-risk categories. The physical risk profile of the portfolio did not change significantly compared to the previous year: sea level rise and floods remain the most relevant risk factors. The portfolio is characterised by a "Medium" risk level in

the hurricane and typhoon, heat stress and water scarcity categories, and by a relatively "Low" risk level in the wildfire category (Chart 13).

Chart 13
Breakdown of the physical risk level of the sovereign exposures of the foreign exchange reserves, by risk category (% portfolio weight)

	Risk level				
Risk factor/	**None**	**Low**	**Medium**	**High**	**Very High**
Flood	0%	0%	7%	60%	33%
Heat Stress	14%	35%	25%	27%	0%
Hurricane & Typhoon	16%	29%	0%	55%	0%
Sea level rise	5%	7%	4%	23%	61%
Drought	9%	33%	29%	29%	0%
Wildfire	16%	54%	29%	0%	0%

Source: MNB calculations, based on Moody's Analytics data

Gold Reserves

The physical risk exposure of gold reserves can only be described through a qualitative analysis. Physical gold is practically indestructible, even in the event of a (climate) disaster, which can be a positive feature compared to other investments, e.g. in securities of specific companies, as physical risks may have a serious impact on the operation and supply chain of certain companies. In the case of bond investments, physical risks are often analysed as supply-side shocks; in the case of gold, this approach implies that the investor takes a position vis-à-vis an entire industry, not a specific company, which is a significant difference compared to bond or equity investments.

Climate change may have negative effects on some actors involved in gold production, but global supply and demand shocks are less likely. No single region accounts for more than one-fifth of global production, which means more stable supply conditions, i.e. local problems that may occur in some places are less likely to lead to global supply shocks.

Based on the above considerations, the physical risk exposure of the gold reserves is considered relatively low compared to other forms of investment.

4.3.2.2 Portfolios Held for Monetary Policy Purposes

As for the portfolios held for monetary policy purposes (BGS, FGS, GSPP, MBPP, GMBPP), Hungary's physical risk profile should be used, as the risk profiles of the regions within the country are relatively homogeneous. The Hungarian sovereign risk levels are substantially lower than those of other countries in the FX reserves, but due to Hungary's relatively small geographical area, the concentration risk is significantly higher. For Hungary, only heat stress presents a high level of risk, while due to its geographical location, the risk categories of sea level rise, hurricanes and typhoons are not relevant. The risk level for wildfires is almost identical to that observed for the sovereign exposures in the FX reserves, while water scarcity has a lower risk level.[42]

[42] It is important to note that the methodology basically uses a relative risk classification between countries. In Hungary, for example, the increasing frequency of temporary droughts and low water levels definitely causes problems at the local level, while the risks caused by water scarcity are lower in global perspective, i.e. in comparison to other countries.

Chart 14
Physical risk profile of Hungary

	Risk level				
Risk factor/	**None**	**Low**	**Medium**	**High**	**Very High**
Flood					
Heat Stress					
Hurricane & Typhoon					
Sea level rise					
Drought					
Wildfire					

Source: MNB calculations, based on Moody's Analytics data

4.3.3 Nature-related Risks

4.3.3.1 Foreign Exchange Reserves

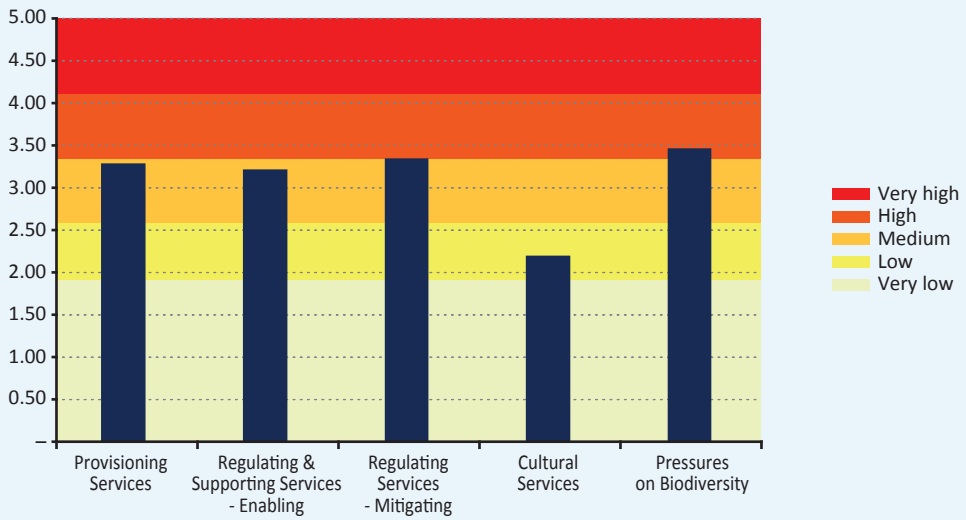
Sovereign Exposures

The *WWF Risk Filter Suite,* developed by the WWF, provides a good starting point for analysing nature-related risks and impacts of the countries in the portfolio. The platform is based on two pillars: the *WWF Biodiversity Risk Filter* provides a general, high-level assessment of the risks of biodiversity loss, while the *WWF Water Risk Filter* allows for a deeper analysis of the water-related risks (e.g. water scarcity, water quality). The data are available at specific geolocation levels, and at regional and national aggregation levels.

It is important to emphasise that while nature-related risks are location-specific, the analysis of specific country profiles offers a good starting point, providing an opportunity to see the main trends and identify problematic exposures. For the latter, it is necessary to analyse the data at a deeper level, at a lower degree of aggregation.

For the entire portfolio, a low to medium risk level (dependency) can be determined for the different risk categories (Chart 15), i.e. there are no acute threats to the economies as a whole, arising from the decline of nature and ecosystem services, while the combined economic activity of the countries can be classified in a higher category in terms of pressure on biodiversity.

