



Identifying, managing and disclosing climate-related financial risks: options for the Reserve Bank of India

Authors: Prashant Vaze, Neha Kumar, Sarah Colenbrander, Lily Burge and Nandini Sharma

17/03/2022

Readers are encouraged to reproduce material for their own publications, as long as they are not being sold commercially. ODI requests due acknowledgement and a copy of the publication. For online use, we ask readers to link to the original resource on the ODI website. The views presented in this paper are those of the author(s) and do not necessarily represent the views of ODI or our partners.

This work is licensed under CC BY-NC-ND 4.0.

How to cite: Prashant Vaze, Neha Kumar, Sarah Colenbrander, Lily Burge and Nandini Sharma (2022) *Identifying, managing and disclosing climate-related financial risks in India: Options for the RBI of India*. ODI Report. London: ODI (<https://odi.org/en/about/our-work/strengthening-climate-risk-assessment-in-indias-financial-sector>).

About the authors and acknowledgements

ODI, Climate Bonds Initiative (CBI) and auctusESG are working together to enable improved monitoring and reporting of climate-related financial risks in India. This initiative is generously funded by UK PACT (Partnering for Accelerated Climate Transitions). The project is timely given that the Reserve Bank of India (RBI) has just joined the Network of Central Banks and Supervisors for Greening the Financial System (NGFS).

The authors are Prashant Vaze (Senior Fellow, CBI); Neha Kumar (India Programme Manager, CBI); Sarah Colenbrander (Director of the Climate and Sustainability Programme, ODI); Lily Burge (Policy Research Analyst, CBI); and Nandini Sharma (Senior Research Officer, ODI).

The authors are grateful for text, advice and comments provided by expert advisers Neha Khanna, Dhruva Purkayastha, Nick Robins, Suranjali Tandon, Sourajit Aiyer; colleagues: Joanna Cutler (CBI), Rathin Roy (ODI) and Nandini Sharma (ODI); Namita Vikas (auctusESG); Sanyukta Dasgupta (Foreign & Commonwealth Development Office). Editorial assistance was provided by Ali Salman Andani (CBI) and Purva Dafle (CBI). The valuable contribution of Sunil Nair, Brij Raj and Nitin Jain (Reserve Bank of India) and Theresa Lober (Bank of England) is gratefully acknowledged.

The views set out in this paper are those of the authors and may not represent the views of the advisers or their organisations.

This project has two strands:

1. We offer training to risk assessment and credit lending staff in Indian banks to equip them to be able to consider climate risks in their financial decisions. This includes introducing staff to environmental, social and governance (ESG) investment terminology, demonstrating how to apply ESG principles in financial assessments and explaining the standards of the Taskforce for Climate-Related Financial Disclosure (TCFD). The modules are available at: <https://odi.org/en/about/our-work/strengthening-climate-risk-assessment-in-indias-financial-sector>
2. We quantify bank lending and bond issuance to fossil fuel industries across India to assess bank exposure to stranded assets and non-performing loans. Using this evidence base, we are examining regulatory options available to the RBI to enable improved supervision and market discipline to manage these climate-related financial risks. This paper summarises the results.

Table of contents

Executive summary	7
1. Introduction and background	11
2. Quantifying financial sector exposure to transition and physical risks from climate change	14
2.1 Data sources and methods.....	14
2.2 Findings	17
3. Review of the Reserve Bank of India's mandate and policies	24
3.1 The RBI's mandate and climate-related risks.....	24
3.2 The Reserve Bank of India's climate-related policies	28
4. Assessment of international best practice.....	32
4.1 Prudential regulation and supervision	33
4.2 Monetary policy	37
4.3 Credit guidance	40
4.4 Central banks' internal reforms	40
5. Recommendations	42
5.1 The RBI's distinctive context	42
5.2 Recommendations for the RBI to consider	43
5.3 Prudential regulation	44
5.4 Credit guidance: direct lending to the taxonomy through PSL and other directed lending	45
5.5 Foundational	46
References.....	48
Annex 1: Indian greenhouse gas emissions 2016	55
Annex 2: Mapping RBI bank lending and IPCC sector classifications	56

List of acronyms

ACPR	Autorité de Contrôle Prudentiel et de Résolution (France)
ASEAN	Association of Southeast Asian Nations
BCBS	Basel Committee on Banking Supervision
BoE	Bank of England
BIS	Bank for International Settlements
BNM	Bank Negara Malaysia
CBI	Climate Bonds Initiative
COP26	26th Conference of the Parties
CPI	Consumer Price Index
CSR	corporate social responsibility
DNB	De Nederlandsche Bank
ECB	European Central Bank
ESG	environmental, social and governance
EU	European Union
GDP	gross domestic product
GFSG	Green Finance Study Group
GHG	greenhouse gas
GRI	Global Reporting Initiative
GVA	gross value added
IBA	Indian Banks' Association
IEA	International Energy Agency
IFC	International Finance Corporation
IPCC	Intergovernmental Panel on Climate Change
IRDAI	Insurance Regulatory and Development Authority of India
MoEFCC	Ministry of Environment, Forest and Climate Change
MoSPI	Ministry of Statistics and Programme Implementation
MNB	Magyar Nemzeti Bank (Hungary)
MSMEs	micro, small and medium-sized enterprises
NABARD	National Bank for Agriculture and Rural Development
NAIC	North American Industry Classification System
NBFC	non-banking financing company
NGFS	Central Banks and Supervisors Network for Greening the Financial System
NHPC	National Hydro Power Corporation
NVGs	National Voluntary Guidelines on Social, Economic and Environmental Responsibilities of Business
PFC	Power Finance Corporation

PFRDA	Pension Fund Regulatory and Development Authority
PSL	Priority sector lending
RBI	Reserve Bank of India
REC	Rural Electrification Corporation
SEBI	Securities and Exchange Board of India
SIC	Standard Industrial Classification
TCFD	Taskforce for Climate-Related Financial Disclosure
UK	United Kingdom
UK PACT	UK Partnering for Accelerated Climate Transitions
UNFCCC	United Nations Framework Convention on Climate Change
US	United States

Executive summary

Average global temperatures have increased by 1°C since pre-industrial times. India is already experiencing the consequences: heavy precipitation, extreme heat, severe flooding, catastrophic cyclones and rising sea levels are damaging lives, livelihoods and assets across the country. Looking forward, the human and economic costs of climate change will only increase. India therefore cannot achieve its development aspirations without taking climate change into account (Dubash, 2019).

Recognising the need for climate-smart economic growth, Prime Minister Mr. Narendra Modi has committed to India becoming a net-zero economy by 2070. He further announced that India will take its non-fossil energy capacity to 500 GW and reduce the carbon intensity of its economy by less than 45% by 2030. These pledges imply a massive expansion and transformation of the power sector. While necessary to mitigate the physical risks of climate change, these commitments potentially create significant transition risks for India's financial sector.

In April 2021, the Reserve Bank of India (hereafter Reserve Bank or RBI) joined the Central Banks and Supervisors Network for Greening the Financial System (NGFS). Launched at the Paris One Planet Summit on 12 December 2017, the NGFS is a group of central banks and supervisors willing to share best practices and contribute to the development of environment and climate risk management in the financial sector, while mobilising mainstream finance to support the transition towards a sustainable economy. The Reserve Bank expects to benefit from the membership of NGFS by learning from and contributing to global efforts on green finance which has assumed significance in the context of climate change.

This report provides an independent analysis to support the Reserve Bank as it plans its response to climate-related financial risks.

First, we demonstrate the compelling case for new guidance or regulation to maintain price stability in the face of low-carbon transition risks. We examine the exposure of Indian financial institutions to high-carbon sectors and firms, particularly those with high levels of indebtedness that compound financial risk. We combine a 'top-down' approach using national-level data on emissions, gross value added (GVA) and borrowing to identify the economic sectors facing transition risks in India, and a 'bottom-up' approach using transaction-level data within those economic sectors to identify specific subsectors and firms at risk.

We find that electricity production, energy-intensive manufacturing (chemicals, petroleum, primary metals and cement), mining and quarrying (including coal) and gas refineries, which comprise 60% of emissions, account collectively for around 12% of all domestic currency bank lending and 40% of bank lending to large corporates. Foreign currency borrowing is a further Rs 5.3 lakh crore (\$76 billion). The carbon intensity of this lending becomes more apparent when we examine lending by subsectors: most lending to the 'mining' sector, for example, is for oil and gas extraction; one-fifth of 'manufacturing' debt is for petroleum refining and related industries; and only 17% of lending to electricity production is to pure-play renewable energy companies. Corporate bond holders are even more exposed to transition risks: bonds issued by the power and oil sectors account for just over one-third of the domestic market; while a further third is accounted for by electricity utilities

excluding independent power producers and renewables. A handful of high-carbon firms dominate bank lending and bond issuance among Indian domiciled firms, as Table ES1 evidences.

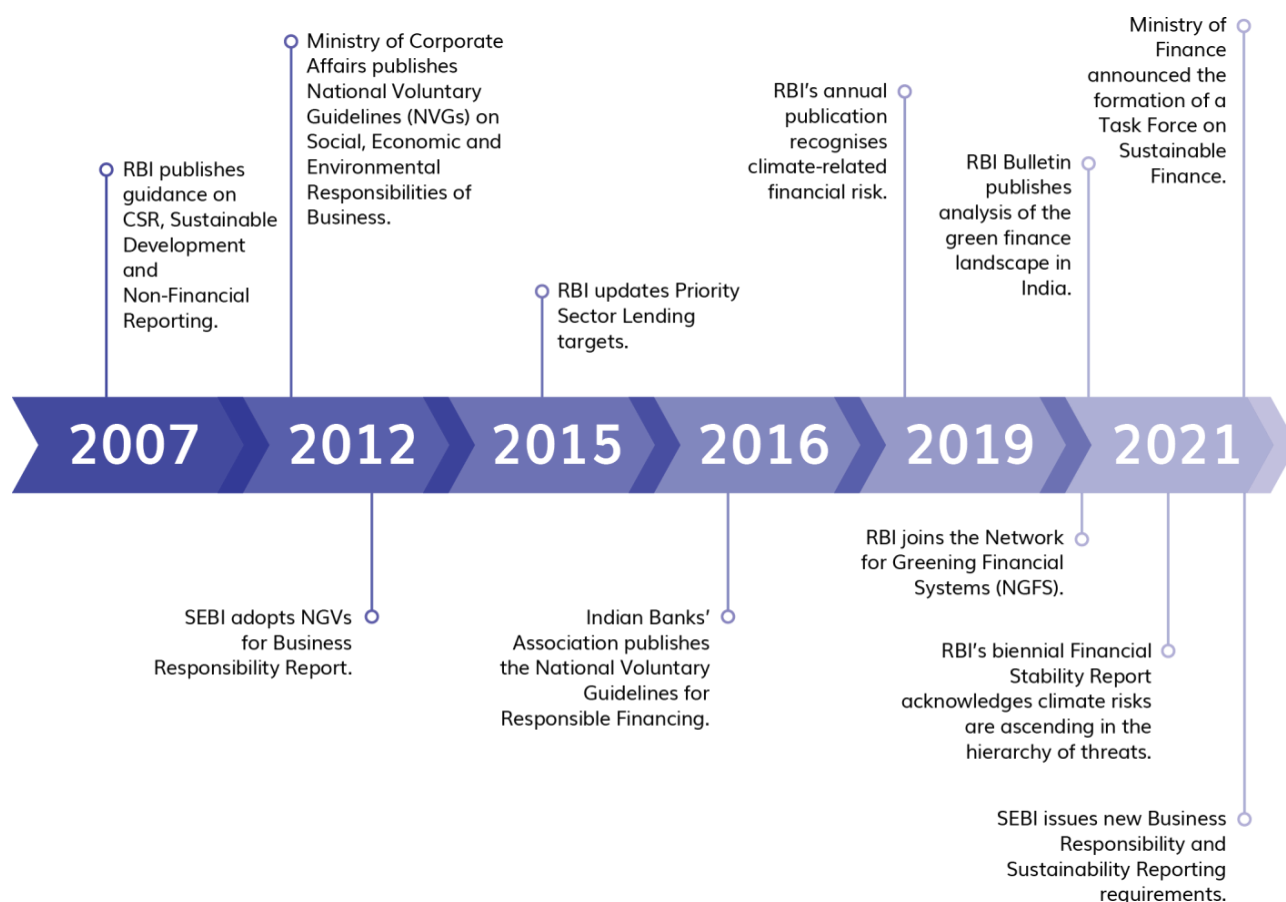
Table ES1: 10 largest borrowers in emission-intensive sectors and 10 largest bond issuers overall in India

Ranking	Company	Sector	Value (Rs crore)	Share in foreign currency (%)
Bank lending				
1	Reliance Industries Ltd	Oil and gas refining and marketing	123,080	100
2	Tata Steel Ltd	Iron and steel	53,270	9
3	Bharat Petro resources Ltd	Oil and gas exploration and production	52,583	100
4	HPCL-Mittal Energy Ltd	Oil and gas refining and marketing	41,399	8
5	Hindalco Industries Ltd	Aluminium	40,007	9
6	ONGC Petro Additions Ltd	Petroleum refining	37,876	5
7	Sasan Power Ltd	Fossil fuel electric utilities	36,257	36
8	Indian Oil Corporation Ltd	Oil and gas refining and marketing	32,103	54
9	HPCL Rajasthan Refinery Ltd	Petroleum refining	28,753	0
10	ONGCVidesh Ltd	Integrated oil and gas	27,530	100
Total:			472,858	52
Bond issuance				
1	Reliance Industries Ltd	Energy	111,114	34
2	Power Grid Corp of India	Utilities	94,570	4
3	NTPC	Utilities	89,117	28
4	Indian Oil Corp	Energy	32,887	51
5	NHPC	Utilities	22,087	0
6	Hindustan Petroleum Corp	Energy	16,754	22
7	Bharat Petroleum Corp	Energy	15,781	71
8	Tata Power Co Ltd	Utilities	9,865	0
9	Oil India Ltd	Energy	7,853	100
10	Adani Transmission Ltd	Electric Utilities	7,405	98
Total:			407,433	28

Source: Bloomberg Finance L.P. database, accessed 3 June 2021.

Second, we review the RBI's mandate and identify key milestones in its sustainable finance journey. We find that the RBI first published advice on corporate social responsibility, sustainable development and non-financial reporting in 2007 (see Figure ES1), but that most of its efforts to date have focused on nurturing opportunities in green finance rather than managing environmental risks. A Sustainable Finance Group was set up in the RBI in May 2021 to lead its efforts and regulatory initiatives in the area of climate risk and sustainable finance. Earlier in January 2021, a Task Force on Sustainable Finance was set up by the Department of Economic Affairs, Ministry of Finance, Government of India. The Terms of Reference of the Task Force include defining the framework for sustainable finance in India, establishing the pillars for a sustainable finance roadmap, suggesting draft taxonomy of sustainable activities and a framework of risk assessment by the financial sector. The creation of the above Taskforce marked a more comprehensive approach to sustainable finance, with the potential to strengthen risk management and as well as mobilise new green capital.

Figure ES1: Key policy milestones in India's sustainable finance journey

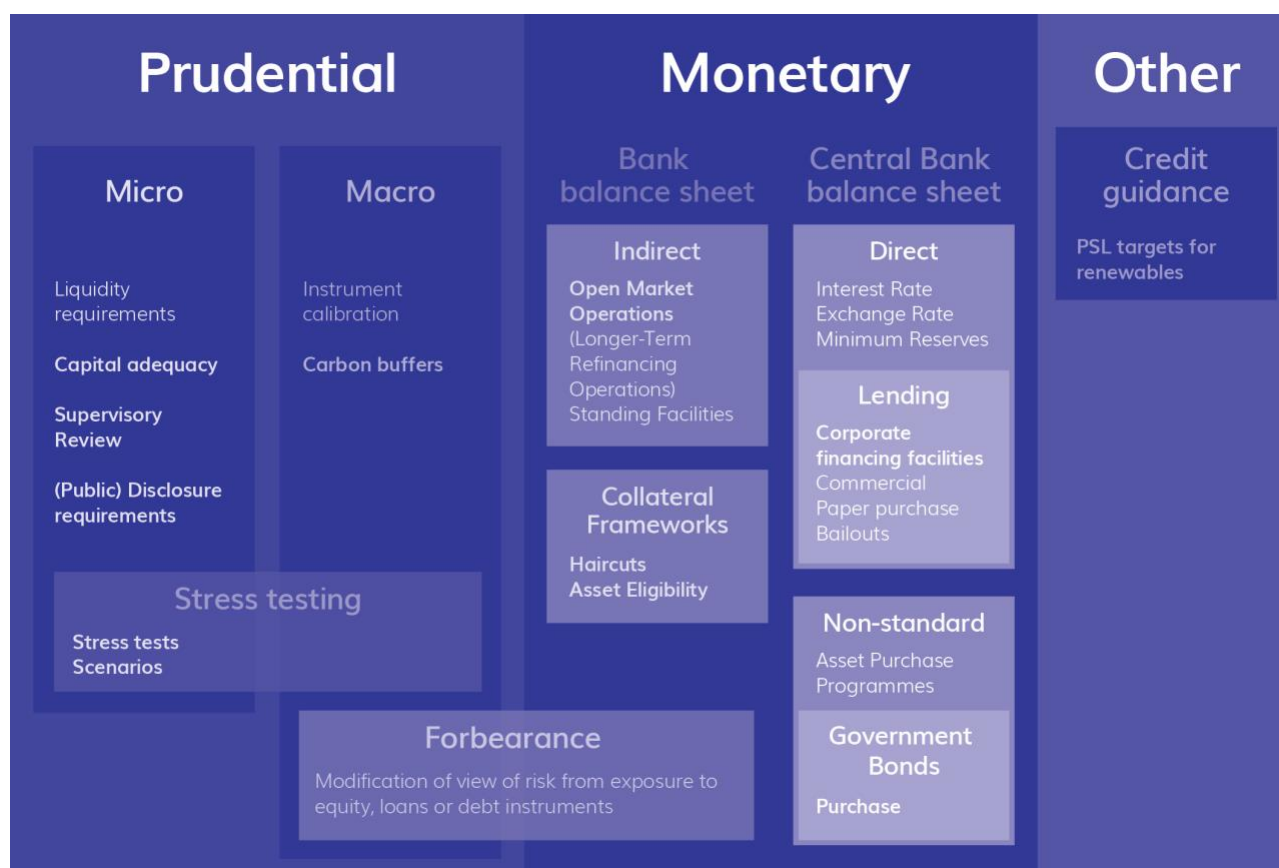


Source: Authors

Third, we review the policies that central banks around the world are adopting to reduce financial-sector exposure to climate risks. The different options are summarised in an original taxonomy (see Figure ES2), illustrating how prudential regulation, monetary policy and credit guidance policy tools fit together. The policies in green have, or could be, adjusted to mitigate climate risks. We briefly consider the feasibility of these different options in the context of India's financial system. Looking beyond the financial sector, Indian regulators must also ensure that any interventions advance the country's development priorities, including reducing poverty, expanding access to services including modern energy, and enhancing resilience to the physical impacts of climate change.

