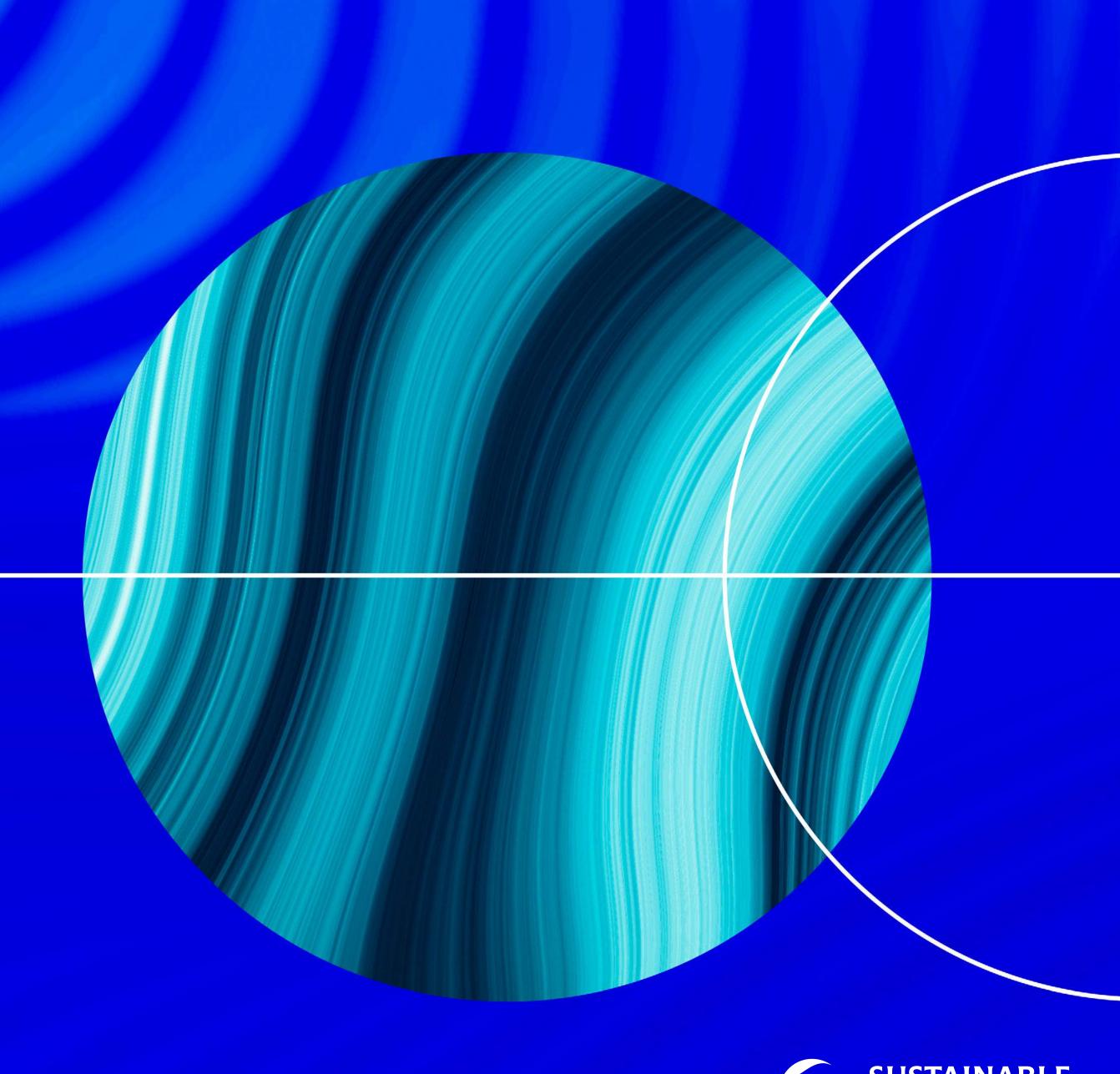
The COP28 Net Zero Atlas

November 2023







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Acknowledgements

The 2030 emissions projections for current policies that are a key input into the Implied Temperature Rise (ITR) calculations in this report were developed in an associated research project led by individuals from the International Institute for Applied Systems Analysis (IIASA) and the NewClimate Institute (see Nascimento et al. 2021).

The authors would like to thank Nicklas Forsell (IIASA) and Leonardo Nascimento (NewClimate) for providing valuable inputs for this report. The report, however, reflects methodological choices and views of the authors and should not be considered to be endorsed by researchers from IIASA or the NewClimate Institute.

We also wish to thank, Claire Cheape, Lori Stoner, Greta Henley, Wendy Croall, Anthony O'Connor, Marie-Adélaïde de Nicolay, Rachel Goldberg, Olaiya Ajadi, Luke Stafford, Chip Thresher, and Delphine Dirat for their comments and reviews on earlier drafts.

Lastly, the authors are also grateful to Joe Sharpe, Mandy Doran, Callum Strachan, and Vasco Alves from Applied Works for their tireless work on the design of this report.

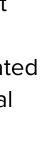
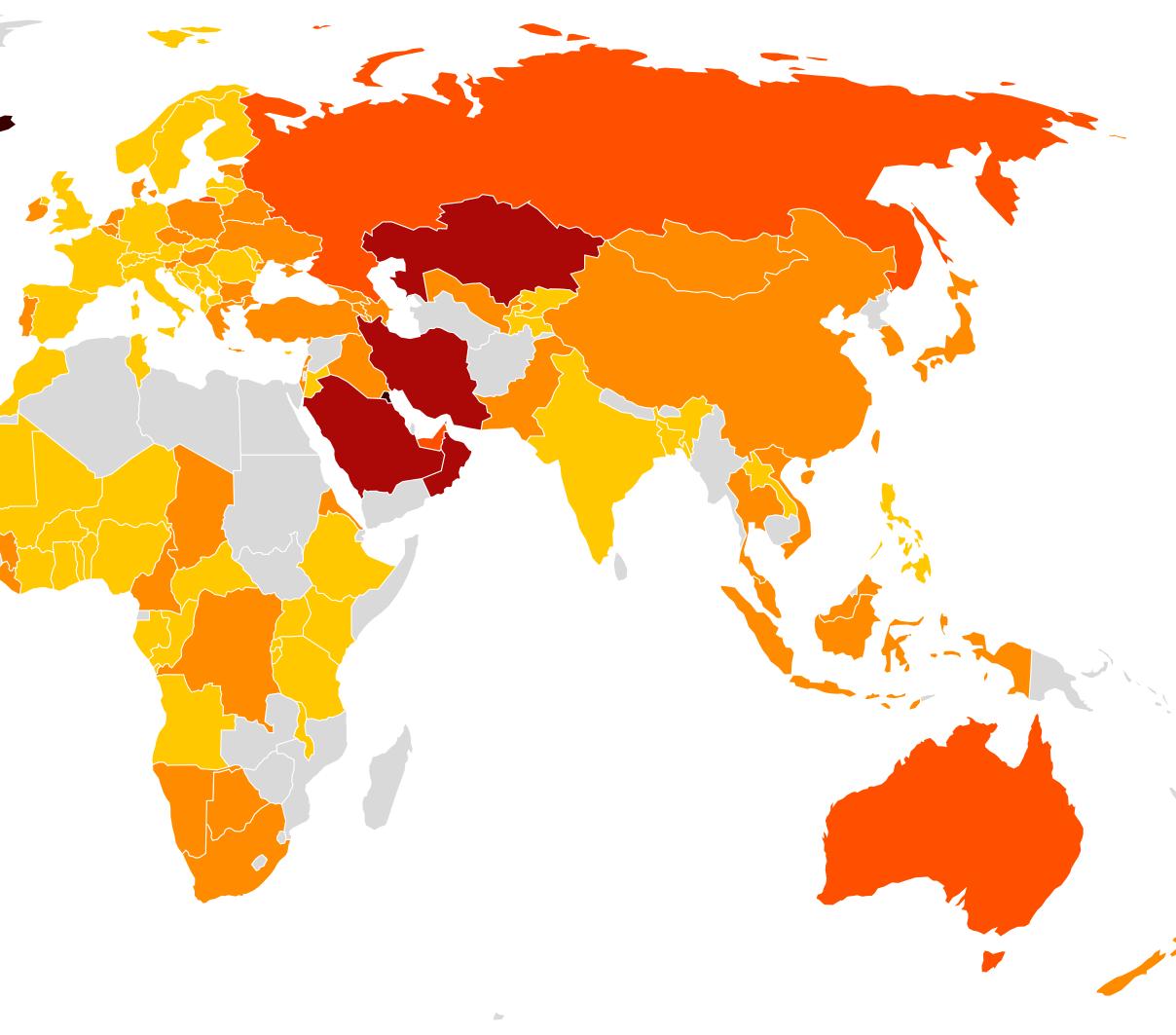








Figure 01: Implied Temperature Rise of every country with a quantifiable NDC target



Source: FTSE Russell & Beyond Ratings Research



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As the latest round of climate negotiations starts in Dubai, world leaders face a challenging outlook. Despite making considerable progress since the conclusion of the Paris Agreement, G20 countries' national ambitions remain offtrack to achieve global climate goals. Indeed, our latest assessment shows that their current 2030 targets imply a 2.6°C temperature rise by the end of the century, rather than the 'well below 2°C' agreed in Paris. These results dovetail closely with those that are emerging from the Global Stocktake.