Chart 15
Weighted risk scores of the portfolio, by risk category

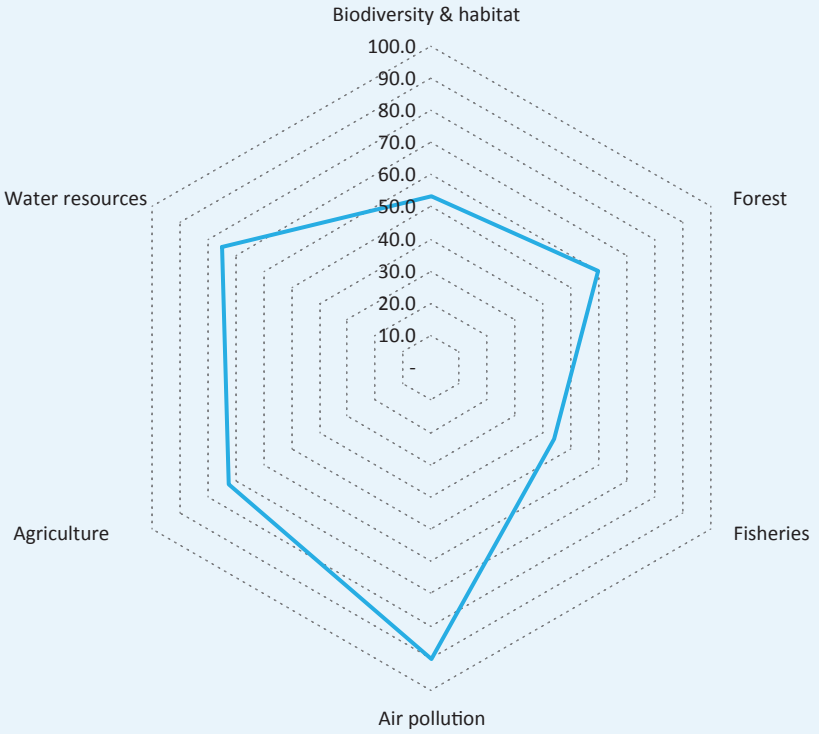


Source: MNB calculations, based on the WWF Biodiversity Risk Filter data

Examining nature-related risks and impacts using the *Environmental Performance Index (EPI)*, we can conclude that the combined score of the countries in the portfolio (62.8) ranks in the first quintile of the global ranking. The methodology developed by the Yale Center for Environmental Law & Policy ranks countries using 58 performance indicators in three main categories (climate change, ecosystem vitality and environmental health). On a scale of 0 to 100, a high score identifies the best-performing countries, while a low score identifies the lower-performing countries (currently, the highest score is 75.7 and the lowest is 24.6).

In addition to the overall scores, the data is also available separately for each performance indicator, providing more detail on the exposures in the portfolio. The ecosystem vitality category can be further divided into six subcategories, and the portfolio is shown to have the lowest score in the "Biodiversity and habitat" subcategory.

Chart 16
Weighted risk scores of the portfolio, by risk category



Source: MNB calculations, based on the Environmental Performance Index[43] data

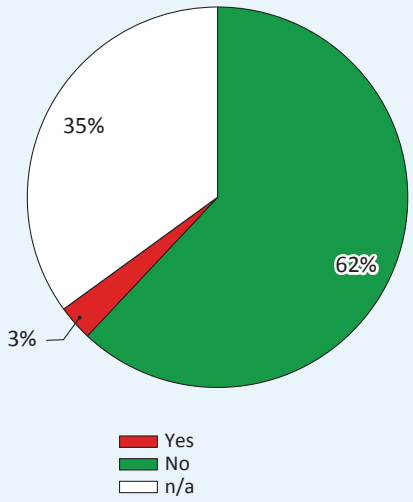
Corporate Portfolios

Nature-related risks and impacts of the corporate exposures can be assessed using "screening"-type indicators. "Negative screening" indicators[44] do not signal any problematic entities in the portfolio; i.e. based on the available data sources, we are not aware of any information that would indicate the involvement of any company in activities with significant threats to the environment.

[43] Block, S. – Emerson, J.W. – Esty, D.C. – de Sherbinin, A. – Wendling, Z.A., et al. (2024). 2024 Environmental Performance Index. New Haven, CT: Yale Center for Environmental Law & Policy. epi.yale.edu

[44] For example, the MSCI *"Operations in biodiversity sensitive areas"* indicator, which identifies companies whose activities affect three or more biodiversity sensitive areas.

Chart 17
Portfolio exposure to sectors with nature-related risks or impacts *

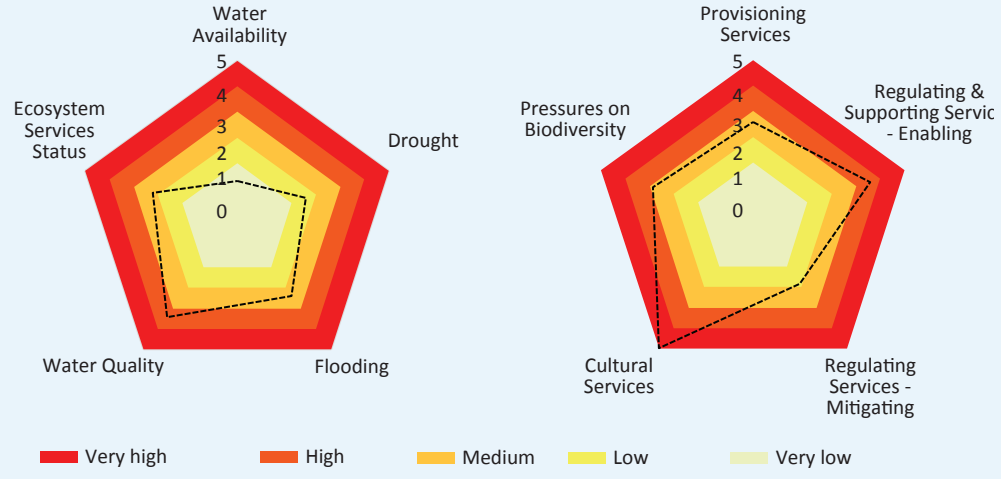


Note: Sectors with material nature-related risks and impacts, as defined by the TNFD.
Source: MNB calculations, based on Bloomberg Finance L.P. data.