Based on these analyses, we offer six recommendations to the RBI, guided by its specific mandate and experiences to date as well as the wider Indian context. Table ES2 summarises these recommendations. Importantly, we have not included any of the monetary policy options in Figure ES2 in our shortlist: we consider that prudential regulation and credit guidance are more important measures as the RBI seeks to climate-proof India's financial system. Our recommendations are intended to initiate a conversation about the most appropriate bundle of policies in an Indian context and how these should be sequenced. We welcome ideas and feedback.

Figure ES2: Policy toolkit of a stylised central bank



Source: Authors

Table ES2: Recommendations to the Reserve Bank of India

Policy type	Policy recommendation
Prudential regulation	<ol style="list-style-type: none"> Require banks to identify, measure and disclose their exposure to transition risks and the extent of green lending (using India's forthcoming sustainable finance taxonomy). Require banks to track lending to green and transition risk activities through tagging individual loans and assets. Develop physical and transition risk scenarios tailored to India and use these to undertake stress tests based on new policy commitments. Work with the Basel Committee to revise capital adequacy ratios to incentivise financial institutions to reduce their exposure to low-carbon transition risks.
Credit guidance	<ol style="list-style-type: none"> Integrate India's forthcoming sustainable finance taxonomy into priority sector lending requirements and increase the proportion of taxonomy-aligned lending in non-priority sectors.
Foundational	<ol style="list-style-type: none"> Ask banks to build the capacity of financiers to identify, measure and manage climate-related risks.

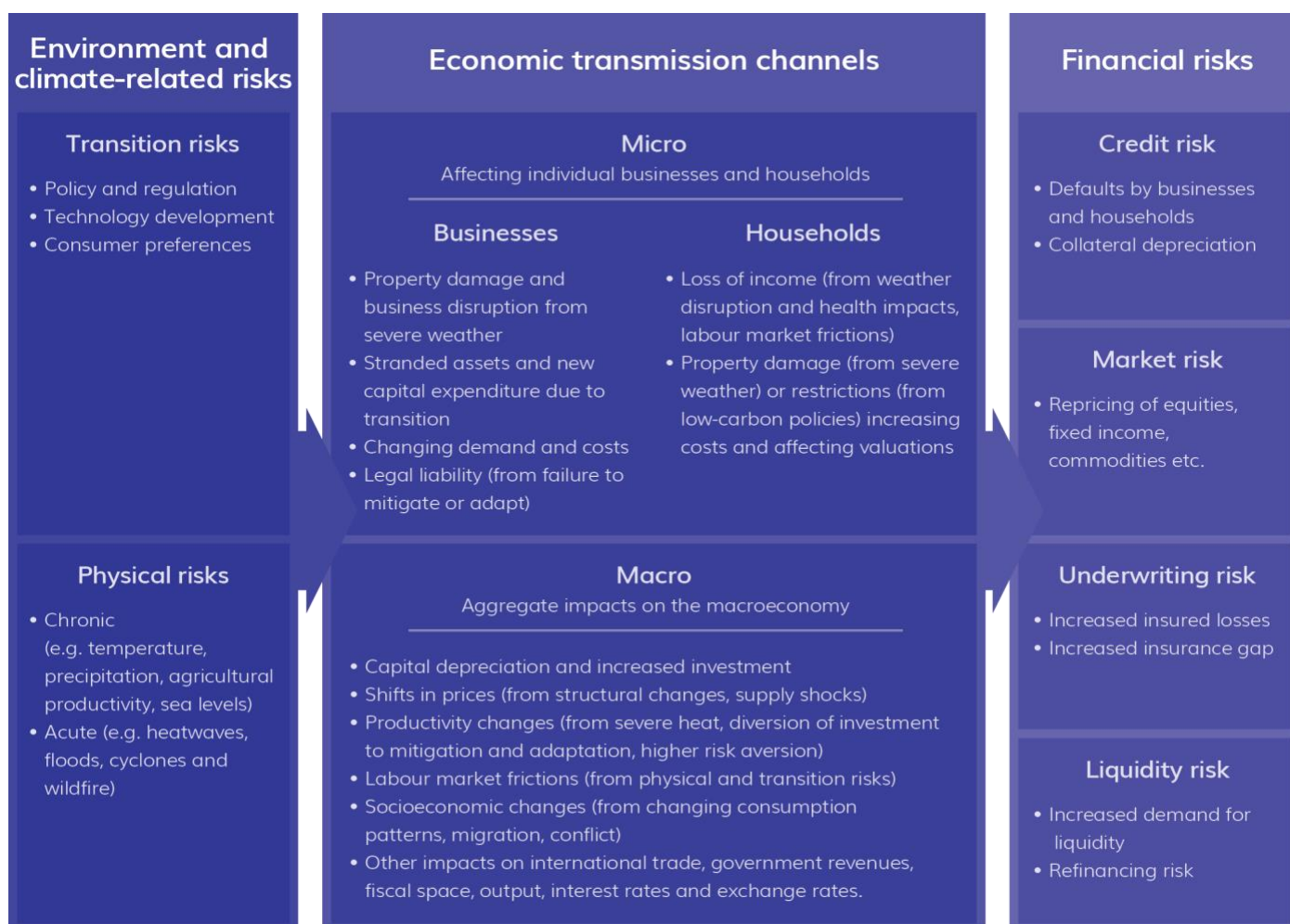
1. Introduction and background

Average global temperatures have increased by 1°C since pre-industrial times. India is already experiencing the consequences: heavy precipitation, extreme heat, severe flooding, catastrophic cyclones and rising sea levels are damaging lives, livelihoods and assets across the country. Going forward, the human and economic costs of climate change will only increase. India therefore cannot achieve its development aspirations without taking climate change into account (Dubash, 2019).

Today, India is the world's third largest greenhouse gas (GHG) emitter (UNFCCC, 2021). This does not mean, however, that India is responsible for global warming. India's per capita emissions are only 40% of the global average (World Bank, 2021) and – despite being home to one in every six people – the country accounts for only 3.2% of cumulative emissions (Friedlingstein et al., 2021). Millions of Indians live in extreme poverty without access to decent housing, basic services or secure livelihoods; Covid-19 has further eroded a decade of development gains. India therefore has many other urgent priorities. Yet this domestic context also means that the country has an outsized interest in mitigating climate change – particularly where climate action can deliver against other objectives such as expanded energy access, improved air quality, and greater food, water and energy security (Picciariello et al., 2021).

There is a growing academic and policy debate about the roles that central banks should play in responding to climate change, including within India. The primary mandate of most central banks is to secure price stability by keeping the rate of inflation within prescribed bands. Many central banks have related responsibilities for financial sector stability (including supervision of individual financial institutions), exchange rate stability and job creation. A growing number of central banks now recognise that climate change poses a threat to these objectives through both its physical impacts and the disruption associated with a low-carbon transition (Campigliano et al., 2018). Sharp shocks, such as a cyclone or closure of a coal-fired power plant, and long-term stresses, such as drought or changing consumer demand, can increase the probability of volatile prices or under-performing investments or loans. If this happens at sufficient scale, it can create threaten financial stability writ large (see Figure 1). Therefore, while sovereign governments may have primary responsibility for responding to climate change, central banks also have an important role to play, given their unique mandate and toolkit.

Figure 1: The transmission of climate-related risks to the financial system



Source: NGFS Overview of Risk Analysis Framework (2020).

Financial supervisors and relevant multilateral organisations (e.g. the Bank for International Settlements, the Financial Stability Board, the Sustainable Insurance Forum) are now coming together to share ideas and lessons around climate risk management in the financial sector. Notably, the Network of Central Banks and Supervisors for Greening the Financial System (NGFS) was established in 2017 to share best practice. That same year, the Task Force on Climate-Related Financial Disclosures (TCFD) published recommendations on how businesses could identify, measure and disclose climate-related risks. The NGFS members have pledged their support for the TCFD recommendations, laying the foundations for a robust and internationally consistent framework for environmental disclosures.

The RBI joined NGFS in April 2021 (RBI, 2021a). This welcome announcement builds on over a decade of relevant activity, as the RBI has previously provided information and non-binding guidance on climate-related financial risks and sustainable finance opportunities. The RBI has much to contribute to these global policy debates. In economic composition (though not in size), India is fairly representative of many emerging economies: agriculture still accounts for a significant share of gross domestic product (GDP) and employment; many people lack access to modern, reliable

energy; and poverty and informality remain widespread. Yet India also stands out for the sophistication of its civil service and the depth of its capital markets, which suggest that it may be able to craft and implement policies that are better suited to the particular needs of emerging economies. Central banks from Indonesia to Nigeria to Turkey may all look to the RBI for inspiration and best practice.

Climate finance was one of the priorities of the 26th Conference of the Parties (COP26) priorities, and its objectives include: 'Central banks and regulators need to make sure that our financial systems can withstand the impacts of climate change and support the transition to net zero' (UKCOP26, 2021). This report provides an independent analysis to support the RBI as it plans its response to climate-related financial risks.

Chapter 2 demonstrates the compelling case for new guidance or regulation to maintain price stability. We do this by examining Indian banks' exposure to low-carbon transition risks, documenting the levels and concentrations of debt in the agriculture, power, mining and manufacturing sectors. Chapter 3 reviews the RBI's mandate, examining its policy toolkit and recent work to evaluate the extent to which its activities already include managing climate risks. Chapter 4 assesses the policies that central banks around the world are adopting to help reduce their domestic financial system's exposure to climate risks, and provide options for the RBI to consider. Finally, Chapter 5 offers tailored policy and institutional recommendations to the RBI, guided by its specific mandate and experiences to date as well as the wider Indian context.

2. Quantifying financial sector exposure to transition and physical risks from climate change

This chapter provides a first-cut analysis of Indian banks' exposure to climate-related transition and physical risks. In the absence of granular, firm-level data on the nature and probability of different climate-related risks, it is difficult to robustly model financial sector exposure. However, our aim is to advance the conversation in India by providing quantitative information about the extent of bank lending and bond issuance to specific sectors, firms and states where there are reasons for concern about climate-related financial risks.

Our analysis focuses primarily on the financial risks of a low-carbon transition, meaning new policies, technological changes or behavioural shifts that affect the profitability or viability of firms that emit GHGs. These changes may take place within or beyond India's borders. Loans to and investments in vulnerable firms are therefore also at risk of not generating the anticipated returns, with implications for the balance sheets of Indian banks. Our analysis of low-carbon transition risk focuses on large, high-emission sectors in India, such as power generation, mining, chemicals and oil and gas refining. The carbon intensity of electricity production in India is well above the world average, reflecting the high share of coal in the generation mix (IEA, 2021).

We also briefly consider the physical risks of climate change, and the implications for the financial sector. We focus particularly on how climate hazards may affect agriculture, which comprises a large share of GDP and employment. This is not to imply that only agriculture is at risk from rising temperatures and extreme weather. For example, huge population centres like Mumbai and Kolkata are highly exposed to storm surge, more severe tropical cyclones and sea level rise. These costs are estimated elsewhere (see Picciariello et al., 2021 for a summary). Our aim is instead to draw a clear link between lending/investment and climate change hazards.

2.1 Data sources and methods

Indian banks are not required to disclose the proportion of their portfolios they invest in different assets, although RBI does require banks to report lending to broad industrial categories. Banks do not currently collect information such as the carbon intensity of their lending portfolios, but insight can be gained by cross-referencing sectoral lending to sectoral emissions. This analysis therefore fills an important knowledge gap in India's financial sector.

We adopted both a top-down and a bottom-up approach to understanding low-carbon transition risks. These approaches are described below.

- The 'top-down' approach looked at national-level data on the sectors' emissions and borrowing. We identified high-carbon sectors using India's most recent emission inventory for the United Nations Framework Convention on Climate Change (UNFCCC). This guided our bottom-up collection of sectoral financial data.
- In our 'bottom-up' approach, we identified firms and states at particular risk by collecting data on individual loans and bond issuances (within the selected sectors) by firms domiciled in India. Given the significant differences between firms in an economic sector (both a hydro-

and a coal-fired power company are in the ‘power sector’), we further reviewed the largest borrowers and bond issuances to identify any indication as to whether these firms were taking action to manage this risk.

Data on total carbon emissions for the **top-down approach** came from India’s GHG inventory for 2016 (MoEFCC, 2021), the country’s most recent, detailed report to the UNFCCC. Data on total aggregate credit in 2021 came from banks’ quarterly regulatory filing to the RBI (RBI 2021b, 2021c) and data on gross value added (GVA) from the Ministry of Statistics and Programme Implementation (MoSPI, 2021a). GVA was used as a denominator to calculate emissions and borrowing intensity for different sectors. We used the latest data on credit and GVA, even though they do not align temporally with the emissions inventory. This is based on the assumption that there are unlikely to be radical changes in the sectoral shares of GHG emissions within a five-year period, while up-to-date information is important for robust regulatory and financial decision-making.

We present these data in four ways to capture different drivers of transition risk. The inclusion of GVA (wages, investment plus profits) is intended to reflect a sector’s economic significance compared with its emissions or debt. This also helps illuminate a sector’s relative capacity to navigate a transition or, commensurately, its vulnerability to transition risks.

Table 1: Four ways to capture different drivers of transition risk

Assessed transition risk	Proxy indicator
1. Aggregate exposure of the banking sector to a sector facing transition risks	Total lending by Indian banks to high-carbon sectors
2. Aggregate transition risk experienced by the high-carbon sector	Total GHG emissions from the sector
3. Probability of individual firms in a high-carbon sector defaulting from transition risks	Carbon intensity of the sector per unit of GVA
4. Probability of a firm defaulting because of high indebtedness (an important compounding risk)	Indebtedness of the sector relative to GVA

There are some limitations to these data sources. First, the national emissions and credit datasets do not define or disaggregate economic sectors in the same way. This means that direct comparisons are imperfect. For example, the RBI identifies bank lending to households for purchasing ‘homes’ or ‘private cars’ but the UNFCCC submission uses a broader definition of ‘buildings’ or ‘road transport’ emissions, which includes non-household ownership. Second, the categorisation of industry the RBI uses is more aggregated than the information on emissions, which can make it difficult to robustly assess the carbon intensity of borrowing. For example, lending to the power sector in the RBI’s classification encompasses hydropower generation, coal-fired power generation and transmission lines. For these reasons, the bottom-up approach using individual firm-level borrowing is important, to ground-truth the sector-level findings. The tables do not consider loan or bond issuance to India’s substantial non-banking financing companies (NBFCs) or to the venture capital sector, which lend to sectors like agriculture, housing and energy that face climate transition and physical risks.

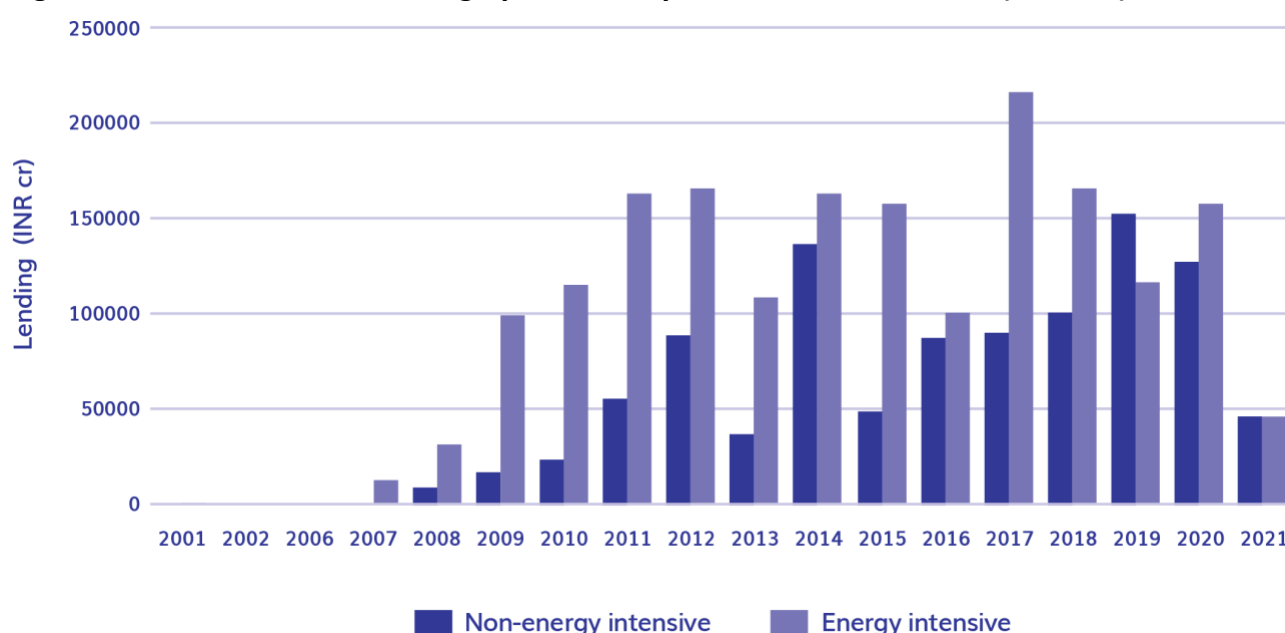
Data on individual financial transactions for the **bottom-up approach** were extracted from two commercial databases, on bonds (Bloomberg) and loans (Refinitiv). In both cases, we extracted data

about the borrowing firm, its sector and the size, currency and tenor of the loan for each deal/tranche. Geographic information to identify the location of the firm was sought – since this might be relevant to physical climate risks – but was unavailable. The Bloomberg data on loans include only the outstanding balance of the debt, which is the correct valuation to assess exposure. However, the loans data were highly incomplete, with just 58 loans listed on the database (typically the syndicated loans).

