



THE MAGYAR NEMZETI BANK'S CLIMATE-RELATED FINANCIAL DISCLOSURE



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Felelős kiadó: Hergár Eszter

1013 Budapest, Krisztina körút 55.

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This analysis involved staff from the MNB's Directorate Monetary Policy Instruments and Foreign Exchange Reserves: Tímea Karácsony, Norbert Kiss-Mihály, Gergely Manasses, Dávid Marczis, Zsolt Mihálovits, Éva Paulik, András Straubinger, Márton Varga.

Other contributors were Gábor Fekete (Operational Services Department), Norbert Holczinger, Balázs Lóránt, Eszter Raciborski (Sustainable Finance and Supervisory Coordination Directorate), Laura Komlóssy (Directorate Lending Incentives), Zoltán Jenőfi (Directorate Structured Finance Strategy), Attila Tapasztai (Directorate Money and Foreign Exchange Markets),

Valuable advice was provided by Barnabás Virág, Deputy Governor, dr Csaba Kandrác, Deputy Governor, dr Mihály Patai, Deputy Governor, Ádám Banai, Executive Director and Pál Péter Kolozsi, Director of the Directorate Monetary Policy Instruments, Foreign Exchange Reserves and Risk Management.

The report has been prepared mainly on the basis of data available as at 31 December 2022. Since data frequency is divergent through the analyses, the analysis horizons may also alter. The printed version has been produced using the solution with the lowest environmental impact realistically achievable. Please print the electronic version only if justified.

Executive Summary

The MNB's statutory objectives include, both directly and indirectly, promoting environmental sustainability and addressing the risks caused by climate change. While the primary mandate of the central bank provides opportunities to address climate change, since mid-2021 the 'green mandate' has further strengthened this by making the promotion of environmental sustainability an explicit objective.

The MNB's decision-making bodies and executives are regularly informed about the impact exerted by climate change and other environmental risks on the financial system and the MNB's operations, and they support environmental sustainability through their decisions.

The MNB's strategy for environmental sustainability has been elaborated in line with its mandates laid down in the MNB Act and its organisational structure. In the Green Monetary Policy Toolkit Strategy, the MNB identifies a number of climate-related risks that may have an impact on price stability. Without compromising its primary objective, the MNB develops its monetary policy toolkit in harmony with long-term environmental sustainability considerations. The MNB's Green Programme sets out the relationship of the supervisory strategy to sustainability objectives, supporting the stability of the financial system through the identification, measurement and management of climate-related and environmental risks. Greening its own operations is also a priority for the central bank, which has set a target of an 80-per cent reduction in direct carbon emissions by 2025 compared to the 2019 level.

In line with the tasks of the MNB, the risk management framework of the central bank is composed of different parts. Given the specific characteristics of climate-related risks, traditional risk management frameworks cannot be applied with adequate accuracy, and it is therefore essential to adjust them and introduce new methodologies. Quantifying and managing climate risks is a dynamically developing field. Environmental sustainability is increasingly reflected in the central bank's operational areas and programmes, such as the asset purchase programme, central bank lending, collateral management and foreign exchange reserve management. Climate change has an indirect impact on financial supervision via the financial system and the real economy.

One of the MNB's primary objectives with this report is to provide information on the widest possible range of its financial instruments and related climate risk aspects. In the short term, mainly due to data availability constraints, the MNB will produce report which is representative from the perspective of its total assets, but is not exhaustive. With regard to foreign exchange reserves, the analysis focuses on sovereign exposures, which represent the core component of the reserves. In respect of monetary policy instruments, the analysis also covers mortgage bonds and corporate exposures in addition to sovereigns. In addition, the climate risk exposures of instruments accepted for collateral management are also discussed.

Following the MNB's monetary tightening measures in 2022, the composition of the central bank's balance sheet stabilised. In 2022, the MNB discontinued its asset purchase programmes, so the size and composition of the asset side of the balance sheet changed less than in previous years. This can also be observed in the values of climate risk metrics.

The MNB analysed the climate-related risk exposure of financial asset portfolios according to the two main climate-related risk categories, namely transition risks and physical risks, broken down by portfolios. The MNB analysed these risks using metrics commonly applied in international practice, supplemented by its own estimates and special analysis for some of the asset categories. The analysis of the climate impacts of financial portfolios was based on the preliminary balance sheet data at the end of 2022 and the latest available annual greenhouse gas (GHG) emissions and corresponding GDP data. To support comparability, the MNB drew largely on the same metrics used in 2021, but also improved the report in a number of respects (e.g. weighted average carbon intensity metric of sovereigns (WACI); Climate Action Tracker analysis; Funding for Growth Scheme (FGS), description of physical risks).

Retrospective and forward-looking transition and physical risk metrics were calculated for the foreign exchange reserve.

The WACI metric of sovereign reserve assets is 318 tonnes CO₂e per million EUR GDP, representing a slight increase compared to 2021 and is slightly higher than the result of the reference portfolio. The energy mix of the sovereign assets in the foreign exchange reserves is the same as the energy mix of the benchmark portfolio, but differs significantly from the 2025 energy mix assumed as necessary in the IEA sustainability scenario. Climate Action Tracker analysis also shows that the climate policies pursued by sovereign entities of invested reserves are substantially falling short of the Paris climate targets. In terms of physical risks, the portfolio is considered relatively risky based on its overall risk score, mainly due to the rise in sea levels.

For the government securities purchase programme, physical risks are presented alongside the WACI.

The WACI metric calculated for Hungarian sovereign assets is 448 tonnes CO₂e per million euro of GDP, which is lower than the average regional carbon intensity used as a benchmark and also lower than the 2021 value. To analyse the physical risks of the programme, it is necessary to assess Hungary's physical risk profile. Hungary's physical risk exposure is relatively low, ranking in the lower third of the universe examined, with only the heat stress risk category posing a serious challenge.

Among the corporate exposures, in addition to WACI, the analysis for the Bond Funding for Growth Scheme (BGS) includes the brown share and physical risks.

The WACI metric for the BGS portfolio is 584 tonnes CO₂e per million euro of value added, slightly higher than in 2021 and higher than the average carbon intensity of the Hungarian corporate sector as a whole, comparable to the average corporate carbon intensity of the countries in the region. The brown share in the BGS portfolio was close to 14 per cent at the end of 2022. Similar to the situation in Hungary, considering most physical risk categories, the BGS portfolio is relatively low risk.

In the case of the FGS, the analysis also covered the risks of transition and physical risks.

The WACI metric for the outstanding stock of FGS loans is 718 tonnes CO₂e per million euro of value added, which exceeds both the average corporate carbon intensity of the Hungarian corporate sector as a whole and that of the countries in the region. The sectoral distribution of the carbon intensity of the loans granted under the scheme is heterogeneous, with the largest loan portfolios in the less carbon-intensive sectors, agriculture being the exception. With regard to physical risks (due to the concentration in Budapest), there is a high similarity with the value of the BGS portfolio.

In contrast to the other asset portfolios, a different methodology was developed to estimate the environmental impact of the mortgage bond purchase programmes, due to the specificities of the instrument.

Thanks to the MNB's Mortgage Bond Purchase Programme approximately 13,000–41,000 thousand tonnes of GHG emissions are saved annually. The Green Mortgage Bond Purchase Programme will save around 7,600 tonnes of GHG emissions per year.

In addition to the WACI metric of certain pledged portfolios, the MNB assessed the share of carbon-intensive assets and physical risk scores in relation to collateral management.

The WACI metric for pledged BGS bonds is 648 tonnes CO₂e/million euro of value added, while for sovereign holdings 448 tonnes CO₂e/million euro of GDP. The composition and valuation (e.g. haircut) of purchased and pledged corporate exposures differ, which explains the difference in the related metrics. As a result of the change in composition, the values of the climate risk metrics under consideration increased also in collateral management in 2022. For physical risks, due to the concentration in Budapest, there is no material difference between purchased and pledged BGS exposures.

The carbon footprint volume of the MNB's operational activities, and the carbon footprint per employee, has decreased by 30 per cent over the past 3 years, with the increased share of working from home following the coronavirus pandemic playing an important role.

Between 85 and 90 per cent of the carbon footprint of operational activities is related to energy use, mainly heating and cooling energy consumption for the operation of buildings. In line with its strategic objectives, the MNB aims to reduce its operational carbon footprint by 80 per cent by 2025 (on a 2019 basis), through the installation of a solar Pv system and for electricity, through energy consumption from 100 per cent renewable sources. The MNB's operational activities are carbon neutral, as it fully offsets its carbon footprint by financing habitat restoration programmes.

Introduction

In 2015, the G20 Financial Stability Board (FSB) established the Task Force on Climate-related Financial Disclosures (TCFD) 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 a more transparent and stable market, these risks are more effectively incorporated into strategic decision-making, thereby supporting capital flows towards sustainable investments.

The TCFD recommendations play an important role in the G30's proposals for achieving carbon neutrality¹. According to this, by 2023 governments should make it mandatory for listed companies in all sectors of the economy to disclose how they will align their business activities with the transition to a carbon-neutral economy. The G30 report proposes a number of steps to increase the quantity and quality of these disclosures. Although the MNB is not a listed company, it wishes to set an example by making disclosures in line with the TCFD recommendations.

The TCFD's recommendations on climate-related financial disclosures are structured around four areas: internal governance, strategy, risk management, and metrics and targets. The most important role in the report is devoted to metrics, in particular the quantification of GHG emissions. The TCFD recommendations also contribute indirectly to improving internal governance, strategy development and risk management in this area.

There is a growing number of central bank publications on central bank climate risks. The MNB's Climate Risk Report published in 2022 was one of the first of its kind among central banks. Recently, besides the Bank of England and the Banque de France, other central banks have also published sustainability and climate risk reports (e.g. Dutch, Italian, German, Brazilian central banks).

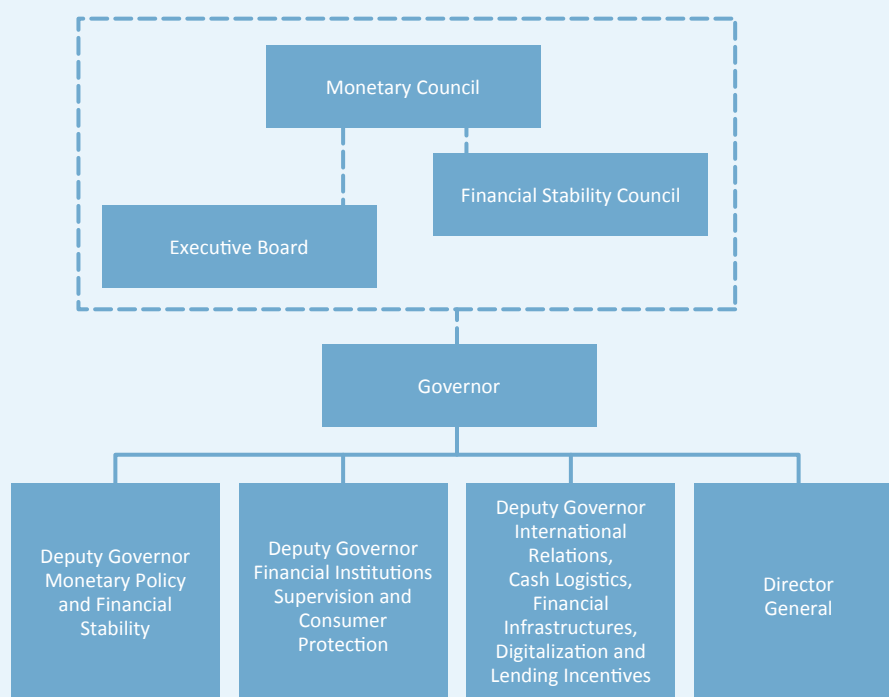
In addition to the TCFD recommendations, binding climate change standards that are coming into force gradually also improve environmental transparency and comparability. One of them is the Sustainable Finance Disclosure Regulation (SFDR), which is already in force in the European Union, including Hungary. Another important change is the Corporate Sustainability Reporting Directive (CSRD), which will be phased in from 2024 and will significantly expand the scope of companies subject to non-financial reporting and level of detail of the reporting. Also crucial for credit institutions and investment firms belonging to banking groups is Article 449a of the EU's Capital Requirement Regulation (CRR), which requires sustainability disclosures and data reporting, and whose provisions are expected to apply from 2025 to all institutions subject to the CRR, in addition to those currently covered. These standards are expected to improve the quantity and quality of available sustainability data.

¹ https://group30.org/images/uploads/publications/G30_Mainstreaming_the_Transition_to_a_Net-Zero_Economy.pdf

1 Corporate governance

Pursuant to Act CXXXIX of 2013 on the Magyar Nemzeti Bank (MNB Act), the MNB supports the stability of the financial intermediary system, enhancing its resilience, ensuring its sustainable contribution to economic growth and, with the tools at its disposal, the Government's policy on economic and, from mid-2021, environmental sustainability, without compromising its primary objective of achieving and maintaining price stability. The MNB was the first European central bank to be granted this so-called 'green mandate', by which the MNB's statutory objectives now include the promotion of environmental sustainability, following a decision of the National Assembly.

Chart 1
Organisational structure of the MNB



The MNB's decision-making bodies are the **Monetary Council (MC)**, the **Financial Stability Council (FSC)** and the **Executive Board (EB)** (Chart 1). 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 of the impact of climate change and other environmental risks on the financial system and the MNB's own operations, and they take measures on this information to promote environmental sustainability.

The **Monetary Council is the MNB's supreme decision-making body**. The powers of the MC include, inter alia, strategic decisions relating to monetary policy, the issuance of legal tender, the accumulation and management of foreign exchange and gold reserves, the management of foreign exchange reserves and the conduct of foreign exchange operations in the context of the implementation of exchange rate policy, as well as statistical tasks. The MC is also empowered to decide on the strategic framework related to macro-prudential tasks, the oversight of payment and settlement and securities settlement systems, the oversight of the financial intermediary system and the functioning as resolution authority, within which the FSC takes decisions. The members of the MC are the Governor, the Deputy Governors and members elected by

the National Assembly. The MC monitors the impact of climate change and other ecological risks on the financial system on an ad-hoc 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 system. The members of the FSC are the Governor and Deputy Governors of the MNB, the executives appointed by the Governor 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, and through its actions it contributes to the implementation of the decisions of the MC and the FSC in support of environmental sustainability. The EB prepares a medium-term Environmental Strategy every 3 years. The targets set out in the Environmental Strategy are backtested in the Annual Environmental Statement adopted by the EB and updated annually. The Statute adopted by the EB in 2014 and the Corporate Social Responsibility Strategy adopted in the same year set out the framework for the Bank's operations in the area of environmental policy and protection. The EB, responsible for managing the MNB's operations, is empowered to decide on the identification, management and measurement of the MNB's major environmental risks and on the implementation of its investments in support of environmental sustainability.

The Governor is the top executive of the EB heading the MNB. The departments under the Governor's direct management are responsible for the MNB's academic and other educational activities related to sustainable finance.

The departments under direction of the **Deputy Governor responsible for monetary policy and financial stability** are responsible for formulating the central bank's proposals for structural reforms 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 to support sustainable economic growth. The area is responsible for the development and ongoing revision of the Green Monetary Policy Toolkit Strategy and for formulating specific proposals for each of the instruments in the implementation of the strategy and, once decisions have been taken, for the operational implementation of the strategy (e.g. green mortgage bond purchases, green portfolio construction).

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 on-site and off-site investigations and supervision activities related to these and to sustainable financial regulation; developing the MNB's position and regulatory proposals on sustainable finance; and contributing to the MNB's academic and other educational, training, awareness-raising, research and international relations-related tasks in the field of sustainable finance. Since 2019, the activities of the Deputy Governor responsible for Supervision of Financial Institutions and Consumer Protection regarding climate-related and other environmental risks and sustainability have been supported by a dedicated unit, the Sustainable Finance Department.

The departments under the direction of the **Deputy Governor responsible for international relations, cash logistics, financial infrastructures, digitalisation and lending incentives** are responsible for exploring, identifying and implementing opportunities for the development and promotion of the domestic green credit and bond market by the central bank; and for supporting and coordinating the MNB's sustainability-related international tasks.