4.3.3.2 Portfolios Held for Monetary Policy Purposes

As for the portfolios held for monetary policy purposes (BGS, FGS, GSPP, MBPP, GMBPP), Hungary's risk profile can be used as a starting point. The *WWF Risk Filter* data shows that water-related risks are present in the categories of water quality and floods, and in general, risks arising from the decline of nature and ecosystem services appear only in the risk category of cultural services. According to the methodology, this category refers to the presence of economic activities (such as tourism, real estate and education) that may be highly dependent on the presence of culturally valuable geographical landscapes or specific sites. Degradation of the key attraction elements can negatively impact businesses that rely on these features.

Chart 18
Portfolio exposure by risk category



Source: WWF Biodiversity Risk Filter, MNB calculations *Source: WWF Water Risk Filter, MNB calculation*

4.3.4 Positive Environmental Impact: Avoided GHG Emissions

For some portfolios, the environmental impact analysis of the programmes and the assessment of the expected or realised positive environmental impacts are also of particular importance. The environmental impacts identified at the level of individual issuers allow the portfolio to be evaluated not only in financial terms, but also in terms of the emissions reductions achieved, while also maintaining the primary financial objectives.

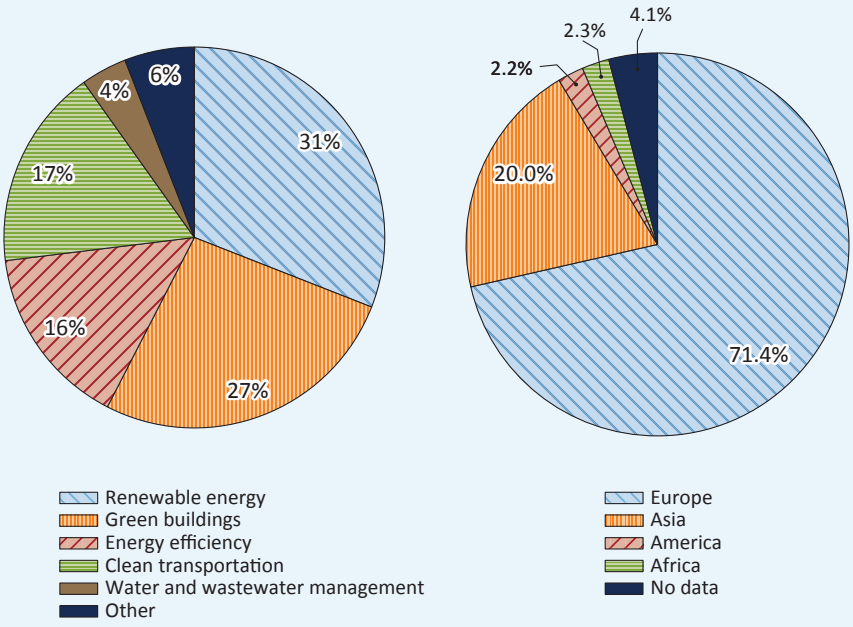
One possible approach to this is the estimation of the avoided GHG emissions. For this analysis, calculations are available for the green bond portfolio, the MBPP/GMBPP and the GHP portfolios.

Dedicated Green Bond Portfolio

Within the foreign exchange reserves, at the end of 2024, there was more than EUR 2.5 billion of exposure to bonds with green or other sustainability labels.[45] This includes a dedicated EUR 500 million green bond portfolio, the positive environmental impact of which is monitored separately by the MNB. In the case of green bonds, the funds raised are invested by the issuer in specific projects that are beneficial from an environmental and energy efficiency perspective. Green bonds facilitate the channelling of capital into green investments and may reduce the cost of funding.

Renewable energy and green buildings account for 58 percent of the funded projects within the dedicated portfolio. The portfolio is denominated in EUR, which reflects the predominance of European issuers and the geographical distribution of the realised green projects.

Chart 19
Type and geographic distribution of funded green projects



Source: Bond issuers' own reports

[45] Sustainable, social, transition

The positive environmental impact of projects financed by green bonds should always be interpreted against a baseline scenario, which represents the hypothetical CO_2 emissions in the absence of the green projects. In 2024, the green bond portfolio contributed to the avoidance of approximately 117,000 tCO_2 emissions, which is roughly equivalent to the annual carbon footprint of a Hungarian settlement with a population of 20,000.[46] The increase compared to the figure of 66,000 tonnes reported in the previous year is attributable, on the one hand, to the increase in the size of the portfolio and, on the other hand, to rearrangements of bonds within the portfolio. Traditional reserve management objectives and considerations are just as relevant for the green bond portfolios as for the MNB's other FX reserve portfolios, which means that the goal is not necessarily the optimisation of the environmental impact; the environmental impact generated in connection with the investment is rather a kind of positive externality.

Mortgage Bond Purchase Programme

According to our estimates, via modernisation of the housing stock, the MBPP contributes to an annual savings of approximately 13,000 to 34,000 tonnes of GHG emissions, while in the case of the GMBPP, the figure is approximately 5,400 tonnes. Mortgage bonds are special securities collateralised by at least 80 percent of the principal and interest payments on mortgage loans disbursed by mortgage banks and their partner banks, as required by law. These loans are backed by real estate, and accordingly the MNB's mortgage bond purchases indirectly finance the construction, purchase and renovation of properties.[47]

Green Home Programme

The specific emissions value of the properties financed under the GHP is about one-third of the average, which corresponds to annual GHG savings of approximately 38,000 to 49,000 tonnes. When analysing the positive environmental impact of the GHP portfolio, the emissions calculated based on the energy efficiency indicators and the specific emissions factors of the financed properties are compared to the estimated average value of Hungarian properties.