We therefore additionally extracted a total of 2,232 loan records from the Refinitiv database, covering Rs 31 lakh crore (\$444 billion) of loans from 1,185 different borrowers valued at the time the loan was taken out. The database is not updated as loans are repaid, and so it exaggerates current exposure. By way of comparison, total bank lending, including lending to small borrowers like households and farmers, was Rs 108 lakh crore in April 2021.

Figure 2 shows the vintage of loans for energy-intensive and non-energy-intensive sectors between 2001 and July 2021 when the data were extracted. As most Indian loans are repaid or refinanced before 13 years have elapsed, few loans remain on Indian banks' books from before 2008.

Figure 2: Annual volume of lending by loan issue year – all loans extracted (Rs crore)



Source: Refinitiv database, analysis by CBI

We extracted all loans on the Refinitiv database. In the analysis in our findings below (Section 2.2), we focus on rupee-denominated loans in four sectors: (1) agriculture; (2) energy-intensive manufacturing (chemicals, petroleum, primary metals and building materials/cement); (3) mining; and (4) electricity and gas. The Refinitiv dataset includes three different industrial classification systems for each loan: the North American Industry Classification System (NAIC), the Standard Industrial Classification (SIC) (used by the India's National Statistical Office) and its own sectoral categorisation. The latter two provide a high level of industrial disaggregation to categorise each borrower. Refinitiv's proprietary classification, unlike that of SIC, distinguishes between firms in the electricity production sector that use different energy sources.

Both databases have gaps in their coverage, as they do not capture all deals. Table 2 sets out discrepancies between the datasets for key sectors, enabling a comparison of the two commercial databases with the data that the RBI receives from bank filings. This reveals that Refinitiv has much better coverage of loans than Bloomberg does, but also reveals that Bloomberg provides valuable information on bond issuance. Unfortunately, it is not possible to cross-check Bloomberg's coverage as the RBI does not publish any information on bond issuances. The Securities and Exchange Board of India (SEBI) provides an overview of the stock of rupee corporate bonds on a quarterly basis. This stood at Rs 37 lakh crore in September 2021. The energy-intensive sectors account for Rs 3.0 lakh crore of corporate issuance; of this, Rs 1.9 lakh crore was issued to the power sector and 1.1 lakh crore to the mining, oil and chemicals sector (see Table 2 below; data extracted from SEBI, 2021). There is also issuance in the financial sector through specialist NBFCs like the Rural Electrification Corporation (REC) and the Power Finance Corporation (PFC), which between them have issued Rs 0.26 lakh crore since 2011. The SEBI data do not reveal how much of this is still outstanding.

Table 2: Data on financial holdings in the power, mining and manufacturing sectors using different sources

Data source	Instrument	Securities	Value (Rs crore)	Value (\$ million)	Coverage by data source (%)
Power sector					
RBI	Loans	NA	566,660	75,555	100
Bloomberg	Loans	56	96,446	12,860	17
Refinitiv	Loans	598	665,648*	88,753*	117*
Bloomberg	Bonds	506	198,094	26,493	NA
Mining, oil and gas refining, chemicals					
RBI	Loans	NA	353,734	47,165	100
Bloomberg	Loans	2	2,360	315	1
Refinitiv	Loans	134	261,203	34,827	74
Bloomberg	Bonds	79	121,235	16,165	NA

Note: *Valued when the tranche was borrowed; no allowance is made for the amortisation of the loan, so '%' is an upper-bound estimate. Data extracted for the Rs-denominated bonds and loans.

Source: Bloomberg (2021); RBI (2021c); Refinitiv (2021).

Table 2 indicates that the bottom-up Refinitiv loans data sum to 117% of the RBI's 'control total' for power, and 74% for some of the other energy-intensive sectors/fossil fuel supply chain. It exceeds the RBI's total as the Refinitiv data are for the original value of loans and do not correct for amortisation.

2.2 Findings

2.2.1 Top-down analysis

Table 3 summarises data on India's emissions, gross outstanding debt and GVA by sector. We were able to map Rs 7.6 lakh crore to UNFCCC sectors, out of the Rs 10.8 lakh crore (\$1.44 trillion) that Indian banks had in outstanding credit in April 2021. Remaining debt was largely to households and could not be attributed to home or car loans. This mapping was viable for around 90% of India's GHG emissions. The remaining 10% of emissions arose in UNFCCC sectors like waste, railways and 'non-specific industry' that could not be matched to the RBI's outstanding credit data. Sectors with

high emission or debt intensity are likely to face greater low-carbon transition risk than those in lower-carbon sectors or with more robust balance sheets. The top three sectors in each category are underlined in the Table.

Table 3: Greenhouse gas emissions, gross outstanding debt and gross value added by sector

UNFCCC sector as defined in inventory	GHG emissions, 2016 (GtCO ₂ e)	Gross outstanding credit, 2021 (Rs crore)	GVA, 2021 (Rs crore)	Emissions intensity (GtCO ₂ e/Rs crore)	Debt intensity
Electricity production	<u>1,127,732</u>	566,660	300,532	<u>3.752</u>	<u>1.886</u>
Agricultural/fisheries	<u>425,053</u>	<u>1,291,299</u>	<u>1,968,571</u>	0.216	0.656
Road transport ¹	<u>247,594</u>	386,412	431,820	0.573	0.895
Cement ²	160,249	50,275	156,264	<u>1.026</u>	0.322
Iron and steel	138,116	216,918	205,036	0.674	1.058
Residential	127,282	<u>1,461,491</u>	<u>2,121,765</u>	0.060	0.689
Refinery and solid fuel production	71,931	66,085	119,912	0.600	0.551
Commercials/institutional	68,976	<u>2,560,628</u>	<u>3,803,664</u>	0.018	0.673
Chemicals	52,606	243,241	241,158	0.218	1.009
Nonferrous metals	45,822	94,785	55,124	0.831	<u>1.719</u>
Non-metallic minerals	28,480	94,785	156,264	0.182	0.607
Civil aviation	16,284	26,309	9,151	<u>1.779</u>	<u>2.875</u>
Mining and quarrying (including coal)	4,096	44,408	322,116	0.013	0.138
Navigation	2,944	5,409	13,007	0.226	0.416
Pulp and paper	2,633	35,542	41,998	0.063	0.846
Textile/leather	2,310	216,120	290,102	0.008	0.745
Engineering sector	1,632	231,058	665,159	0.002	0.347
Glass/ceramic	397	9,124	20,207	0.020	0.452
Total in mapped sectors	2,524,137	7,600,548	10,921,850	0.231	0.696
Total for India	2,833,333	10,860,425			

Note: *Lending for auto-loans and transport operators (excludes shipping and aviation); ** GVA from manufacture of other non-metallic mineral products.

Source: MoEFCC (2021); MoSPI (2021a); RBI (2021b & c).

The top-down analysis of emissions, indebtedness and GVA shows that electricity production is by far the largest source of emissions, accounting for 40% of the country's GHGs. This sector also accounts for 5.2% of outstanding credit lent by Indian banks. With high average emission intensity and levels of debt relative to GVA, firms in electricity production in India face very high low-carbon transition risks. These risks would vary substantially among firms within the sector – for instance, a generator producing coal-fired power will have high transition risks whereas those producing solar, wind or hydropower will face none.

Agriculture accounts for 15% of India's GHGs and 11.9% of credit. However, its emissions and debt levels are low relative to its large value added, which moderates the transition risk posed to the financial system. However, there is debt outside the formal banking sector, so risks lie elsewhere. Similarly, while road transport is the third largest source of emissions, low-carbon transition risks are dispersed across many millions of vehicle owners, and thus pose less of a systemic financial risk. However, the sought-after speed of India's transition to electric vehicles – 100% plug-in electric by 2030 – may itself pose risks to automobile manufacturers and firms selling auto-fuels.

A handful of energy-intensive sectors, such as cement, iron and steel, and non-ferrous metals are moderately large emitters and borrowers, with high emission and/or debt intensities. Firms in these sectors almost certainly pose a transition risk to their creditors, and possibly systemic financial risks. Civil aviation has very high indebtedness and emissions intensity but in India contributes little to overall emissions (0.6%) or borrowing (0.2%) so would not give rise to systemic financial risks.

2.2.2 Bottom-up analysis

Table 4 suggests that bank lending is a more important source of finance for high-carbon sectors than bond issuance: the value of loans to the power sector (Rs 5.6 lakh crore) is almost three times that of total bond issuances (Rs 2 lakh crore), with a similar ratio in chemicals and oil and gas extraction. Relatedly, loans are far more widely used than bonds for corporate funding needs, with just 30 corporate issuers of rupee debt in our focus sectors, compared with 1,185 borrowers. We therefore consider lending first, followed by bond issuance.

Table 4 shows total rupee and foreign currency borrowing for the selected industries. Altogether, we identified 715 loans from 412 firms within these sectors with total borrowing of Rs 11.6 lakh crore (\$155 billion) with an average loan of Rs 1,627 crore (\$217 million). These loans account for around 11% of outstanding debt from Indian banks. As well as the loans shown in Table 4, there were 101 renewable electricity generators, which borrowed a total of Rs 1.1 lakh crore (\$15 billion).

Table 4: Total value of borrowing* by high-carbon sectors in 2021 (Rs crore)

Sector (SIC-2-digit)	Indian rupee	Foreign currency	Grand total
Manufacturing	433,484	139,248	572,732
Chemicals and allied products	52,518	66,380	118,898
Fabricated metal products, ex. machinery and transportation equipment	20,504	0	20,504
Petroleum refining and related industries	98,351	30,909	129,260
Primary metal industries	225,359	41,211	266,570
Stone, clay, glass and concrete products	36,752	748	37,500
Mining	109,611	247,281	356,892
Coal mining	8,565	0	8,565
Metal mining	28,581	1,391	29,972
Mining and quarrying of non-metallic minerals, ex. fuels	3,158	0	3,158
Oil and gas extraction	69,307	245,890	315,198
Nondurable goods	500	0	500
Chemicals and allied products	300	0	300
Petroleum and petroleum products	200	0	200
Transportation, communications, electric, gas and sanitary services	7,12,471	1,51,686	8,64,156
Electric, gas and sanitary services	6,92,174	1,51,686	8,43,860
Pipelines, ex. natural gas	20,297	0	20,297
Grand total	1,256,065	538,215	1,794,280

Note: Value based on the original value of loan, no adjustment for amortisation.

Source: Refinitiv (2021).

Although the agriculture sector accounts for a large share of total outstanding credit (see Table 3), it represents only a small proportion of lending in the Refinitiv database because the database focuses on corporate loans.

Lending in Indian rupees is dominated by the utilities sector (electric, gas and pipelines), with Rs 5.8 lakh crore (\$77 billion) of borrowing. It is followed by the primary metal industry, with Rs 2.2 lakh crore (\$30 billion) of loans. Firms in the oil and gas extraction sector collectively borrow more than those in the primary metal industry, but they rely on foreign debt, with just Rs 0.67 lakh crore (\$9 billion) of their \$42 billion funded by local banks.

The SIC classification does not distinguish between different energy sources used to generate electricity. Therefore, utilities in Table 4 includes renewable energy companies that are not exposed to low-carbon transition risks. Refinitiv's proprietary industrial classification system has a more disaggregated breakdown of the power sector (and its equipment supply chain), allowing us to tease out 'green' businesses (see Table 5).

Table 5: Value of domestic currency borrowing by electric utilities and equipment suppliers (Rs crore)

Electrical subsector (Refinitiv business classes)	Electric and other services combined	Electric services	Total
Electrical utilities (not mentioned below)	67,135	448,100	5,15,228
Alternative electric utilities	0	292	292
Hydroelectric and tidal utilities	8,833	20,456	29,297
Renewable energy equipment and services	0	25,752	25,752
Renewable energy services	0	1,593	1,593
Renewable independent power producers	0	13,927	13,927
Solar electric utilities	1,780	14,675	16,455
Wind electric utilities	337	14,869	15,206
Wind systems and equipment	0	6,245	6,245
Grand total	78,093	5,45,901	6,23,994

Source: Refinitiv (2021).

Table 5 shows that electricity generation and equipment firms have borrowed Rs 6.2 lakh crore (\$83 billion).¹ The majority, 83%, is lent to utilities like NTPC that generate electricity from fossil fuels and renewables (primarily the former); the balance of 17% is to utilities that generate power exclusively from renewables or supply equipment to the power sector, a fast-growing segment of the market. More is lent to older hydropower firms, like Jaiprakash Power Ventures and JSW Hydro, than to emerging players in solar and wind. Suppliers to renewable electricity and manufacturers of solar and wind equipment borrowed Rs 0.33 lakh crore (\$4.5 billion).

Table 6 gives information about the largest borrowers in fossil fuel-intensive sectors. We see their borrowing is equally split between foreign currency borrowing (especially for Reliance Industries) and Indian rupee borrowing. The large borrowers are from the oil and gas and the iron and steel industries. Many different electricity generators and distribution companies borrow money so do not feature among the biggest individual bank borrowers. Oil and gas businesses borrow mainly from foreign banks, which at least reduces the exposure of Indian financial institutions to their low-carbon transition risk.

¹ The loans would mostly be included in the Electric, gas and sanitary services row of Table 4, except for Rs 31 crore that would sit under Equipment.

Table 6: Value of borrowing by top 10 energy-intensive sector borrowers (Rs crore)

Company	Indian rupee	Foreign currency	Grand total	Sector	Share of Rs issuance (%)
Reliance Industries Ltd	-	123,080	123,080	Oil and gas refining and marketing	0
Tata Steel Ltd	48,700	4,570	53,270	Iron and steel	91
Bharat Petro resources Ltd	-	52,583	52,583	Oil and gas exploration and production	0
HPCL-Mittal Energy Ltd	38,145	3,254	41,399	Oil and gas refining and marketing	92
Hindalco Industries Ltd	36,268	3,740	40,007	Aluminium	91
ONGC Petro Additions Ltd	36,006	1,870	37,876	Petroleum refining	95
Sasan Power Ltd	23,168	13,089	36,257	Fossil fuel electric utilities	64
Indian Oil Corporation Ltd	14,900	17,203	32,103	Oil and gas refining and marketing	46
HPCL Rajasthan Refinery Ltd	28,753	-	28,753	Petroleum refining	100
ONGCVidesh Ltd	-	27,530	27,530	Integrated oil and gas	0
Grand total	225,940	246,918	472,858		48

Source: Bloomberg Finance L.P. data, accessed 3 June 2021.

In addition to considering bank lending, we examined the value of outstanding bonds issued by firms in the sectors facing high low-carbon transition risk – namely, energy utilities, extraction of fossil fuels and chemicals. These sectors account for the vast majority of Indian corporate bond issuance.

Table 7: Value of outstanding rupee- and foreign-denominated bond issuance by energy-intensive sector in 2021 (Rs crore)

Sector	Indian rupee	Foreign currency	Total
Utilities			
Electric utilities	104,884	10,980	115,864
Independent power and renewables	92,663	26,096	118,758
Gas utilities	598	0	598
Extraction of fossil fuels	-	-	-
Oil, gas and consumable fuels	115,340	79,454	194,794
Oil and gas storage and transportation	2,730	0	2,730
Chemicals	-	-	-
Diversified chemicals	202	0	202
Chemicals	2,034	0	2,034
Total	318,452	116,530	434,981

Source: Bloomberg Finance L.P. data, accessed 3 June 2021.

Around 73% of energy-intensive sector corporate bonds are denominated in Indian rupees. These are likely to sit on the balance sheets of Indian mutual funds, insurance funds and banks. Foreign currency bonds account for the remaining 27% of debt issued and are likely to be held by foreign investors.

Looking at the sectors in which bonds are issued, it is clear that purchasers of Indian corporate bonds (the majority of which are Indian financial institutions) are heavily exposed to transition risks. The utilities sector, specifically the power utilities, is the largest issuer of corporate bonds, accounting for \$26 billion of domestic currency issuance. This is split between electric utilities responsible for the generation, transmission and distribution of power and independent power producers that only generate electricity. This is evidenced in Table 8, which lists the 10 largest outstanding corporate bond issuances. The top three companies account for over 70% of the rupee issuance; two (Reliance Industries and NTPC) are heavily dependent on fossil fuels. Reliance Industries specialises upstream in oil and gas exploration and production. Three other firms in the top 10 are predominantly in oil

refining and retail. Only two of the top 10 bond issuers do not necessarily face transition risks. NHPC (formerly the National Hydro Power Corporation) produces clean electricity, while the Power Grid Corp is a transmission company and will have a vital role to play in a low-carbon energy transition.

Table 8: Top 10 firms in emission-intensive sectors in terms of outstanding bond issuance (Rs crore)

	Company	Indian rupee	Foreign currency	Grand total	Sector	Share of Rs issuance (%)
1	Reliance Industries Ltd	73,373	37,741	111,114	Energy	23
2	Power Grid Corp of India	90,830	3,740	94,568	Utilities	29
3	NTPC	63,777	25,340	89,118	Utilities	20
4	Indian Oil Corp	16,230	16,657	32,890	Energy	5
5	NHPC	22,087	0	22,086	Utilities	7
6	Hindustan Petroleum Corp	13,014	3,740	16,754	Energy	4
7	Bharat Petroleum Corp	4,562	11,219	15,785	Energy	1
8	Tata Power Co Ltd	9,865	0	9,868	Utilities	3
9	Oil India Ltd	-	7,853	7,853	Energy	0
10	Adani Transmission Ltd	165	7,240	7,404	Electric utilities	0
	Remaining 20 issuers	24,540	2,999	27,541		8
	Total	318,452	116,530	434,980		

Source: Bloomberg Finance L.P. data, accessed 3 June 2021.