The departments under the **Director General's** direction are responsible for reducing the MNB's carbon footprint, in particular with regard to building operations and the vehicle fleet; for the management, support and implementation of the MNB's environmental activities; and for the operation of the MNB's Environmental Management and verification

System; monitoring the MNB's waste management activities; developing and implementing the MNB's Corporate Social Responsibility Strategy; and disseminating an environmentally sustainable financial culture and awareness among large sections of society.

In addition to ad-hoc cooperation and multi-disciplinary projects, the MNB's sustainability and environmental risk departments also report on their activities to one another 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 Strategy

The primary objective of the MNB is to achieve and maintain price stability and, without compromising its primary objective, to support the maintenance of stability and improvement of the resilience of the financial system, its sustainable contribution to economic growth and to support the economic policies of the Government using the instruments at its disposal. The core tasks of the central bank are defined in Article 4 (1) to (7) of the MNB Act, such as the elaboration and implementation of monetary policy, maintaining price stability, managing foreign exchange reserves, issuing banknotes and coins, and ensuring the stability of the financial intermediary system through the identification and management of micro– and macro-prudential risks.

The amendment to the legislation, which entered into force on 2 August 2021, extends the MNB’s mandate to support government policy on environmental sustainability. With the amendment, the MNB is legally obliged to integrate environmental sustainability considerations in its activities without compromising its primary objective of achieving and maintaining price stability.

2.1 GREEN MONETARY POLICY TOOLKIT STRATEGY

In July 2021, the document ‘Sustainability and central bank policy – Green aspects in the MNB’s monetary policy toolkit’ was published, which sets out the strategic orientations for mainstreaming long-term environmental sustainability considerations through central bank instruments. The MNB identifies a number of risks stemming from climate change, including both transition and physical risks, which may have implications for price stability and financial stability. The design of central bank instruments should therefore take into account that environmental sustainability is a prerequisite for the fulfilment of the primary mandate.

The MNB considers it its mission to develop its monetary policy instruments in line with its tasks and mandate as laid down in the MNB Act, without compromising its primary objective, while ensuring that long-term environmental sustainability is taken into account. It also wants to play an active role in supporting the transition to a low-carbon economy, and in developing and implementing international best practice.

To achieve this mission, the Bank has identified the following strategic objectives:

- Contributing to a sustainable economic transition;
- Supporting the achievement of climate targets;
- Increasing the climate-awareness of the financial system;
- Shaping consumer and social attitudes;
- Adopting international best practices;
- Assessing the climate exposure of monetary policy instruments.

Possible directions for the greening of monetary policy (Chart 2):**• Improving transparency and reporting**

The MNB's TCFD report falls under this heading, through which the Bank demonstrates the emergence of sustainability considerations in the Bank's governance, strategy and risk management practices, and provides an example for domestic financial sector actors.

• Central bank incentives for green lending:

According to the MNB's assessment, it can make a significant contribution to sustainability through the renewal of the residential housing stock, an area accounting for a² third of domestic primary energy use. In response to this challenge, the MNB has launched the Green Mortgage Bond Purchase Programme, the first asset purchase programme to focus on sustainability. The aim of the programme is to foster green lending through the creation of a domestic green mortgage bond market, to promote best practices and thus build an energy-efficient real estate portfolio. In the first phase of the programme, the MNB's programme actively supported all domestic mortgage banks to develop their frameworks and to enter the green mortgage bond market with new issues. In line with the tightening of the monetary policy stance, in 2022 the MNB suspended purchases under the programme. Later on, the new focus of the green mortgage bond purchase programme may be to establish the highest possible green standards, to strengthen green quality and to converge towards national and international standards by renewing maturing stocks.

The FGS Green Home Programme, launched in October 2021 as part of the Funding for Growth Scheme, in line with the Green Monetary Policy Toolkit strategy and as one of its first steps, promoted the creation of a green housing loan market and the mainstreaming of environmental sustainability considerations in the domestic housing market by providing low-interest central bank funds. The programme with an overall allocation of HUF 300 billion, which closed at the end of September 2022, enabled around 8,600 households to build or buy an energy-efficient new home.

• Green collateral management

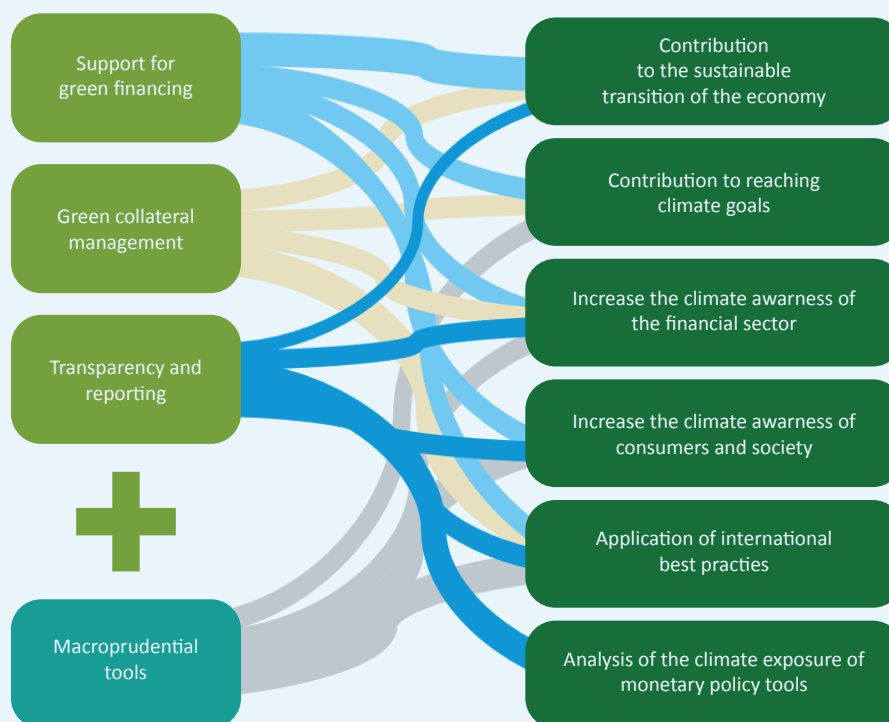
In its monetary policy-related collateral management activities, the MNB assumes green risks via the assets it accepts as collateral. For this reason, the Bank is exploring opportunities for green collateral management, which can have an impact on greening bank exposures and influencing risk management practices through liquidity management at commercial banks. The MNB amended its collateral management rules in 2022, adding new green reporting requirements. In addition, the MNB supports the issuance of green securities by applying preferential haircuts.

• Fitting macroprudential measures into a green monetary policy toolkit

In addition to the elements related to the monetary policy toolkit, the MNB is also looking at greening the macroprudential toolkit. (As of 1 July 2021, green mortgage funding can be considered with a preferential weighting in the calculation of the mortgage funding adequacy ratio.) In addition, the Bank is considering the integration of green risk monitoring elements into its risk assessment and decision-making framework.

² <https://www.ebrd.com/news/2020/energy-efficiency-in-hungary-begins-at-home.html>

Chart 2
Possible directions for the greening of monetary policy



2.2 FOREIGN EXCHANGE RESERVES STRATEGY

One of the MNB's fundamental statutory tasks is the management of the country's foreign exchange reserves, which is defined by the central bank objectives. The maintenance of foreign exchange reserves is justified to support monetary and exchange rate policy; to provide the necessary foreign exchange liquidity; to meet the expectations of market participants; and to secure the transactional foreign exchange needs of the State. When investing foreign exchange reserves, the central bank follows a tripartite regime of safety-liquidity-return, in line with international best practices, i.e. it aims to achieve the highest possible level of returns while keeping risks low and providing the necessary liquidity.

In 2022, the MNB managed foreign exchange reserves in eight main currencies (EUR, USD, JPY, GBP, AUD, RMB, CZK, PLN) in different portfolios. In line with conservative reserve portfolio management, a significant proportion of the foreign exchange reserves are made up of highly rated government securities, considered to be credit risk-free. In addition to sovereign issues, foreign exchange reserves also include (supranational) issues by international institutions, highly rated corporate and bank issues and covered bonds. In order to achieve geographical diversification, the foreign exchange reserves include exposures to different countries, but the majority of the issues are from developed countries with good credit ratings.

In recent years, the wider application of environmental sustainability considerations has also become a priority for central banks. In addition to meeting the primary objectives of reserve maintenance, central banks have an important role to play in developing green bond markets and successfully implementing the green transition of economies ('supportive approach'). In addition, the value of foreign exchange reserves may be strongly affected by the realisation of the transition and physical risks associated with financed issues ('defensive approach'). Although the likelihood of risks only materialising appears to be significant in the longer term, even in the short term it is still unavoidable to explore the issue, take the necessary steps and assess the investment strategy from a climate risk perspective.

The MNB has taken a number of steps to integrate environmental considerations into its operational framework, in line with its responsibilities under the MNB Act. In 2019, the MNB was among the first central banks to decide to construct a portfolio of dedicated green bonds within its foreign exchange reserves.

However, achieving climate targets and managing climate risks is a long-term process, which may require further actions by central banks in the future, including in the area of foreign exchange reserve management. One of the key roles of central banks in addressing the challenges of climate change is to develop and support international practice and to be a role model for actors in the world of business. In this context, foreign exchange reserves can help to develop the green investment market, for example by holding and further purchasing green bond portfolios. In addition, an important challenge is to integrate climate risks and green considerations into the traditional risk management and investment framework in the medium to long term.

2.3 SUPERVISORY STRATEGY

Environmental risk management is highlighted in the supervisory strategy. As a financial supervisory authority, the MNB is committed to strengthening, preserving and improving the stability of the financial system, with a particular focus on consumer protection, digitalisation and sustainability. The MNB's supervisory objectives are described in the A Stability and Confidence 2.0 strategic framework for 2020–2025. Its mid-term review has become necessary in 2022 due to regulatory and economic changes since autumn 2019 and the new sustainability mandate of the MNB. The Supervisory Authority's vision, mission and the values it represents and communicates have remained unchanged, the descriptions set out in 2019 continue to be valid and form the basis of the revised Supervisory Strategy Framework (Stability and Confidence 2.1³). At the same time, the issue of environmental sustainability is even more pronounced in the strategy than before, in line with the environmental sustainability mandate and the MNB's Sustainable Balance and Catching-up Programme⁴ announced in May 2022.

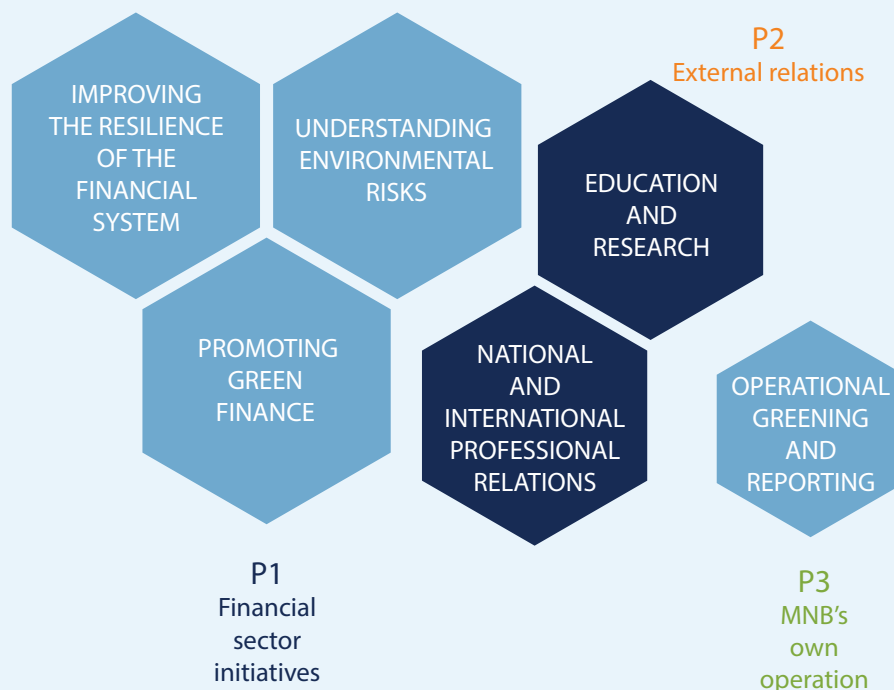
The MNB launched the Green Programme in January 2019, an initiative that is still unique in Central and Eastern Europe. The Green Programme follows a holistic vision and is based on three pillars (Chart 3):

1. Measures affecting the financial system, including analyses to explore environmental risks and to improve the resilience of the financial system and the environment for green financing.
2. Building social and international relations, covering education, research, and building national and international professional relationships.
3. The greening of the MNB's operations, including the neutralisation of carbon emissions from the MNB's own operations, and reporting, such as this climate risk report.

³ <https://www.mnb.hu/felugyelet/felugyeleti-keretrendszer/felugyeleti-es-fogyasztovedelmi-strategia>

⁴ <https://www.mnb.hu/letoltes/fenntarthato-egyensuly-es-felzarkozas-144-javaslat-20220519.pdf>

Chart 3
Pillars of the MNB Green Programme



In addition to improving the resilience of the financial system, the Bank is paying particular attention to identifying environmental risks and developing a green financing environment. In recent years, the fact that the accumulation of climate change and broader environmental risks creates vulnerabilities for financial institutions has become generally accepted and requires the development of new types of competences. The Green Recommendation for credit institutions, an updated version of which was published in August 2022 (Recommendation No 10/2022 (VIII. 2)), helps to prepare for this⁵. The document sets out expectations around three deadlines and five dimensions. The MNB monitors compliance with the Recommendation on an ongoing basis, from 2023 in the comprehensive review of the credit institutions. Another objective is to support the preparation of the non-banking sectors. As a first step, the MNB conducted a survey on the climate change preparedness of the insurance sector in 2022 Q4.

In 2022, the MNB continued to identify sustainability risks of the financial system, using a number of measurement tools, methodologies and processes. Using the Bank Carbon Risk Index, the MNB monitors the evolution of the transition risks of the banking system as a whole (and of individual institutions) on a quarter-by-quarter 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 results and methodology of the latter are expected to be published in 2023. A further objective of the MNB is to examine the climate exposures of the non-banking segments of the financial system, therefore the insurance climate stress test is under preparation.

The financial risks of biodiversity loss are being addressed by the Bank in an international project. In order to make progress in the identification and measurement of broader environmental risks, from September 2022, the MNB has started a collaboration with experts from the OECD Committee on Financial Markets, the European Commission and selected commercial banks, with the aim of assessing the financial risks, impacts and interactions arising from biodiversity loss and developing a regulatory framework.

⁵ <https://www.mnb.hu/letoltes/10-2022-zold-ajanlas.pdf>

Given the central role of the financial system in allocating capital, the greening and mobilisation of financial services towards financing sustainable economic activities is a crucial element of the MNB's Green Programme. Therefore, the MNB has launched green preferential capital requirement programmes for banks in the retail, corporate and municipal lending segments, including green bonds. Due in part to the programme, the popularity of green debt instruments has increased in recent years.

The MNB also considers it important to support the greening of the operations of the Hungarian financial system. To promote this, in 2019 the Bank established a Green Finance Award in the banking, fund management and insurance segments to recognise the best environmental performance in the financial sector and to encourage the sustainable operations of financial institutions through its reputational value.

The pursuit of environmental sustainability is also essential for the placement of green investment instruments in portfolios, but this requires the correct application of the relevant disclosures. The Bank's aim is to support compliance with EU regulations, and to this end it published an Executive Circular in March 2021⁶ and a Q&A in June 2022⁷.

2.4 INTERNATIONAL PARTNERSHIPS

In order to implement its green programmes effectively and to exchange best practices, the Bank builds professional relationships at national and international level. 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 build international relationships in the field of climate risk and green finance initiatives. To this end, since 2019 the Bank has been an active member of the Network for Greening the Financial System (NGFS), a global central bank and supervisory initiative. In the same year, the MNB joined the Advisory Council of the Energy Efficient Mortgages Initiative (EEMI), which aims to promote preferential loans for energy efficiency investments. The MNB is also actively involved in the development of related regulations by the European Supervisory Authorities (EBA, ESMA, EIOPA).