4.4 EVOLUTION OF THE MNB'S ENVIRONMENTAL FOOTPRINT

4.4.1 Operational Activities

The MNB's target for the 2020–2022 cycle was to reduce its operational carbon footprint by at least 30 percent relative to 2019. The target was exceeded, as the MNB reduced its per employee carbon footprint by nearly 60 percent by the end of 2022 compared to the baseline.

By the end of the 2023–2025 planning cycle, the MNB plans to reduce the carbon footprint per employee by another 15 percentage points (i.e. by 75 percent relative to the reference year). By the end of 2024, based on the preliminary data,[48] the carbon footprint associated with the MNB's operational activities was reduced by 3,738 tonnes, showing a reduction of 68.1 percent versus the baseline.

[46] https://ksh.hu/s/kiadvanyok/fenntarthato-fejlodes-indikatorai-2023/3-40

[47] It is worth mentioning that, compared to Western Europe, the MNB's programmes were able to achieve a relatively high reduction in emissions, which is because Hungarian properties are more outdated.

[48] Not yet audited at the time of drafting the report

Table 3
Carbon footprint of the MNB's operations over time

Carbon emissions/sources	Evolution of the carbon footprint (t CO_2e)						Change in 2023, %	Change from base year 2019 %
	2019. base	2020.	2021.	2022.	2023.	2024.*		
Natural gas and district heating	848.00	966.00	981.00	1,975.00	1,127.00	1,323.00	17.39	56.01
Vehicles fleet	122.95	104.36	104.31	115.56	122.00	118.00	-3.28	-4.02
Refrigerants	-	5.36	5.38	3.35	2.38	2.38	-	-
SCOPE 1 total	**970.95**	**1,075.72**	**1,090.69**	**2,093.91**	**1,251.38**	**1,443.38**	**15.34**	**48.66**
Electricity	4,092.00	2,624.00	3,013.00	87.00	7.10	105.00	1,378.87	-97.43
SCOPE 2 total	**4,092.00**	**2,624.00**	**3,013.00**	**87.00**	**7.10**	**105.00**	**1,378.87**	**-97.43**
Air travel	945.05	201.30	33.00	411.40	811.00	649.00	-19.98	-31.33
Business travel (car, abroad)	2.42	0.40	0.50	2.80	3.90	3.10	-20.51	28.22
Business travel (car, domestic)	7.79	1.90	2.70	10.40	10.30	15.03	45.92	92.95
Taxi	2.65	3.20	3.50	4.60	2.30	1.80	-21.74	-32.01
Banknote briquette (used as an energy source)	-	18.20	17.00	15.30	14.00	13.99	-0.09	-
Recycled paper	-	1.90	3.00	0.80	0.55	0.50	-9.09	-
Communal waste	-	155.80	110.00	60.71	57.00	52.00	-8.77	-
SCOPE 3 total	**957.90**	**382.70**	**169.70**	**506.01**	**899.05**	**735.42**	**-18.20**	**-**
SCOPE 1 – SCOPE 3 total	**6,020.85**	**4,082.42**	**4,273.39**	**2,686.93**	**2,157.53**	**2,282.80**	**5.81**	**-62.09**
Carbon footprint (tonnes/employee)	**4.60**	**3.10**	**3.20**	**1.89**	**1.50**	**1.47**	**-2.41**	**-68.11**

** preliminary data*
Source: MNB

Energy consumption continues to have the most significant impact on the development of the carbon footprint. The increasingly extreme weather conditions caused by climate change are leading to higher energy consumption. In 2024, it was not possible to fully offset the increase in the carbon footprint associated with higher energy consumption against reductions in business travel and other areas, resulting in a modest increase in the carbon footprint from operational activities.

The MNB aims to reduce its carbon footprint resulting from its operational activities and is seeking opportunities to further green its energy mix and further increase the proportion of renewable energy.

However, emissions cannot be eliminated completely. To compensate for emissions that cannot be further reduced, the MNB has been financing habitat restoration projects, with the active involvement of WWF Hungary. Projects included planting a 27-hectare forest near the village of Geszt in the Körös–Maros National Park in 2022, and afforestation and grassland reconstruction on 32 hectares at Drávaszentes jointly with the Danube–Drava National Park Directorate in 2023. Furthermore, from 2024, a new habitat reconstruction project covering approximately 36 hectares is being carried out in Kállósemjén, in the Hortobágy National Park.

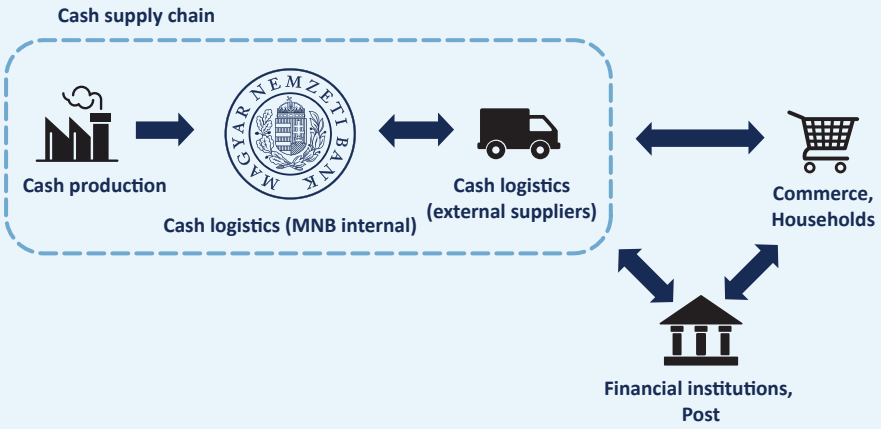
In addition to carbon offsetting, the projects also provide ecosystem services, thus contributing, among other things, to the preservation of biodiversity and to mitigating the effects of climate change.