To explore financial sector exposure to physical climate risks, we considered outstanding credit in the agriculture sector. Table 9 presents the 10 states with the largest volume of outstanding agricultural loans. It also includes an indicator of that state's vulnerability to climate risks. Of the 10 states with the largest agricultural borrowing, only West Bengal is also considered highly vulnerable to climate risks. However, it is important to recognise that this categorisation of vulnerability by the National Bank for Agriculture and Rural Development (NABARD) is a relative measure: states with 'low' vulnerability to climate risks are still vulnerable in an absolute sense. Moreover, there may be confounding factors. For example, farmers in states with high frequency of extreme weather events may be considered less creditworthy and therefore have less access to finance, which would explain why states with 'high' vulnerability also have less outstanding credit. It is worth stressing that climate risks are growing disproportionately, and historical data do not necessarily represent a good guide to future impacts. For instance, Chennai and Mumbai have recently experienced severe extreme weather events despite Tamil Nadu and Maharashtra being classified as 'low' vulnerability.

Table 9: Outstanding agriculture credit vs. climate risk vulnerability, by state

State	Outstanding credit (Rs crore)	Vulnerability to climate risk
Tamil Nadu	421,171	Low
Andhra Pradesh	264,201	Moderate
Uttar Pradesh	224,772	Moderate
Maharashtra	201,664	Low
Karnataka	195,110	Moderate
Rajasthan	168,703	Moderate
Madhya Pradesh	145,831	Moderate
Kerala	139,494	Low
Telangana	121,017	Low
Punjab	120,150	Low
Gujarat	118,892	Moderate
West Bengal	84,644	High
Total	2,205,649	

Source: RBI (2021c); NABARD (2020).

This chapter has looked at data on Indian bank lending and bond issuance to sectors that are vulnerable to low-carbon transition risk. The power sector is of particular importance because of the very significant extra new funding needs. Our major findings are as follows:

- The energy-intensive sectors of manufacturing (chemicals, petroleum, primary metals and building materials/cement), mining, and electricity and gas account for 60% of emissions.
- Collectively, these borrow Rs 12.3 lakh crore. This is around 12% of all Indian bank lending and 40% of lending to large corporates (as recorded on the Refinitiv database). Foreign currency borrowing is a further Rs 5.4 lakh crore.
- Bonds issued by the power and oil sectors were roughly one-third of the value of borrowing from banks.
- Lending to electrical utilities is 6.2 lakh crore, of which only 17% is to renewable energy companies.
- There is also further exposure through agricultural loans (17% of credit), which are a major source of emissions and also vulnerable to physical risks.
- Rupee loans are highly concentrated in a small number of large borrowers in the oil and refining sector. The power sector borrowers, though in aggregate very large, consist of many loans to power generators and distribution companies that cannot rely directly on foreign lending.

3. Review of the Reserve Bank of India's mandate and policies

This chapter looks at the RBI's mandate and the reasons that it is increasingly beginning to factor climate change into its operations. We review some of the research that the RBI has already conducted in this area, and its decision in April 2021 to join the NGFS. The chapter goes on to look at the background and developments in the sustainable finance strategy currently being developed by the RBI together with SEBI and financial regulators. This overview can reveal critical gaps in the regulatory landscape as well as which policy instruments might be available and appropriate to manage climate-related financial risks in an Indian context.

3.1 The RBI's mandate and climate-related risks

There are broadly three reasons why the RBI should look at climate change and associated risks: price stability, financial stability and – most recently – the opportunity to use Covid-19 stimulus measures to forge a rapid and sustainable economic recovery.

3.1.1 Price stability

The RBI's mandate outlined in the *RBI of India Act 1934* (and amended in the *Finance Act 2016* when the new inflation targeting framework was introduced (RBI, 2020)) is:

To regulate the issue of Bank notes and keeping the reserves with a view to securing monetary stability in India and generally to operate the currency and credit system of the country to its advantage; to have a modern monetary policy framework to meet the challenge of an increasingly complex economy; to maintain price stability while keeping in mind the objective of growth.

Price stability – that is, stable prices and market confidence in the external value of the rupee – is therefore the primary purpose of the RBI. Recent inflation rates are presented in Figure 3 for information.

The monetary policy framework of India has evolved over recent decades from a monetary-targeting regime in the mid-1980s to a flexible inflation-targeting regime introduced in 2016. The inflation target is based on the Headline Consumer Price Index (CPI combined) and set by the Government of India at 4% with a +/- 2% tolerance band and for a five-year period from August 2016 to March 2021. The tolerance band is a unique feature, reflecting the incidence of supply and external shocks to headline inflation in India. The repo rate (i.e. the interest rate at which the RBI lends to financial institutions) is set by a six-member Monetary Policy Committee, which is required to meet four times a year, although it has usually met on a bi-monthly basis.

Figure 3: Consumer Price Index inflation rate, 2016–2021

CPI Inflation Rate 2016-2021



Source: MoSPI (2021b) Open Data Portal

The physical impacts of climate change are already affecting price stability in India. The timing and precipitation levels of the southwest monsoon season, which runs from June to September, are already shifting. The changing weather is affecting crop yields and thus food prices (Soora et al., 2013; BIRTHAL et al., 2014), including for staples like onions, tomatoes and potatoes, which have a large weight in the CPI basket. As global average temperatures continue to rise, upward pressure on food prices, and increasing volatility around this upward trend, will make it difficult to meet domestic CPI inflation targets. Other climate-related shocks and stresses may also affect production, with downstream impacts on price stability. Extreme flooding in northern Thailand in 2011, for example, severely disrupted electronics manufacturing, causing a global spike in the price of cars and computers. Severe weather events such as extreme heat are already among the main causes of power outages worldwide (Nicolas et al., 2019), creating productivity shocks that lead to higher prices.

Low-carbon transition risk could quite likely jeopardise price stability in India in the not-too-distant future. This is perhaps particularly apparent in the power generation sector, where the unexpected retirement of coal-fired power plants or natural gas shortages could lead to spikes in electricity prices. In 2021, under-investment in new gas production, geopolitical tensions and supply chain disruptions caused power crunches across Asia and Europe, underscoring the vulnerability of fossil fuel dependence (Twidale, 2022). Looking forward, the global coal phase-out may increase the level and volatility of gas prices. In this way, low-carbon measures abroad can also affect price stability within India.

3.1.2 Financial stability

The RBI supervises and regulates financial institutions operating in India to ensure they have sufficient liquidity and capital to protect against economic and financial shocks. The RBI is also the lender of last resort for Indian financial institutions if their failure to access credit will threaten the wider financial system. This role underpins a second reason that central banks are starting to pay attention to climate risks: financial stability.

According to a recent keynote address² delivered by Mr. M. Rajeshwar Rao, Deputy Governor, Reserve Bank of India (Rao, 2013):

Uncertainty around the severity and timing of climate and environment related impact is a source of financial risk and may have a bearing on the safety and soundness of individual financial institutions.

Our analysis in Chapter 2 demonstrates that the Indian financial sector is exposed to physical risks (through loans to the agriculture sector) and low-carbon transition risk (through loans and bond purchases to high-carbon sectors). Some financial institutions will inevitably be more exposed than others, either because they are based in highly vulnerable regions or because they have specialised in particular types of loans and investments prone to climate risk. A prolonged spell of extreme weather or a sudden realisation that climate risks are material could lead to a disorderly correction in key market segments (a so-called ‘Minsky moment’), creating stranded assets and balance sheet losses. Some Indian financial institutions have added climate emissions to the materiality matrix of their sustainability reports this current financial year.

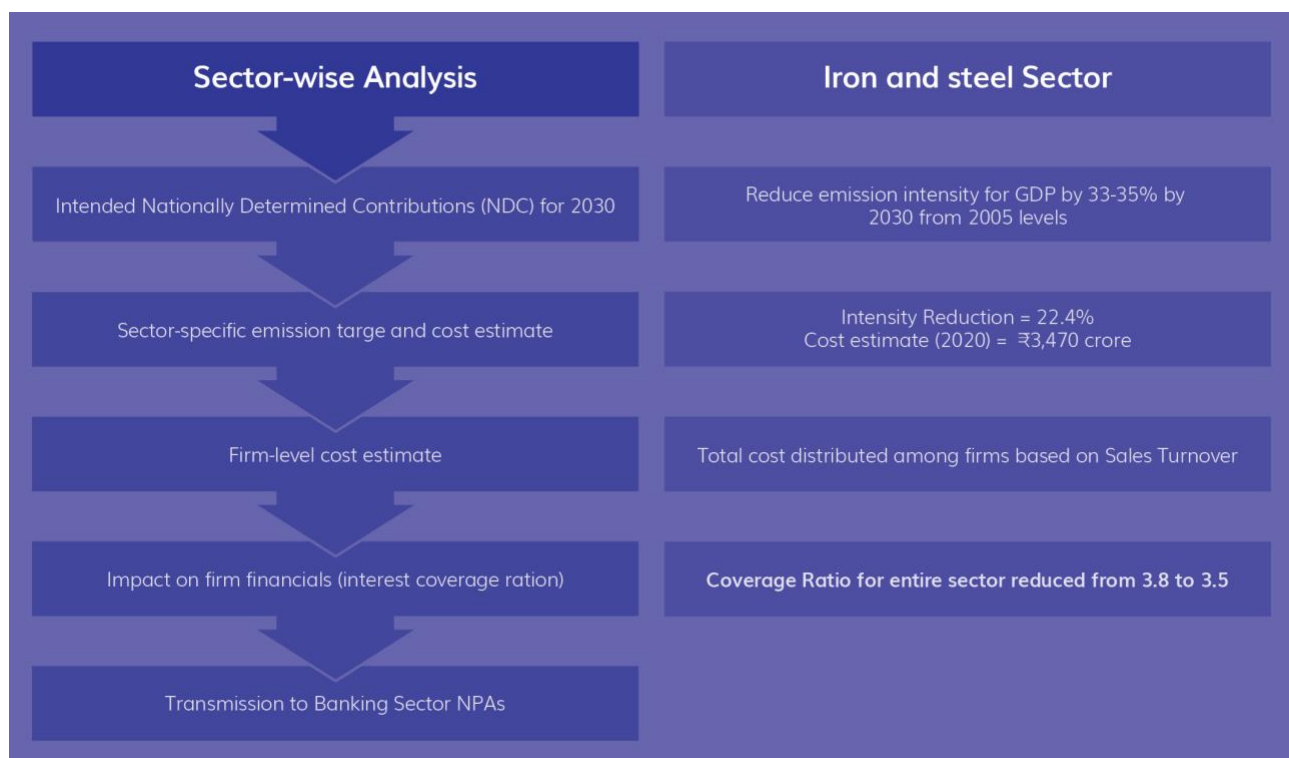
In his recent speech, Deputy Governor of the RBI, Mr Mahesh Kumar Jain, Deputy Governor, Reserve Bank of India drew an important distinction between a stable financial system and a resilient one (Jain, 2021). While a stable financial system is able to withstand shocks, a resilient financial system ‘will be able to adapt and reconfigure itself in response to a shock in addition to absorbing it’. The speech outlined the 3As of resilience: anticipatory capacity, absorptive capacity and adaptive capacity. Central banks and regulators enhance anticipatory capacity through risk disclosure requirements and supervisory stress testing and build absorptive capacity through micro-prudential regulations relating to minimum capital and liquidity requirements. The impact of climate-related risks can be treated in a similar way to other macroeconomic and financial risks – though there is more work to be done on identifying and quantifying climate-related risks, as well as understanding how they intersect with each other and other kinds of financial risks.

The RBI has accordingly carried out some exploratory scenario building and stress testing for the iron and steel sector. It recently published a top-down assessment of technology-related transition costs in these sectors, looking at the impact of emissions reduction targets on profitability. The RBI

² Heed to Heal - Climate Change is the Emerging Financial Risk (Keynote Address delivered by Mr. M. Rajeshwar Rao, Deputy Governor, Reserve Bank of India on September 16, 2021 - at the CAFRAL Virtual Conference on Green and Sustainable Finance). The address can be accessed at the following link https://rbi.org.in/Scripts/BS_SpeechesView.aspx?Id=1127

assumed an emissions intensity reduction of 22.4% in the iron and steel sector by 2030 compared with 2005. It found that low-carbon measures would reduce the operating profit coverage ratio (operating profit/interest cost) to 3.5 from 3.8 for the sectors taken together (see Figure 4). This is a useful exercise in understanding the consequences of emissions reduction pathways on the profitability of energy-intensive sectors of the economy and working through the impacts on the financial sector.

Figure 4: Iron and steel industry impact assessment process



Source: RBI (2021d).

3.1.3 Covid-19 recovery: build back better

The Covid-19 pandemic has devastated lives and economies across the world. However, it also provides a unique opportunity for central banks and other financial regulators to steer economic development towards a more sustainable path – to ‘build back better’.

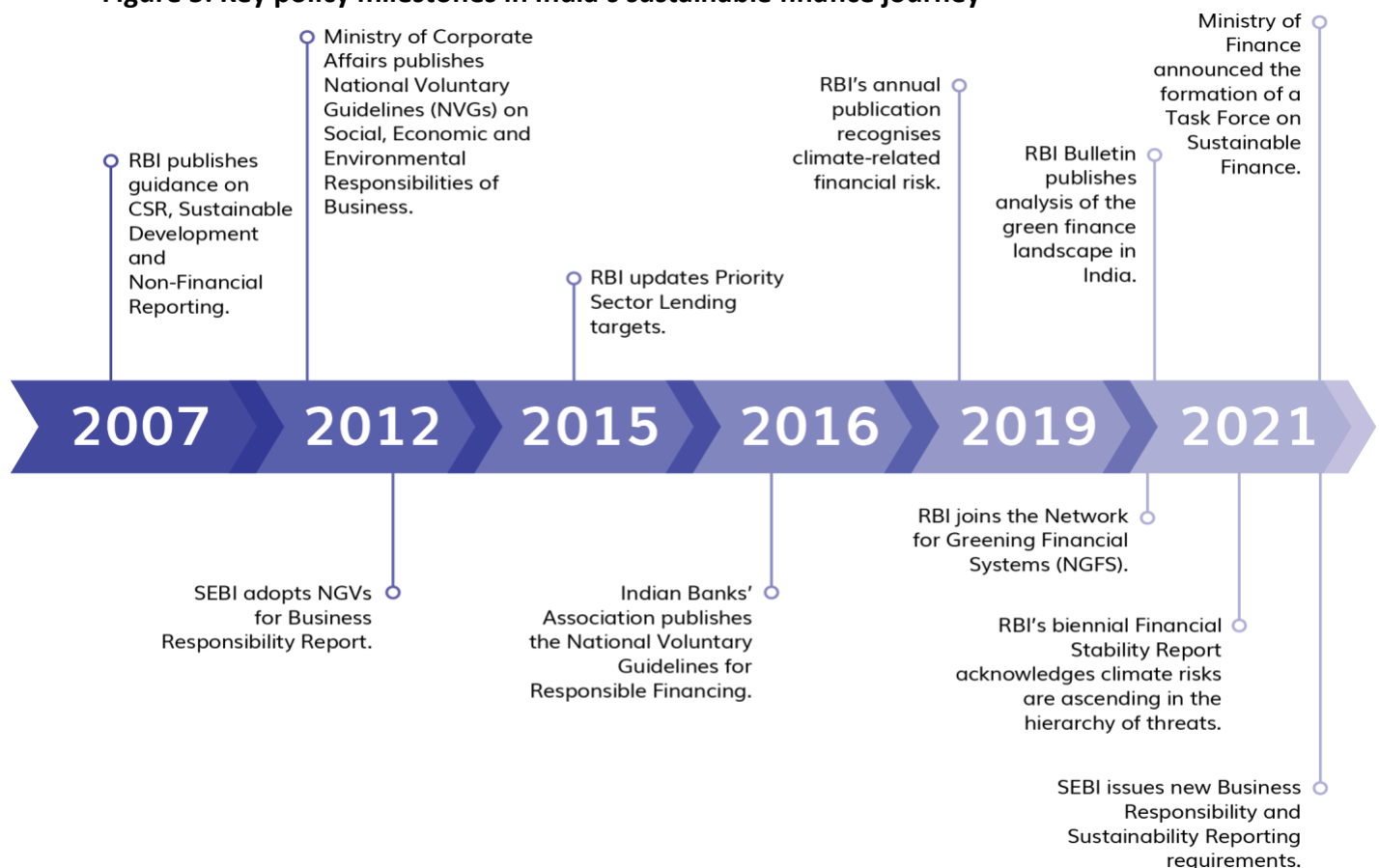
To date, central banks have deployed liquidity measures, general easing of credit constraints (especially to crisis-hit sectors) and stimulus spending. The RBI has employed some of these types of measures to alleviate stress in some areas of the economy and financial sector, including liquidity-enhancing measures, easing of collateral constraints and loan moratoria. However, less than 1% of central banks have taken environmental, social or climate-related risks into account as they have responded to the pandemic (Dikau et al., 2020). This is what Fiji has done, raising its import substitution and export finance facility to provide renewable energy businesses, among others, a concessional rate. More often than not, the purpose of the intervention has been to increase liquidity and increase economic activity irrespective of the sector.

Given that less than a quarter of India's population are fully vaccinated at the time of writing, there are likely to be future waves of Covid-19 – possibly caused by new variants. Moreover, the Indian economy saw the largest overall contraction in the country's history in 2020/21, and is still recovering. The RBI therefore still has time to calibrate its response and recovery measures to manage climate risks. This is important because the magnitude and breath of measures taken by central banks in response to Covid-19 will have long-lasting effects on national economies.

3.2 The Reserve Bank of India's climate-related policies

The above section recapped the reasons that the RBI cares about climate change. This section reviews the RBI's efforts to address environmental concerns to date, as well as the role it is playing in India's emerging sustainable finance strategy.

Figure 5: Key policy milestones in India's sustainable finance journey



Source: Authors

3.2.1 Early cognisance and cautious engagement (2007–2012)

The RBI was the first regulator in India to put out advice on corporate social responsibility (CSR), sustainable development and non-financial reporting. This was as far back as a decade and a half ago, in 2007, and years before the domestic corporate sector and the government began to consider

environmental, social and governance (ESG) issues systematically through market and policy interventions. The RBI set out the relevance of ESG for the financial sector drawing lessons from international good practice and voluntary frameworks. For example, it drew on the Global Reporting Initiative (GRI) on ESG disclosures, on the International Finance Corporation (IFC) Equator Principles on environmental and social performance standards for project finance and on the Kyoto Protocol on carbon markets as credible and sufficient market instruments to tackle global warming.