The MNB takes an active role in promoting sustainability awareness. The sustainability turnaround can only be a success if both the profession and the public have the right knowledge. Through its social contacts, the MNB intends to support awareness-raising and educational activities on green finance. To increase the knowledge base on green finance, green finance courses, advanced college events and adult education courses are offered in cooperation with universities in Hungary.

Starting from 2019, the MNB hosts an annual international green finance conference in Budapest, with the participation of renowned international experts, professionals, market operators and policy makers. These occasions are also used to reward academics and research teams for their excellence in environmental issues and green finance. Specialist articles and studies on sustainability by MNB experts also help to raise awareness. In addition, the Bank has developed a dedicated website called Family Green Finance to raise the ecological awareness of the population.

2.5 SUSTAINABILITY STRATEGY FOR THE MNB'S OWN OPERATIONS

In order to reduce the environmental footprint of MNB's operations, the Bank operates an Environmental Management System (EMS). The introduction of the EMS in 2011 was preceded by an environmental risk assessment, involving the identification of significant environmental factors. On the basis of these factors, the MNB's senior management defined the two main directions of the Bank's long-term environmental strategy: reducing the environmental footprint of the buildings needed for its operation and reducing the carbon footprint of the cash supply chain.

- **The increasing 'application' of renewable energy is seen as an opportunity to make buildings more environmentally friendly, both by installing solar power plant and by purchasing such energy from the market.** There are already limits to leverage either of these options, and the margins for future renewable energy from the energy market are likely to

⁶ <https://www.mnb.hu/letoltes/129526-3-2021-sfdr-vezetoi-korlevel.pdf>

⁷ <https://www.mnb.hu/letoltes/20220629-sfdr-tr-qa-final.pdf>

increase. In the context of climate change, there has been a steady increase in energy demand in recent years, affecting mainly energy consumption for heating, but it is also becoming a regular occurrence that century-old summer heat records are repeatedly broken, leading to increasing energy demand for the operation of cooling systems.

- **The main ways to reduce the carbon footprint of the cash supply chain are to increase local banknote and coin recycling by credit institutions and to reduce the transport tasks within the supply chain on the cash processing side.** Almost without exception, the measures to reduce the environmental footprint on the cash supply chain affect the internal processes of market-based companies, so the central bank can play a consultative role in orienting participants towards environmentally conscious behaviour by presenting the possibilities for reducing the carbon footprint of cash processing and credit institutions and outlining the long-term benefits.

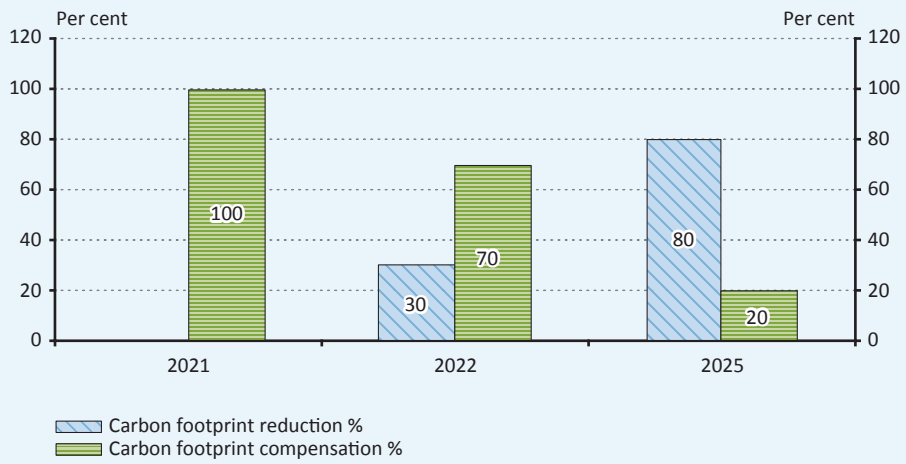
In the context of cash, the importance of digitalisation should be emphasised. Digitalisation contributes to promoting environmental sustainability and addressing climate change risks by reducing the use of cash, and thus the negative environmental impacts of cash logistics. Payment options should be developed also beyond the use of cash, for example, the environmental burden of transfers, i.e. open bank payments, is lower than that of card payments.

The environmental management system operates in 3-year cycles, with the current cycle covering the period 2020–2022. Medium-term strategic objectives are set for each cycle and the implementation of these objectives is supported by the Environmental Programme.

Based on the medium-term environmental strategy announced by the Magyar Nemzeti Bank in 2020, the MNB shifted to carbon-neutral operation from 2021. In implementing this strategy, the MNB

- fully neutralised its 2020 carbon emissions related to its operational activities by offsetting them in 2021 through its participation in a domestic habitat restoration project;
- reduced the carbon footprint associated with its operational activities by at least 30 per cent by the end of 2022:
 - installed a solar PV system in the Logistics Centre;
 - ensure that 50 per cent of the electricity used in the office buildings serving the MNB's operations comes from renewable sources;
- achieve carbon-neutral operations within 5 years, with an 80 per cent carbon footprint reduction and a 20 per cent offset
 - ensure that 100 per cent of the electricity used in the office buildings serving the MNB's operations comes from renewable sources.
- intends to offset its remaining emissions by financing habitat restoration projects, such as the planting of a 27-hectare forest in the Körös-Maros National Park.

Chart 4
Timetable for the transition to carbon neutrality



3 Risk management

Central bank risk management frameworks consist of different parts, as central banks often have several mandates. Since central bank responsibilities are also diverse, the risks they face and the processes for managing these risks can differ greatly, and the organisational and asset structures of the institutions can vary.

3.1 CHARACTERISTICS OF CLIMATE-RELATED RISKS

For climate-related and environmental risks, the defining criterion is ‘dual materiality’, which covers environmental materiality, in addition to financial materiality. In other words, the consequences of climate change can affect an institution from a financial point of view, and the institution can also have an impact on the environment through its activities and investments. When detailing the climate-related risks impacting central banks, a distinction is made between the transition and physical risk channels.

- **Transition risks** arise from the difficulties of transitioning to a low-carbon and climate resilient economy. Changes in policy or technology, or rapid shifts in consumer attitudes, can all cause a sudden revaluation in the price of financial instruments. As a consequence, credit and market risks may increase and, in certain scenarios, the resulting losses could even threaten financial stability.
- **Physical risks** arise from the physical effects of climate change, i.e. changes in the long-term climate and an increase in the severity and frequency of extreme weather events. With physical risks, it is not only the risk of losses due to the destruction of physical assets and infrastructure that is considered, but also the breakdown of value chains, loss of biodiversity, negative impacts on human health and well-being, which in extreme cases could lead to migration and conflict. Understandably, this has an impact on the productivity of companies or the value of physical and financial assets, which may also affect financial stability.

Given the specific characteristics of climate risks, traditional risk management frameworks and methodologies cannot be applied with sufficient accuracy. Traditional risk assessment builds on historical data, analyses widely accepted metrics and uses methodologies that are reliable and robust. By contrast, climate change leads to changes that are characterised by a high degree of uncertainty, i.e. determined not only by the interaction of economic and financial impacts, but also inter alia by environmental, technological and cultural impacts. These processes interact with each other to generate unpredictable impacts that are wide-ranging and potentially very severe. These risks are non-linear, irreversible and characterised by a fat tail distribution.

Many of the impacts of climate change will materialise and be reflected in financial risks over longer time horizons, but that they can only be mitigated by actions taken today. Long horizons are not compatible with traditional business planning and risk taking. In addition, the lack of necessary data is also a major problem. High quality, abundant data are essential to understand and assess risks accurately and to develop reliable models. Since models based on historical data are not sufficient, forward-looking estimates are also required, for example through scenario analysis or climate stress tests. Identifying the right data sources and metrics is also a priority on the MNB side.

Although the details of how climate-related and environmental risks will materialise are unknown, it can be stated with absolute certainty that the materialisation – of some combination – of the transition and physical risks is inevitable. Their timing, severity and subsequent manageability will depend on how we respond to them: if the targets of the Paris Climate Agreement are met globally, we will face higher transition risks, but if ineffective climate policies continue, the future will be determined by the occurrence of physical risks.

Each central bank function has different risk characteristics, taking into account their objectives, and a different risk management approach should be applied, and thus it is worth outlining the MNB's traditional and climate risk approaches by central bank functions.

3.2 CLIMATE-RELATED RISKS: MONETARY POLICY

In relation to its monetary policy and reserve management tools, the MNB includes Hungarian and foreign exposures, typically bonds or loans, in its balance sheet. The Bank monitors the risk of these exposures and takes into account not only monetary policy but also risk management (climate-related risk) considerations in its relevant decisions. At the MNB, the tasks of identifying, measuring and managing risks to the central bank's balance sheet, preparing decisions and monitoring risks are performed by a single unit for the various central bank functions. The management of climate risks should also be integrated into this conventional framework.

3.2.1 Central bank asset purchases

Following the global economic crisis in 2008, asset purchase programmes have become a central element of the central bank's toolkit. The MNB also launched programmes to purchase government securities, mortgage bonds and corporate bonds. The primary objectives of these instruments include ensuring the achievement of the inflation target, monetary easing, supporting companies' access to long-term, low-cost funding and developing certain markets. The introduction of these instruments has increased the MNB's balance sheet and risk exposure. Before launching the programmes, the MNB considered the key parameters (e.g. amount, maturity) and their impact and risks (credit risk, market risk) on its balance sheet. In the course of 2022, the MNB suspended or discontinued its asset purchase programmes in line with the tightening of the monetary policy stance and the use of the allocations.

If the central bank does not place sufficient emphasis on mainstreaming climate risk considerations in its asset purchase programme, it may not be able to fulfil its mandate adequately, to support the green transition of the economy and to meet the government's economic policy objectives. The green transition of the Hungarian economy could also improve the MNB's bond exposures from a climate risk perspective. The bonds purchased by the MNB are concentrated due to geography and the small number of issuing entities, thus it is particularly important to assess the associated climate-related risks. Especially because, due to the long remaining maturities, the MNB may hold the bonds for several decades as planned, over which time horizon the probability of realisation of climate risks is significant.

Against this background, the MNB formulated its Green Monetary Policy Toolkit Strategy in 2021. In line with this, the MNB has already taken steps to address climate risks in the short term by launching the Green Mortgage Bond Purchase Programme. In the medium to longer term, however, it is important to assess how to move in a green direction for other programmes as well. In the medium term, the MNB's priority is to quantify the climate-related risk impacts of the programmes, including the identification and acquisition of appropriate data sources and making methodological decisions, which are ongoing.

The positions taken in the asset purchase programmes are regularly presented to the MNB's decision-making fora. In the medium term, the MNB aims to include climate risk data and analysis in these reports.

3.2.2 Central bank loans/collateral management

Central banks' lending activities serve several purposes, and therefore the related frameworks can be diverse. Traditional central bank lending is a short-term (e.g. overnight, one-week) commitment, which plays a key role in the liquidity of the banking system. In recent years, however, central banks have also sought to help the market to run smoothly using longer-term, focused programmes. By offering banks long-term funding on attractive terms, they maintain favourable borrowing conditions for banks and encourage lending to the real economy.

These loans represent the most significant items on central banks' asset side, and thus central banks are also exposed to significant risks through this activity. In accordance with the provisions of the MNB Act, the Bank does not assume credit risk in its lending activities, i.e. it originates credit to money market clients only in secured form. When setting the lending conditions, the MNB also considers the related market risks.

The MNB also evaluates the climate-related risks in the context of lending and collateral management. Climate risk can be considered in the targeted lending activities of central banks, and climate risk considerations are consistent with their primary objectives. By shaping these programmes in a targeted way, central banks can encourage the green transition in the economy and green lending in the banking system. In this context, the MNB has decided, for example, to launch the FGS Green Home Programme.

Similar considerations are also relevant in collateral management. Central banks can effectively 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 relevant issues. Therefore, from a climate risk perspective, collateral management can also be an effective tool for developing the Hungarian green bond market and improving the financial stability of the banking system. It is important to note that changes to the collateral management framework can be effectively implemented even in the event of a tightening monetary policy stance.

In addition to policy considerations, the central bank also takes into account the financial risks of climate exposures associated with collateral. By modifying the framework, climate risk exposures can also be reduced for collateral accepted in collateral management. (It should be noted, however, that the exposure of central banks in the context of collateral management is only indirect, as the primary obligor of 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 potentially lower default risk or higher returns and lower price volatility.

- **Short-term measures:** Taking into account the above considerations, the MNB decided to apply a preferential haircut for green bonds in 2021 as a short-term element of its collateral management strategy. It formulated transparency expectations in 2022.
- **Long-term review of the framework:** A key objective at the MNB is to understand and manage green risks. In a long-term project, considering international best practices, the MNB is exploring how climate risks can/should be integrated into the collateral management framework (e.g. climate risk assessment of collateral pools, formulation of requirements; greening of mortgage bond reporting requirements; positive/negative differentiation; exclusion; development of internal rating methodology; issue of reflecting climate risks in bond prices). The transparency of the international and Hungarian green bond market and the related reporting need to improve substantially.

3.2.3 Foreign exchange reserves

The MNB determines its investment policy with respect to foreign exchange reserves - taking into account the central bank's objectives - by considering the risk-liquidity-return framework, and in line with international central banking practice, is considered to be a fundamentally conservative investor. It mitigates the arising risks (credit risk, market risk, liquidity risk) by applying a strict limit system.

The Bank analyses climate risk exposure in terms of (i) policy risk and (ii) financial risk. The MNB supports green bond markets and issuers' access to the market by creating demand, while giving priority to reserve maintenance objectives. With these considerations in mind, the MNB was among the first central banks to construct a green bond portfolio, with a small initial size compared to other reserve assets, in line with the central bank's prudent approach. In this context, the MNB is continuously examining the options for moving forward in terms of currencies, markets and issuers.

The financial risk aspects of climate-related risks are also important in reserve management. Physical or transition risks may represent a market and credit risk for the reserve assets via an increase in spreads or a deterioration in the probability of default. These risks need to be identified, measured and managed, for which the MNB has taken the necessary steps. In this context, it is worth distinguishing between a short-term and a long-term approach.

- **Short term:** The MNB's investment horizon is essentially short. The MNB's reserves are largely protected against climate risks over this short time horizon. One reason for this is that climate risks will have an increasing impact over a time horizon of several decades. On the other hand, the MNB mainly holds sovereign exposures of developed countries with high credit quality thresholds, where exposures are well diversified. On one hand, this means that the risk of default is low and, on the other hand, the risk of repricing is also low because of the short-term exposures.
- **Long term:** The current structure of the reserves allows the MNB to develop and implement its long-term strategy without a rapid and drastic reallocation of reserves. As time passes, it will become increasingly important to make appropriate, gradual steps in the reserves. Climate risk exposure can be managed with simpler limits (e.g. concentration limits, exclusions), but more complex models may also need to be implemented (climate risk cost framework, VaR, green benchmark). As the market evolves and international best practices become more established, the scope of available data and their reliability will improve, which supports and is a prerequisite for the next steps.

In the traditional reserve management limit system, daily limit monitoring is in place and monthly, quarterly and semi-annual reporting supports the work of the decision-making fora. Climate risk reporting in the MNB is still evolving, and the MNB is currently analysing the climate impact of its green bond portfolio and sovereign exposures in a semi-annual report. With the implementation of climate risk limits and the development of data reporting, the MNB would like to move towards a framework of traditional limit monitoring and reporting in the medium term, and it is envisaged that climate risk monitoring will be mainstreamed into traditional risk management in an integrated fashion.

3.3 CLIMATE-RELATED RISKS: FINANCIAL STABILITY

Climate-related risks affect the MNB not only directly, but also indirectly. They spill over into the financial system via the real economy, causing losses first to economic actors and then to investors and creditors. Therefore, climate change has an indirect impact on the financial system and a double cascading effect on the central bank. For example, the losses of credit institutions, whether concentrated in one institution or affecting the whole banking system at once, can have serious consequences. The MNB, as the authority responsible for the stability of the financial system, monitors these developments.