Meanwhile, the physical effects of climate change have been increasingly felt in 2023. Record temperatures are driving climate hazards across the globe, from deadly heatwaves in the US and China, to wildfires in Canada and Hawaii, and extreme flooding in Libya and Greece. As physical risks continue to escalate – and they will, even in a 1.5°C scenario – we make the case that investors need to start focusing not only on transition efforts but also on how governments and companies are planning to adapt to life on a hotter planet. However, our research shows that even in advanced economies, adaptation planning and adaptation finance are still in their infancy.

This Net Zero Atlas shares a wealth of data and insights on the transition and physical risks to which G20 countries are exposed. It also systematically evaluates how governments are responding both in terms of their emissions-reduction commitments and national adaptation strategies. It is critical for investors to grasp these challenges and understand how they are reshaping growth trajectories and asset valuations around the world.

Fiona Bassett Group Head of Benchmarks and Indices CEO, FTSE Russell





G20 still poorly prepared as climate hazards are beginning to materialise

The eight years since the conclusion of the Paris Agreement in 2015 have been the hottest measured. 2023 has seen unsettling new records, with average global temperatures in July 2023 hitting 16.95°C.ⁱ This is 1.1°C above the pre-industrial average for July; and, according to the analysis of climatic records, the hottest month on Earth in the last 120,000 years."

Rising temperatures are fuelling new climate extremes, with heatwaves, wildfires and flooding becoming more common, damaging, and deadly. The combined cost of heatwaves in China, the US, and Southern Europe could reach 0.6 percentage points of global GDP in 2023. In Libya, heavy rainfall triggered floods, killing over 4,000 and displacing 10 times as many in September. In Canada, 18 million hectares of forest, an area half the size of Italy, burned this summer in the worst wildfire season ever,^{iv} releasing more than 1.7 billion tonnes of carbon dioxide in just a few months, three times Canada's typical annual emissions.^v

As systemic pressures are building, some insurers are beginning to refuse to provide cover for the most exposed assets. In May, for example, the largest US property insurer announced it would cease to provide new property and casualty insurance in California, citing "rapidly growing catastrophe exposure" among the key reasons.

In the third edition of our Net Zero Atlas, we expand our analysis of physical risks that G20 countries face to examine how governments are beginning to respond to these risks. We survey the status of these adaptation plans for G20 members and assess the breadth and depth of planning in each country on various criteria, such as the description of funding mechanisms or the existence of monitoring and evaluation processes.

We have identified publicly available National Adaptation Plans or Strategies for 19 of the G20 countries. Overall, however, we find that:

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In contrast to transition strategies, G20 countries' adaptation strategies are still in their infancy.

Overall, they appear ill-suited to meet the scale and complexity of the emerging adaptation challenge.

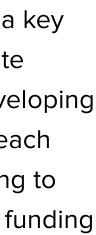
Even as common features begin to emerge, G20 countries' adaptation strategies are still heterogeneous and clearly identified best practice is yet to emerge. Structured comparisons across G20 countries are challenging as strategies still vary widely in scope and granularity.

Despite recent progress, we find only limited evidence of systematic resourcing, implementation and monitoring of adaptation plans, even among advanced G20 economies.

Few nations have developed detailed implementation delivering higher-level strategies.

plans and mechanisms to monitor progress on As physical climate risks begin to materialise, these plans will become critical in shaping outcomes across G20 economies and beyond. Indeed, we argue that understanding what these plans entail and how credible they are may become as important for investors as assessing governments' transition strategies and emission-reduction targets.

In this context, adaptation finance is emerging as a key challenge, even as costs remain difficult to estimate accurately. This is particularly salient for many developing countries, where actual adaptation needs might reach US\$160 billion to US\$340 billion per year according to UN estimates,^{vi} 5-10 times higher than the current funding commitments from developed countries^{vii}.



We point to persistent ambition & implementation gaps in G20 countries transition efforts...

As governments are trying to limit the extent of climate change, the 'ratcheting-up' process of the Paris Agreement continues to deliver at least a partial success. Turkey and Brazil are the latest G20 countries to submit revised, more ambitious Nationally Determined Contributions (NDCs) ahead of COP28 – including Brazil's ground-breaking commitment to achieve net zero deforestation by 2030.

However, no other G20 countries have made new pledges since COP27; and as the pace of new commitments has slowed, the world remains off track to achieving the Paris Agreement goals of limiting global warming to well below 2°C. Indeed, our calculations show that achieving the mid-century targets of G20 countries would align with 2.1°C by the end of the century, unchanged from COP27.

We also continue to observe persistent gaps in the commitments of G20 countries:

targets track towards half a degree higher temperatures than their mid-century targets. $(2.6^{\circ}C \text{ vs } 2.1^{\circ}C) - \text{with } 1.0^{\circ}C \text{ or wider gaps for}$ Australia, Russia and Saudi Arabia; and gaps of 0.5°C or larger for another seven G20 countries, including Canada and China.

In aggregate, we estimate annual emissions would be 7.9% higher under current policies than targeted under their NDCs. For some, these gaps are much larger – 0.5°C or larger for Saudi Arabia, South Korea, the US and Canada.

narrow these gaps

Mirroring the emerging results of the Global Stocktake,^{viii} our exploration of marginal abatement cost (MAC) curves suggests that closing the gap to a 1.5°C aligned trajectory can mostly be achieved through cost effective technologies. We estimate that over half of the abatement needed to get G20 countries back on track towards the goals of the Paris Agreement can be met through cost effective deployment of ready-to-use technologies.

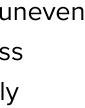
An 'ambition gap' as G20 countries' 2030 NDC

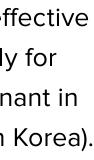
An 'implementation gap' as G20 members policies are not yet sufficient to achieve the NDCs.

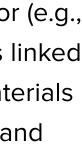
...and to near term, cost-effective opportunities to

However, accelerating the transition among G20 countries will require careful consideration of the uneven distribution of decarbonisation opportunities across different sectors and countries. Our analysis clearly shows that:

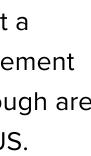
- The Energy System still offers the most cost-effective near-term abatement opportunities, particularly for G20 countries where fossil fuels are still dominant in the power mix (e.g. China, Australia and South Korea).
- For countries with a large manufacturing sector (e.g., Germany and Japan) abatement opportunities linked to rapid electrification, greater energy and materials efficiency are now among the most impactful and attractive.
- Similarly, countries with large Agricultural and Forestry sectors (for example, Indonesia or Brazil) have large, and relatively low-cost abatement opportunities in those sectors (c.45%).
- The Buildings and Transport sectors represent a comparatively small amount of near-term abatement for the G20 – c. 8% and 9% respectively – though are more significant in Germany, the UK and the US.











Policy makers will gather in Dubai for COP28 this December against the backdrop of the 'First Global Stocktake'. The results of this inaugural stocktake, a critical mechanism within the Paris Agreement, provide an assessment of collective progress globally towards climate commitments and the key implications for the path forward.