In Section 5.3 of the 27-page enclosure accompanying the 2007 circular (RBI, 2007), the RBI notes that:

... the banking and finance's immediate environmental and social impacts are relatively low because most of those impacts are delivered through the activities of other businesses that rely on financial institutions – the businesses in a loan or investment portfolio. However, despite the relatively indirect nature of their environmental and social impacts, banks need to examine the effects of their lending and investment decisions.

It suggests that overlooking sustainability could transfer risks to financial institutions through, for example, higher loan defaults, falls in the value of financial assets, liability for damages arising from negligent investment advice and loss of reputation and standing as a result of association with polluting businesses. The circular advises that progress made on CSR and sustainable development 'could' be placed in the public domain along with the annual accounts of banks. However, voluntary disclosures under GRI were limited to a handful of companies, and only three financial institutions produced a sustainability report.

3.2.2 Discourse on sustainable finance picks up (2012–2019)

India became a signatory to the Paris Agreement and the Sustainable Development Goals in 2015, which gave a fillip to efforts at aligning finance with these issues. Domestically, the experience with the National Voluntary Guidelines on Social, Economic and Environmental Responsibilities of Business (commonly known as the NVGs) and Business Responsibility Reporting (BRR), released in 2012, generated a degree of awareness as well. But a large majority of financial institutions regarded sustainability or ESG concerns as peripheral to their core business of lending and investment.

As ESG focused on the risk management and performance of financial institutions, it was almost always considered onerous, as it demanded that additional considerations be integrated into the credit appraisal functions of banks. Green finance, on the other hand, focused on opportunities for mobilising and allocating capital. Not only markets but also governments started to pick up on the trend. The G20 established a Green Finance Study Group (GFSG) comprising ministries of finance and central banks, which identified ways to mainstream green finance. The RBI contributed to this process and mentioned the findings of the GFSG in its 2016 annual report as part of its information dissemination function.

Around the same time, the RBI acted as an observer on the development of the Responsible Financing Guidelines, developed by the Indian Banks' Association through a consultative process

with banks and non-banking financial institutions and communicated that it would develop a green finance strategy as the next step to its GFSG involvement, gathering inputs from the IBA.

Looking at 2018/19, the RBI noted the risk of climate change for financial assets and the need to accelerate green finance for environment-friendly sustainable development (RBI, 2019b). Among the top challenges, the report lists 'greenwashing' or false claims of environmental compliance, plurality of definitions and maturity mismatches between long-term green investment and short-term interests of investors, and notes the need for more coordinated policy action.

This period of the RBI's engagement on environmental risks can be described as light touch, with increasing awareness of international discussions.

3.2.3 Increasing momentum (2020 onward)

In January 2021, a Task Force on Sustainable Finance has been set up by the Department of Economic Affairs, Ministry of Finance, Government of India. The Terms of Reference of the Task Force include defining the framework for sustainable finance in India, establishing the pillars for a sustainable finance roadmap, suggesting draft taxonomy of sustainable activities and a framework of risk assessment by the financial sector. The Taskforce includes the RBI, alongside SEBI, the Pension Fund Regulatory and Development Authority (PFRDA) and the Insurance Regulatory and Development Authority of India (IRDAI). The work of the Taskforce is further divided into four working groups: sustainable taxonomy, disclosure regulations, a roadmap and best practices. The Regulations Working Group is chaired by the RBI and looks into disclosures, risk and resilience, and specific recommendations for regulatory changes that may be considered to deliver an effective sustainable finance ecosystem. A Sustainable Finance Group was also set up in the Reserve Bank of India in May 2021 to lead its efforts and regulatory initiatives in the area of climate risk and sustainable finance.

Taxonomies are an important part of the sustainable finance agenda because they classify activities according to their environmental and social sustainability. Work on an Indian sustainable taxonomy is already well underway. This aims to combine the best-in-class international frameworks while contextualising them to India's objectives and priorities. The taxonomy has three objectives:³

1. To mobilise and allocate international and domestic capital at scale to finance India's climate, environmental and social priorities at attractive terms.
2. To enhance disclosures to track capital flows and risks to India's climate, environmental and social priorities.
3. To redesign market and policy incentive structures to contribute towards India's climate, environmental and social priorities.

³ As with the EU Taxonomy, there are three high-level principles for a sustainable activity: that it makes a substantial contribution to environmental/social objectives; does no significant harm; and ensures minimum social safeguards. The Indian taxonomy work identifies six environmental goals: climate change mitigation and adaptation/resilience; sustainable land use and management; reduction and control of land, air and water pollution; conservation, protection and restoration of biodiversity and natural ecosystems; and promotion of a circular economy. There are also three social goals to ensure a just transition for all: equitable access to health and nutrition, education and opportunities; creation of decent and sustainable livelihoods; and inclusion and empowerment of women, and marginalised and vulnerable individuals and communities.

In other countries and regions, like the EU, a taxonomy of environmentally sustainable activities has provided a framework for assessing and disclosing climate risk exposure by non-financial and financial firms, along the lines developed by the TCFD established by the Financial Stability Board of the G20 in 2015. India already has a basis for disclosure of environment risks by large companies, which could be expanded.

Three reports published in 2021 give an insight into other work by the RBI on sustainable finance. First, the RBI presented the details of its 2019 internal (unpublished) assessment of credit exposure for industry sectors dependent on fossil fuels and vulnerability of the banking sector in the face of a policy shift away from fossil fuels. The RBI analysis suggests that the direct credit outstanding of public sector banks was 6.3% in March 2019, and that of private sector banks 3.8%, hence not very significant. However, indirect exposure in all industrial sectors is high, thus moving away from fossil fuels could affect the production costs and finances of different sectors. The RBI indicates that banks with high exposure will need to systematically reduce their exposure over a period of time and should be able to assess, manage and report climate-related financial risks. It also points to the need for training and capacity-building within banks to integrate a fuller understanding of climate risks.

Second, the RBI produced a detailed analysis of the green finance landscape in India in its January 2021 Bulletin (RBI, 2021d). This acknowledges that green finance is an important means to secure long-term sustainable economic growth. The two challenges highlighted are the high borrowing cost for green bonds and weak market infrastructure. The article links high borrowing costs to information asymmetry in the market and suggests that developing a better information management system could help in reducing maturity mismatches and borrowing costs and lead to more efficient resource allocation in the green bond segment. For more robust market infrastructure, the RBI suggests: (1) increased coordination between investment and environmental policies; (2) an implementable policy framework for both national and state levels in addressing the existing frictions; (3) deepening of the corporate bond market; and (4) standardisation of green investment terminology, consistent corporate reporting and removing information asymmetries between investors and recipients.

Third, more recently, in its July 2021 Financial Stability Report, the RBI addressed and acknowledged that climate risks were ascending in the hierarchy of threats to financial stability across advanced and emerging economies alike (ibid.). For central banks, the implications of climate change for the financial system entail two major dimensions: monitoring financial entities' exposure to physical and transition climate risks as part of supervisory functions on an ongoing basis; and stress testing to measure the resilience of the system to such risks.

The analysis above suggests that the RBI is steadily informing itself through its own analysis and through engagement with international coalitions such as the NGFS and peers. Additional perspectives such as the ones presented in this report can strengthen the basis for understanding the options that it can realistically exercise in the short to medium term.

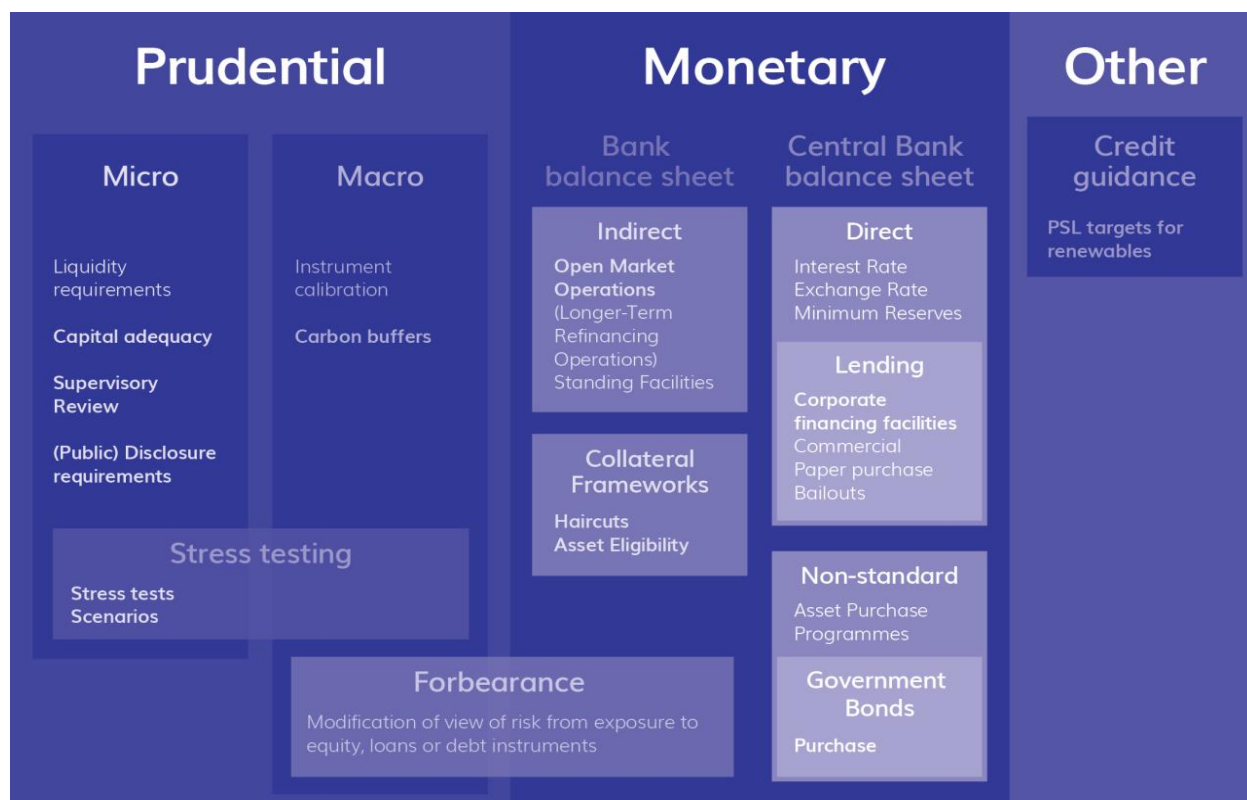
4. Assessment of international best practice

This chapter reviews the measures that central banks in different countries are taking to identify and mitigate climate-related financial risks. The NGFS has been an important platform for knowledge sharing and peer learning on these different measures, enabling central banks and other financial supervisors to go further and faster on climate change. The chapter draws on the working papers produced by the NGFS' five workstreams and papers produced by member central banks.

Central banks have a wide range of powers, including setting target interest rates (and intervening in money and financial markets to achieve the desired rates), lending to financial institutions for liquidity and settlement purposes, and supervisory and regulatory powers to ensure that individual financial institutions have sufficient capital and liquidity to cover potential losses. Their supervisory and regulatory powers constitute an extensive toolkit for achieving their given mandates of monetary and financial stability. Following the 2008/09 banking crisis and the Covid-19 pandemic, central banks around the world have more actively deployed these instruments to help stimulate economic recoveries.

Many of these tools could also be calibrated to help mitigate climate-related financial risks or 'build back better' following the pandemic (Burge et al., 2021). Figure 6 is a stylised representation of central banks' toolkits. The items in green are those tools that are or could be modified to manage climate risk (NGFS, 2020c). This section examines each basket of tools in turn: prudential regulation, monetary powers and credit guidance.

Figure 6: Policy toolkit of a stylised central bank



4.1 Prudential regulation and supervision

Prudential regulation is intended to mitigate the risks of financial instability. The Basel Committee on Banking Supervision (BCBS) is the primary body responsible for guiding the prudential regulation of banks. It has introduced Basel III, a global framework for regulating the financial sector. Basel III has three pillars: pillar 1 includes minimum capital requirements, pillar 2 includes supervisory review and pillar 3 includes market discipline. These are underpinned or enabled by improved risk disclosure requirements, which mandate banks to identify, measure and report their exposure to specific financial risks. In India, the RBI still uses the Standardised Approach and external credit ratings to inform how capital risk weights are applied.

4.1.1 Disclosure requirements

Many central banks are now expanding risk disclosure requirements to encompass the physical and/or low-carbon transition risk of climate change. Disclosure is intended to redress potential mispricing of financial assets by improving information about the risk–return ratio. Assessing climate-related risks is complicated: there are uncertainties around how physical risks will unfold; it requires assumptions about how climate policies, new technologies and consumer behaviour will evolve; and there are multiple channels of transmission between climate risks and the real economy and financial sector. As introduced in Chapter 1, the TCFD has published a comprehensive framework for non-financial and financial firms to assess, manage and disclose their climate-related risks (TCFD, 2017).

Although the TCFD’s emphasis was initially on voluntary reporting, a growing number of economies are introducing mandatory climate-related risk disclosure over the next few years. This will enable the relevant central banks to use prudential regulation, monetary policy and credit guidance to respond to climate-related risks.

The corollary of climate-related risk disclosure requirements is sustainable finance taxonomies, which provide a classification of activities that are considered environmentally positive or neutral. While risk disclosure highlights areas where financial institutions should ideally reduce their exposure, sustainable finance taxonomies highlight areas where they should preferentially direct resources. Countries and regions developing sustainable finance taxonomies include the following:

- The **EU** published its Taxonomy Regulation in 2020. The detailed science-based screening criteria map activities that make ‘a substantial contribution’ to climate mitigation and adaptation in 2021. The Taxonomy is intended to be a ‘living’ document and future work will extend it to all six of the EU environmental objectives and all of the four high-level principles underlying them.⁴ The Sustainable Finance Disclosure Regulation covers financial market participants and the Corporate Sustainability Reporting Directive will apply to non-financial companies. The UK has followed the EU requiring mandatory disclosure for large companies.

⁴ The EU Taxonomy has three high-level principles for a sustainable activity – that it makes a substantial contribution to environmental/social objectives, does no significant harm and ensures minimum social safeguards. This is complemented by six environmental objectives: climate mitigation and adaptation, sustainable use and protection of water and marine resources; transition to a circular economy; pollution prevention and control; and protection and restoration of biodiversity and ecosystems.

- **China's** work on defining sustainable activities has been geared more directly towards supporting the development of a green bond market. The People's Bank of China's Green Finance Task Force recommended the adoption of a Green Bond Endorsed Product Catalogue in China in 2015; this was updated in 2021.
- The Association of Southeast Asian Nations (**ASEAN**) region, **Canada, Japan, South Africa, Russia** and, of course, **India** are developing sustainable finance taxonomies. South Africa and Colombia draw heavily on the EU model. There is also work underway to develop taxonomies that are accepted across multiple jurisdictions, setting clear standards for green investment while allowing some flexibility for local contexts.

4.1.2 Stress testing

One of the great challenges with financial risk management is that different risks can interact, compounding the threat to financial systems. Higher energy prices can affect growth rates, reducing the capacity of firms to repay loans. For this reason, central banks and other regulators can develop scenarios to understand the extent and interplay of different risks, including those related to climate change. The NGFS has provided some high-level global scenarios looking forward to 2050, which central banks can draw on to guide national scenario development and stress testing.⁵ The scenarios are grounded in the climate, energy technology, land-use and economic models used by the Intergovernmental Panel on Climate Change (IPCC) expert working groups.

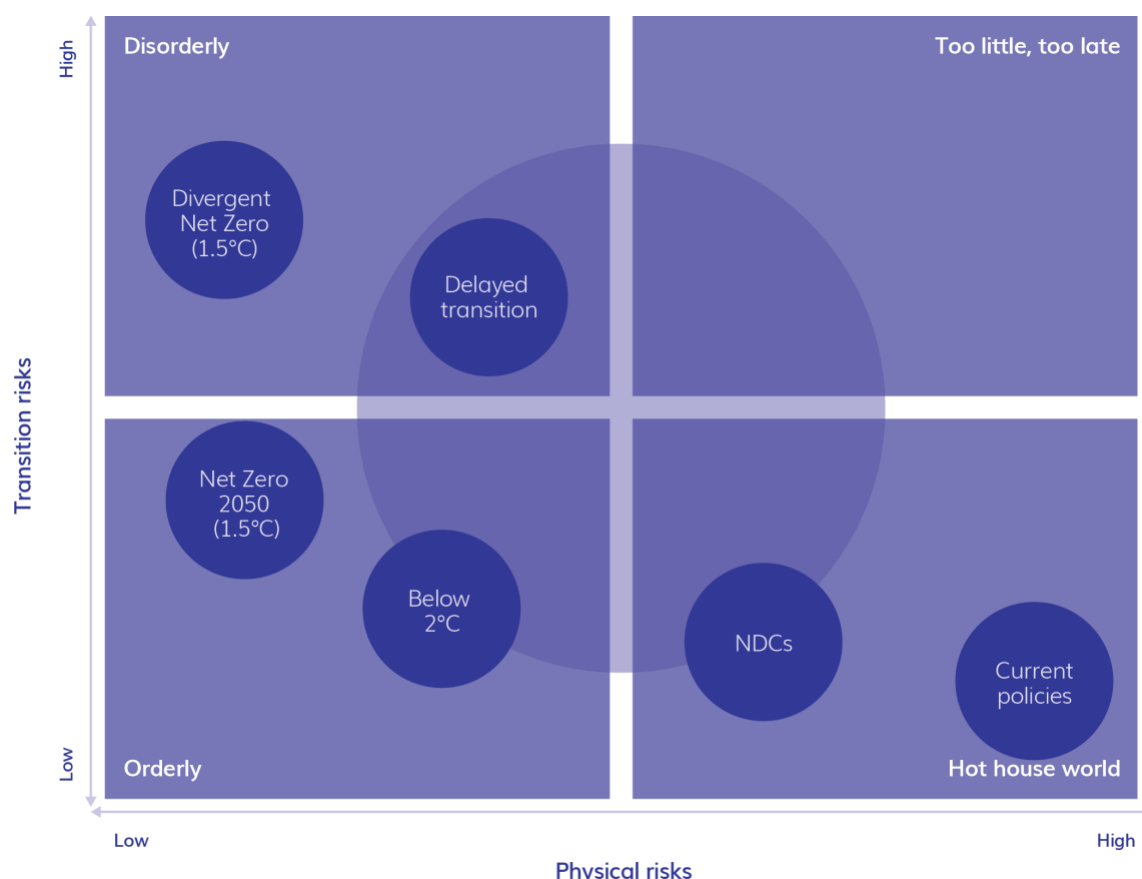
The NGFS scenarios, below, updated in 2021, underscore the trade-offs between physical and low-carbon transition risk (NGFS, 2021d). They provide supervisors with 30-year forward projections of climate mitigation policies and scenarios for how physical climate risks might unfold. Figure 7 shows the six scenarios, ranging from the 'current' (inadequate) climate policy to two 'net-zero' policies. The scenarios have been developed by a consortium of international modelling centres⁶ integrating climate, energy technology, land-use and economic models used in the IPCC expert working groups. They simplify policy initiatives to make risk analysis tractable. For instance, mitigation policy is proxied by an 'equivalent carbon tax' (through regulations, trading schemes and fossil fuel subsidy removals). Using this approach, the carbon tax to attain net zero before 2050 is an unprecedented \$700–800/tCO₂ by 2050. By way of contrast, the global average in 2019 was around \$20/tCO₂ (Burke and Byrnes, 2019). The six scenarios, which use a suite of internally consistent climatic and economic assumptions, are intended to form a common framework that central banks can use to undertake climate stress testing. Avoiding transition costs in the early years likely corresponds to higher physical climate impacts in future years, as it implies weaker efforts to cut GHG emissions. This explains why there are no scenarios with high physical and low-carbon transition risk.