The process of risk management can be divided into distinct, successive phases. (Chart 5) The identification and detection of risks is the first essential step, with the aim of determining the risks that threaten the institution's operations and business. The assessment of the identified risks provides an opportunity to determine their materiality and then assess their size. The active management of risks itself can only be undertaken after these steps. From the perspective of the central bank, there are some risks that it only monitors, while it consciously seeks to mitigate others.

Chart 5
The MNB's focus on environmental risks in relation to financial stability



3.3.1 Identification

As a result of methodological improvements in environmental risks, the MNB is able to conduct more and more accurate forward-looking analyses:

- The analysis of carbon concentration, conducted by the MNB in 2019, looked at the proportion of corporate loans provided by the domestic banking sector to finance companies in GHG-intensive sectors, thereby estimating the magnitude of transition risks. Given the limited data availability, it was necessary to further develop the analysis.
- The Banking Carbon Risk Index is a more detailed analysis that combined transaction-level data with sub-sector-level GHG-intensity data, and as a result, more accurate data quantifying transition risks for the sector as a whole as well as for individual institutions became available.
- In 2021, the MNB assessed the climate risk resilience of the Hungarian banking system for the first time using long- and medium-term climate risk stress tests. The long-term stress test was conducted on the basis of three scenarios. An orderly transition trajectory, where the transition to a low-carbon economy is successful; a disorderly transition trajectory, where the transition is sudden and faster due to a delay in action; and an unsuccessful transition trajectory, where the Paris Agreement targets are not met.
- The MNB plans to publish the results and methodology of the short-term credit institutions climate stress test in 2023. The Bank plans to carry out the exercises annually in the future, while expanding the scenarios tested and institutional coverage.
- A further objective of the MNB is to examine the environmental exposures of the financial system as broadly as possible, therefore the insurance climate stress test is under preparation.

3.3.2 Measurement

The MNB reports annually on the assessment of climate risks in the Green Finance Report. The individual assessment of financial institutions is gradually being integrated into micro-prudential supervisory activity. From 2021, the first edition of the Green Recommendation, the MNB started to monitor and analyse the preparedness and attitudes of Hungarian credit institutions towards environmental sustainability aspects at institutional level (by means of self-assessments, own action plans and prudential discussions). From 2023, the evaluation of the Green Recommendation was integrated into the Supervisory Review and Evaluation Process (SREP).

3.3.3 Management

The next step after risk assessment is risk management. For a company, managing climate risks can be done, for example, by changing the business model, changing suppliers or even investing in green projects, but from a credit institution's perspective it is achieved indirectly. For a bank, climate risks can be reduced via climate risk limits or, for example, via exposure reduction strategies. From a financial supervision perspective, this is therefore a double cascading effect, as the MNB's objective in this context is to preserve the financial stability of individual credit institutions, and it can achieve its risk management objectives by making proposals, recommendations and developing regulations.

- The publication of the Green Recommendation in 2021 and its update in 2022 are important milestones in the management of these risks. Taking into account international and EU regulatory developments, the MNB formulated expectations and best practices for credit institutions, helping prepare for new regulations in the coming years and recommending specific steps to be taken. It covers wide range of banking activities, from the definition of business models and strategies, through internal governance and risk management, to disclosures, with a particular emphasis on the application of the UN Principles for Responsible Banking, which are considered international best practice. If the level of compliance with these recommendations improves in the Hungarian banking sector, the level of climate risk to the financial system may also be reduced, and the likelihood of a shock-like response to new, stricter regulations may also be reduced. After the first edition of the Green Recommendation, all domestic credit institutions prepared a gap analysis, which was assessed by the MNB in the context of prudential discussions.
- The retail, corporate and municipal green preferential capital requirement programmes launched by the MNB are also designed to indirectly reduce transition risk for banks. If utilisation of these programmes increases, it will contribute to an increase in the share of environmentally sustainable exposures in the bank loan portfolio, and thus make the banking system less vulnerable to climate policy or technological shocks.

3.4 OPERATIONAL RISKS

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 in the design and operation of the operational risk management framework. Activities related to operational risk management and business continuity management are decentralised within the MNB, where one department plays a coordinating role and provides methodological guidance.

Operational risk management is carried out in line with international standards: in the context of the processes, operational risks are assessed, a bank-wide risk map is prepared, event registers are kept to show the associated losses, and then on an annual basis, risks are summarised, residual risks are identified and presented to the executive management. Where climate risks become relevant for a workflow (e.g. increased tasks, workload, human stretching; need to optimise task allocation), they are analysed as part of the normal operational risk management workflow.

A key area of operational risk management is business continuity, which can be severely affected by physical risks. Risk events also arise from fortuitous events and unforeseen external circumstances that create uncertainties in the MNB's operations and need to be minimised. Direct risks arising from the MNB's operations may also be affected by the impacts of climate change and environmental degradation. 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 high summer temperatures, which can damage the operational infrastructure, making business continuity difficult. A focus area of operational risk management is to ensure business continuity and the preparation of related plans. From their point of view, the source of the disruption (e.g. climate risk or simple power outage) is not of primary importance, and the restoration of operation should be ensured in the short term.

The MNB's operations generate GHG emissions and other environmental footprints, which have a negative impact on the environment and thus pose a reputational risk to the MNB. The MNB primarily manages its impact on the environment by measuring and reducing its carbon footprint.

For example, transition risks have an impact on changes in 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.

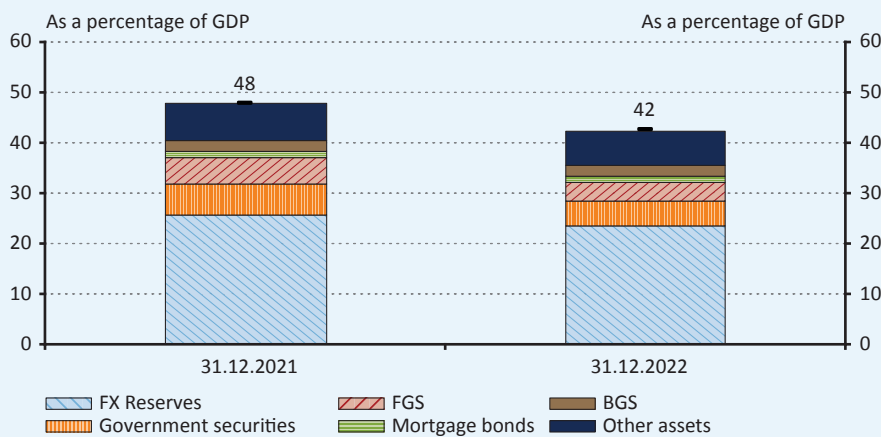
4 Climate risk metrics and targets

The methodology and the choice of metrics used were based on the recommendations developed by the G20 Financial Stability Board’s TCFD and on existing and growing examples of central bank practices. As there is not yet any standard practice for the preparation of TCFD reports, the MNB prepared its second TCFD report second considering existing international practices and the specific characteristics of its financial portfolios, and also using the experience gained from the first report.

4.1 SCOPE OF FINANCIAL INSTRUMENTS EXAMINED

In response to the crisis caused by the COVID- 19 pandemic, the MNB took several ‘easing’ measures in 2020 to ensure the necessary liquidity and appropriate monetary conditions, which were completed in 2021-22 in a changed inflationary environment, stabilising the level and composition of the MNB’s balance sheet. 3-year and 5-year secured forint loans were introduced during the period of the COVID-19 pandemic, the government securities purchase programme (GSP) was launched, and the new Funding for Growth Scheme Go! was launched. The central bank also relaunched its mortgage bond purchase programme (MBPP), expanded the programme’s size of the Bond Funding for Growth Scheme (BGS) and increased its international reserves. The central bank decided to discontinue its crisis management programmes in 2021. The targeted measures taken by the MNB in 2020 and 2021 also had a significant impact on the composition and size of the central bank’s balance sheet, which did not change significantly in 2022. As a result of these measures, according to preliminary data, the MNB’s balance sheet total at the end of 2022 was HUF 28,100 billion (EUR 70 billion⁸) (Chart 6). The change is explained by the growth of the MNB’s balance sheet (mainly the impact of foreign exchange reserves) and GDP.

Chart 6
Asset side of the MNB's balance sheet



Note: The forecast of the balance sheet composition in 2022 is based on preliminary data and December GDP forecast.

Source: HCSO, MNB

The MNB aims to be able to provide information on the widest possible range of its instruments and related climate risk considerations. The MNB’s long-term objective is to produce a climate risk report on its entire asset portfolio. In the short term, due to continuing data availability constraints, the MNB will produce report which is representative from the perspective of its total assets, but is not exhaustive. Regarding the foreign exchange reserves, the focus of the analysis is on sovereign exposures, representing the core of the reserves. In respect of monetary policy instruments, the analysis also covers mortgage bonds and corporate exposures in addition to sovereigns. Furthermore, the MNB considers it particularly important to provide a summary of the climate risk exposure related to collateral management.

⁸ The 30.12.2022 EURHUF exchange rate is used for the conversion of HUF portfolio values in the report.

4.2 METHODOLOGY AND DATA SOURCES

The MNB analysed the climate risk exposure of its financial asset portfolios based on the two main climate change risk categories of transition risks and physical risks.

- **Transition risks** are the risks associated with the transition to a carbon-neutral economy that arise from changes in the structure of the economy. To measure the transition risk of portfolios, the MNB primarily used the Weighted Average Carbon Intensity (WACI), which is the proposed metric for the climate impact of financial asset portfolios based on the TCFD recommendations. The WACI metric was calculated by the MNB for all asset classes under review, except for the Mortgage Bond Purchase Programme (MBP). In addition to the WACI, the other metrics used in the report to analyse the transition risks are the proportion of carbon-intensive assets (brown share) in corporate portfolios and the energy mix of sovereign portfolios, as well as the Climate Action Tracker (CAT) calculations.
- Assessing physical risks involves significant technical challenges, including the need for detailed geographical data to determine the severity of potential weather events occurring at different locations. The MNB uses data and models from Four Twenty Seven (427, Moody's Analytics) to analyse physical risks. In the current report, the analysis of physical risks covers a narrower range of financial assets included in the MNB's balance sheet, i.e. sovereign exposures and Hungarian corporate bonds.

The analysis of the climate impacts of financial portfolios was based on the preliminary balance sheet data at the end of 2022 and the latest available GHG emission data and corresponding GDP data. The latest GHG data available for the assets were used to prepare the report, which for the foreign exchange reserves portfolio means 2020 GHG data and for the Hungarian assets 2021 GHG data. For detailed methodological descriptions, see the Annex. The MNB has quantified even more than one metric for each asset category, based on a methodology in line with TCFD recommendations and international best practice, to gain a broader understanding of the risks and opportunities of climate change (Table 1).

The MNB made methodological improvements in the metrics used in several areas. Prior to preparing the report, the Bank assessed the scope for improvement in terms of coverage and metrics. To support comparability with the previous year's report, stability of methodologies is important. Taking this into account, the MNB refined the framework for the determination of the WACI metric used for sovereigns in the 2022 report and analysed CAT scenarios as a new forward-looking climate risk metric. It also analysed the physical risks associated with corporate exposures in the FGS portfolio. In the case of collateral management, the climate risk analysis of large corporate loans was not carried out due to their specific characteristics, which could have led to excessive bias.

Table 1
Asset categories covered in the TCFD report and the set of metrics used for their analysis

	Gold and Foreign Exchange Reserves	Government Securities Purchase Programme	Bond Funding for Growth Scheme (BGS)	Funding for Growth Scheme (FGS)	Mortgage Bond Purchase Programme	Collateral Management
Coverage in the Report	sovereign issues	Hungarian government securities	Hungarian corporate bonds	Hungarian SME-loans	Hungarian mortgage bonds	Hungarian government and corporate bonds
Metrics applied	WACI, energy mix, CAT, physical risk	WACI, energy mix, physical risk	WACI, brown share, physical risk	WACI, brown share, physical risk	saved GHG-emissions	WACI, brown share, physical risk

Source: MNB, preliminary portfolios as at end of 2022

Regarding the climate risk analysis as a whole, it is worth noting that the values of the transition and physical risk metrics are also influenced by country- and central bank-specific factors. For the MNB, the focus is on monetary policy objectives and considerations, which are fundamental to both the composition of the central bank balance sheet and the operation of the central bank. Therefore, the portfolios analysed (and their climate risk characteristics) are shaped by the MNB's statutory obligations and monetary policy programmes, on the one hand, and by national economic characteristics, on the other.

For the time being, the analysis of climate risks of financial instruments is still subject to a number of general challenges stemming from the evolving methodology and the quantitative and qualitative shortcomings of the available data. The most relevant of these are the following.

- **GHG emission data are available with significant delays** for both sovereign and corporate asset categories; thus in some cases only data for earlier periods than the date of analysis were available.
- **In the area of climate-related risks, consistent data reporting practices across all asset categories have not yet been established**, making it difficult to carry out an analysis across different asset portfolios.
- **There are considerable differences in the methodology used to measure climate risk on a geographical basis.** Generally speaking, reporting practices are more advanced in developed countries and large companies operating in developed countries, partly due to a more stringent regulatory environment. In Hungary, the reporting of companies' environmental impacts is at a less advanced stage, mainly due to the size and resource constraints of companies, which has made the analysis more difficult to perform and has most likely reduced its accuracy. Companies providing climate risk data and analysis focus on global enterprises in line with market needs and data availability, making analysis of smaller firms a significant challenge even when outsourcing the analysis.

The measurement and reporting of climate risks is at an early stage, for which no international standard practice has yet been developed, and the analyses presented in this report are based on available data and are subject to methodological constraints. The dynamic evolution of the methodology and the regulatory environment could play an important role in addressing these challenges in the future.

4.3 CLIMATE RISK ANALYSIS OF THE MNB'S FINANCIAL INSTRUMENTS

The results of the indicators used by the MNB in line with the TCFD Recommendation are presented according to the asset categories mentioned above, quantifying the exposure of each portfolio to climate risks.

4.3.1 Climate risk analysis of foreign exchange reserves

The MNB focused on sovereign exposures when analysing the foreign exchange reserves in terms of climate risk. Sovereign assets cover a substantial part of the reserve portfolios, and thus the environmental impact of foreign exchange reserves can be effectively assessed even without regard to other asset classes. In addition to sovereign issues, foreign exchange reserves also include (supranational) issues by international institutions, highly rated corporate and bank issues and covered securities, for which climate risk data are not presented in this report. In order to achieve geographical diversification, the foreign exchange reserves include exposures to different countries, the majority of which are issues from developed countries with good credit ratings. In terms of climate risk, the MNB's EUR 250 million earmarked green bond portfolio is remarkable.

4.3.1.1 Transition risk: carbon intensity (WACI)

For the purpose of comparing/measuring the environmental performance of sovereign reserve assets, a portfolio representing the currency composition of the IMF's official foreign exchange reserves has been identified as the reference portfolio. To manage the foreign exchange reserves portfolios, the MNB uses market bond indices, which are tailored to the needs and constraints of the central bank. The MNB did not use the portfolio management benchmarks as a reference for the calculation of the WACI metric, as they were designed without taking into account climate risk considerations; instead, a neutral external benchmark, the IMF COFER composition, was used. In the calculation of the carbon intensity of the reference portfolio, the GHG intensity of countries was weighted by the share of the emitting country's currency in the IMF COFER (Table 2).