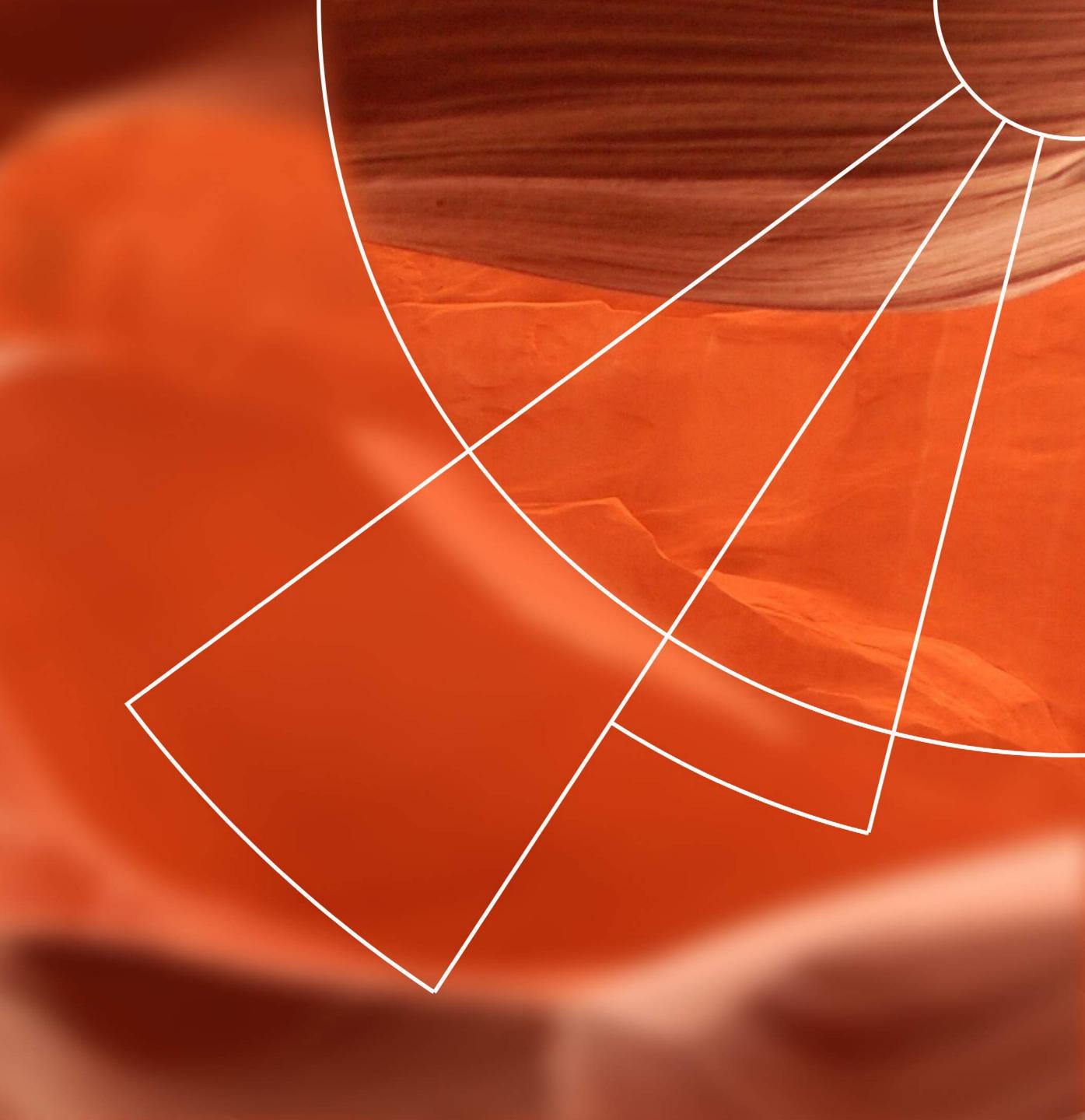
This report assesses the transition and physical risk profiles of G20 member countries, which together account for two-thirds of the world's population and around 80% of global GDP and greenhouse gas emissions. In Chapter 1, we assess G20 countries' pledges and policies through the lens of implied temperature rise (ITR) calculations. ITR provides a consistent (if highly stylised) metric to assess alignment with different global warming trajectories and to systematically compare climate commitments across countries and over time. It also provides valuable context to investors considering the climate alignment of sovereign issuers within their portfolios.

In Chapter 2, we turn our attention to physical risk, expanding on last year's analysis to outline recordbreaking climate conditions in 2023 and knock-on impacts for G20 nations. Crucially, we expand our analysis to consider the state of national adaptation planning, systematically comparing the breadth and depth of preparation in each country.

Supporting the analysis, we summarise country-level findings in Country Profiles for each G20 nation within Chapter 3, detailing key climate transition policies, corresponding ITRs, and outlining current and future exposure to physical risks, as well as their main adaptation policies.



Transition Risk



Implied Temperature Rise estimates for national carbon commitments

The country-level temperature metrics (denoted in °C) presented in this report indicate the global Implied Temperature Rise (ITR) that would result if every country that has a commitment or set of policies with the same level of ambition as the studied country. However, they do not imply that those countries alone can have such an influence on global temperature.

Interpreting these temperature metrics, it is important to note that two countries with a Nationally Determined Contribution (NDC) or mid-century target, which indicates the same level of emissions reduction, may not share the same ITR. As the methodology also considers historical cumulative emissions, a country that has already used a significant portion of its carbon budget will need to decarbonise at a faster rate than a target year (e.g. 2050) to remain in line with the Paris Agreement's objectives. Our methodology includes four key steps:

We first estimate the annual emissions of each country in 2030 for NDCs and current policies, and for mid-century targets (2050 for most countries). We calculate this based on the reductions implied by the announced NDCs and mid-century targets,¹ assuming that countries meet their goals. For the current policies, we use projections developed by the International Institute for Applied Systems Analysis

(IIASA) and New Climate.² These projections operate under the assumption that no additional mitigation measures will be undertaken beyond the policies already in place.

- 3

We then calculate each country's share of the global 'carbon budget' – the total available emissions volume consistent with a 2°C scenario.

The global budget consistent with a 2°C scenario is based on the MESSAGE-GLOBIOM model used in IPCC's assessment reports. The distribution of this budget across countries is based on LSEG's CLAIM model.³ It simulates millions of possible ways to distribute the global carbon budget across individual countries according to their climate and economic profile (historical emissions, energy intensity, GDP/capita, etc.), as a basis for estimating the most likely national carbon budget allocations for various timeframes.

Next, we determine the gap between a country's projected emissions for its commitments or current policies and its carbon budget under a **1.5°C or 2°C scenario on the same timeframes.** This 'emissions gap' is the main variable in assessing the alignment of a country with a global warming target.

Lastly, we calculate the ITR above pre-industrial levels for each country and scenario, respectively.⁴ This calculation is based on an equation that effectively converts estimated future GHG emission volumes into an ITR for each country. This proprietary methodology is based on an approach and equation adapted from IPCC (2018)⁵ and Rogelj et al. (2019).⁶

Box 1. Updating our ITR calculations

Beyond new commitments, the update in the ITR from last year's edition reflects⁷:

- Updated historical emissions inventories to 2021 a) (including Land Use, Land-Use Change and Forestry (LULUCF)-related emissions).
- Enhancements to how non-CO₂ greenhouse gases b) (like methane) are reflected in our ITR calculation based on more granular data made available by the IPCC (see Annex 2b).
- Updating the transient climate response to C) cumulative emissions (TCRE) coefficient to reflect the latest climate science on the relationship between GHG emissions and global temperature rise (see Annex 2b).

The resulting adjustments to our ITR values are limited (typically below 0.1°C⁸), except for 0.2–0.3°C downward revisions in our ITR results for the NDCs of some particularly carbon-intensive economies including Saudi Arabia, Russia, Canada and Australia. These revisions principally result from lower-than-expected emissions levels during the pandemic, implying that countries did not consume their allocated carbon budgets as quickly as expected during that time and so can spread that 'extra budget' between now and 2030.



Since its conclusion eight years ago, the Paris Agreement has delivered remarkable progress...

For the third consecutive year, we update our annual analysis of G20 countries' climate commitments and policies ahead of global climate talks at the 28th Conference of the Parties (COP28).

Some eight years after the conclusion of the Paris Agreement, the framework has succeeded in eliciting at least one set of voluntary emission reduction commitments (the NDCs) from all 196 signatories. The 'ratcheting-up' process that is a core element of the agreement has also been at least a partial success. Indeed, since the conclusion of the agreement, all G20 countries, which are the focus of this report, have added a mid-century target (or 'long-term mitigation goal'). All but two of the G20 have also substantially increased the ambition level of their 2030 target through revised NDCs. The exceptions are Russia, which has not updated its NDC, and Brazil.

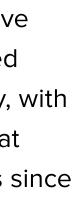
Indeed, Turkey is the latest G20 country that has updated its NDC. The government announced in April that it would aim to almost double the targeted reductions versus a business-as-usual level from a 21% to a 41% reduction by 2030.⁹ While the government has not yet aligned the country's NDC with the Paris Agreement's goals, it substantially reduces the ITR of Turkey's 2030 goal from 2.9°C to 2.4°C, and aligns its NDC more closely with the trajectory of its current policies, which we estimate to imply 2.5°C warming.

In September 2023, Brazil announced that it would revise its NDC for a fourth time, effectively restoring the ambition level of its first NDC submissions which had been lowered under the previous Bolsonaro administration. Though not yet ratified at the time of the writing and so not included in our calculations, this revised ambition level will target 53% reduction in emissions by 2030 compared with 2005 levels (previous target was 50% reduction).