4.4.2 Carbon Footprint of the Cash Supply Chain

In measuring the environmental performance of the cash supply chain, the MNB focuses on the following activities:

- Cash production, the operations of MNB subsidiaries involved in the production process
- Cash logistics activities within the MNB (distribution, processing)
- Activities of the cash logistics service providers (suppliers)

Chart 20
Flow of cash across the economy



The carbon footprint of the cash supply chain is calculated using the Bilan Carbone methodology, using emissions factors. It is important to point out that the process focuses on the root causes of the most significant environmental impacts. The aim is to establish a comprehensive picture that can be used to track changes year after year. Cash production accounts for 20 percent of the carbon footprint of the entire cash supply chain, while transportation comprises 80 percent. By the end of 2024, both factors were significantly had been reduced.

The majority of the environmental impact of the cash supply chain is related to supply chain operators (mainly cash logistics transport companies), where fuel consumption was the main source of emissions. Within the cash supply chain, in the case of cash production and the MNB's internal logistics, CO_2 emissions are caused mainly by the energy consumption of buildings and the machinery and equipment needed for production and processing.

Table 4
Carbon footprint of the cash supply chain*

Period	Cash supply chain carbon footprint (tCO2e)	Change versus 2018 (tonnes)	Change versus 2018 (percent)
2018	21,204		
2019	19,522	-1,682	-7.9
2020	18,273	-2,931	-13.8
2021	21,078	-126	-0.6
2022	16,892	-4,312	-20.3
2023	13,540	-7,664	-36.1
2024**	12,922	-8,282	-39.1

** The data are calculated from the raw data received from the actors in the cash supply chain.*
*** Preliminary, unaudited data*
Forrás: készpénzszállító cégek, MNB

The analysis shows that the main factors contributing to the recent improvement in environmental performance are:

- MNB subsidiaries involved in cash production organise their activities based on strict environmental management system requirements.

- The internal cash logistics activities of Hungarian Mint Ltd. and the MNB are carried out within a single facility (MNB Logistics Centre), where 100 percent of the electricity used comes from renewable sources since 2022; this significantly reduced the carbon footprint compared to previous years.

- Among the actors in the cash supply chain, the vehicle fleet of the transport companies carrying out activities with the highest environmental impact is constantly being modernised.

In the future, the most obvious way to reduce the carbon footprint of cash transportation may be to decrease the distances travelled by cash transport vehicles and upgrade the vehicle fleet. This can be achieved without jeopardising the security of the cash supply, primarily by encouraging the reuse of banknotes and coins at the local (bank branch) level. This would eliminate the need to transport fit-for-circulation banknotes flowing into the branches for processing and then returning them, to meet demand. The number of dedicated machines (typically ATMs with banknote reuse capability) has increased in recent years, but they only account for around one-quarter of the entire ATM network, still leaving significant room for further growth in the future.

5 Annex – Metrics Used in the Analysis – Methodology and Limitations

Emissions Indicators

While consistency is a primary consideration in the analysis, there may be differences in the range and the calculation of the emissions metrics disclosed for different asset categories, due to methodological specificities and the available data sets. Methodological differences make it difficult to compare the results of portfolio evaluations and do not allow for the calculation of a carbon emissions or carbon intensity ratio aggregated at the balance sheet level.

a) Sovereign Portfolios

The central banks of the euro area published their first harmonised climate-related financial reports in 2023. Disclosures were prepared on the basis of a consistent framework following the TCFD and PCAF recommendations. In the common framework, central banks use a uniform methodology to measure and publish the weighted average carbon intensity (WACI) and the total carbon emissions and carbon footprint for their EUR-denominated portfolios managed by them for non-monetary policy purposes. Individual central banks may publish analyses with a broader coverage and different indicators; for example, the ECB published an analysis covering corporate bond holdings purchased for monetary policy purposes, in addition to non-monetary policy portfolios.

In order to achieve a higher degree of comparability, the MNB made several modifications to the previously used analysis methodology for sovereign assets, in line with the practices applied by euro area central banks. In addition to WACI as the main transition risk indicator, the total carbon emissions and the carbon footprint of sovereign portfolios were also calculated, using both the production and consumption approaches. The production approach takes the GHGs produced within a country as the basis of calculating the indicators. This approach corresponds to the approach followed by the UNFCCC in preparing national emissions inventories. The consumption-based approach modifies emissions data for the effects of foreign trade, capturing the GHG emissions generated by a given country's consumption.

b) Corporate Portfolios

When estimating the carbon intensity of the FGS and BGS portfolios, sectoral averages were used due to the lack of company-specific data, which may distort the results of the analysis. For the sectoral classification, the MNB used NACE categories, within which, for the BGS, more detailed industry carbon intensity data are also used, with a weighing corresponding to the proportion within the portfolio. The main disadvantage of this approach is that the most carbon-intensive sectors may also include companies that are trying to achieve carbon neutrality through new, innovative technologies, while sectors classified as non-carbon intensive may also include companies with particularly high carbon intensity (e.g. an issuer's green bonds may have the same sectoral classification as its traditional bonds even though the amount of carbon emissions is significantly different). This is also the case for the biased classification of companies producing green energy. Taking all this into account and keeping robustness, international best practice and comparability in mind, reclassifications and corrections were applied in the calculations to tackle any distortions with material effects.