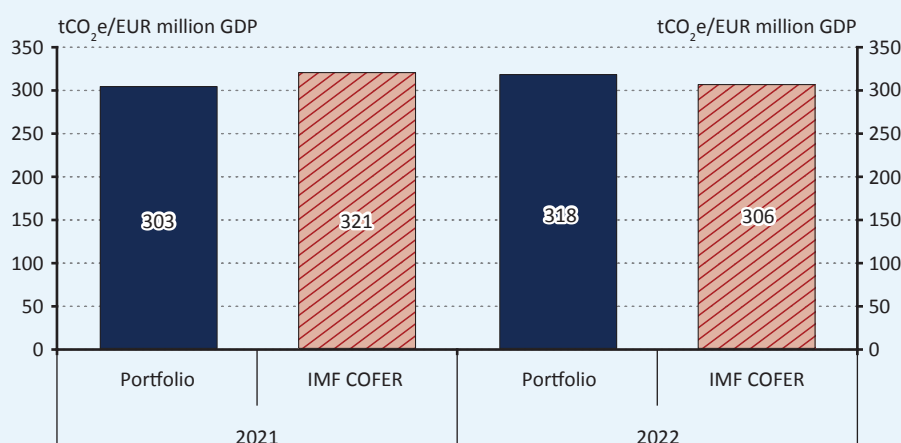
Table 2**Main issuers in the sovereign exposures of MNB and in the IMF COFER**

MNB sovereign exposures		IMF COFER	
<ul style="list-style-type: none"> • Australia • United Kingdom • Euro area • Japan • China 	<ul style="list-style-type: none"> • USA • Other 	<ul style="list-style-type: none"> • Australia • United Kingdom • Euro area • Japan • Canada 	<ul style="list-style-type: none"> • China • Switzerland • USA • Other

Note: In the IMF's COFER statistics, the share of 'Other currencies' is 3.3 per cent based on 2022 Q3 data, which was omitted in the compilation of the benchmark.

Source: MNB, IMF

The WACI metric for the sovereign exposure of the reserve portfolios was 318 tonnes CO₂e per million euro of GDP, 5 per cent higher than the previous year and 4 per cent higher than the reference portfolio (Chart 7). The increase in the WACI metric was caused by changes in several factors. The most significant impact stemmed from changes and reallocations in the reserve structure. In addition, the annual GHG emissions of the countries under review fell, which was accompanied by an average decrease in GDP of around 5 per cent in the emitting countries.

Chart 7**WACI metric for the sovereign exposure of foreign exchange reserves and the IMF COFER, 2021-2022⁹**

Note: (1) The Portfolio contains the sovereign exposures of the foreign exchange reserves. (2) IMF COFER is a reference portfolio weighted according to the foreign exchange composition of official foreign exchange reserves as published by the IMF, based on the allocated foreign exchange reserves.

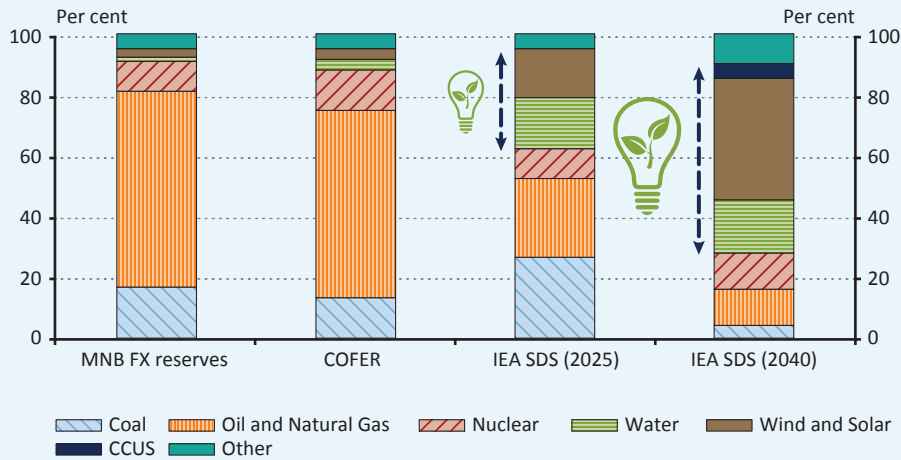
Source: MNB calculation based on IMF, OECD, World Bank, UNFCCC GHG Data Interface, and Climate Watch data

4.3.1.2 Transition risk: energy mix and CAT analysis

The analysis examined the energy mix of issuers of sovereign securities included in the foreign exchange reserves. One of the benchmarks used in this analysis was the portfolio represented by the IMF COFER, and in addition, serving as a forward-looking estimate, the Sustainable Development Scenario (SDS) published by the International Energy Agency (IEA) was used as a benchmark (Chart 8). The SDS is an integrated scenario that sets out a pathway to ensure access to reliable, sustainable and modern energy services, contributes to reducing air pollution and effectively tackles climate change. This IEA scenario also examines, among other things, how to meet the climate targets of the Paris Climate Agreement.

⁹ The methodology for analysing the carbon intensity of foreign exchange reserves changed slightly, which had an impact on the range of assets covered. To ensure comparability, the 2021 carbon intensity metric was recalculated to take these into account.

Chart 8
Energy production by sources

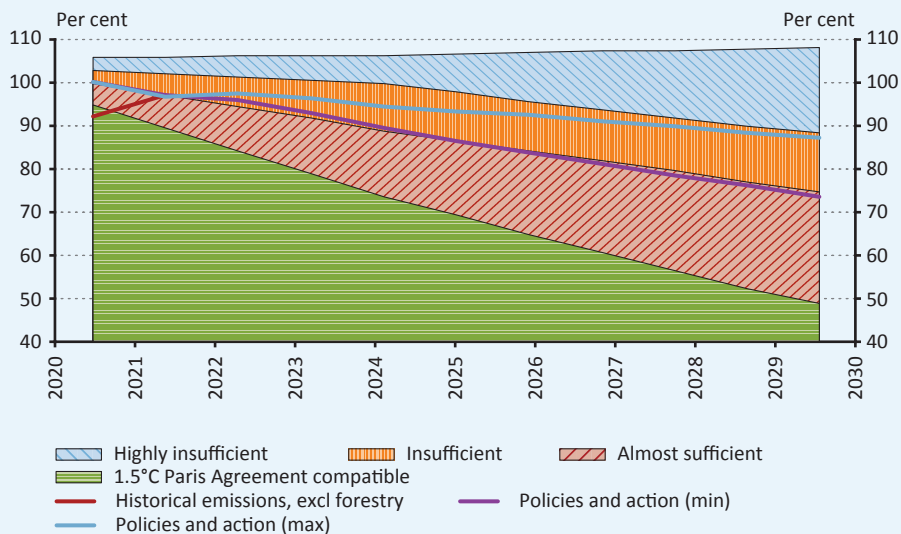


Note: Carbon Capture, Utilisation and Storage (CCUS) refers to innovative technologies to reduce GHG emissions.
Source: MNB calculations based on 2021 energy production data from the International Energy Agency

The current energy mix of the sovereign assets of foreign exchange reserves is almost identical to the IMF COFER value approximating the world’s foreign exchange reserves and changed minimally compared to last year’s composition. However, the current energy mix of the foreign exchange reserve countries differs substantially from the 2025 mix assumed as necessary in the IEA sustainability scenario. In the context of reserves, the dominance of natural gas and oil feedstocks is the largest (over 60 per cent), which is significantly higher than the 26 per cent set for 2025 in the IEA scenario. Based on the IEA scenario, a substantial development of renewables is needed in the IMF COFER countries.

This is supported by data from CAT¹⁰, one of the best-known climate change monitoring organisations, which shows that the majority of countries in IMF COFER do not meet the requirements of the Paris Climate Agreement. CAT monitors governments’ climate actions and measures it against the globally agreed Paris Agreement target. CAT has provided this independent, forward-looking analysis since 2009, through a collaboration between two organisations, Climate Analytics and the NewClimate Institute.

Chart 9
Different future climate scenarios for the sovereign exposure of foreign exchange reserves



Source: MNB calculations based on Climate Action Tracker 2021 climate scenario data.

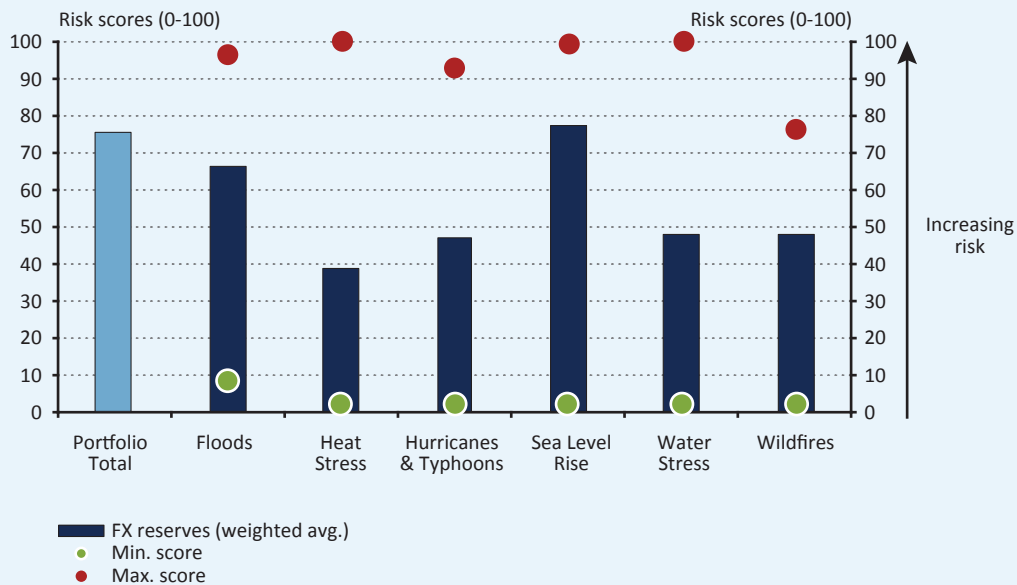
¹⁰ <https://climateactiontracker.org/>

Overall, the sovereign exposure in the MNB's foreign exchange reserves is in the range of 'almost sufficient' and 'insufficient' climate scenarios, based on current data. Based on this, the sovereign exposures held in the MNB's foreign exchange reserves are currently not in line with the 1.5 degrees Celsius Paris Climate Goals.

4.3.1.3 Physical risk

As with the composition of COFER, the sovereign exposure of the foreign exchange reserves consists primarily of issues from developed economies, and thus the physical riskiness of the portfolio is determined by data from the world's leading economies. The portfolio has a relatively risky ranking in the universe based on its overall risk score (76th percentile). The portfolio scores highest in the sea level rise and flood risk categories. In the other four physical risk categories, the relative position of the exposure shows a more favourable picture, ranking in the less risky half of the universe under review (Chart 10). Due to portfolio rebalancing, the value increased slightly compared to last year.

Chart 10
Physical risk scores of sovereign exposure of foreign exchange reserves



Note: The scores represent the weighted average of the scores of the sovereign entities in a given category weighted by their shares in the foreign exchange reserves.

Source: Four Twenty Seven (Moody's Analytics), MNB

4.3.1.4 Green bond-portfolio

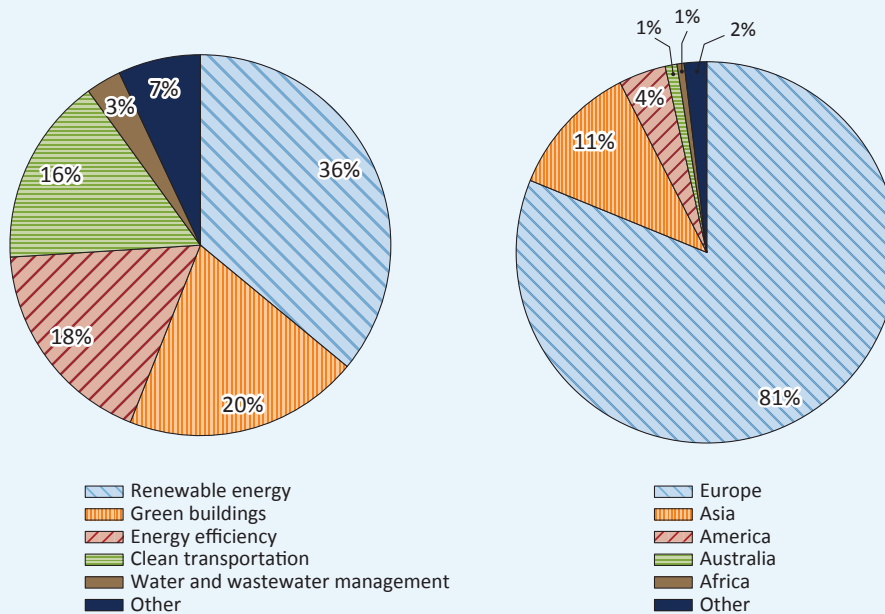
In line with the increase in environmental risks, green bonds become one of the most dynamically growing investment asset classes. In the case of green bonds, the funds raised are invested by the issuer in specific investments that are beneficial from an environmental and energy efficiency perspective. Green bonds simultaneously facilitate the channelling of capital into green investments, reduce the cost of access to finance and raise awareness of the financial risks associated with environmental degradation. It is characteristic for the green bond market that bonds are issued with longer maturities but at lower nominal values than non-green bonds from the same issuer. Although these instruments represent only a fraction of the total global bond market, experts see significant potential, supported by the growing awareness of environmental issues and the fight against climate change.

The MNB started to build up its dedicated green bond portfolio and thereby integrating environmental sustainability into its reserve management in 2019. The portfolio is EUR-denominated, includes mostly green bonds from supranational and German sovereign issuers. The size of the portfolio within the reserve roughly reflects the size of the global green bond market (~1-2 per cent), which is mainly justified by liquidity considerations. Due to the intended purpose of

green investments, the risk-reward characteristics of the green bond portfolio differ from those of other types of bond investments of the foreign exchange reserves only in terms of interest rate risk (slightly longer duration).

In addition to the establishment of a green bond portfolio, monitoring the positive environmental impact generated by the investments is also of key importance. Taking this into account, the MNB monitors also the annual positive environmental impact of green bond investments and publishes it for the sake of transparency and setting a good example. In 2022, this impact was 73,000 tonnes of CO2 avoided, which is roughly equivalent to the carbon footprint of a Hungarian municipality of 15,000 inhabitants per year. The decrease compared to the some 94,000 tonnes of CO2 avoided in the previous year is due to a reallocation between bonds within the green bond portfolio. More than half of the projects funded are renewable energy and green buildings. As the green bond portfolio is denominated in euro, this is reflected in the predominance of European issuers and the geographical distribution of green projects realised. However, projects in Africa and Asia have also been financed, mainly thanks to projects by supranational issuers, which in many cases generate an even higher overall green ‘return’ due to the green investments that have replaced often more polluting operations in these countries (Chart 11).

Chart 11
Type and geographic distribution of financed green projects



Source: bond issuers' own reports

4.3.2 Climate risk analysis of the MNB’s exposure to the government bond market

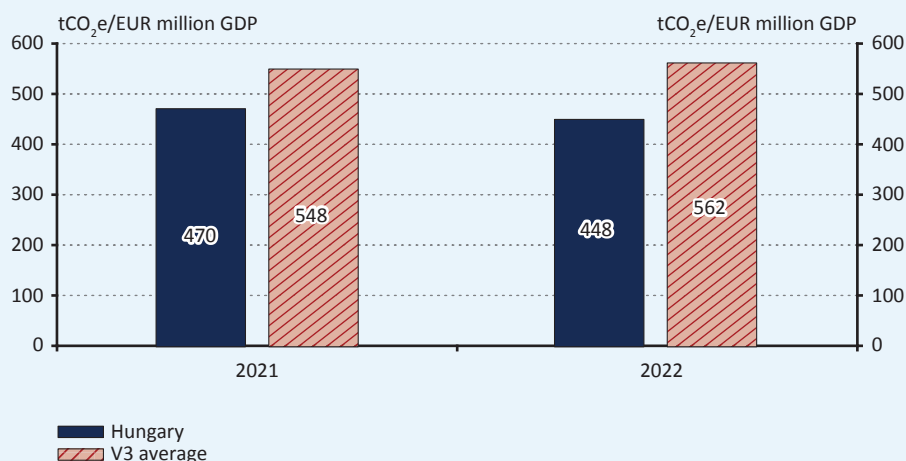
The MNB started purchasing government securities (GSP) on the secondary market in May 2020. The introduction of government securities purchases was justified to address the adverse effects of the financial market turbulence caused by the COVID-19 pandemic on domestic markets. Although the MNB stopped its purchases in December 2021, it continues to hold HUF 3,300 billion (EUR 8.2 billion) of government securities on its balance sheet, mostly with maturities of 5–20 years.

In addition to the GSP, it should be noted that during collateral management, the MNB takes on exposure to the government securities market as an indirect risk. The MNB accepts as collateral virtually all issuances of the Hungarian bond market, in addition to large corporate receivables, 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) in the eligible portfolio of HUF 10,000 billion. In the Hungarian securities market, government securities represent the largest volume and dominate the composition of the pledged portfolio (more than 75 per cent).