...but as the pace of new commitments has slowed, G20 targets remain off track from achieving the Paris Agreement

However, as 2030 national climate milestones move increasingly into focus, the pace of new or updated commitments from countries has slowed markedly, with Turkey and Brazil being the only G20 countries that have set new 2030 or mid-century climate targets since COP27 in Sharm el-Sheikh.

This slowing of commitments leaves governments offtrack to achieve the Paris Agreement's goals for now. Almost all G20 countries are now targeting to achieve net zero by mid-century.¹⁰ The majority are targeting 2050, Germany by 2045, and several emerging economies after 2050, including Turkey by 2053; Russia, Saudi Arabia, China, and Indonesia by 2060; and India by 2070. However, it is important to emphasise that while achieving net zero emissions describes an endpoint, climate change is driven by the cumulative GHG emissions until that point. As such, net zero goals do not automatically equate to a 1.5°C aligned trajectory (or any other specific temperature pathway).



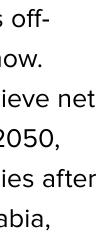
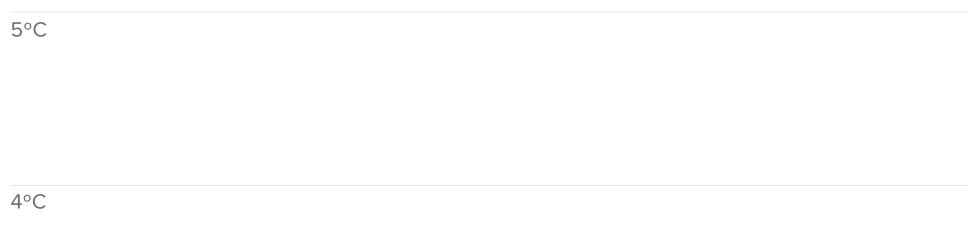
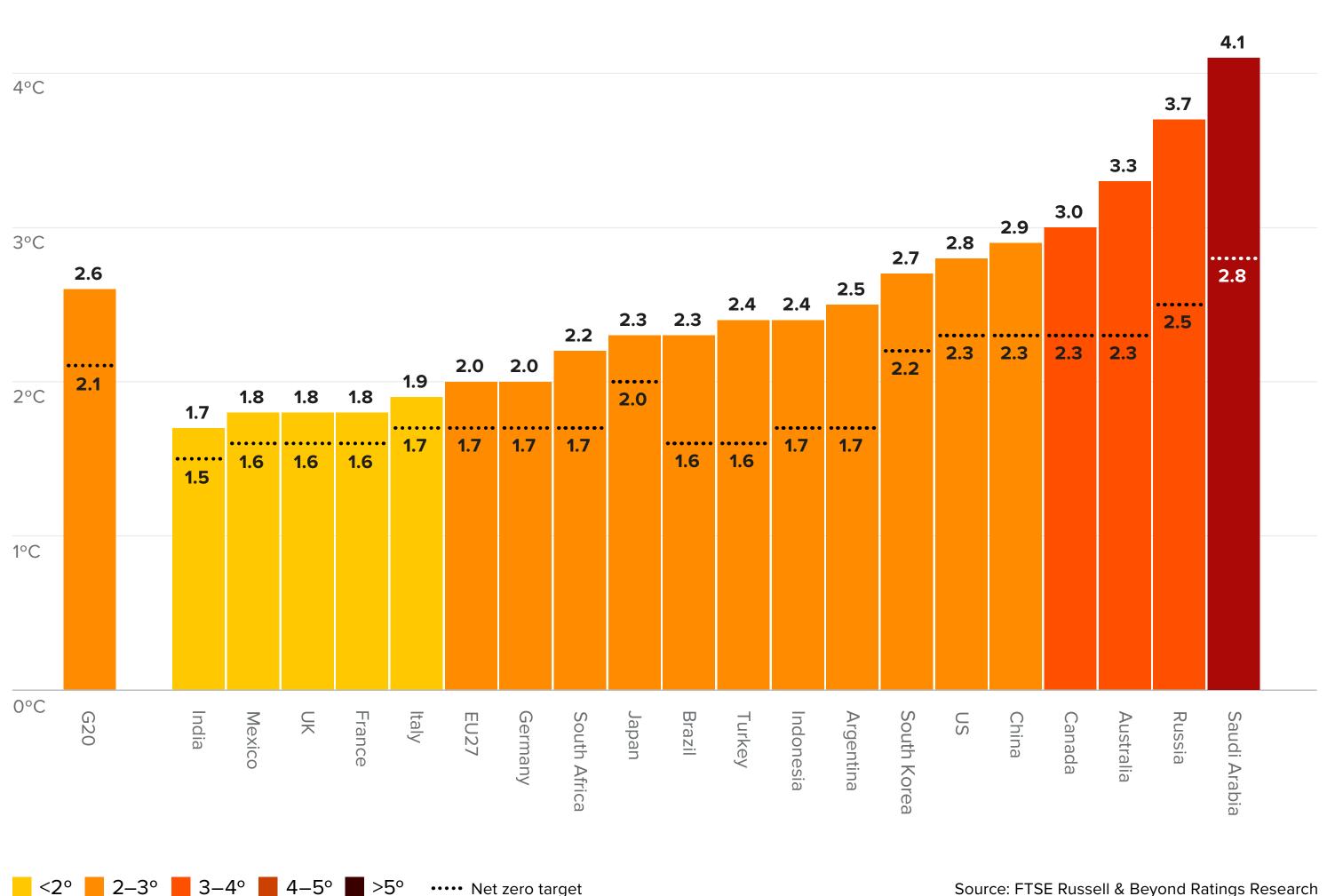


Figure 02: The ambition gap between NDCs and mid-century targets remain pronounced Implied Temperature Rise for G20 countries for 2030 NDCs and mid-century targets

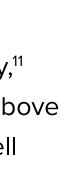




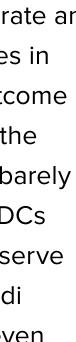
Overall, we estimate that achieving the G20 countries' mid-century targets would align with a global temperature rise of 2.1°C by the end of the century,¹¹ unchanged from COP27. This remains materially above the Paris Agreement's goal to limit warming 'to well below 2°C above pre-industrial levels' and pursue 'efforts to limit the temperature increase to 1.5°C'.¹² As shown in Figure 02, only 12 G20 members' targets align with below 2°C, while eight align with above 2°C pathways, including those of the world's largest emitters, China and the US.

Worse still, all G20 countries continue to demonstrate an 'ambition gap': 2030 NDC targets for G20 countries in aggregate are tracking towards a temperature outcome approximately half a degree Celsius warmer than the mid-century targets (2.6°C vs 2.1°C). This gap has barely shifted from last year's gap when we estimated NDCs to align with approximately 2.7°C warming. We observe a 1.0° C gap or wider for Australia, Russia and Saudi Arabia, and gaps of 0.5° C or larger for another seven G20 countries, including Canada and China.

Source: FTSE Russell & Beyond Ratings Research







Box 2. Current trends could put 1.5°C out-ofreach within a decade

The Global Stocktake – which Article 14 of the Paris Agreement prescribes to take place for the first time in 2023 and every five years thereafter¹³ – will conclude at COP28 with the so-called "consideration of outputs" that will summarise the findings of the two-year assessment process and the key implications for the path forward. The results of the "technical dialogue" as part of the Stocktake indeed suggest that the "ambition of NDCs is not collectively sufficient to achieve the Paris Agreement Temperature goal", estimating a gap to a 1.5°C scenario of 20.3–23.9 GtCO₂e of annual emissions by 2030.¹⁴

The Stocktake calculations show that closing this gap would require the world to reduce emissions by 43% by 2030 versus 2019 levels.¹⁵ Another way to look at this is that if, going forward, countries were to reduce their emissions following the full implementation of their NDCs, the world would exhaust its remaining carbon budget¹⁶ for a 1.5°C alignment by 2032¹⁷ (see Figure 03).

The latest IPCC Report AR6 Climate change 2023 estimated the historical emissions over the period 1850-2020 to be equal to 2,390 $GtCO_2$, with a range of uncertainty of 240 $GtCO_2$. The remaining carbon budget to limit warming to 1.5°C relative to the period 1850–1900 with a 50% probability is estimated to equal to 500 $GtCO_2$. The implementation of the NDC would emit 430 $GtCO_2$ over the period 2020–2030, leaving 70 $GtCO_2$ of budget to be emitted, which is estimated at around two years of emissions.