A number of central banks have started developing scenarios and running stress tests for climate-related risks, although their approaches differ in terms of coverage and sophistication. Table 10 describes some of these early stress tests to provide a flavour of what they entail and the kind of information that they can uncover.

⁵ <https://www.ngfs.net/ngfs-scenarios-portal/explore/>, accessed 15 October 2021.

⁶ Climate Analytics, Eidgenössische Technische Hochschule Zürich, the Potsdam Institute for Climate Impact Research, University of Maryland, the International Institute of Applied Systems Analysis and the National Institute of Economic and Social Research.

Figure 7: Illustrative scenarios to guide stress testing by central banks and financial supervisors



Positioning of scenarios is approximate, based on an assessment of physical and transition risks out to 2100.

Source: NGFS (2021d).

Table 10: Stress testing by financial regulators and supervisors

Financial regulator or supervisor	Experience
De Nederlandsche Bank (DNB – the Netherlands)	The DNB completed a stress test for transition risks in 2018 and for physical risks in 2020. The analysis of energy transition risks modelled the impacts of policy shocks, technology shocks, double shocks and confidence shocks on the macroeconomy and financial system (DNB, 2018). The analysis of physical risks assessed the exposure of residential mortgage portfolios to flood risks (DNB, 2017). Floods with a frequency of 1/200 years to 1/1,000 years could lead to losses of €20–60 billion.
Autorité de Contrôle Prudentiel et de Résolution (ACPR – France)	The ACPR completed a pilot stress test focusing on transition risks in 2021. This focused on four sectors: mining, coking and refining, oil and agriculture. Nine banks and 15 insurance companies from France participated. The preliminary results suggest that the potential impacts in these exposed sectors defaulting is three times higher than the shock from Covid-19 in 2020 (ACPR, 2021).
European Central Bank (ECB)	The ECB conducted a stress test in 2021 assessing the physical and transition risks facing 2,000 banks and 4 million companies worldwide over a 30-year period (ECB, 2021a). This showed the heterogeneity of physical and transition risk exposure across regions, sectors and financial institutions. For example, 70% of the credit exposed to physical risks lay with just 25 firms. This stress test also explored complexities posed by coalescing of natural hazards and systemic amplifiers such as protection gaps (non-insured losses). The ECB has announced that the next supervisory stress tests in 2022 will focus on climate-related risks (ECB, 2021b).
Bank of England (BoE)	BoE is currently assessing the climate risk exposure of assets held by UK banks at the end of 2020 (BoE, 2021a). The exercise focuses on three NGFS scenarios and is intended to be a learning exercise to develop the capabilities of the participants.

4.1.3 Capital adequacy

Central banks require financial institutions to hold sufficient capital and reserves to mitigate the unexpected losses. These minimum requirements – capital adequacy ratios – are set by the prudential regulator based on a risk assessment of different types of assets. A risk weighting is applied to government bonds, corporate bonds, mortgages, unsecured loans and other types of assets, typically using historical data like credit ratings, country risk scores and historical default rates.

With climate change, historical data are unlikely to provide a reliable estimate on the likelihood of default, especially for companies whose activities are especially exposed to transition or physical risks. Central banks can add a ‘green-supporting factor’ or ‘dirty-penalising factor’ to accommodate absence or presence of low-carbon transition risk, linked to sustainable finance taxonomies; more sophisticated methods are needed to account for physical climate risks. Climate-smart risk weightings would mean that financial institutions have to set aside more of their scarce capital if they provide loans to businesses that are highly exposed to climate-related risks. Financial institutions would then raise the interest rate charged for such loans, increasing financing costs and deterring investments.

A number of central banks are adjusting or evaluating their capital adequacy ratios in response to climate-related risks. The Hungarian central bank **Magyar Nemzeti Bank** (MNB) has announced preferential capital requirements for mortgages to energy-efficient homes, loans for building retrofits (MNB, 2021b), renewable energy production and green bonds (MNB, 2019). It plans to include additional sectors that satisfy the EU Sustainable Finance Taxonomy (MNB, 2020). The governor of **Bank Negara Malaysia** (BNM) has announced that BNM is considering introducing extra capital requirements, alongside supervisory assessments, for banks that take inadequate consideration of climate risk (BNM, 2021). The **European Banking Authority** is likely to introduce ESG capital requirements when it updates its Supervisory Review and Evaluation Process, which are guidelines Europe’s financial supervisors use to assess risks faced by individual banks (Verney, 2021).

4.1.4 Carbon capital buffers

A counter-cyclical capital buffer is a mandatory capital cushion that financial institutions are required to hold, in addition to other minimum capital requirements, the rate of which the central bank varies to counteract the natural boom and bust economic cycle.

By analogy, to more effectively take account of exposure to low-carbon transition risk, central banks could introduce a carbon capital buffer, whereby financial institutions are required to hold a certain volume of capital proportionate to the emissions intensity of their portfolio. A carbon capital buffer could simultaneously provide an added layer of capital to help stabilise the financial system as transition shocks unfold and create economy-wide incentives to allocate finance away from high-carbon sectors and technologies. This instrument would particularly protect the financial sector from future ‘carbon bubbles’ – that is, allocating large amounts of credit to high-carbon assets or sectors that may be stranded as policies or markets shift. This phenomenon has often been associated with the build-up of system-wide risk (BIS, 2019). No central bank has yet implemented

a carbon capital buffer but there have been calls for their implementation (D’Orazio and Popoyan, 2019).

4.2 Monetary policy

Monetary policy seeks to maintain the rate of inflation in an economy within a target band set by government. Physical risks can lead to supply disruption, and hence price shocks, especially of food and essential commodities. Similarly, low-carbon transition risk can lead to shocks especially in fuel/energy prices.

Central banks can use monetary policy instruments to tilt the playing field towards green financial assets, and thereby reduce the cost of capital for green investments. Table 11, taken from a recent NGFS publication, provides more detail of the way central banks can use monetary policy to respond to climate risks in their economies. It is followed by examples of measures that have been actually implemented by different central banks around the world.

Table 11: Options for adjusting operational frameworks to climate risks

Credit operations ^a	
(1) Adjust pricing to reflect counterparties’ climate-related lending	Make the interest rate for central bank lending facilities conditional on the extent to which a counterparty’s lending (relative to a relevant benchmark) is contributing to climate change mitigation and/or the extent to which they are decarbonising their business model.
(2) Adjust pricing to reflect the composition of pledged collateral	Charge a lower (or higher) interest rate to counterparties that pledge a higher proportion of low-carbon (or carbon-intensive) assets as collateral or set up a credit facility (potentially at concessional rates) accessible only against low-carbon assets.
(3) Adjust counterparties’ eligibility	Make access to (some) lending facilities conditional on a counterparty’s disclosure of climate-related information or on its carbon-intensive/low-carbon/green investments.
Collateral ^b	
(4) Adjust haircuts ^c	Adjust haircuts to better account for climate-related risks. Haircuts could also be calibrated such that they go beyond what might be required from a purely risk mitigation perspective in order to incentivise the market for sustainable assets.
(5) Negative screening	Exclude otherwise eligible collateral assets, based on their issuer-level climate-related risk profile for debt securities or on the analysis of the carbon performance of underlying assets for pledged pools of loans or securitised products. This could be done in different ways, including adjusting eligibility requirements, tightening risk tolerance, introducing tighter or specific mobilisation rules, etc.
(6) Positive screening	Accept sustainable collateral so as to incentivise banks to lend or capital markets to fund projects and assets that support environmentally-friendly activities (e.g. green bonds or sustainability linked assets). This could be done in different ways, including adjusting eligibility requirements, increasing risk tolerance on a limited scale, relaxing some mobilisation rules, etc.
(7) Align collateral pools with a climate-related objective	Require counterparties to pledge collateral such that it complies with a climate-related metric at an aggregate pool level.
Asset purchases ^d	
(8) Tilt purchases	Skew asset purchases according to climate-related risks and/or criteria applied at the issuer or asset level.
(9) Negative screening	Exclude some assets or issuers from purchases if they fail to meet climate-related criteria.

Source: NGFS (2021a).

a Credit operations are widely used to provide aggregate liquidity and usually take the form of collateralised lending.

b Collateral policy defines the range of assets that can be pledged to secure central bank credit operations.

c NGFS 2021a , Annex 1, expands upon the different approaches for haircuts and valuation adjustments.

d Central banks may buy a variety of assets to exert greater influence on longer-term interest rate levels.

4.2.1 Open market operations

Open market operations are activities taken by central banks, like buying and selling government bonds and other securities, to influence the money supply in the economy and transmit the interest rate set by the monetary policy committee. Purchasing securities increases money supply and reduces interest rates; selling securities increases interest rates. In theory, open market operations could be tilted towards green assets like green government securities. However, such operations take place with high frequency and are of short duration, and properties like liquidity and credit quality are understandably more important attributes of the asset.

4.2.2 Haircuts and asset eligibility

Central banks can increase the supply of money in the economy by providing loans to financial institutions. To mitigate their risk, central banks provide loans against collateral. Collateral frameworks set out which assets are *eligible* to be pledged, and the haircut – the reduction in value it applies to that asset based on its risk assessment. Collateral frameworks have significant impacts on prices and the allocation of capital, as assets that are eligible as collateral with lower haircuts are more valuable to financial institutions.

Collateral frameworks are often designed to be ‘neutral’ by reflecting the wider financial market. However, financial markets are not carbon-neutral but rather weighted towards capital-intensive and incumbent firms that may also have a large carbon footprint, such as those in the aviation, car manufacturing, oil and gas, or steel sectors. Central banks loaning in line with the market are therefore disproportionately exposed to the risk of stranded assets.

Central banks can account for climate risks in their collateral frameworks both through reforming which assets are eligible as collateral and by adjusting the haircut that they apply to assets. Investment professionals widely use negative screening exclude the worst offenders on different ESG metrics. Central banks also use negative screening (NGFS, 2019) but typically on more stringent criteria, to avoid perceptions of political intervention. To date, few if any central banks have adjusted collateral frameworks to exclude carbon-intensive assets, firms or sectors (NGFS, 2020b).

Adjusting the haircuts applied to assets offers a less controversial way for central banks to green monetary policy. Haircuts are intended to reflect the risk of the pledged assets falling in value if the central bank has to make a distressed sale. Haircuts are calculated based on historical data, which do not capture the emerging low-carbon transition risk facing fossil fuel assets. The converse of these are green-supporting factors, which value green assets offered as collateral – as identified by a green taxonomy – more than vanilla assets. Climate stress tests or carbon intensity may provide a more useful evidence base for introducing ‘green-supporting factors’ or ‘dirty-penalising factors’ along a sliding scale (Dafermos et al., 2021). While haircuts are a useful instrument, Dafermos et al. (2021) found that greening haircuts does not significantly reduce the carbon intensity of central banks’ collateral; it should also be accompanied by negative screening. Greening these would affect capital supply/capital access to conventional sectors if they are carbon-intensive (as is the policy intention) on the belief that the current risk–return data used to price loans do not represent future risks accurately.

A number of central banks have implemented measures to tilt collateral frameworks towards green financial assets. In 2018, the **People's Bank of China** opened its collateral framework to investment-grade green bonds and high-quality green loans in its medium-term lending facility (CPI, 2020). It has argued that the inclusion of green loans has not compromised the creditworthiness of collateral pledged by banks, as green loans have had a lower non-performing loan ratio than have overall loans. In 2021, the **ECB** included sustainability-linked bonds in its collateral framework (ECB, 2020b) and the governor of the Banque de France has called for still more comprehensive decarbonisation of the ECB's collateral framework (Banque de France, 2021b).

4.2.3 Asset purchase programmes

In addition to holding assets as collateral, central banks hold substantial volumes of assets on their balance sheets for operational purposes, such as influencing interest rates in the economy or exchange rate stabilisation. Typically, these comprise government bonds, foreign exchange reserves, gold, corporate bonds and equities.

In some countries, notably the US, the EU and the UK, there has been a significant expansion of central banks' balance sheets recently through quantitative easing – that is, the large-scale purchase of assets to inject liquidity into the economy. Quantitative easing was motivated initially by the 2008/09 banking crisis and, more recently, has been spurred by the Covid-19 pandemic. As with collateral frameworks, asset purchasing programmes could be tilted in favour of green assets, thereby reducing the cost of capital for environmentally sustainable activities. India has not operated a quantitative easing programme to stimulate demand so this tool has not been available to the RBI.

While some central banks have emphasised the principle of 'market neutrality' in their asset purchases, a number of forward-looking central banks have taken measures to green their asset purchases. For example:

- Since 2018, the **Banque de France** has sought to align the equity portion of its €23 billion asset portfolios since 2018 with a below 2°C warming scenario (Environment Finance, April 2021) excluding fossil fuel stocks and weighting other companies according to ESG scores. It is also on track to meet its target of allocating €1.7 billion to transition financing by the end of 2021 (Banque de France, 2021). By 2024, it will exit coal investments and exclude companies that derive over 10% of their revenue from oil or over 50% from gas (Reuters, 2021).
- In 2021, **Suomen Pankki** (the central bank of Finland) announced a goal of carbon neutrality (based on Scope 1 and 2 emissions) for its own investment activities (Bank of Finland, 2021). It will restrict its equity and corporate bond investments in fossil fuel companies and gradually shift to low-carbon assets. It also signalled that it might restrict holdings of foreign sovereign bonds by countries that are not meeting their Paris Agreement obligations. Along with other euro area central banks, the Bank of Finland has agreed to calculate the carbon footprint of its investment activities, and expects to publish its estimates in 2022.
- **Sveriges Riksbank** and **MNB** (the Swedish and Hungarian central banks) have taken climate risks into account in their foreign exchange reserve holdings. The Sveriges Riksbank has

applied climate risk weightings to a portion of its SEK 500 billion foreign exchange reserves, and excluded bonds from the highly fossil fuel-dependent provinces of Alberta in Canada and Queensland and Western Australia in Australia. Meanwhile, Hungary's MNB created a dedicated green bond portfolio within its foreign exchange reserves in 2019.

- The **Bank of England** announced that, by the end of 2021, it would adjust its corporate bond requirements within its asset purchasing programme to account for issuers' climate impact (BoE, 2021b). It discussed the possibility of restricting bond purchases to issuers with credible net-zero plans but, until these are more fully developed, will tilt its purchases based on metrics such as emissions reduction plans (BoE, 2021c).

4.3 Credit guidance

4.3.1 Priority sector lending

Central banks may mandate either that a certain share of loans is issued to specific sectors or that firms in those sectors have access to credit at discounted interest rates. Asian central banks have used priority sector lending (PSL) to increase the supply or reduce the cost of credit for specific sectors, typically either those that are underserved by financial markets (such as smallholder agriculture or energy access) or that are strategically significant (such as export-oriented manufacturing).

A handful of central banks are experimenting with introducing climate-smart sectors into priority sector lending. The **RBI** added renewable energy as a priority sector in 2015; in 2020, it introduced sub-categories of renewable energy and doubled the lending cap to Rs 30 crore. At the end of March 2020, the aggregate outstanding bank credit to the non-conventional energy sector constituted 7.9% of the outstanding bank credit to power generation compared with 5.4% in March 2015. **Bangladesh Bank** requires financial institutions to allocate 2% of all loans to green projects and for 15% of all loans to meet a wider definition of supporting 'sustainable' activities.

4.3.2 Other credit guidance policies

In 2021, the **Bank of Japan** announced that it would support financial institutions to allow them to offer a zero-interest rate to climate-compatible projects in Japan. Banks are incentivised to offer these loans as they are exempt from the negative interest rates paid on the reserves held with the central bank (Kihara, 2021). The announced programme replaces an earlier, growth-oriented lending facility, which provided 0.1% subsidy to banks that financed projects deemed to contribute to economic growth (Obe, 2021).

4.4 Central banks' internal reforms

In addition to introducing policies and regulations to influence financial decisions, central banks can adjust their operations to demonstrate good practice and embed climate considerations in their internal processes and structures. Table 12 documents some of these reforms.