4.3.2.1 Transition risk: carbon intensity (WACI)

The WACI metric also used to assess the government securities exposure, which is a measure of the total economy's emissions (greenhouse gas emissions) to GDP. Hungary's WACI metric is 448 tonnes CO₂e per million euro of GDP, lower than the regional average and the previous year's value (Chart 12). Hungary's carbon intensity metric is compared to the carbon intensity index of the V3 countries¹¹, due to their close cooperation and similar investor perceptions.

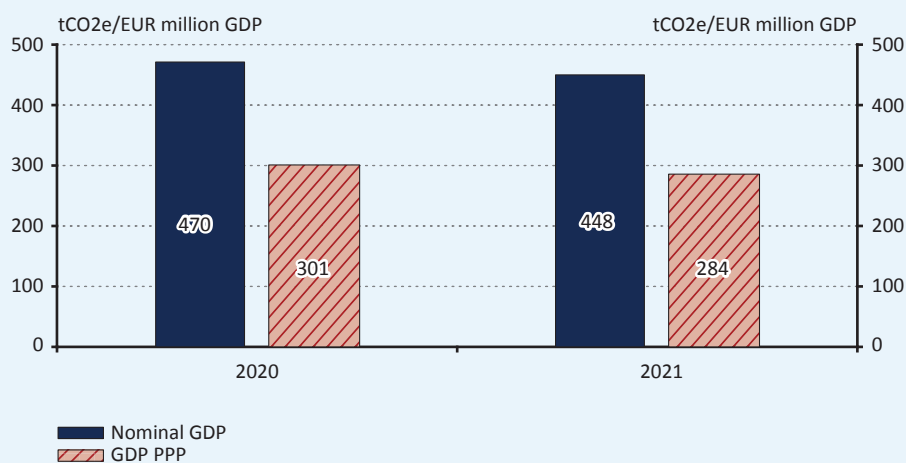
Chart 12
Carbon intensity of domestic and regional economies



Source: Eurostat

The carbon intensity metric of Hungarian government securities is also calculated using GDP at purchasing power parity. In 2022, the carbon intensity of Hungarian government securities was 448 tonnes CO₂e per million euro of GDP calculated with nominal GDP, while with PPP GDP it was 284 tonnes CO₂e per million euro of GDP (Chart 13). The results are in line with expectations, and accordingly using PPP GDP results in a lower carbon intensity for the Hungarian sovereign exposure.

Chart 13
Carbon intensity of Hungary calculated using nominal and PPP GDP (2021-2022)



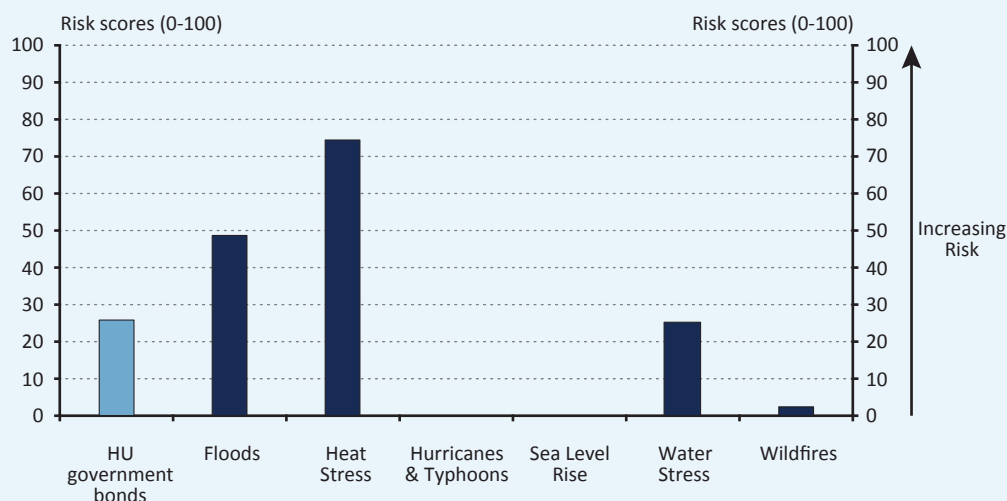
Source: Eurostat, HCSO

¹¹ V3 countries refers to the members of the Visegrád Cooperation (V4) other than Hungary: Czech Republic, Poland and Slovakia.

4.3.2.2 Physical risk

To assess the physical risks of Hungarian government securities exposure, an overview of Hungary's physical risk profile is necessary. Overall, Hungary's exposure to physical risk is considered as relatively low, in the lower third of the universe analysed by the data provider (26th percentile). Among the risk categories, Hungary is most exposed to the risk of heat stress (75th percentile), while in the other categories it is in the less risky half of the universe. Due to Hungary's geographical location, hurricanes, typhoons and sea level rise do not pose a significant physical risk (Chart 14).

Chart 14
Physical risk scores for Hungary (Hungarian government securities)



Source: Four Twenty Seven (Moody's Analytics), MNB

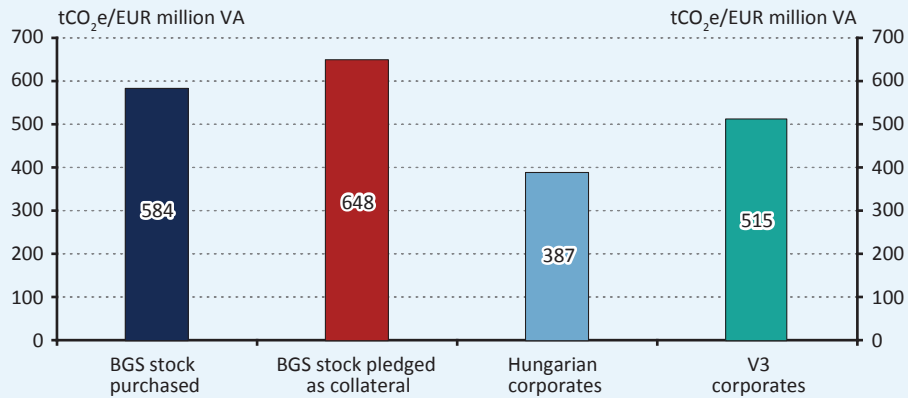
4.3.3 Climate risk analysis of the Bond Funding for Growth Scheme (BGS)

The BGS was launched by the MNB in 2019 as a result of a strategic decision to develop the capital markets in order to increase liquidity in the corporate bond market. The MNB aims to ensure that domestic companies have sufficient access to other forms of financing, including bond issuance, in addition to bank loans, by increasing liquidity in the bond market. Under the programme, the central bank purchased HUF 1,550 billion (EUR 3.9 billion) of bonds issued by non-financial corporates with good credit ratings. The Monetary Council decided at its meeting in December 2021 to end the BGS and no further purchases were made. A substantial stock of BGS bonds is transferred to banks, which in many cases also pledge them as collateral (HUF 340 billion (EUR 0.8 billion) in nominal value).

4.3.3.1 Transition risk: carbon intensity (WACI)

The average carbon intensity metric of the BGS portfolio is 584 tonnes CO₂e per million euro of value added, which is higher than the value of the Hungarian corporate sector as a whole, but closer to the average corporate carbon intensity of the V3 countries (Chart 15). This represents a slight increase compared to the previous year (in contrast to the downward trend for the corporate sector as a whole), primarily driven by the sector composition of the securities purchased during 2022.

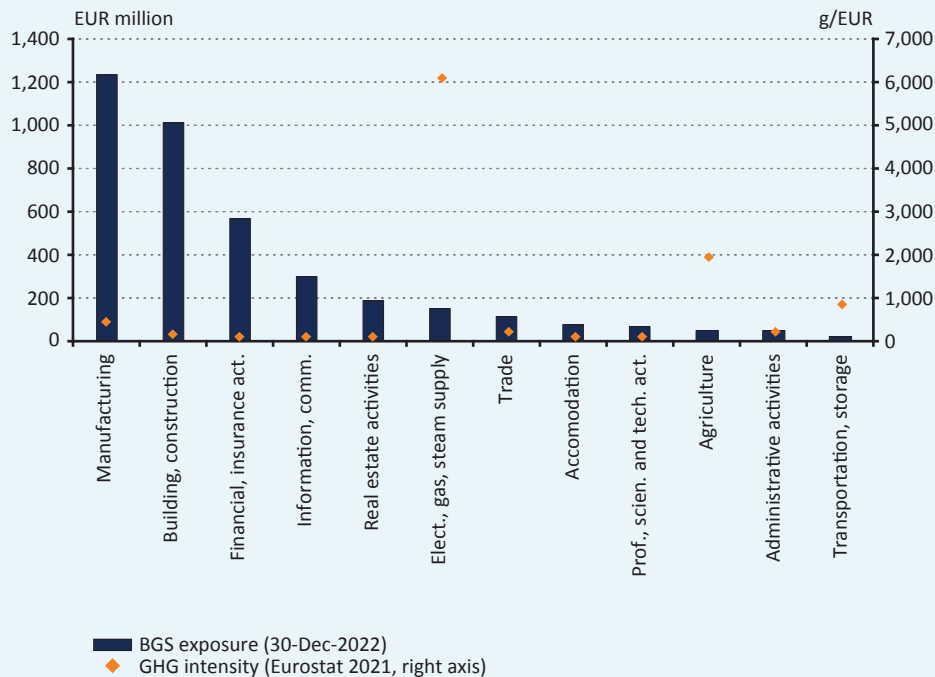
Chart 15
Carbon intensity of the BGS bonds, Hungarian and V3 companies



Source: Eurostat, MNB

Based on the sectoral analysis, the most carbon intensive sector held by the portfolio is electricity, gas, steam and air conditioning, but with a weight of only 4 per cent (Chart 16). However, the carbon intensity of this section contributed significantly to the weighted carbon intensity (210 tonnes CO₂e per million euro of value added), as the GHG intensity of this sector is extremely high at 6,113 tonnes CO₂e per million euro of value added.

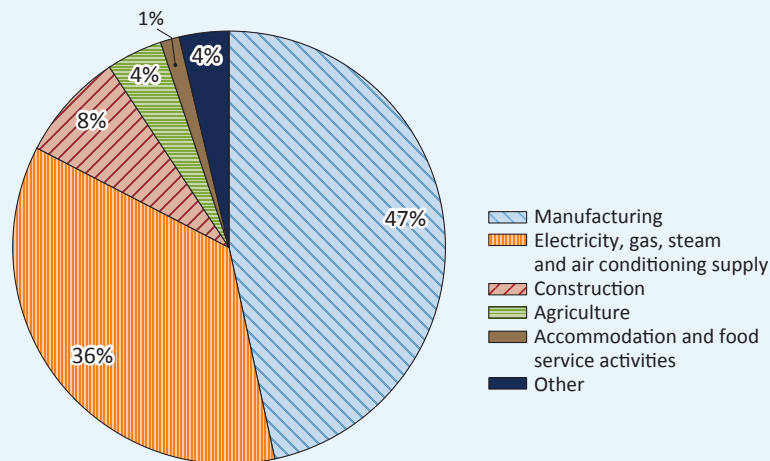
Chart 16
Sectoral distribution of the BGS portfolio and carbon intensity of each sector



Source: Eurostat, MNB

Only three sectors, manufacturing, electricity, gas, steam and air conditioning, as well as construction, contributed 90 per cent to the WACI of the BGS portfolio (Chart 17). The high value of electricity is mainly explained by the high GHG intensity of the sector, while for manufacturing and construction by the high amount in the BGS portfolio.

Chart 17
Contribution of the main sectors to the GHG intensity of the BGS portfolio



Source: Eurostat, MNB

The MNB accepts as collateral virtually all issuances of the Hungarian bond market, where – due to the structure of the market – government securities dominate the pledged collateral. The average carbon intensity metric of the pledged corporate collateral (7 per cent of the pledged securities portfolio) at the end of 2022 is 648 tonnes CO₂e/million EUR of value added. The value of the corporate metric is below the FGS's GHG emissions but above the WACI of the BGS exposures in the MNB portfolio. The scope and holdings of securities purchased and pledged differ. In addition, due to the difference between the market prices used for securities purchases and the acceptance prices used for collateral management, securities and emissions of the same issuer are weighted differently in the analysis of collateral management and securities purchase programmes. (For example, in the case of corporate bonds, due to the credit rating and associated haircut assignment, in addition to the market premiums taken into account, a higher acceptance value is associated with capital-intensive firms in sectors with relatively high GHG emissions.)

Compared to the WACI value of the previous year, the 648 tonnes CO₂e/million EUR of value added represents an increase in the pledged corporate collateral. The increase is due to several factors: On the one hand, there is the change in the eligible collateral (the impact of downgrades, outflows from the collateral pool and new issues during the year) and, on the other hand, the change in the prices at which securities are accepted due to market movements.

3.7.3.2 Transition risk: brown share

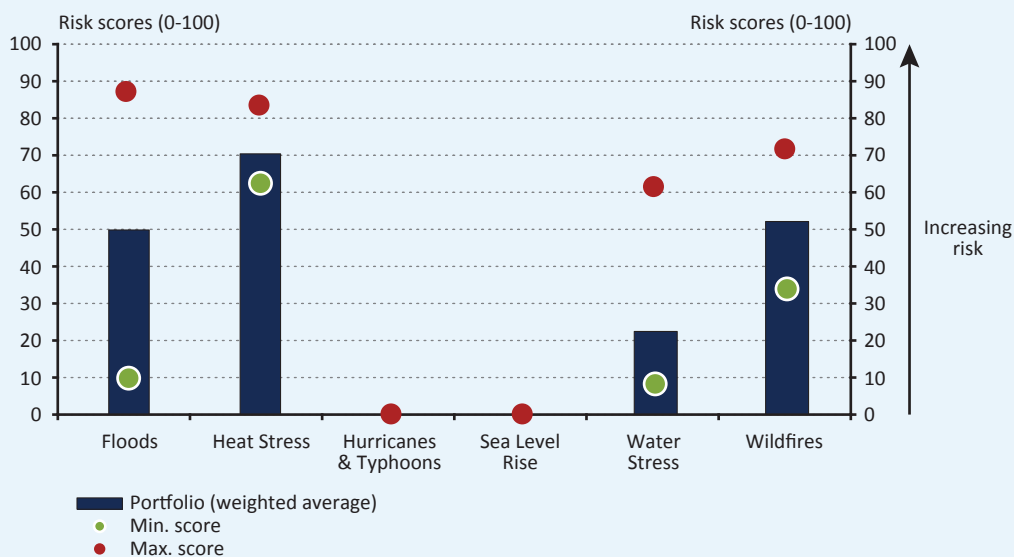
At the end of December 2022, the brown share of the BGS portfolio was 14 per cent. As of 31 December 2022, there were three carbon-intensive emissions in the portfolio, representing a significant increase compared to previous years due to the composition effect.

Of the HUF 340 billion (EUR 0.8 billion) in corporate holdings pledged as collateral, HUF 45 billion (EUR 0.1 billion) can be classified as brown assets, so that at the end of 2022, they accounted for nearly 13 per cent within the corporate exposure of the pledged stock. This represents an increase compared to last year, as seen for purchased paper.

4.3.3.3 Physical risk

The BGS corporate bond portfolio exhibits relatively low risk across most of the physical risk categories. While the coverage of Hungarian entities is complete, the depth of analysis of Hungarian companies is not complete due to data gaps. In the corporate exposure, the headquarters of the issuing companies are highly concentrated geographically (the vast majority are located in Budapest), which also has a strong impact on the physical risk assessment of the exposure. Among the physical risks in the portfolio, heat stress, wildfires and floods are dominant (71st, 53rd and 51st percentiles, respectively), while based on the other risk metrics, the exposure is only moderately or not at all risky. (Chart 18) It should be noted that the methodology of the data provider has changed since the previous report was published, resulting in a more significant change (increase) in the scores for certain locations in the flood risk category. The physical risks of BGS securities pledged in collateral management are very similar to those of the purchased portfolio, with scores in most risk categories almost identical. The largest difference is characteristic of the flood risk category, where the pledged portfolio falls in the 62nd percentile, mainly due to the different portfolio composition.