Figure 03: Global carbon budgets under different scenarios¹⁸

Carbon budget for a 50% chance of limiting warming to $1.5^{\circ}C$ (CO₂)

Historical emissions 2,390 Gt (+/- 240 Gt)

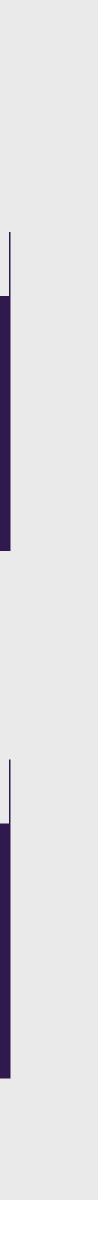
Carbon budget for a 67% chance of limiting warming below 2°C (CO₂)

Historical emiss 2,390 Gt (+/- 24

Source: IPCC Report



ssions 240 Gt)		Remaining after 2030 720 Gt (+/- 10 Gt)
rt AR6 Climate 2023	NDC 430 Gt (+/- 10 (Gt)



Just seven years out, G20 governments need to further strengthen policy incentives to meet their national 2030 targets

To better understand how G20 countries are progressing towards their targets, we also examine the alignment of the current policies, based on projections developed in collaboration with the New Climate Institute and IIASA. These projections capture the level that G20 countries' 2030 GHG emissions would track towards if their current climate-related policies remained in force unchanged. The gap between these projections and NDCs can be interpreted as a measure of how closely countries are tracking towards achieving their climate goals, based on policy implementation (policy announcements without actual legislative implementation are not considered in our projections).

In aggregate, these estimates show that G20 countries' current climate policies lag slightly behind their 2030 targets. Under current policies, we estimate 2030 emissions for G20 countries to be 7.9% higher than targeted under their NDCs — or aligning with a 2.8°C pathway vs 2.6°C for the NDCs. We note, though, that for some G20 countries these gaps are significantly larger, 0.5°C or larger for Saudi Arabia, South Korea, the US and Canada — pointing to the need for material policy acceleration to reach their national 2030 targets (see Figure 04).

For many emerging economies, we previously observed room to increase NDC targets as our current policies' projections were tracking to more ambitious outcomes. However, this relationship has evolved as NDC ambitions have increased (e.g. for Turkey) or our emissions estimates under current policies have been revised upwards.

Despite bright spots, policy progress since COP27 has been incremental

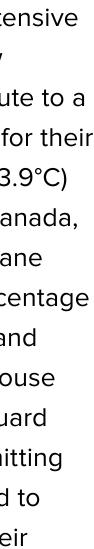
Since we last surveyed G20 members' climate policies ahead of COP27, improvements have been incremental. Among the largest emitters, the most important development has been the completion of the legislative implementation in the EU of the "Fit for 55" agenda in April 2023. This included new vehicle fleet emission limits, mandating the phase-out of new combustion engines car sales in the block by 2035; and comprehensive reforms of the European Emission Trading System (ETS), which will expand to additional sectors and target a 62% emissions reduction by 2030 from 2005 levels (vs 43% previously).

One of the most notable developments across G20 countries has been Brazil's commitment to reach net zero deforestation of the Brazilian Amazon by 2030.¹⁹ Apart from its impact on nature and biodiversity, deforestation is a key driver of Agriculture, Forestry and Other Land Use (AFOLU) emissions, and Brazil in 2022 accounted

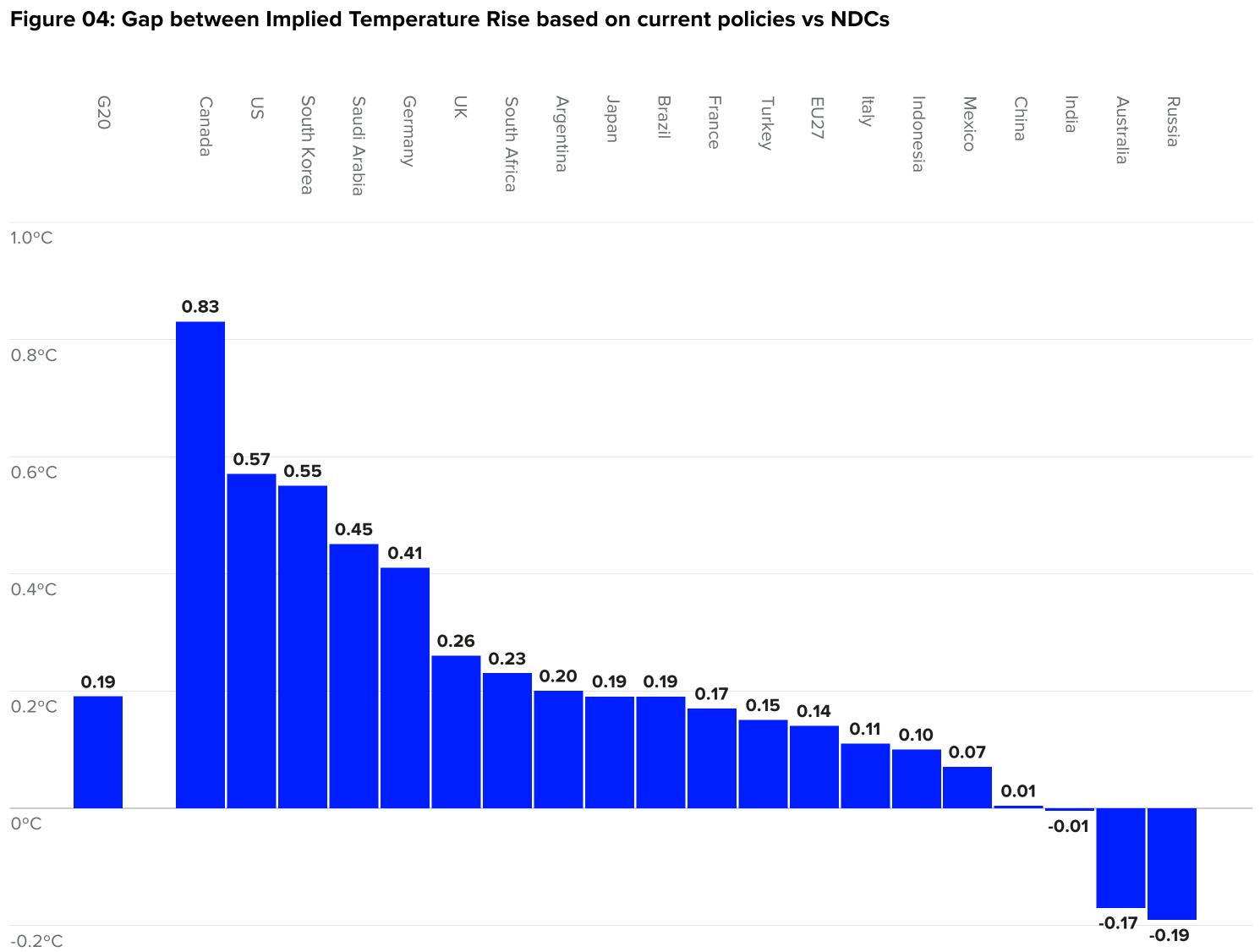
for over 40% of primary forest loss globally.²⁰ Broader adoption of these types of targets could drive significant impact given the large and cost-effective abatement opportunities AFOLU offers, particularly to G20 countries such as Indonesia, Argentina or France.

Canada and Australia, among the most carbon-intensive G20 members, have also introduced material new climate policy measures. These measures contribute to a substantial reduction in our estimates of their ITR for their current policies, by 0.6°C for Canada (from 4.5 to 3.9°C) and by 0.4°C for Australia (from 3.6 to 3.2°C). In Canada, these measures include for example a new "Methane Strategy" which commits to an additional five percentage point reduction in domestic methane emissions²¹ and an increase in the carbon price under the Greenhouse Gas Pollution Pricing Act.²² In Australia, the Safeguard Mechanism, which requires Australia's highest-emitting facilities to limit their emissions, has been updated to close loopholes and require facilities to reduce their emissions in line with Australia's climate targets.²³

By contrast, other countries have reduced their ambition. Though not yet signed into law and so not included in our calculations, UK Prime Minister Rishi Sunak announced a planned roll-back of several low-carbon policies in September 2023 — extending the deadline for phaseout of new sales of fossil fuel cars and new gas or oil domestic heating boilers until 2035.²⁴



ransition Risk



Italy	Indonesia	Mexico	China	India	Australia	Russia	

Source: FTSE Russell & Beyond Ratings Research

MAC curves point to the lowest hanging fruit to accelerate decarbonisation

The stocktake emphasises that despite significant challenges, 'there are now sufficient cost-effective opportunities to address the 2030 emissions gap'.²⁵ We estimate that 55% of the near-term abatement needed to get back on track at the G20 level could be met through ready-to-use decarbonisation technologies like renewables; a further 32% could be met by improving energy and resources efficiency; while a far smaller proportion (approximately 4%) requires accelerating the deployment of early-stage technologies (e.g. carbon capture and storage or low-carbon fuels).²⁶