Table 12: Reform options available to central banks

Reform options	Description
Changing the mandate of the central bank	To empower central banks to take action on climate change, national governments can introduce an explicit mandate to manage climate-related risks or support a low-carbon transition. 12% of central banks already have a specific mandate on sustainability (Dikau and Volz, 2019). The mandate is typically couched in terms of <i>sustainable growth of the economy</i> (e.g. Bangko Sentral ng Pilipinas , Bank Negara Malaysia , Central Bank of Iraq , Monetary Authority of Singapore , South African Reserve Bank) and on occasion for sustainable development (e.g. Nepal Rastra Bank). Altogether, 29% of central banks are mandated to support government priorities, which usually include sustainability (ibid.).
Changing the remit of key decision-making committees	Crucial decisions about central bank policy are often made by dedicated units or committees with relevant expertise. National governments can adjust the remits of these bodies to consider climate change. In the UK, for example, the chancellor changed the remits of the Monetary Policy Committees and Prudential Policy Committee of the Bank of England 'to act with a view to building the resilience of the UK financial system to the risks from climate change and support the government's ambition of a greener industry, using innovation and finance to protect our environment and tackle climate change' (BoE, 2021b).
Establishing cross-cutting climate functions	A number of larger central banks have established internal climate functions to support departments across the organisation. The Banque de France , for example, has established a climate hub that sits inside the financial stability unit, reflecting the importance of the stress tests. However, the bank envisages interactions with many other teams, like the one overseeing responsible investing. The ECB also has established a climate change centre, which reports to the ECB's president, and set out an action plan structured around five workstreams (ECB, 2021c).
Improving external communications	Central banks can encourage financial institutions to act on climate change by clearly communicating new policies and signalling their direction of travel. The Bank of Japan , for instance, has published a strategy document setting out a timetable of proposed actions on monetary policy, prudential regulation, research and its diplomatic effort in groupings like G20 and Basel (Bank of Japan, 2021). It also has an excellent website on climate summarising its own efforts and providing resources from international organisations it has joined (NGFS, the Executives' Meeting of East Asia-Pacific Central Banks, Basel Committee, Financial Stability Board): https://www.boj.or.jp/en/about/climate/index.htm/ .
Climate-related disclosures	A growing number of central banks are reporting their own carbon footprint and/or exposure to climate-related risks. The Bank of England and Reserve Bank of New Zealand are also disclosing their exposure to climate-related risks in line with the TCFD's recommendations. The BoE's methodology uses the emissions intensity of the UK economy as a proxy for the emissions intensity of its holdings of UK gilts, the largest asset on its balance sheet.
Capacity-building	The Banco Central do Brasil has implemented a multi-week training course on green finance for its staff, and ASEAN central banks are planning a similar exercise. The Bangko Sentral ng Pilipinas joined the Sustainable Banking Network in 2018 and has collaborated with the IFC to help the banking sector integrate ESG capacity into banking operations (IFC, 2018).
Greening own investment portfolios	In addition to asset purchasing for monetary policy purposes, central banks have their own investment portfolios to fund their own and, in some cases, other public sector pension liabilities. NGFS has carried out a major review of these (NGFS, 2019).

5. Recommendations

5.1 The RBI's distinctive context

Central banks are increasingly experimenting with and deploying novel mechanisms to manage climate risks in their economies.

The background to this report is the energy transition arising from the announcements made by Hon'ble Prime Minister Mr Narendra Modi at COP26 in Glasgow, and the anticipated rapid decarbonisation between the year of peak emissions and 2070 that follows. This report considers how the RBI can support the government by ensuring the financial system is effectively positioned to deliver in this regard. In the international context, India has both a unique perspective and set of challenges with regard to financing its energy transition, which are detailed below.

- **Challenges in mobilising energy investment, given continued substantial commitments to the sector.** Demand for power is still growing; added to this, the expanded targets for renewable energy create a substantial need for further capital expenditure in the sector. Within India's Rs 100 trillion National Infrastructure Pipeline (Government of India, 2021) for the period 2020–2025, about a quarter is assigned to the energy sector. However, the power sector also has substantial non-performing assets (albeit in the distribution sector), which restricts banks' appetite to provide further credit and increase their exposure to the energy sector. The RBI needs to consider whether to redefine sector exposure limits, given the need for more investment, or whether to take further steps to refinance these loans from the debt capital market.
- **Higher risk of stranded assets.** India is likely to face a very fast energy transition, with one observer, the Council on Energy, Environment and Water, suggesting that emissions will peak around 2040 before falling to net zero by 2070. The country also has relatively young energy infrastructure: the average age of operating coal-fired plants is just 13 years and the capital costs have not yet been fully amortised. Early stranding will crystallise these balance sheet losses. As 500 GW of intermittent renewables comes on stream, the operating hours of existing plants will fall, leading to deterioration in the financial viability of the fossil fuel generators and increasing the scale and risk of stranding of assets.
- **Underdeveloped debt markets.** The corporate bond market is relatively underdeveloped, with most of the finance for power assets supplied through bank lending and remaining on banks' balance sheets rather than being refinanced through the debt capital market. The RBI needs to continue to work with the government and financial regulators to deepen the debt capital market.
- **Extensive poverty and vulnerability.** India remains a lower-middle-income country with hundreds of millions of people living below the poverty line and lacking access to risk-reducing infrastructure. Its citizens are therefore much more vulnerable to the physical risks of climate change, which the RBI has recognised in its pioneering work looking at the effects of unseasonal monsoons on inflation. This socioeconomic context creates a need for emission-producing investments that can enhance resilience to climate change but also a strong incentive for India to pursue less carbon-intensive development pathways. It is for this reason that social issues are front and centre of India's sustainable taxonomy

development – something of which India is rightly proud. The combination of environmental and justice makes it difficult for the regulator to define what a *just transition* might entail.

In combination, these trends and circumstances have important implications for India’s financial sector. Banks, NBFCs and others will be called upon to finance much-needed energy infrastructure, yet these investments could bump into prudential banking rules about excessive exposure to a single sector. Too few financiers are aware of the extent to which the low-carbon transition risk may jeopardise investments in the sector. The RBI has a critical role to play in equipping financial institutions with the knowledge, tools and frameworks necessary to finance India’s energy ambitions and maintain financial stability in a carbon-constrained world.

5.2 Recommendations for the RBI to consider

This paper has laid bare the exposure of Indian financial institutions to low-carbon transition risk. We have assessed the policy options available to central banks and outlined the RBI’s engagement to date with green finance and climate risks. It is clear that more must be done to ensure financial stability during India’s rapid energy transition, particularly given the catastrophic physical risks that climate change will also inflict on the country.

Given this distinctive context, we have identified six priority interventions for the RBI as it engages with climate risks. Our recommendations reflect the distinctive features of the Indian financial sector (e.g. asset purchase programmes have less significance given that the RBI’s portfolio comprises primarily sovereign bonds and gold) and the unique tools that it has available (e.g. Asian central banks primarily deploy PSL). We have not included any of the monetary policy options introduced in Section 4 in our shortlist; rather, we consider that prudential regulation and credit guidance are more important measures as the RBI seeks to climate-proof India’s financial system. Our recommendations are intended to initiate a conversation about the most appropriate bundle of policies in an Indian context and how to sequence these. We welcome ideas and feedback.

Table 13: Recommendations to the RBI

Policy type	Policy recommendation
Prudential regulation	<ul style="list-style-type: none"> • Ask banks to measure and disclose low-carbon transition risk and green lending (using the Indian taxonomy). • Require banks to track lending to green and transition risk activities through tagging individual loans and assets. • Develop physical and transition risk scenarios for India and undertake stress tests based on new policy commitments. • Work with the Basel Committee to revise capital adequacy ratios to better reflect exposure to climate transition risks.
Credit guidance	<ul style="list-style-type: none"> • Integrate India’s taxonomy into PSL requirements and increase the proportion of taxonomy-aligned lending in non-priority sectors.
Foundational	<ul style="list-style-type: none"> • Ask banks to build the capacity of financiers to identify, measure and manage climate-related risks.

5.3 Prudential regulation

5.3.1 Guidelines for banks measuring and disclosing their transition risk management strategies

It is important that banks adopt standard guidelines for measuring and disclosing climate-related risks. These are preconditions for stress tests and supervisory review and therefore an important foundation for improved supervision and market discipline. The G7 and China have committed to mandatory disclosure of climate-related risks, so this will be the norm in over 60% of the global economy (HM Treasury, 2021).

We suggest the RBI introduce guidelines for disclosing climate risks using the TCFD report as a template.

5.3.2 Tracking lending to green and brown assets using a sustainable activities taxonomy activity (tagging system)

To understand their exposure to climate risks, banks need to collect and ‘tag’ relevant data about counterparty risk at the individual asset level. This includes information on the location (physical risks) and subsectors (climate-related risks) of loans and investments. This can be aggregated to evaluate exposure at the counterparty and portfolio level.

The Indian taxonomy is focusing initially on thresholds for agriculture, energy and transport and on ‘green’ activities. In future, ‘significant harm’ also known as ‘brown activities’ may also be included. Data collection should use the Indian taxonomy’s activity definitions, once agreed, but it also needs to cover ‘significant harm’ activities.

We suggest that the RBI ask banks to tag assets and project finance loans to identify assets exposed to climate risks – ‘brown assets’. It should also identify opportunities from climate change, identified by the Indian taxonomy, which apply SEBI’s Green Bond Guidelines and the Loan Market Association’s Green Loan Principles which ensure traceability.

5.3.3 Scenario building and stress testing

Scenario building and stress tests help banks understand their climate risk exposure, including any data gaps that need to be addressed. At the time of writing, some 31 countries around the world are exploring or have undertaken climate stress tests (NGFS, 2021c). The ECB and Banque de France have published results from their exercises.

The RBI’s scenario will need to take on board India’s own political announcements on short-term 2030 targets, the phasing-down of coal and the adoption of electric vehicles, as well as the long-term goal of reaching net-zero emissions by 2070. The RBI will then be able to apply static stress tests to understand the resilience of individual institutions and the financial system writ large under the different scenarios.

Some examples of stress tests that could be run might include: if coal-fired power generation is to be phased down by 2040–2050; if the EU and the US both adopt a carbon border adjustment

mechanism; if there is a severe drought in the northwest; and if there are a series of severe cyclones in the Bay of Bengal.

We suggest the RBI develop its own physical risk and transition scenarios by tailoring the NGFS scenarios to the Indian context and arrange a climate stress test of Indian banks.

5.3.4 Capital adequacy ratios

Within the central banking community, there has been much discussion about whether it is appropriate for capital adequacy ratios to be adjusted for future threats in the absence of credit risk performance data in the historical data series. Some central banks are of the view that weights for different assets should anticipate future risk; others feel such adjustments are largely political decisions and should be implemented by finance ministries through instruments like carbon pricing. A couple of countries have identified lower levels of default in mortgage loans for energy-efficient homes and adjusted risk weights accordingly, described in Section 4.1. However, so far, risk weights have not been changed in anticipation of future stranding.

There are two particular reasons for India to reform capital adequacy ratios to take account of climate-related risks. First, India is anticipating an especially swift reversal in the carbon intensity of economic activity, transitioning from peak emissions to net zero within a few decades. This pathway increases the threat of stranded fossil fuel assets. Given the scale of lending to fossil fuel-dependent sectors presented in Section 2, although individual banks may be exposed to this risk for only a relatively short period of time (the tenor of the loan), the risk remains within the financial system as a network risk, rather than as a risk to any specific institution. Second, Indian private sector entities are already displaying caution in financing fossil fuels. In a recent auction for the purchase of coal mines, for example, 48 out of the 67 sites received no private sector bids (Varadhan, 2021). State-owned banks that step into the breach may therefore be disproportionately exposed to climate risks, which will ultimately translate into government liabilities.

We also note that banks and central banks are open to litigation on how they respond to climate risks. The non-governmental organisation ClientEarth brought proceedings against the Belgian central bank and the ECB alleging that the two institutions had failed to take environmental issues into account in their decisions to purchase corporate bonds (NGFS, 2021b). A similar logic could be applied to central banks' determination of risk weights applied to different assets.

We suggest that RBI look at risk-weights following the approach of the Basel Committee in this regard.

5.4 Credit guidance: direct lending to the taxonomy through PSL and other directed lending

PSL is an almost unique mechanism deployed by a handful of Asian central banks. In India, its mandate is to increase credit to sectors of the economy that have traditionally been poorly served, like agriculture and micro, small and medium-sized enterprises (MSMEs). Small-scale renewable energy was recently made one of the PSL categories. PSL lending collectively accounts for 40% of banks' net credit. Banks are wary of increasing the amount of net credit any further, but it is

important for the nation to divert capital flows to climate change mitigating activities and ensuring that existing PSL monies are helping the poorly served sectors of the economy adjust to physical climate risks.

The Indian taxonomy will identify activities that meet green and social goals and can be used to screen PSL lending (e.g. to ensure money is lent to climate-proofed projects). But a balance needs to be struck to ensure that the poorly served beneficiaries in the current definition are not squeezed out. There is no easy answer to this conundrum. We suggest considering a new way of using credit guidance where, within a credit sector (e.g. lending for home loans or car loans), targets are set for the proportion that is taxonomy-aligned.

Banks have always been required to provide a minimum level of lending to agriculture, a sub-target within PSL. In view of the high level of exposure of Indian agriculture to the physical risks of climate change, it is important that farmers favour land, crops and agronomic methods that anticipate the changing climate.

We have two suggestions, outlined below, as to how the PSL might operate that avoid the ‘squeeze’ on existing beneficiaries or increasing the aggregate share of PSL funding.

- **Climate and social proofing existing PSL category credit:** Once the Indian taxonomy is agreed, we suggest including a minimum level of lending for taxonomy-aligned investment within the agriculture sub-sector to ensure lending obliges farmers to observe social and climate risks safeguards.
- **Switching non-PSL lending to taxonomy-aligned from taxonomy-unaligned:** We suggest that the RBI explore with banks how to set targets in non-PSL sectors like power generation and transport, raising the proportion of their taxonomy-aligned lending activities. This means asking banks to increase the proportion of lending within car loans away from internal combustion engine vehicles to lending for electric vehicles, two/three wheelers or public transport.

5.5 Foundational

5.5.1 Capacity-building of financial institutions

In parallel with this paper, we completed a landscape analysis of the state of climate knowledge and practice in 10 frontrunning Indian banks, mutual funds and development finance institutions (auctusESG *et al.*, 2022). We found many had signed up to sustainability principles and collected data on various ESG risks but only a handful had systematically used these data to guide investment and lending decisions. Specifically, only four of the participating institutions integrate the results of their risk assessment processes into business continuity planning or internal capital adequacy assessment processes; only two integrate these findings into credit risk assessments or enterprise risk management frameworks; and only one has adopted methods to mitigate, share or transfer identified ESG and climate risks. At the individual level, 78% of the 153 respondents were generally aware of ESG concepts and climate-related risks. However, less than half the respondents were aware of any specific ESG rating methodologies and fewer than one in five were aware of specific standards or guidelines for assessing ESG lending risks.

Given the speed at which sustainable finance needs to be mobilised and the magnitude of physical and low-carbon transition risk from climate change, there is an urgent need for action to climate-proof India's financial sector. However, the findings from our landscape assessment indicate that finance professionals and financial institutions are not voluntarily acquiring the knowledge or introducing the processes necessary to manage climate-related risks. Given the myriad standards and methodologies available, banks are indicating a desire for regulators to provide greater clarity.

The RBI should therefore signal that financial institutions need to develop expertise on climate-related risks in preparation for the deployment of new policies and guidance, including the options identified above. The RBI can support this process through dialogue with the financial sector about regulatory expectations, priorities and timelines, which would encourage institutions to invest in the skills of their credit lending and risk management staff. Banks that already measure and disclose climate-related risks could further be invited to participate in scenario building and pilot stress testing, creating an incentive for other banks to follow suit. Open dialogue and participatory processes can further ensure that regulators, financiers and the wider ecosystem are using the same language, concepts and frameworks, which would build broad awareness and reduce the scope for greenwashing.

References

ACPR – Autorité de Contrôle Prudentiel et de Résolution (2021) 'A first assessment of financial risks stemming from climate change: the main results of the 2020 climate pilot exercise'. Paris: ACPR.

auctusESG, ODI and Climate Bonds Initiative (2022) 'ESG and climate risk management in the Indian financial sector: A landscape analysis of 10 leading financial institutions'. Mumbai: auctusESG. (<https://odi.org/en/about/our-work/strengthening-climate-risk-assessment-in-indias-financial-sector>)

Bank of Finland (2021) 'Bank of Finland sets climate target'. Press Release, 14 September (<https://www.suomenpankki.fi/en/media-and-publications/releases/2021/bank-of-finland-sets-climate-target-for-its-investment-portfolio--carbon-neutrality-to-be-achieved-by-2050-at-the-latest/>).

Bank of Japan (2021) 'The Bank of Japan's strategy on climate change'. Release, 16 July (https://www.boj.or.jp/en/announcements/release_2021/rel210716b.pdf).

Banque de France (2020) *Climate-related risks and central banks' collateral policy: a methodological experiment*. Paris: Banque de France.

Banque de France (2021a) *Responsible investment report 2020*. Paris: Banque de France.

Banque de France (2021b) 'The role of central banks in the greening of the economy'. Speech, 2 November (<https://www.banque-france.fr/en/intervention/role-central-banks-greening-economy>).

Banque de France (2021c) 'Green finance: the Banque de France launches its Climate Change Centre (CCC) and publishes its 3rd Responsible Investment Report (SRI)'. Press Release, 30 March (https://www.banque-france.fr/sites/default/files/medias/documents/cp_ra_isr_et_ccc_engl.pdf).

Bertram, C., Hilaire, J., Kriegler, E. et al. (2021) 'NGFS climate scenario database: technical documentation V2.2'. NGFS (https://www.ngfs.net/sites/default/files/ngfs_climate_scenarios_technical_documentation_phase2_june2021.pdf).

Birthal, P.S., Khan, M.T., Negi, D.S. and Agarwal, S. (2014) 'Impact of climate change on yields of major food crops in India: implications for food security' *Agricultural Economics Research Review* 27(2): 145–155.

BIS – Bank for International Settlements (2019) 'The capital buffers in Basel III'. FSI Executive Summary, 28 November (https://www.bis.org/fsi/fsisummaries/b3_capital.htm).

BIS (2021) 'India – debt securities issues and amounts outstanding, in billions of US dollars (Q1, 2021). Table C3'. BIS (<https://stats.bis.org/statx/srs/table/c3?c=IN&f=pdf>).