Chart 18
Physical risk scores of the BGS bond portfolio



Source: Four Twenty Seven (Moody's Analytics), MNB

Box 4-5

Green bonds in the BGS portfolio

While it is not a dedicated purpose of the BGS programme, the MNB also buys green corporate bonds under the programme. The central bank purchased from 21 series of green bonds up to 31 December 2022, raising the share of green bonds in the total BGS portfolio to over 20 per cent. The largest issuers were construction, manufacturing and real estate development companies.

All green bonds issued under the BGS are part of a Green Bond Framework that has been externally reviewed by an independent third party, i.e. they can be designated as green bonds in line with international standards. Based on the objectives set out in Green Bond Frameworks, companies contribute to a number of UN Sustainable Development Goals (SDGs) (Chart 19). Among the goals, Affordable and Clean Energy (7), Responsible Consumption and Production (12) and Action against Climate Change (13) are the ones most frequently included in the emissions frameworks. The positive environmental impacts of green bonds have not yet been measured by the MNB, which can be attributed to the short time since the bond purchases.

Chart 19
Distribution of SDGs in the BGS Green Bond Frameworks by frequency



Source: MNB

4.3.4 Climate risk analysis of the Funding for Growth Scheme (FGS)

The FGS was 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 per cent, which they could re-lend to micro, small and medium-sized enterprises at a maximum interest rate of 2.5 per cent, up until 2020. At different stages of the FGS, the MNB set a number of parameters, including the maximum maturity, amount and purpose of the loan, but was not restrictive in terms of sectors, so that any enterprise in any economic activity could apply for funding under the scheme.

4.3.4.1 Transition risk: carbon intensity (WACI)

The WACI metric for the outstanding stock of FGS loans is 718 tonnes CO₂e per million euro of value added. The carbon intensity of the FGS portfolio exceeds both the average corporate carbon intensity of the Hungarian corporate sector as a whole and that of the V3 countries (Chart 20). The value of the metric slightly increased compared to the previous year, explained by the changing sector composition due to drawdowns and repayments.

Chart 20
Carbon intensity of the FGS portfolio, Hungarian and V3 companies

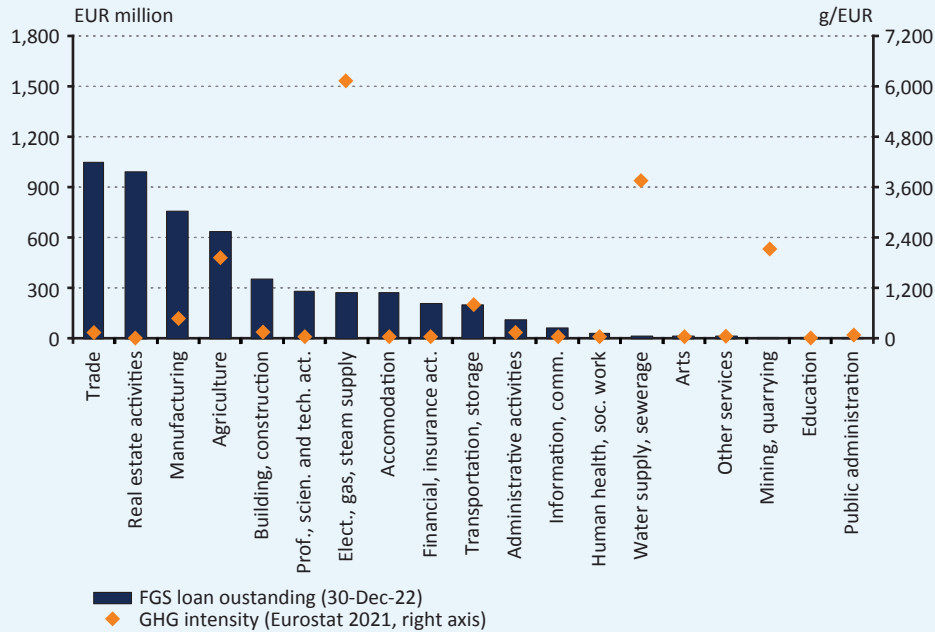


Note: The FGS portfolio does not include the portfolio of sole proprietors and agricultural primary producers.

Source: Eurostat, MNB

The sectoral distribution and GHG intensity of the outstanding stock of loans under the FGS of around HUF 2,112 billion (EUR 5.3 billion) at the end of 2022 also showed a heterogeneous picture (Chart 21). Almost 95 per cent of the outstanding loan portfolio was concentrated in 10 sectors with GHG intensities ranging from 39 to 6,113 tonnes CO₂e per million euro of value added. The largest loan portfolios are in less carbon intensive sectors, with the exception of agriculture.

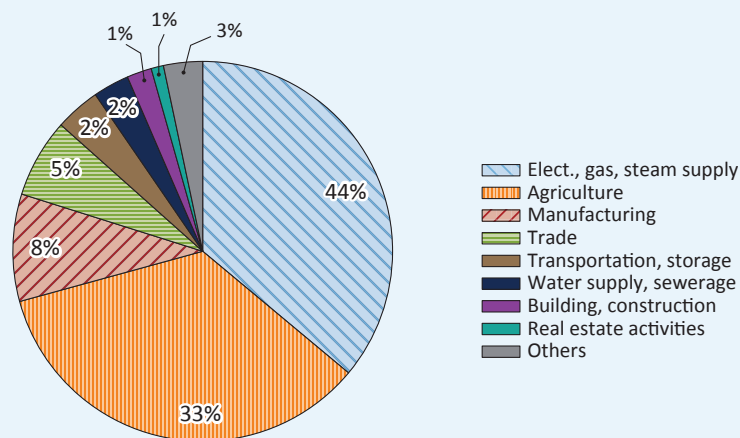
Chart 21
Sectoral distribution of FGS portfolio and GHG intensity of each sector



Source: Eurostat, MNB

Only five sectors contributed to 93 per cent of the WACI metric of the FGS portfolio: electricity generation, agriculture, manufacturing, trade and transport and storage (Chart 22). The high contribution of the agriculture, electricity generation and transport and storage sectors can be explained largely by the high GHG intensity of these sectors, while for manufacturing and trade by the high FGS stock.

Chart 22
Contribution of the main sectors to the GHG intensity of the FGS portfolio



Source: Eurostat, MNB

Within the FGS portfolio at end-2022, the carbon intensity of investment loans was higher than that of working capital and redeeming loans, based on the WACI metric. The WACI metric for investment loans, representing almost 56 per cent of the portfolio analysed, was 858 tonnes CO₂e per million euro, while the WACI for working capital type and redeeming transactions was 542 tonnes CO₂e per million euro of value added.

4.3.4.2 Transition risk: brown share

In the outstanding stock of loans under the FGS amounting to around HUF 2,112 billion, the weight of carbon-intensive sectors can be considered low, with only 5 per cent of the total FGS portfolio linked to these sectors at the end of 2022 (Table 3). In terms of brown assets of the FGS portfolio, amounting to roughly HUF 104 billion, the largest contributors were the borrowings of companies active in electricity generation, which account for more than 97 per cent.

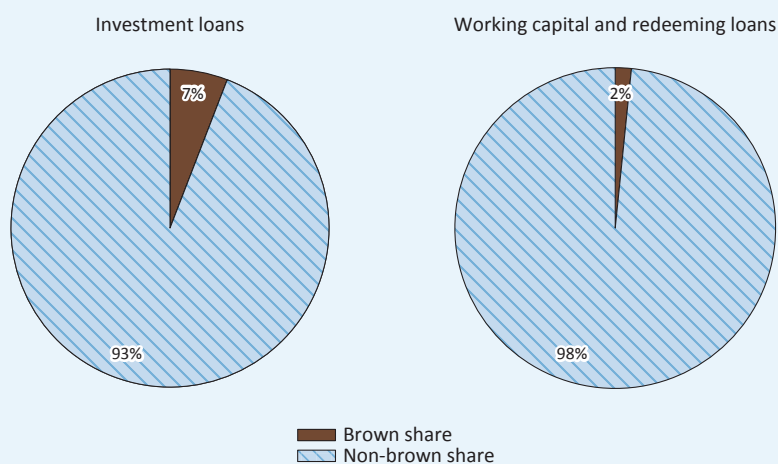
Table 3
Carbon-intensive sectors within the FGS portfolio

Carbon intensive sectors (NACE code)	Outstanding loans (EUR million)	Number of Contracts	Number of Corporates
Production of electricity (3511)	252.74	532	406
Trade of electricity (3514)	3.03	22	18
Wholesale of solid, liquid and gaseous fuels (4671)	1.85	119	55
Transmission of electricity (3512)	1.85	1	1
Support activities for other mining and quarrying (0990)	0.34	29	8
Support activities for petroleum and natural gas extraction (0910)	0.31	5	3
Other (3513, 3521, 3523, 3522, 0520)	0.06	21	11
Total	260.18	729	502

Source: Eurostat, MNB

Similar to the WACI, the brown share is also higher in relation to investment loans (Chart 23). However, for both investment and working capital type and redeeming loans, electricity generation accounts for more than 96 per cent of brown assets, followed by the contribution of electricity trading for both loan purposes.

Chart 23
Carbon-intensive sectors within investment, working capital type and redeeming loans

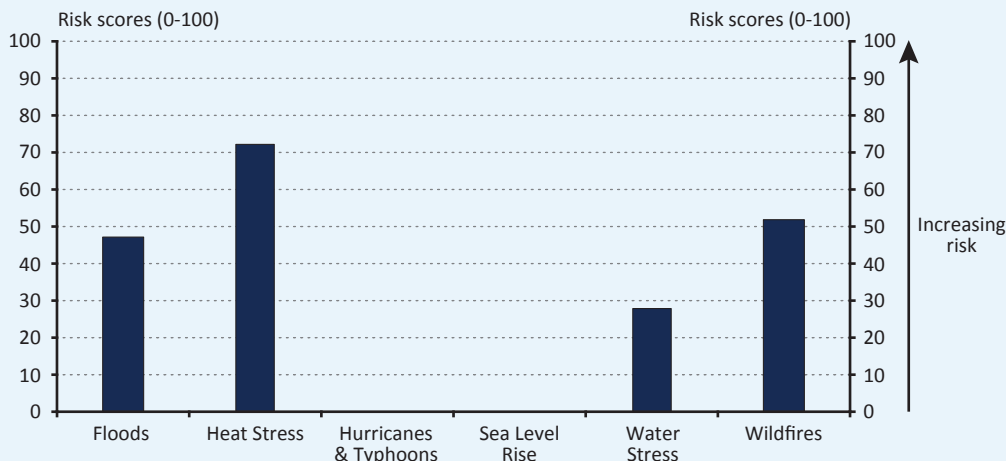


Source: MNB, Eurostat

4.3.4.3 Physical risk

Looking at the physical risks of FGS loans at a regional (county level), the outstanding portfolio is most exposed to heat stress and wildfire risks, with a risk profile similar to the BGS portfolio. Although the share of metropolitan exposure is high also in this case, the spatial distribution of the FGS portfolio is more diversified. Similar to the BGS portfolio, heat stress and wildfire dominate among the risk categories, while based on the other risk indicators, the portfolio is in the less risky half of the universe (Chart 24).

Chart 24
Physical risk scores for FGS loan portfolio



Source: Four Twenty Seven (Moody's Analytics), MNB

4.3.5 Climate risk analysis of the Mortgage Bond Purchase Programme (MBP)

In 2018, the MNB launched its Mortgage Bond Purchase Programme, the first phase of which lasted until the end of 2018, and reintroduced the purchase programme in 2020 to mitigate the negative economic impact of the coronavirus pandemic. Under the programmes, the MNB purchased fixed-rate mortgage bonds denominated in forints from domestic mortgage institutions and placed a strong emphasis on participation conditions enhancing transparency. At the end of 2021, the green mortgage bond purchase programme was launched, which was also subsequently discontinued due to the tightening of central bank measures, and currently only maturing stocks can be renewed. The stock of mortgage bonds purchased under the programme amounted to HUF 687 billion (EUR 1.7 billion) at the end of 2022.

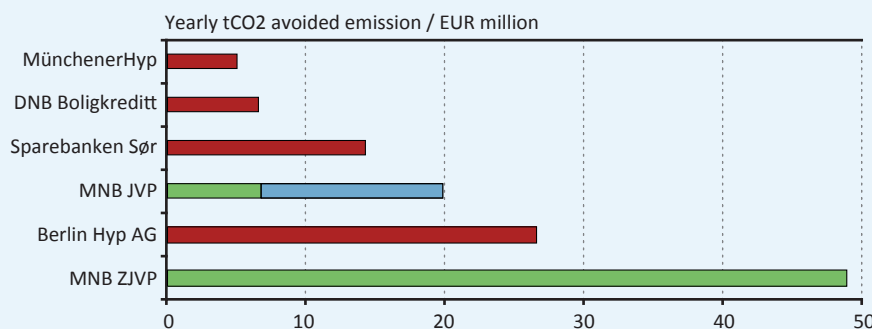
The aim of this analysis is to estimate the CO₂ emission reductions resulting from the MNB's Mortgage Bond Purchase Programme. Mortgage bonds are special securities collateralised by at least 80 per cent of the principal repayments and interest payments on mortgage loans granted by mortgage banks and their partner banks, as required by law. The collateral for these loans is real estate; thus, the MNB's mortgage bond purchases indirectly finance the construction or purchase of real estate.

- It is estimated that due to the MNB's Mortgage Bond Purchase Programme (first two phases), through the modernisation of the housing stock, annual emissions amounting to between 13,000 and 41,000 tonnes will be saved.
- With respect to the mortgage bonds purchased as part of the green mortgage bond purchase programme, 7.6 thousand tonnes of GHG emissions are saved annually.

In an international context, the emissions savings of mortgage bond purchase programmes have been compared to the impact of green mortgage bonds issued in Western Europe (Chart 25). Overall, the MNB's programmes could achieve relatively high emission reductions per million euros. This may be partly due to the fact that, on the one hand, the Hungarian real estate portfolio is basically starting from a more outdated situation and, on the other hand, domestic

real estate is relatively cheaper, thus the amount of money invested may result in a larger reduction of emissions. It is also important to underline that different institutions may have different loan targets and property types behind their mortgage loans, with different criteria, which also affect the reported results.

Chart 25
CO₂ emissions avoided per million euros in tonnes per year for certain green mortgage bonds and the MNB programmes



Note: For the MBP, the light blue bar indicates the estimation band. The values shown have been calculated using a different, individual estimation methodology and with several uncertainty factors, therefore their comparison with the other green mortgage bonds shown should be treated with caution. Source: MünchenerHyp, DNB, Sparebanken Sør, Berlin Hyp AG, OTP Jelzálogbank, Takarékszövetkezet, Unicredit Jelzálogbank, Erste Jelzálogbank issuers' own reports, MNB calculation

4.4 EVOLUTION OF THE MNB'S CARBON FOOTPRINT

4.4.1 Operational activities

The MNB has been continuously monitoring its operational carbon footprint for 10 years and is striving to reduce it. The volume of the carbon footprint, and the carbon footprint per capita, has decreased by 30 per cent in the last 3 years. 85–90 per cent of the CO₂ footprint is related to energy use.