However, accelerating the transition among G20 countries will require careful consideration of the uneven distribution of decarbonisation opportunities across different sectors and countries. To better illustrate this, we use marginal abatement cost curves (MACC) to analyse the decarbonisation potential of different abatement measures on country-by-country and sectorby-sector bases.²⁷

Energy 16,333 N Figure 06: Aba Energy 39% Industry 26% Transport 9% Buildings 8% AFOLU 19%

*percentages may not sum to 100% due to rounding

Figure 05: Emissions profile of the G20 in 2021²⁸

Mt		Transport 6,229 Mt		AFOLU 6,844
	Industry 11,102 Mt		Buildings	s 2,897 Mt

Mt		Transport 6,229 Mt		AFOLU 6,844 Mt
	Industry 11,102 Mt		Building	s 2,897 Mt
atement potential in the G20 be	etween now and 2030*			
		Source.	FTSF Russall	& Bevond Ratings Research

Source: FTSE Russell & Beyond Ratings Research

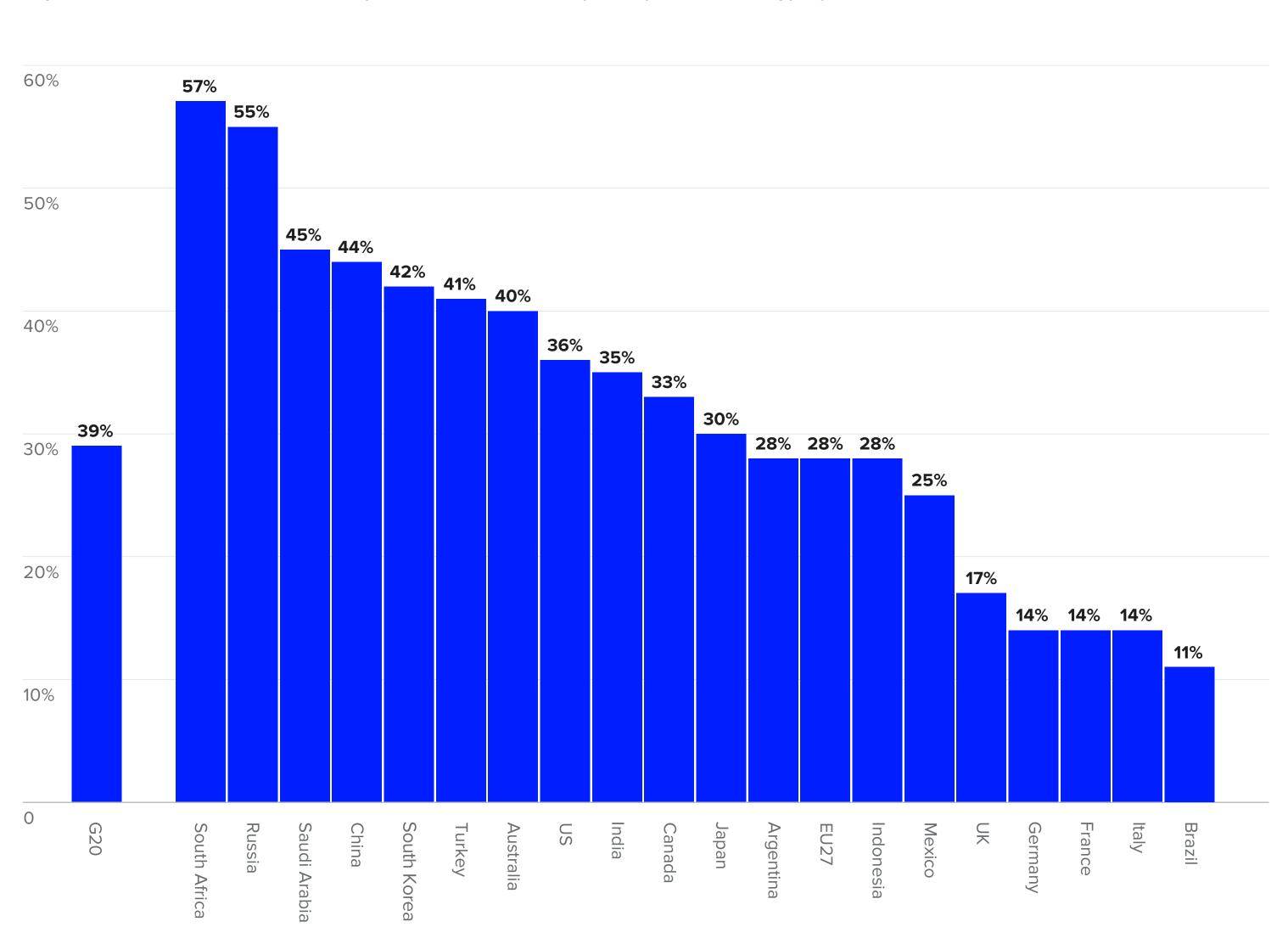
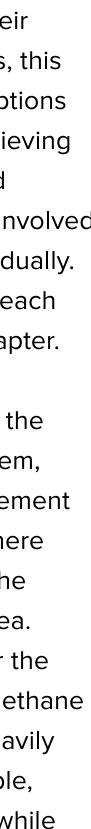
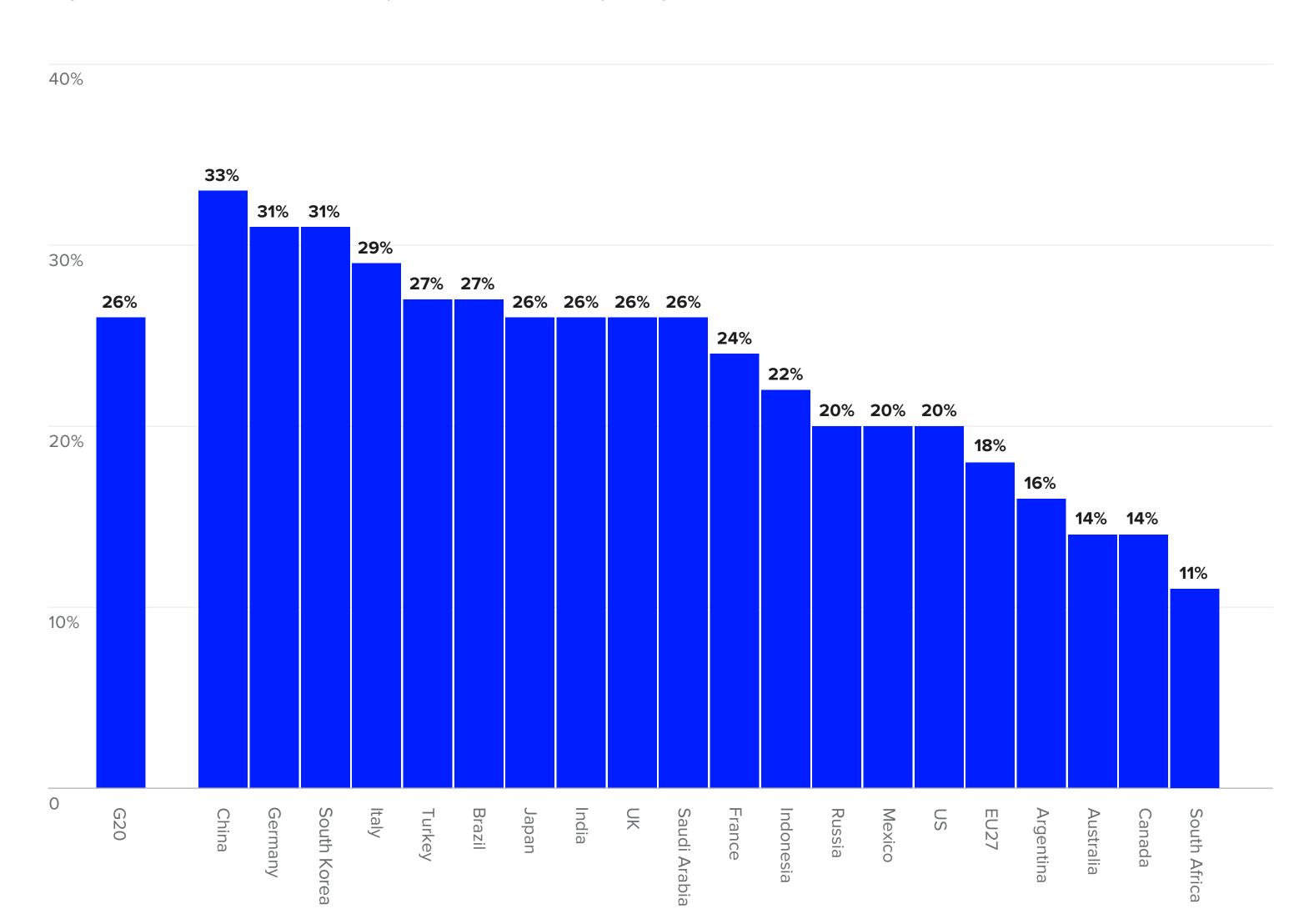


Figure 07: Abatement potential by 2030 for a 1.5°C trajectory in the Energy System

MAC curves for individual countries basically rank the options to decarbonise different sectors by their economic cost. Although a highly stylised analysis, this approach can help to identify the most efficient options for G20 countries to not only close the gap to achieving the NDCs, but also to shift towards a 1.5°C aligned emissions trajectory. Our assessment of the G20 involved a detailed analysis of each member country individually. The abatement potential and emissions profile of each country are presented in the 'Country Profiles' chapter.