BNM – Bank Negara Malaysia (2021) 'Governor's keynote address at the JC3 Flagship Conference'. (<https://www.bnm.gov.my/-/governor-keynote-jc3-flagship-conference>).

BoE – Bank of England (2021a) 'Key elements of the 2021 Biennial Exploratory Scenario: financial risks from climate change'. BoE, 8 June (<https://www.bankofengland.co.uk/stress-testing/2021/key-elements-2021-biennial-exploratory-scenario-financial-risks-climate-change>).

BoE (2021b) 'MPC remit statement and letter and FPC remit letter'. BoE, 3 March (<https://www.bankofengland.co.uk/news/2021/march/mpc-remit-statement-and-letter-and-fpc-remit-letter>).

BoE (2021c) 'Options for greening the Bank of England's Corporate Bond Purchase Scheme'. BoE, May (<https://www.bankofengland.co.uk/-/media/boe/files/paper/2021/options-for-greening-the-bank-of-englands-corporate-bond-purchase-scheme-discussion-paper.pdf?la=en&hash=9BEA669AD3EC4B12D000B30078E4BE8ABD2CC5C1>).

BoE (2021) 'The Bank of England's climate-related financial disclosure 2021'. BoE, 17 June (<https://www.bankofengland.co.uk/prudential-regulation/publication/2021/june/climate-related-financial-disclosure-2020-21>).

Burge, L., Mok, L. and Vaze, P. (2021) *Embedding sustainability into the COVID recovery: a primer for ASEAN central banks*. London: Climate Bonds Initiative.

Burke, J. and Byrnes, R. (2019) 'What the UK can learn from carbon pricing schemes around the world'. Carbon Brief, Guest Post, 2 August (<https://www.carbonbrief.org/guest-post-what-the-uk-can-learn-from-carbon-pricing-schemes-around-the-world>).

Campigliano, E., Dafermos, Y., Monnin, P. et al. (2018) 'Climate change challenges for central banks and financial regulators' *Nature Climate Change* 8:462–468.

Choi, J., Escalante, D. and Lund Larsen, M. (2020) 'Green banking in China'. CPI Discussion Brief (<https://www.climatepolicyinitiative.org/wp-content/uploads/2020/08/Green-Banking-in-China-Emerging-Trends-1.pdf>).

Dafermos, Y., Gabor, D., Nikolaidi, M. et al. (2021) *Greening the eurosystem collateral framework*. London: New Economics Foundation.

Dikau, S. and Volz, U. (2019) *Central bank mandates, sustainability objectives and the promotion of green finance*. Working Paper 222. London: School of Oriental and African Studies.

Dikau, S., Robins, N. and Volz, U. (2020) 'A toolbox of sustainable crisis response measures for central banks and supervisors, second edition: lessons from practice'. INSPIRE Briefing Paper.

London: Grantham Research Institute on Climate Change and the Environment, London School of Economics and Political Science and SOAS Centre for Sustainable Finance.

DNB – De Nederlandsche Bank (2017) *Waterproof – an exploration of climate-related risks for the Dutch financial sector*. Amsterdam: DNB.

DNB (2018) 'An energy transition risk stress test for the financial system of the Netherlands'. Occasional Studies 16(7). Amsterdam: DNB.

D'Orazio, P. and Popoyan, L. (2019) 'Fostering green investments and tackling climate-related financial risks: which role for macroprudential policies?' *Ecological Economics* 160: 25–37.

Dubash, N.K. (2019) 'An introduction to India's evolving climate change debate: from diplomatic insulation to policy integration' in N.K. Dubash (ed) *India in a warming world: integrating climate change and development*: 1–28. Oxford: Oxford University Press.

ECB (2020a) 'ECB publishes final guide on climate-related and environmental risks for banks'. ECB Press Release, 27 November (https://www.bankingsupervision.europa.eu/press/pr/date/2020/html/ssm.pr201127~5642b6e68d.en.html?utm_source=POLITICO.EU&utm_campaign=e9aa236bd4-EMAIL_CAMPAIGN_2020_11_27_12_19&utm_medium=email&utm_term=0_10959edeb5-e9aa236bd4-189088905).

ECB (2020b) 'ECB to accept sustainability-linked bonds as collateral'. ECB Press Notice, 22 September (www.ecb.europa.eu/press/pr/date/2020/html/ecb.pr200922~482e4a5a90.en.html).

ECB (2021a) *Climate-related risk and financial stability*. Frankfurt: ECB.

ECB (2021b) 'Shining a light on climate risks: the ECB's economy-wide climate stress test'. ECB Blog, 18 March (www.ecb.europa.eu/press/blog/date/2021/html/ecb.blog210318~3bbc68ffc5.en.html).

ECB (2021c) 'ECB sets up climate change centre'. ECB Press Notice, 25 January (https://www.ecb.europa.eu/press/pr/date/2021/html/ecb.pr210125_1~3fc4ebb4c6.en.html).

Environmental Finance (2021) 'Banque de France creates climate change centre, assesses biodiversity impact'. Environmental Finance, April (<https://www.environmental-finance.com/content/news/banque-de-france-creates-climate-change-centre-assesses-biodiversity-impact.html>).

Eur-Lex (2019) 'Regulation (EU) 2019/2088 of the European Parliament and of the Council of 27 November 2019 on sustainability-related disclosures in the financial services sector'. (<https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02019R2088-20200712>).

Friedlingstein, P., O'Sullivan, M., Jones, M.W., et al. (2020) 'The global carbon budget 2020' *Earth System Science Data* 12(4): 3269–3340.

Government of India (2021) 'National infrastructure pipeline'. (<https://indiainvestmentgrid.gov.in/national-infrastructure-pipeline>).

HM Treasury (2021) 'G7 finance ministers and central bank governors communiqué'. Policy Paper, 5 June (<https://www.gov.uk/government/publications/g7-finance-ministers-meeting-june-2021-communiqué/g7-finance-ministers-and-central-bank-governors-communiqué>).

IEA – International Energy Agency (2021) *India energy outlook 2021*. Paris: IEA.

IFC – International Finance Corporation (2018) 'BSP, IFC encourage Philippine banks to integrate ESG practices, promote sustainable finance'. IFC, 13 February (<https://pressroom.ifc.org/all/pages/PressDetail.aspx?ID=25729>).

Mahesh Kumar Jain, (13 Aug 2021) "*Building a More Resilient Financial System in India through Governance Improvements*" (https://www.rbi.org.in/Scripts/BS_SpeechesView.aspx?Id=1113).

Kihara, L. (2021) 'Factbox: the Bank of Japan's new scheme and approach on climate change'. Reuters, 18 June (<https://www.reuters.com/business/sustainable-business/bank-japans-new-scheme-approach-climate-change-2021-06-18/>).

Krishnan, A. and Maxwell, S. (2020) *Counting carbon in global trade: why imported emissions challenge the climate regime and what might be done about it*. ODI Report. London: ODI.

MNB – Magyar Nemzeti Bank (2019) 'MNB introduces a green preferential capital requirement programme'. MNB Press Release, 18 December (<https://www.mnb.hu/en/pressroom/press-releases/press-releases-2019/mnb-introduces-a-green-preferential-capital-requirement-programme>).

MNB (2020) 'Facilitation, deadline-extension in the green capital requirement programme'. MNB Press Release, 20 July. (www.mnb.hu/en/pressroom/press-releases/press-releases-2020/facilitation-deadline-extension-in-the-green-preferential-capital-requirement-programme).

MNB (2021a) *Green finance report*. Budapest: MNB.

MNB (2021b) 'Notice on the criteria for the Preferential Green Capital Requirement Treatment for housing loans'. MNB Press Notice (<https://www.mnb.hu/letoltes/notice-preferential-green-capital-requirement.pdf>).

MoEFCC – Ministry of Environment, Forest and Climate Change (2021) *India: third biennial update report to the United Nations Framework Convention on Climate Change*. Delhi: MoEFCC.

MoSPI (2021a) 'Gross value added data'. (<https://www.mospi.gov.in/web/mospi/reports-publications/-/reports/view/templateFive/22001?q=RPCAT>).

MoSPI (2021b) 'Open Data Portal' (<https://data.gov.in/resources/month-wise-cpi-c-and-wpi-inflation-2017-2020-ministry-finance>).

Rao, M Rajeshwar (2021) *Heed to Heal – Climate Change is the Emerging Financial Risk* (https://rbi.org.in/scripts/BS_ViewBulletin.aspx?Id=20563).

NABARD (National Bank for Agriculture and Rural Development) (2020) *Annual report 2019-20*. Mumbai: NABARD.

NGFS – Network of Central Banks and Supervisors for Greening the Financial System (2019) *A sustainable and responsible investment guide for central banks' portfolio management*. (<https://www.ngfs.net/sites/default/files/medias/documents/ngfs-a-sustainable-and-responsible-investment-guide.pdf>).

NGFS (2020a) *Guide to climate scenario analysis for central banks and supervisors*. NGFS, June (https://www.ngfs.net/sites/default/files/medias/documents/ngfs_guide_scenario_analysis_final.pdf).

NGFS (2020b) *Guide for supervisors, integrating climate-related and environmental risks into prudential supervision*. NGFS, September (https://www.ngfs.net/sites/default/files/medias/documents/ngfs_guide_for_supervisors.pdf).

NGFS (2020c) *Overview of environmental risk analysis by financial institutions*. NGFS (https://www.ngfs.net/sites/default/files/medias/documents/overview_of_environmental_risk_analysis_by_financial_institutions.pdf).

NGFS (2020d) *Survey on monetary policy operations and climate change: key lessons for further analyses*. NGFS, December (https://www.ngfs.net/sites/default/files/medias/documents/survey_on_monetary_policy_operations_and_climate_change.pdf).

NGFS (2021a) *Adapting central bank operations to a hotter world*. NGFS, March (<https://www.ngfs.net/en/adapting-central-bank-operations-hotter-world-reviewing-some-options>).

NGFS (2021b) *Climate-related litigation: raising awareness about a growing source of risk*. NGFS, November (www.ngfs.net/sites/default/files/medias/documents/climate_related_litigation.pdf).

NGFS (2021c) *Guide on climate-related disclosure for central banks*. NGFS, December (https://www.ngfs.net/sites/default/files/medias/documents/guide_on_climate-related_disclosure_for_central_banks.pdf).

NGFS (2021d) *NGFS Climate Scenarios for central banks and supervisors* (https://www.ngfs.net/sites/default/files/media/2021/08/27/ngfs_climate_scenarios_phase2_june2021.pdf).

Nicolas, C., Rentschler, J., Potter van Loon, A., et al. (2019) 'Stronger power: improving power sector resilience to natural hazards'. Sector Note for LIFELINES: The Resilient Infrastructure Opportunity. Washington DC: World Bank.

Obe, M. (2021) 'BOJ to offer interest-free loans under new climate facility'. Nikkei Asia, 16 July (<https://asia.nikkei.com/Economy/BOJ-to-offer-interest-free-loans-under-new-climate-facility2>).

Picciariello, A., Colenbrander, S., Bazaz, A. and Roy, R. (2021) *The costs of climate change in India: a review of the climate-related risks facing India, and their economic and social costs*. ODI Literature Review. London: ODI.

RBI (2007) "Corporate Social Responsibility, Sustainable Development and Non-Financial Reporting – Role of Banks" RBI/2007-08/216 (<https://rbidocs.rbi.org.in/rdocs/notification/PDFs/82186.pdf>).

RBI (2019a) 'Report of the Internal Working Group to Review Agricultural Credit'. RBI, 13 September (<https://www.rbi.org.in/Scripts/PublicationReportDetails.aspx?UrlPage=&ID=942>).

RBI (2019b) *Report on trend and progress of banking in India, 2018/19*. Delhi: RBI.

RBI (2020) 'Minutes of the Monetary Policy Committee Meeting'. Press Release, 20 August (https://www.rbi.org.in/Scripts/BS_PressReleaseDisplay.aspx?prid=50240).

RBI (2021a) 'RBI joins Network for Greening the Financial System'. Press Release, 29 April (https://rbi.org.in/scripts/BS_PressReleaseDisplay.aspx?prid=51496).

RBI (2021b) 'Quarterly BSR-1: outstanding credit of scheduled commercial banks'. (https://m.rbi.org.in/scripts/Pr_DataRelease.aspx?SectionID=354&DateFilter=YearMonth_PR).

RBI (2021c) 'Sectoral deployment of bank credit – May 2021'. RBI, 30 June (https://rbi.org.in/Scripts/BS_PressReleaseDisplay.aspx?prid=51823).

RBI (2021d) *Financial stability report*. Delhi: RBI.

Refinitiv (2021) 'Outstanding loans domicile India' (<https://www.refinitiv.com/en>).

Robins, N., Dikau, S. and Volz, U. (2021) *Net-zero central banking: a new phase in greening the financial system*. London: Grantham Research Institute on Climate Change and the Environment and Centre for Climate Change Economics and Policy, London School of Economics and Political Science and Centre for Sustainable Finance, SOAS, University of London.

SEBI – Securities and Exchange Board of India (2021) ‘Corporate bonds dataset’ (<https://www.sebi.gov.in/statistics/corporate-bonds.html>).

Soora, N.K., Aggarwal, P.K., Saxena, R. et al. (2013) ‘An assessment of regional vulnerability of rice to climate change in India’ *Climatic Change* 118: 683–699.

TCFD – Task Force on Climate-Related Financial Disclosures (2017) ‘Recommendations of the Task Force on Climate-Related Financial Disclosures’. TCFD, June (<https://assets.bbhub.io/company/sites/60/2020/10/FINAL-2017-TCFD-Report-11052018.pdf>).

Thomas, L. (2021) ‘French central bank to exit coal, cap oil and gas investments’. Reuters, 19 January (<https://www.reuters.com/article/france-centralbank/french-central-bank-to-exit-coal-cap-oil-and-gas-investments-idUSL1N2JT1WJ>).

Twidale, S. (2022) ‘Analysis: governments no match for markets in European energy crunch’. Reuters, 19 January (<https://www.reuters.com/business/energy/governments-no-match-markets-european-energy-crunch-2022-01-19/>).

UKCOP26 – United Kingdom 26th Conference of the Parties (2021) ‘Climate finance delivery plan: meeting the US\$100 billion goal’ (<https://ukcop26.org/wp-content/uploads/2021/10/Climate-Finance-Delivery-Plan-1.pdf>).

UNFCCC – United Nations Framework Convention on Climate Change (2021) ‘National greenhouse gas inventory data for the period 1990–2019. Report by the secretariat’ (<https://unfccc.int/documents/306767>).

Varadhan, S. (2021) ‘No bids for over 70% of Indian coal mines up for auction’. Reuters, 9 July (<https://www.reuters.com/world/india/no-bids-over-70-indian-coal-mines-up-auction-2021-07-09/>).

Verney, P. (2021) ‘EU banking regulator mulls update to capital requirements based on ESG’. Responsible Investor, 23 June. (<https://www.responsible-investor.com/articles/eu-banking-regulator-mulls-update-to-capital-requirements-based-on-esg>).

World Bank (2021) ‘CO₂ emissions (metric tons per capita)’. (<https://data.worldbank.org/indicator/EN.ATM.CO2E.PC>).

Annex 1: Indian greenhouse gas emissions 2016

IPCC inventory sector	GHG emissions 2016 (kT CO ₂ eq)		
	Energy	Non-energy	Total
Electricity production	1,127,732	-	1,127,732
Agricultural/fisheries	2,648	407,821	410,469
Road transport	247,594	-	247,594
Non-specific Industries	181,685	2,167	183,852
Cement	53,658	106,591	160,249
Iron and steel	135,420	2,696	138,116
Residential	127,282	-	127,282
Waste	-	75,232	75,232
Refinery	71,931	-	71,931
Commercials/institutional	68,976	-	68,976
Chemicals	1,982	44,617	46,599
Nonferrous metals	7,704	38,118	45,822
Non-metallic minerals	-	28,480	28,480
Civil aviation	16,284	-	16,284
Biomass burnt for energy	14,584	-	14,584
Railways	7,612	-	7,612
Manufacturing of solid fuel	6,923	-	6,923
Fertiliser	6,007	-	6,007
Mining and quarrying	4,096	-	4,096
Navigation	2,944	-	2,944
Pulp and paper	2,633	-	2,633
Textile/leather	2,310	-	2,310
Engineering	1,632	-	1,632
Bricks	609	-	609
Glass, ceramic	-	397	397
Total GHG emissions	2,092,246	706,119	2,798,365

Source: Adapted by CBI from MoEFCC (2021), Appendix Chapter 2.

Annex 2: Mapping RBI bank lending and IPCC sector classifications

IPCC category	RBI industrial classification for bank lending	
1. Energy industries		
a. Electricity production	2.18.1	Power
b. Refinery	2.8	Petroleum, coal products and nuclear fuels
c. Manufacturing of solid fuel	2.8	Petroleum, coal products and nuclear fuels
2. Manufacturing industries construction		
a. Cement	2.12	Cement and cement products
b. Iron and steel	2.13.1	Iron and steel
c. Non-ferrous metals	2.13.2	Other metal and metal product
d. Chemicals	2.9 & 2.10	Chemicals and plastics
e. Pulp and paper	2.7	Paper and paper products
f. Food and beverages	2.3 & 2.3	Food processing and beverage tobacco
g. Non-metallic minerals		
h. Mining and quarrying	2.1	Mining and quarrying (including coal)
i. Textile/leather	2.4 & 2.5	Textiles and leather
j. Bricks	2.19	Other i
k. Fertiliser	2.9.1	Fertiliser
l. Engineering	2.14 & 2.15	All engineering
m. Non-specific industries	2.16 & 2.19	Other industries
n. Glass, ceramic	2.11 & 2.12	Glass and cement
3. Transport		
a. Road transport	3.1 & 4.7	Transport operators and vehicle loans
b. Civil aviation	3.1	Transport operators
c. Railways	3.1	Transport operators
d. Navigation	3.4	Shipping
4. Other sectors		
a. Commercials/institutional	3	Services
b. Residential	4.2 & 5.3	Housing (including priority sector housing)
c. Agricultural/fisheries	1 & 5.1	Agriculture and allied activities
d. Biomass burnt for energy	5.1	Agriculture and allied activities
5. Waste	2.18.4	Other infrastructure

Source: CBI.adapted from IPCC and RBI