Table 4
Trend in carbon footprint of operational activities

Carbon emissions/sources	Evolution of the carbon footprint (CO ₂ emissions in tons)					Change from base year 2019, %
	2017	2018	2019	2020	2021	
Natural gas and district heating	880	835	848	966	981	15.1
Vehicles fleet	135	125	123	104	104	-14.0
Refrigerants	-	-	-	5.4	5.4	-
SCOPE 1 total	1,015	960	971	1,076	1,090	11.8
Electricity	3,785	4,010	4,092	2,624	3,013	-28.5
SCOPE 2 total	3,785	4,010	4,092	2,624	3,013	-28.5
Air travel	1,122	843	945	201	33	-81.3
Business travel (abroad)	3.9	2.8	2.4	0.4	0.5	-49.2
Business travel (domestic)	7.1	9.0	7.8	1.9	2.7	-71.7
Taxi	3.0	2.3	2.6	3.2	3.5	28.4
Banknote briquette (used as an energy source)	-	-	-	18.2	17.0	-
Recycled paper	-	-	-	1.9	3.0	-
Communal waste	-	-	-	156	110	-
SCOPE 3 total	1,136	857	958	383	170	-69.4
SCOPE 1-SCOPE 3 total	5,936	5,827	6,021	4,082	4,273	-29.4
Carbon footprint per capita (tons/capita)	4.7	4.5	4.6	3.1	3.2	-30.4

Source: MNB

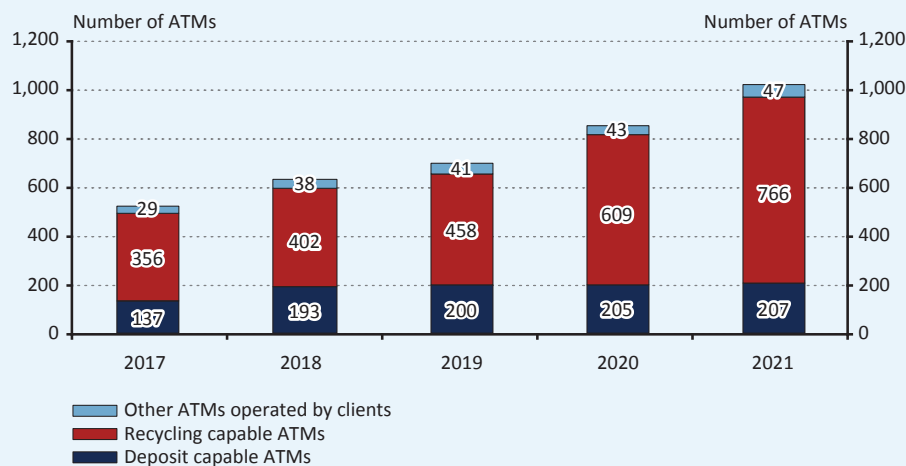
The MNB undertook in its medium-term environmental strategy to reduce its operational carbon footprint by 30 per cent by the end of 2022 (based on 2019). This commitment was already achieved at the end of 2021.

- Based on the above, the goal is to reduce the carbon footprint by 80 per cent by 2025 (baseline 2019), which the MNB plans to achieve mainly through the installation of photovoltaic systems and 100 per cent renewable energy for the electricity supply of our buildings.
- The Covid pandemic has led to a significant change in work practices, with meetings/discussions moving to the virtual space, which has significantly reduced business travel. There is no noticeable reduction in the carbon footprint of buildings related to working from home, given that the variable (headcount-dependent) part of energy use in office buildings is significantly lower compared to permanent use.
- It is important to address a seemingly contradictory piece of data: the impact of global warming on heating energy use is not decreasing, but has been on a steady upward trend in recent years. The heating season starts earlier and extends until late spring compared to the last 15-25 years. In addition, the winter weather is significantly colder, albeit for a shorter period than in the past. An analysis of the temperature trends during the heating period shows that even with the same or higher average monthly temperatures, there are occasions when higher energy consumption occurs, for example, when there are significant frosts for 7–12 days in a given month.
- The MNB aims to reduce its carbon footprint from its operational activities, but this cannot be completely reduced. To compensate for emissions that cannot be further reduced, the MNB will finance habitat restoration projects that can absorb the entirety of its carbon footprint in the coming years. An example of nature-based programmes implemented with the help of WWF Hungary is the 27-hectare afforestation project near the municipality of Geszt in the Körös-Maros National Park.

4.4.2 Carbon footprint of the cash supply chain

Today, the transport of cash, which mainly involves the collection of banknotes from merchants and bank branches and their return to ATM machines after processing at central sites, can be deemed mainly responsible for the carbon footprint of the cash supply chain. However, since the early 2010s, domestic credit institutions have increasingly adopted customer-operated banknote deposit and recycling machines, which allow banknotes to be processed locally without the need for transport, thus reducing the associated environmental impact. Such equipment is already an integral part of the infrastructure of virtually all credit institutions, and during 2021 the total number of machines exceeded 1,000, with the installation of around 60 new machines, representing an increase of almost 20 per cent. Furthermore, in December 2021, nearly 31 per cent of cash payments were made through customer-managed machines, up from 26 per cent a year earlier, and these changes are considered to have led to significant environmental improvements that could continue in the coming years.

Chart 26
Customer-operated ATMs suitable for banknote recycling or depositing



In 2023, the central bank started to prepare its environmental sustainability recommendations on the business model, strategy, operations and risk management of money processing companies. Following the publication of the Recommendation, the Bank will continuously monitor compliance with the requirements set out in the Recommendation and, based on the experience gained, will decide whether it is necessary to adopt regulations to mainstream environmental sustainability considerations.

While the volume of cash production has not changed significantly (a slight increase was recorded), the number of banknotes in circulation has increased every year over the period shown in the table. In 2021, the volume of banknote raw material production increased by 15 per cent, which also affected the related energy consumption. In addition, natural gas consumption has significantly increased in all the organisations concerned, due to the increasingly extreme weather conditions (longer heating season, shorter periods of extreme cold with increasing frequency) related to the heating of their buildings. Based on data from cash-in-transit companies, the most important factor influencing the evolution of their carbon footprint, the number of kilometres driven, decreased by more than 20 per cent until 2020, but returned to pre-pandemic levels in 2021.

Table 5
Trend in carbon footprint of the cash supply chain

Period	Carbon footprint of the banknote supply chain (t)	YoY change (t)	YoY change (%)
2018	21,204		
2019	19,522	-1,682	-7.9
2020	18,462	-1,060	-5.4
2021	21,078	2,616	14.2

Source: cash-in-transit companies, MNB

Annex – metrics used to analyse climate risks – methodology and limitations

Weighted Average Carbon Intensity (WACI): A metric quantifying the GHG emissions per unit of GDP or value added generated by portfolios. The benefit of an intensity-based metric is that it allows the environmental performance of the entity issuing the security to be back tested, enabling the investor to mitigate climate risk by identifying and managing the most carbon-intensive entities. Calculation of the metric is simple, can be easily applied to different asset classes and allows for comparison across portfolios. Nevertheless, the outliers and the nominal metrics used for normalisation can introduce bias in the value of the carbon intensity index. Whilst consistency is a primary consideration in the analysis, there may be differences in the calculation of the carbon intensity metric for different asset categories due to methodological specificities and the available data set. Methodological differences make it difficult to compare the results of portfolios and do not allow for the calculation of a carbon intensity metric aggregated at the balance sheet level. Accordingly, the carbon intensity of each asset category is not always compared with the same reference portfolio. The WACI metric measures carbon intensity at the portfolio level and thus indirectly captures the GHG emissions of financial portfolios, rather than showing the direct carbon emissions associated with the MNB's own operations.

Table 6	
Characteristics of the key metrics in the TCFD report	
Weighted Average Carbon Intensity	
Definition	Climate-risk metric included in TCFD recommendations measuring the average carbon intensity of the portfolios
General information	<p>Advantages:</p> <ul style="list-style-type: none"> • The metric can be easily applied in different asset classes. • The calculation of the metric is simple. • The metric makes it possible to compare between identical asset types and portfolios, regardless of the portfolio size. • The change of the metric over time provides useful information. • It makes the decomposition analysis of climate risk of the portfolio possible. <p>Disadvantages:</p> <ul style="list-style-type: none"> • The metric is sensitive to outliers. • Due to normalisation with current values (market value, current GDP), prices can have biasing effect. The improvement of the metric does not necessarily mean a decrease in GHG emissions.
Sovereign asset portfolios (FX reserves, government securities purchase programme)	
Description	The metric quantifying the GHG emissions of the assets in the portfolio arising in the production of a unit of GDP Unit of measure: tonne CO ₂ e/million euro of GDP
Formula	$WACI = \sum_i \frac{\text{market value of exposure}_i}{\text{market value of the portfolio}} * \frac{\text{GHG emissions of the country}_i}{\text{nominal GDP of the country}_i}$
Data source	<ul style="list-style-type: none"> • GHG: Eurostat (Air Emissions Accounts, government securities), UNFCCC (FX reserves) • GDP: Eurostat (GSPP), OECD and World Bank (foreign exchange reserves)
Corporate asset portfolios (BGS, FGS, large corporate loans)	
Description	The metric quantifying the GHG emissions of the assets in the portfolio arising in the production of a unit of value added Unit of measure: tonne CO ₂ e/million euro of value added
Formula	$WACI = \sum_i \frac{\text{market/collateral value of sector}_i}{\text{market/collateral value of the portfolio}} * \text{GHG intensity of the sector}$
Data source	<ul style="list-style-type: none"> • GHG intensity: Eurostat (Air Emissions Intensities)
<p><i>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 data gaps, the corporate WACI metrics are calculated using value-added based sector GHG intensity data instead of turnover.</i></p> <p><i>Source: MNB, TCFD</i></p>	

In the case of the sovereign WACI, the implicit assumption behind the use of this metric is that government securities ultimately finance the activity of the economy, and therefore the emissions of the whole economy should be taken into account. The advantage of the metric is that it is simple to calculate, the data are accessible and available for several countries (with similar methodologies), so that international comparisons are possible. It should be noted, however, that it is a very indirect metric in terms of assessing the emission implications of government securities.

In the denominator of the WACI metric for sovereign assets different GDP metrics can be used. In addition to nominal GDP, the use of GDP measured in real or purchasing power parity terms was considered. In the MNB's 2022 report, the carbon intensity metrics for sovereign exposures were calculated using real GDP at constant (2019) prices and exchange rates, therefore the effects of price increases and exchange rate changes do not distort the metric. As a result of the change in methodology and updates to the available data, the values of the sovereign carbon intensity metrics have changed also retrospectively. Calculating with real GDP ensures that the carbon intensity metric reflects the actual change in real terms. GDP calculated at purchasing power parity is specifically a statistic used in international comparisons to eliminate the distorting effect of different price levels. The issue of GDP used in the denominator can present a significant discrepancy, especially for developing countries. One of the main reasons for the lack of uniform practice among central banks to measure the WACI metric is that the TCFD recommendations are primarily developed for the analysis of corporate portfolios.

The WACI metric for the reserve portfolios is calculated using National Greenhouse Gas Inventory data (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 (CO₂e).¹² In case of some countries which are not part of the United Nations Framework Convention on Climate Change and do not report GHG Inventory Data, the PRIMAP-hist¹³ time-series data available on the website of Climate Watch¹⁴ have been used. Due to the production approach, National Emission Inventories do not include GHG emissions generated in other countries but associated with imported products, which can introduce a significant bias in the metric. The Air Emissions Accounts (Eurostat) data use a resident rather than territorial approach to quantify GHG emissions of economic operators.

The lack of company-specific data distorts the results to some extent. In the absence of micro-level data, for companies the analyses used sectoral average metrics, which can lead to biases in GHG emissions (e.g. the sector classification of a green bond of an issuer is the same as that of a traditional bond, while the amount of carbon dioxide emitted is significantly different). This is also the case for the biased classification of companies producing green energy. Overall, their impact on the value of the metrics is small, and therefore, bearing in mind robustness, international best practice and comparability, corrections are only applied in case of clear, material distortions. A disadvantage of the sectoral approach to corporate exposures 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.

For the sectoral classification, the MNB has used the economic sections defined by NACE Rev. 2, within which, for the BGS, more detailed industry carbon intensity data are also used, weighted by the shares within the portfolio. The resulting sectoral GHG intensity data may differ from other MNB portfolios (FGS portfolio) for the same economic sections, as the more detailed industry breakdown also differs across portfolios. The issuers participating in the BGS are non-financial corporations, and therefore the composition of the portfolio differs from the composition of the metric representing the Hungarian corporate sector (all economic activities except households), which may also lead to a significant difference in the value of the carbon intensity metric.

¹² Signatory countries to the 1992 United Nations Framework Convention on Climate Change (UNFCCC) have committed to preparing an annual national GHG emissions inventory, for which the Intergovernmental Panel on Climate Change (IPCC) guidelines provide the guiding standards (2006 IPCC Guidelines for National Greenhouse Gas Inventories).

¹³ Gütschow, J.; Günther, A.; Pflüger, M. (2021): The PRIMAP-hist national historical emissions time series v2.3.1 (1850-2019). zenodo. doi:10.5281/zenodo.5494497. (Gütschow et al. (2016): The PRIMAP-hist national historical emissions time series, Earth Syst. Sci. Data, 8, 571–603, <http://doi.org/10.5194/essd-8-571-2016>)

¹⁴ Climate Watch. 2022. Washington, DC: World Resources Institute. <https://www.climatewatchdata.org>.

Brown share: The analysis of brown (carbon-related) 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, as these are the most exposed to risks, both from a technological and regulatory perspective. To identify carbon-intensive industries, the TCFD Working Group recommends using the Global Industry Classification Standard (GICS) sector classification. According to the TCFD 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 has 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 metric provides a snapshot of the proportion of brown assets and can therefore change dynamically as the asset portfolio changes. In addition, the metric does not assess exposure based on the direct carbon intensity of issuers, but rather on sector classification, thus providing an indirect picture of brown assets.

Energy mix: A substantial shift in the world's energy mix from burning fossil fuels to using renewable energy sources is needed to meet the Paris Agreement. One way of measuring the risks arising from this transition could be to study the energy mix of the countries issuing securities. The methodology will help investors to better assess the exposure of the countries in their portfolio to the risks associated with the development of a carbon-neutral energy system. Countries where major structural change is required due to the high share of fossil fuel use are obviously more exposed to the risks associated with transition. 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 capacity required for transition and the strategic plans and measures of the country to address climate risk, for which further forward-looking analysis is required.

Climate Action Tracker (CAT): In order to provide a forward-looking assessment of the transition risks of sovereign portfolios, the MNB reviewed the countries' carbon emission reduction targets. Estimates can include uncertainties and the range of trajectories can be wide, but nevertheless the assessment can provide useful information for assessing transition risks across a wide range of the investment universe. Future scenarios for sovereign exposures of foreign exchange reserves were calculated on a weighted average basis, based on the emission levels assigned by the CAT climate trajectories created in the collaboration of two organisations, the Climate Analytics and the NewClimate Institute. The weights were determined according to the ratios of the sovereign exposures included in the foreign exchange reserve.

Physical risk: For the analysis of physical risks, the model of the external data provider (427, Moody's Analytics) takes into account the results of six risk categories: flood, heat stress, hurricanes and typhoons, sea level rise, water scarcity (water stress), and risks from wildfires. Within the risk categories, a number of indicators are quantified that capture the change in the exposure of the entity (country or company) to physical risks over the forecast horizon (the 2030s). The scenario used to predict physical risk is based on the GHG trajectory RCP8.5 adopted by the IPCC. The scores for the risk categories 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 and risks are not quantified. The current phase of physical risk analysis is suitable to draw attention to the riskiest areas and entities. However, the analysis is not suitable for comparing the results of different asset classes (different universes).

Socio-economic aspects are added to the analysis of the physical risk of sovereign entities. The results of the physical risk model should be linked to socio-economic aspects, as it is important that only geographical areas relevant for economic activity and population are included in the analysis. In practice, the model does this by assessing the proportion of the country's economic activity (GDP), population and agricultural area that is located in areas considered to be at critical levels in terms of physical risk categories.

Mortgage bonds: For mortgage bonds, the main point of the methodology is to determine the CO₂ emission reductions achieved. The methodology used is more refined compared to the 2021 report. The rationale and assumptions of the model and the building stock data remained unchanged. The model used for estimation includes a number of simplifying assumptions: consequently, due to the high estimation uncertainty, several values and scenarios were tested for a number of parameters. However, whereas previously we used the average estimated emission factors from the Clim'Foot database, combined with building stock data, in the current report we have also made our estimates using the Partnership for Carbon Accounting Financials' data on emission factors. Using the latter method, we estimated a baseline stock with

essentially lower emissions and a lower emission avoidance. Information on the reduction in emissions achieved through the purchase of mortgage bonds as part of the green mortgage bond purchase programme was used from the mortgage banks' mandatory impact reports. The emissions reductions quantified in each report are weighted by the MNB's holdings held at the end of 2022.

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H-1013 BUDAPEST, KRISZTINA KÖRÚT 55.