Our exploration of MAC curves clearly shows that the largest source of GHG emissions, the energy system, also offers the most cost-effective near-term abatement opportunities. These are greatest for countries where carbon-intensive fossil fuels are still dominant in the energy mix, such as China, Australia or South Korea. Also, large fossil fuel producers, such as Russia or the United States that generate significant 'fugitive' methane emissions from fossil fuel production²⁹ and rely heavily on them for domestic use. South Africa, for example, produces about 90% of its electricity from coal,³⁰ while we estimate that lowering these fugitive emissions could represent almost 25% of Saudi Arabia's emission reductions for 2030.³¹ In contrast, additional abatement options are relatively marginal for countries such as Brazil or France, where fossil fuels play only a limited role in the power generation mix.³²





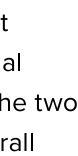
For countries, such as Germany or Japan, the most costefficient abatement opportunities now are often in the Industrial sector, through driving rapid electrification, greater energy and materials efficiency. In contrast, for G20 countries with large agricultural and forestry sectors, including Indonesia or Brazil, we estimate the abatement potential of the AFOLU sector represents almost 45% of total potential.

Somewhat surprisingly, we estimate the additional nearterm abatement potential in the Buildings and Transport sectors represents a comparatively small amount of the G20 total at 9% and 8%, respectively. This typically reflects larger and cheaper emissions reductions potential through the energy or AFOLU sectors. However, for countries currently making progress to rapidly decarbonise their power sector (such as Germany, UK and the US), Buildings and Transport sectors are relatively important to deliver additional emissions reductions. For these three countries, the two sectors combined account for 30-40% of the overall mitigation potential.