Table 5 Sovereign asset portfolios (FX reserves, Government Securities Purchase Programme)	
Weighted Average Carbon Intensity (WACI)	
Description	This indicator measures the portfolio's exposure to carbon-intensive entities. It is the GHG intensity per PPP-adjusted GDP (production approach) or per population (consumption approach) of the emitting country multiplied by the proportion of exposure in the portfolio. Unit of measure: tonnes of CO_2e/EUR millions of GDP or tonnes of CO_2e per capita.
Formula	$WACI = \sum_i \frac{market\ value\ of\ exposure_i}{market\ value\ of\ portfolio} * \frac{GHG\ emission\ of\ the\ country_i}{PPP-adjusted\ GDP\ or\ GDP\ (at\ 2019\ prices)\ or\ population_i}$
Data source	GHG: MSCI (2022), GDP: World Bank
Total Carbon Emissions (TCE)	
Description	Indicator of the total GHG emissions financed by the portfolio. Unit of measure: tonnes of CO_2e.
Formula	$TCE = \sum_i \frac{market\ value\ of\ exposure_i}{PPP\ adjusted\ GDP_i} * GHG\ emission\ of\ the\ country_i$
Data source	GHG: MSCI (2022), GDP: World Bank
Carbon Footprint (CF)	
Description	Total GHG emissions of the portfolio relative to the size of the portfolio. Unit of measure: tonnes of CO_2e/EUR millions of GDP.
Formula	$CF = \frac{\sum_i \frac{market\ value\ of\ exposure_i}{PPP\ adjusted\ GDP_i} * GHG\ emission\ of\ the\ country_i}{market\ value\ of\ portfolio}$
Data source	GHG: MSCI (2022), GDP: World Bank
Corporate asset portfolios (BGS, FGS)	
Weighted Average Carbon Intensity (WACI)	
Description	A metric quantifying the GHG emissions of the assets in the portfolio arising in the production of a unit of value added. Unit of measure: tonnes of CO_2e/EUR millions of value added
Formula	$WACI = \sum_i \frac{nominal\ value\ of\ investment_i}{market/collateral\ value\ of\ portfolio} * GHG\ intensity\ of\ sector_i$
Data source	Eurostat (Air Emissions Intensities, 2023)

Note: In the TCFD recommendations for the corporate sector, turnover data are used in the calculations, but in the MNB's TCFD report, due to gaps in individual data, the corporate WACI metrics are calculated using value-added based sector GHG intensity data instead of turnover.

In the production-approach, the WACI for the reserve portfolios was calculated using data aligned with the National Greenhouse Gas Inventory data available from external data providers (GHG Inventory, UNFCCC), which quantifies the amount of GHG emissions produced in a country's territory in accordance with international guidelines, for the seven main GHGs, expressed in carbon dioxide equivalents (CO_2e).

Brown Share

The analysis of carbon-intensive (brown) corporate exposures is important for investors, because the transition to a carbon neutral economic structure will be most challenging for companies with high carbon intensity, both from a technological and regulatory perspective. To identify carbon-intensive industries, the TCFD Working Group recommends the Global Industry Classification Standard (GICS) sector classification. According to the TCFD's assessment, the energy and utilities industries (excluding water utilities and renewable energy companies) are the most carbon-intensive sectors, and therefore

the financial exposure to companies operating in these sectors should be assessed. The MNB used the NACE Rev. 2 sector classification, instead of the GICS classification, within which the GICS carbon-intensive sectors can be matched with a high degree of overlap. The disadvantage of the metric is that it does not assess exposure based on the carbon intensity of individual issuers, but rather on the basis of sector classification, thus providing an indirect picture of brown assets.

Energy Mix

In order to meet the goals of the Paris Agreement on Climate Change, the composition of the world's energy production needs to shift significantly from fossil fuels to renewable energy sources. One way of measuring the risks arising from this transition could be to study the energy mix of the countries issuing securities. The energy mix is a good starting point for examining the transition risks arising from the structural characteristics of the energy supply, but it does not provide information on the level of energy supply, the capacities required for the transition and the strategic plans and measures of a given country to address climate risk.

Climate Action Tracker (CAT)[49]

For a forward-looking assessment of transition risks of the sovereign portfolios, data from Climate Action Tracker are suitable, which outlines potential future emissions pathways based on the GHG reduction commitments of countries, which are measured against the targets of the Paris Agreement. For the calculation of reserve-level aggregate indicators, the weights were determined according to the proportions of sovereign exposures included in the foreign exchange reserves.

Bloomberg Government Climate Risk Scores

Bloomberg uses three dimensions to assess each country's relative transition risks related to climate change compared to other countries. On a scale of 0 to 10, 10 is the best score.

- *Carbon Transition Score: assesses a country's past, current and projected emissions.*
- *Power Sector Transition Score: assesses a country's progress and future efforts to decarbonise its energy sector, taking into account the current share of fossil fuel and renewable generation and the level of clean energy investments.*
- *Climate Policy Score: evaluates a country's progress in achieving net-zero goals and in developing frameworks related to green debt issuance and renewable energy policy.*

MSCI Sovereign CVAR[50]

The MSCI[51] Sovereign CVAR examines the financial impact of NGFS scenarios and assumes different changes in yields and monetary policy responses to climate change. A methodological assumption is that the market immediately reprices individual financial instruments today in a way that reflects future interest rates in a given climate scenario.

- *Orderly 1.5°C ("Net Zero2050"): In this scenario, global warming is limited to 1.5°C through stringent and immediate climate policies. This temporarily increases inflation via a sudden increase in the price of polluting energy sources, which leads to a rise in short-term yields.*

[49] Climate Action Tracker

[50] MSCI ESG Research - How Climate Transition Risk May Impact Sovereign Bond Yields

[51] With regard to all MSCI data presented in this report, it should be noted that MSCI ESG Research LLC obtains the information from sources it believes to be reliable, but does not guarantee the accuracy, completeness or timeliness of such information. None of the data should be used on its own to determine which securities to buy or sell, or when to buy or sell them. None of the information constitutes investment advice or a recommendation to make (or refrain from making) any investment decision and should not be relied upon as such. Details on the use of the data can be found at the link below: https://www.msci.com/notice-and-disclaimer-for-reporting-licenses

- *Orderly 2°C ("Below 2 degrees"): Global warming is limited to 2°C by immediately implemented climate policies that are more moderate than in Net Zero scenarios. As a result, yields diverge less from the climate-agnostic baseline scenarios, resulting in smaller yield curve shocks (the shock on the curve tends to be more parallel).*

- *Disorderly 1.5°C ("Divergent Net Zero"): Despite limiting global warming to 1.5°C, this scenario involves higher carbon prices due to divergent policies across sectors and a quicker, later phase-out of fossil fuels. The lack of policy coordination places a high burden on consumers. Interest rates tend to rise compared to the baseline (after a short dip for some countries) and remain higher for longer. This tends to push the longer end of the yield curve up more.*

- *Disorderly 2°C ("Delayed transition"): Global annual emissions will not decline until 2030. By then, drastic action is needed to limit warming to 2°C, with varying levels of action across countries and regions. The disorderly transition leads to an increase in interest rates once the delayed transition begins. Generally, the shorter end of the curve is less affected, but the longer end moves more upward.*

- *3° ("NDC"): In this scenario, currently pledged Nationally Determined Contributions (NDCs) are fully implemented, reaching energy and emissions targets in all countries. Carbon prices increase slightly, resulting in a mild impact on the yield curve.*

- *3° ("Current policies"): The current lax climate policies will continue, so there will be no transition risks, only productivity losses resulting from physical risks in the given countries.*

When using the methodology, it is important to highlight that the potential losses associated with the interest rate risk of the bond portfolio are not the same as the macroeconomic costs to the economy as a whole in different scenarios. From a macroeconomic perspective, the impact of the different climate scenarios on economic variables such as real GDP is likely to be much more relevant than changes in interest rates.

ND-GAIN Index[52]

The University of Notre Dame's ND-GAIN country index identifies four main country groups based on 45 indicators, according to a country's vulnerability to climate change and other global environmental sustainability challenges, as well as its ability and readiness to improve resilience:

1. *These countries face the greatest challenges and have a strong need for investment and innovation to improve their adaptive capacity.*

2. *These countries are better prepared to respond to the challenges of climate change, but they also have greater adaptation needs.*

3. *These countries currently face relatively moderate challenges related to climate change, but their adaptive capacity is also low.*

4. *These countries are less vulnerable, and their capacity to adapt is relatively good.*

Vulnerability is assessed by taking into account six life-sustaining factors: food, water, health, ecosystem services, human habitat and infrastructure. Each factor is represented by six additional indicators, which can be grouped around three main components:

– *The extent to which human society and the factors that support it are exposed to changing climatic conditions in the future. (This mainly captures the physical factors contributing to vulnerability.)*

[52] ND-GAIN Country Index

– The extent to which climate change affects the population; factors that increase vulnerability include the degree of dependence on climate-sensitive sectors, and factors such as topography and demographics, and the proportion of the population vulnerable to climate hazards.

– Society's ability to adapt to reduce the negative effects of events related to climate change.

Readiness is assessed by the methodology by taking into account the ability of a given country to direct investments towards measures that facilitate the adaptation process.

– Economic readiness: an investment environment that facilitates the mobilisation of capital from the private sector.

– Governance readiness: the stability of the social and institutional structure that contributes to investment risks.

– Social readiness: conditions that help a given society to use investments efficiently and fairly.

MSCI Implied Temperature Rise[53]

This indicator shows how companies and investment portfolios are aligned with the goals of the Paris Climate Agreement. The key to understanding the ITR is the concept of the "carbon budget", i.e. how much the world can emit so that global warming does not exceed 1.5 or 2°C by 2100; and its extension, i.e. how much a company can emit, taking into account its fair share of global decarbonisation.

The ITR is about extrapolating the global implied temperature rise over the 2100 horizon as if the entire economy had the same carbon budget overshoot or undershoot as a given company or portfolio. The methodology does not take into account the costs and the avoided emissions associated with the transition to a low-CO_2 economy.

Moody's Physical Risk Scores

For the analysis of physical risks, the model of the external data provider (Moody's Analytics) takes into account the results of six risk categories: flood, heat stress, hurricanes and typhoons, sea level rise, drought (water stress), and risks from forest fires and wildfires. Within the risk categories, a number of indicators are quantified that capture the change in the exposure of the examined entity (country or company) to physical risks over the forecast horizon. The scores for each risk category correspond to a percentile rank order, i.e. from 0 to 100, where 0 represents the lowest risk level and 100 the highest risk exposure. Accordingly, physical risk scores show the relative riskiness of entities within the universe of analysis. This methodology of physical risk analysis is suitable for drawing attention to the most risky areas and entities. However, the analysis is not suitable for comparing the results of different asset classes (different universes).

Avoided GHG Emissions

- *In the case of the foreign exchange reserves, the reductions in GHG emissions published in each issuer's impact reports were aggregated for the analysis. There are significant differences in the methodology of the reports published by issuers, and the lack of transparency makes the analysis difficult; in some cases, therefore, direct consultation with the issuer or reliance on expert estimates was necessary.*

- *In the case of MBPP, the estimate was made by combining data on the mortgage bonds purchased, on mortgage loan disbursements and on the total estimated stock of residential properties in the National Building Energy Strategy. Energy savings are converted into emissions avoidance based on the Clim'Foot database and the emissions factors of the Partnership for Carbon Accounting Financials (PCAF).*

- *Information provided by mortgage banks in their impact reports was used for the GMBPP.*

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[53] MSCI ESG Research - Implied Temperature Rise Methodology

- *The annual GHG emissions generated during the annual operation of the properties participating in the GHP were estimated based on the specific energy consumption (energy classification), size and emissions factors provided by the PCAF. The methodology takes into account only the GHG emissions saved in the operation of buildings; no data are available on emissions associated with construction.*

WWF Risk Filter Suite

The platform is based on two pillars: the WWF Biodiversity Risk Filter provides a general, higher-level assessment of the risks of biodiversity loss, while the WWF Water Risk Filter allows for a deeper analysis of the water-related risks. The platform covers several risk categories in line with the TNFD recommendations: physical and reputational (transition-regulatory) risks.

The extent of the physical risks is determined by the degree to which an economic process depends on the natural and human-induced conditions of the terrestrial and marine environment, and by the extent to which the environmental pressures resulting from economic processes can impair ecosystem services. The erosion of these systems can lead, for example, to a decline in productivity or an increase in the costs of production factors. The methodology uses five main risk categories:

- *Provisioning services: Many economic processes rely on inputs provided by nature, the quantity or quality of which can lead to increased costs or disruptions to the production process. This risk category includes the four main natural resources needed for production: fresh water, timber, wild plant and animal species, and marine fish.*

- *Regulating and supporting services: Regulatory and supporting ecosystem services are essential for certain economic processes, particularly crop production and livestock farming. This risk category includes five main ecosystem services: condition of soil, water, air, ecosystem and pollination.*

- *Mitigation services: the occurrence of natural hazards can severely affect certain economic processes, the negative impacts of which can be mitigated by intact ecosystems. This risk category includes the following natural hazards: landslides, forest fires, pests, diseases, resistance to herbicides and extreme heat.*

- *Cultural services: some industries, such as tourism, real estate and education, may be heavily dependent on culturally valuable landscapes, seascapes or specific locations. The degradation of the key attraction elements can negatively impact businesses that rely on these features.*

- *Pressures on biodiversity: factors that have a clear negative impact on biodiversity and ecosystem processes, such as land, freshwater, and marine use changes, deforestation, invasive species and pollution.*

The platform uses a variety of data sources as input for the different indicators, typically expressed in different units of measurement. For comparability and aggregation purposes, raw data are normalised on a scale from 1 to 5, with individual thresholds for each indicator; a risk score of 5 is very high, while a score of 1 represents very low risk.

An overall high risk score may be caused by high dependence on ecosystem services (risk categories 1-4), OR high impact on biodiversity (risk category 5), and endangered ecosystem services OR high pressure on biodiversity at the site.

EPI Environmental Performance Index[54]

The 2024 version of the EPI Index, developed by the Yale Center for Environmental Law & Policy and the Columbia University's Center for International Earth Science Information Network, evaluates the countries in relation to eleven environmental sustainability issues, using 58 performance indicators spanning three main categories (climate change, ecosystem vitality and environmental health), to assess the countries in their progress of implementing the UN Sustainable Development Goals, the Paris Climate Agreement, and the Kunming-Montreal Global Biodiversity Framework.

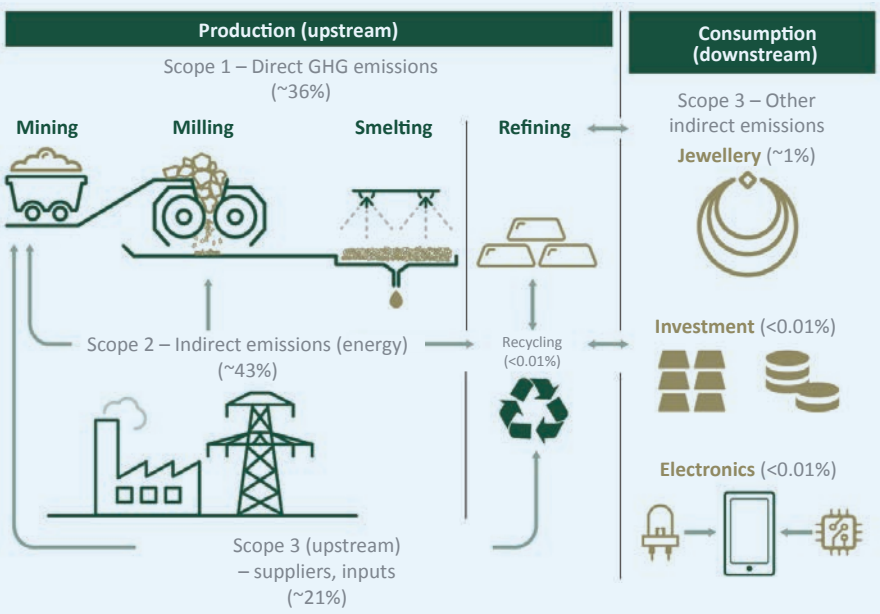
The advantage of a comprehensive composite index is that it condenses data on dozens of sustainability issues into a single indicator. To make each metric easier to interpret, raw environmental data is transformed into indicators that score countries on a scale of 0 to 100, from worst to best performance.

The climate change category accounts for 30 percent of the index, while ecosystem vitality accounts for 45 percent. The latter aims to show how well countries are doing in protecting the ecosystem services in six subcategories: biodiversity and habitats, forests, fisheries, air pollution, agriculture and water resources. The environmental health category accounts for 25 percent of the score: it measures how well countries protect their population from the health effects of environmental pollution. It is divided into four further subcategories: air quality, wastewater and drinking water, heavy metals and waste management.

The index is useful in that it allows for the synthesis of the environmental information, a compact comparison between the countries and the identification of trends and problem areas, while at the same time obscuring differences in detail at this level of aggregation. Furthermore, it is important to note that the EPI Index is based on a number of assumptions and subjective methodological choices, and readers are therefore advised to treat the scores and rankings as a starting point for further analysis and examination of more detailed data.

[54] https://epi.yale.edu/measure/2024/EPI

Gold value chain and related GHG emissions



Source: World Gold Council (2019)

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