Source: FTSE Russell & Beyond Ratings Research

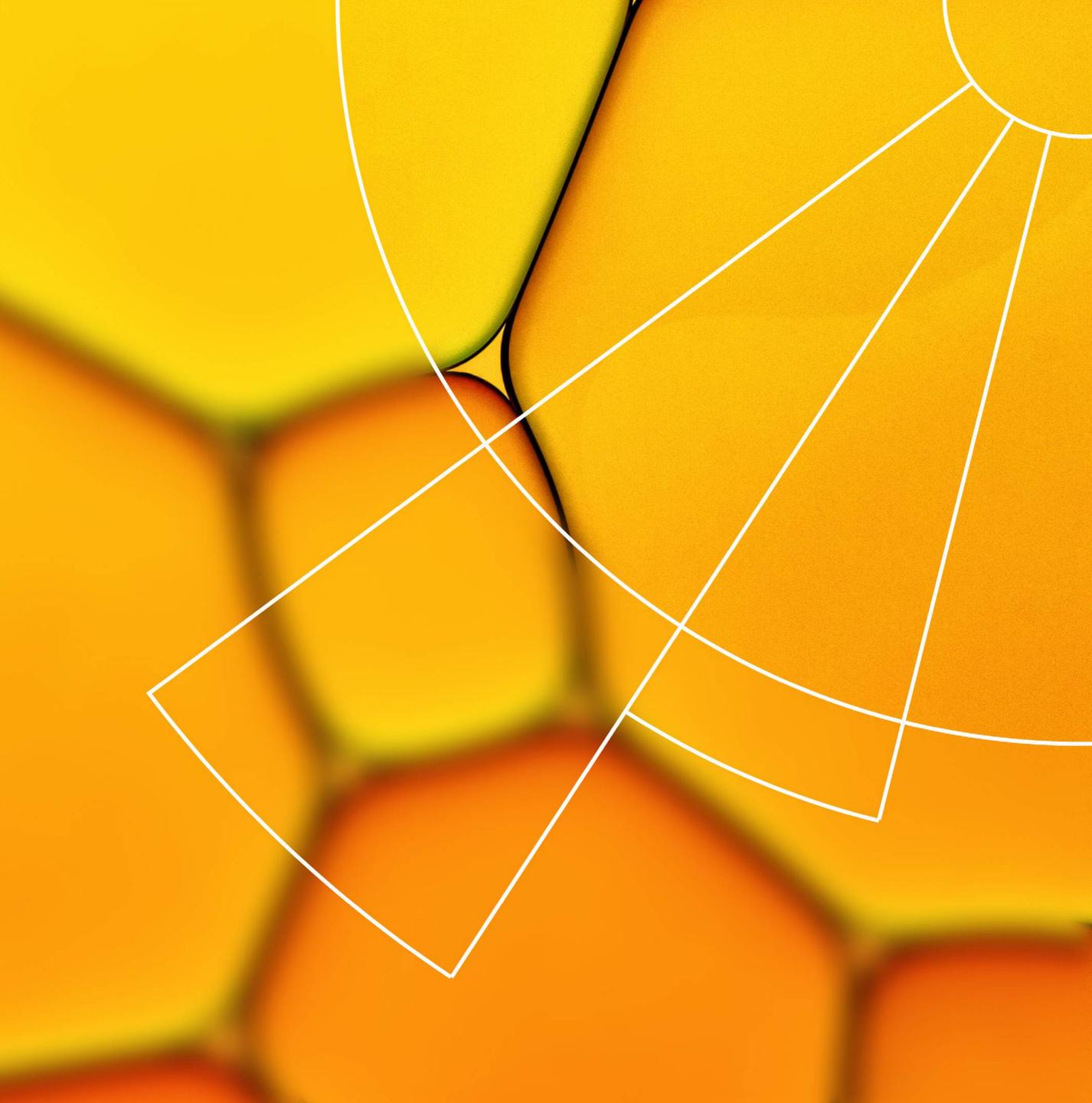




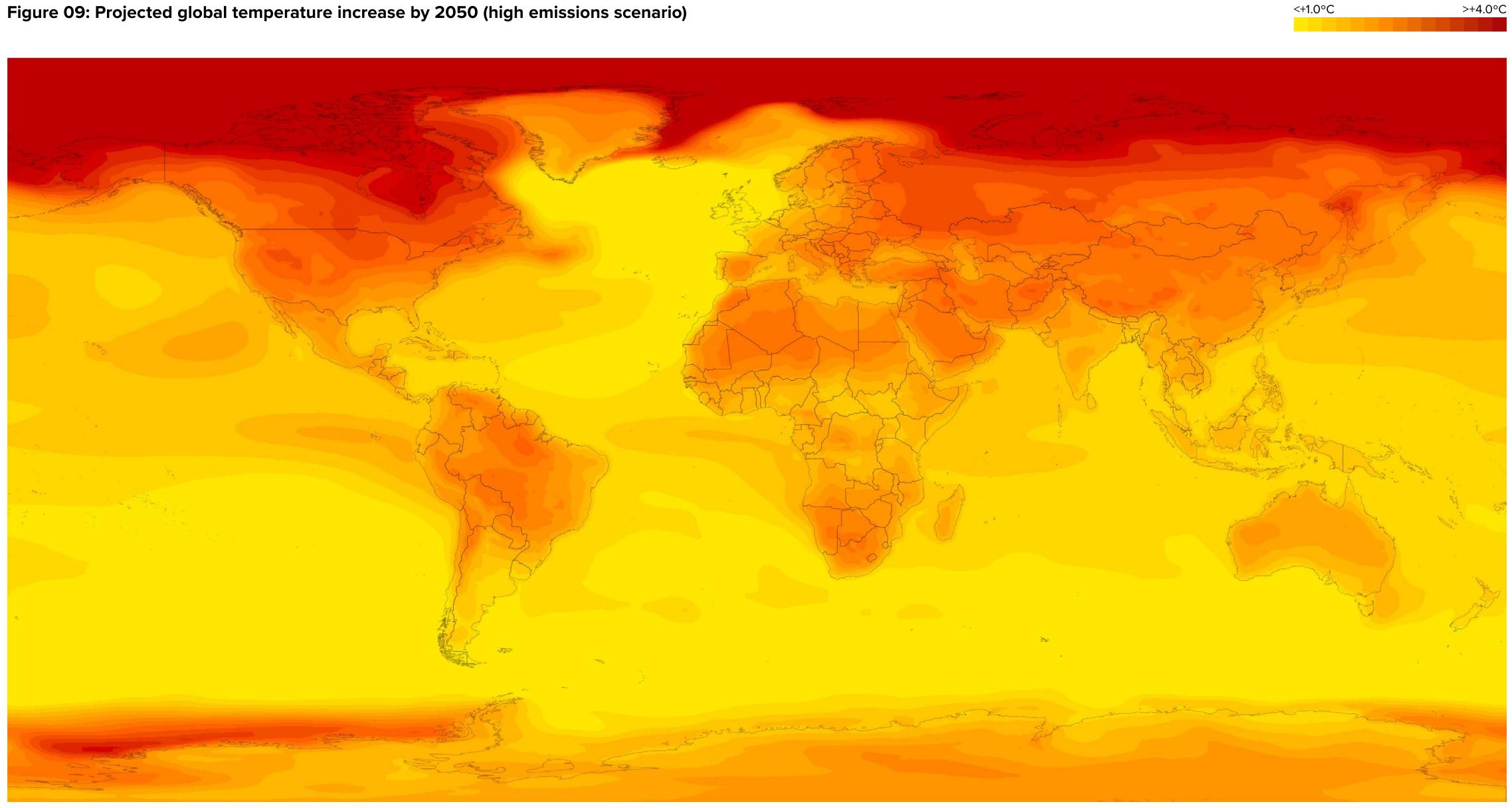


Chapter 2

Physical Risk







Climate change has become the new normal

Investor thinking on climate risk has been dominated by a focus on transition risks for businesses and society. The physical effects of climate change are now materialising evermore clearly and are set to intensify rapidly over the coming years and decades^{1,2}. As a result, investors increasingly seek to improve their understanding of climate-related physical risk that companies and economies face as well as the adaptation strategies to mitigate and manage these risks.

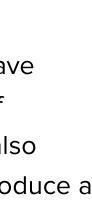
In last year's COP27 Net Zero Atlas, we surveyed how different types of climate-related physical impacts warmer temperatures, droughts, heatwaves, crop yield losses, wildfires, storms, flooding, and rising sea levels – are beginning to impact G20 economies. We also analysed the key challenges those economies are likely to face as physical climate risk escalates during this century, emphasising that:

Physical risks are already material and escalating quickly for G20 economies. The cost of extreme weather events that can be attributed to climate change has been estimated at US\$2.9 trillion for the 2000–2019 period.³

By 2050, physical risks are likely to present a significant economic and policy challenge for those jurisdictions. Also by this date, the costs induced by rising sea levels in Europe alone could reach hundreds of billions of euros.⁴

The direct impacts for the G20 are likely to be exceeded by knock-on effects from physical risks materialising outside of their own territorial borders (from political and financial instability to supply chain disruption and migration). Though estimates are highly uncertain, climate change might force up to one billion people to migrate.⁵

In this year's COP28 Net Zero Atlas, we update and broaden this analysis. The key physical risks that individual G20 economies are facing, which we have identified, are updated and summarised as part of the G20 country profiles in the next chapter. We also highlight key developments since COP27 and introduce a survey of G20 countries' adaptation strategies.



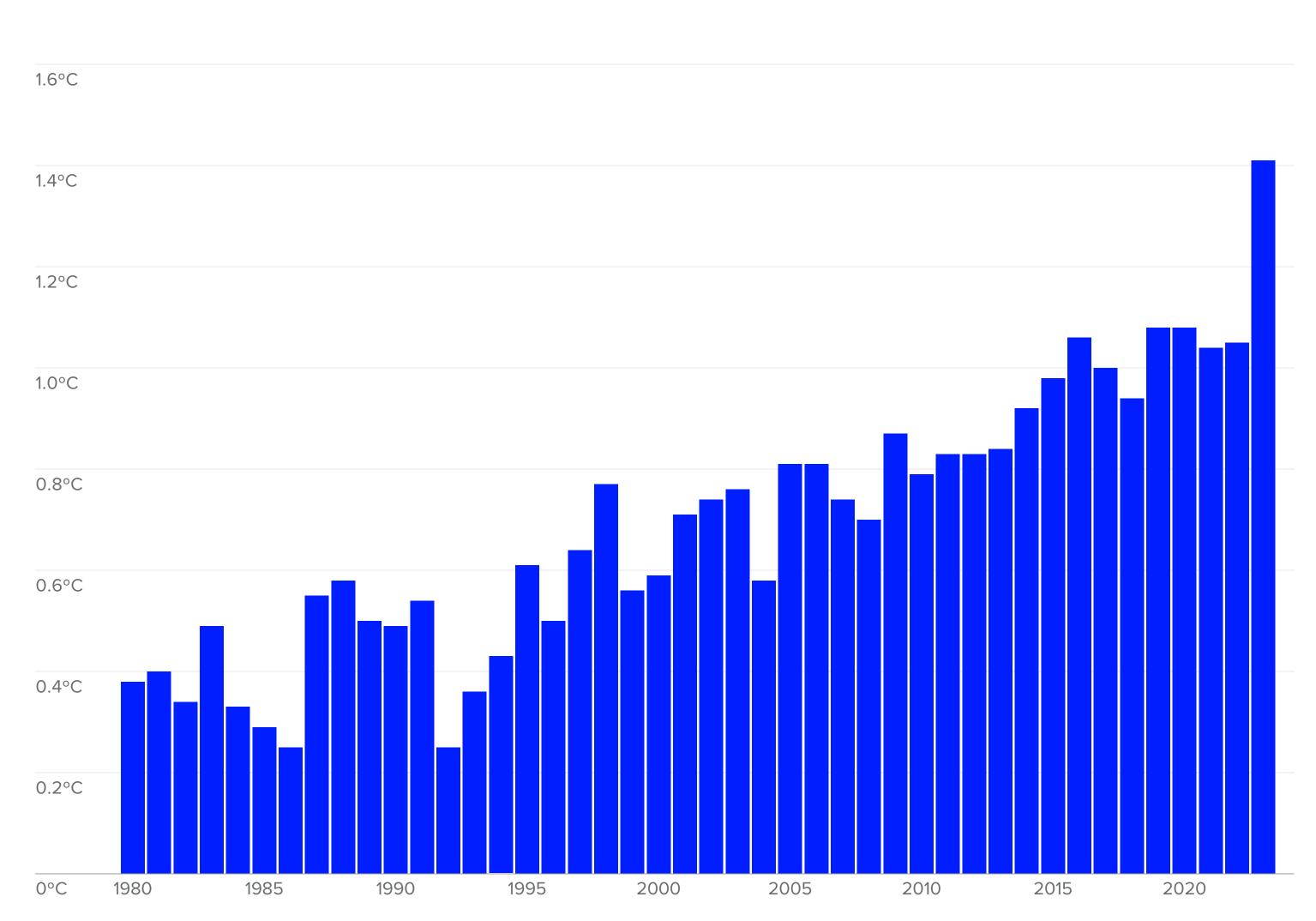
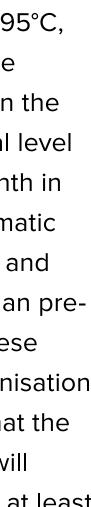


Figure 10: Temperature anomaly for July–September

Record-breaking temperatures in 2023

Evidence for the increasing effects of climate change has continued to accumulate since COP27. In April, the World Meteorological Organisation (WMO) annual State of the Global Climate report highlighted the years 2015 to 2022 as the eight warmest years on record,⁶ with 2023 set to extend this trend.

Indeed, with an average global temperature of 16.95°C, July 2023 is the hottest month ever recorded since the advent of modern meteorological monitoring in the 1940s.⁷ This record is 1.1°C above the pre-industrial level average temperature for July⁸ and the hottest month in the last 120,000 years according to analysis of climatic records.⁹ The heat has continued into September, and the July to September period was 1.4°C warmer than preindustrial levels.^{10,11} Although just three months, these findings align with the World Meteorological Organisation projections that estimate a two-in-three chance that the annual average near-surface global temperature will briefly surpass 1.5°C above pre-industrial levels in at least one of the years between 2023 and 2027.¹²



Source: ERA5, C3S/ECMWF

Ocean warming also broke records in July, having already contributed to global sea level rise through thermal expansion with NASA attributing one-third to one-half of almost 10cm in global sea level rise observed since 1995.¹³ In addition, the Antarctic sea ice extent was lower than ever recorded since satellite observations began, with a monthly value for July almost 15% below average.¹⁴

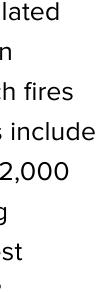
Impacts are being felt in G20 countries worldwide

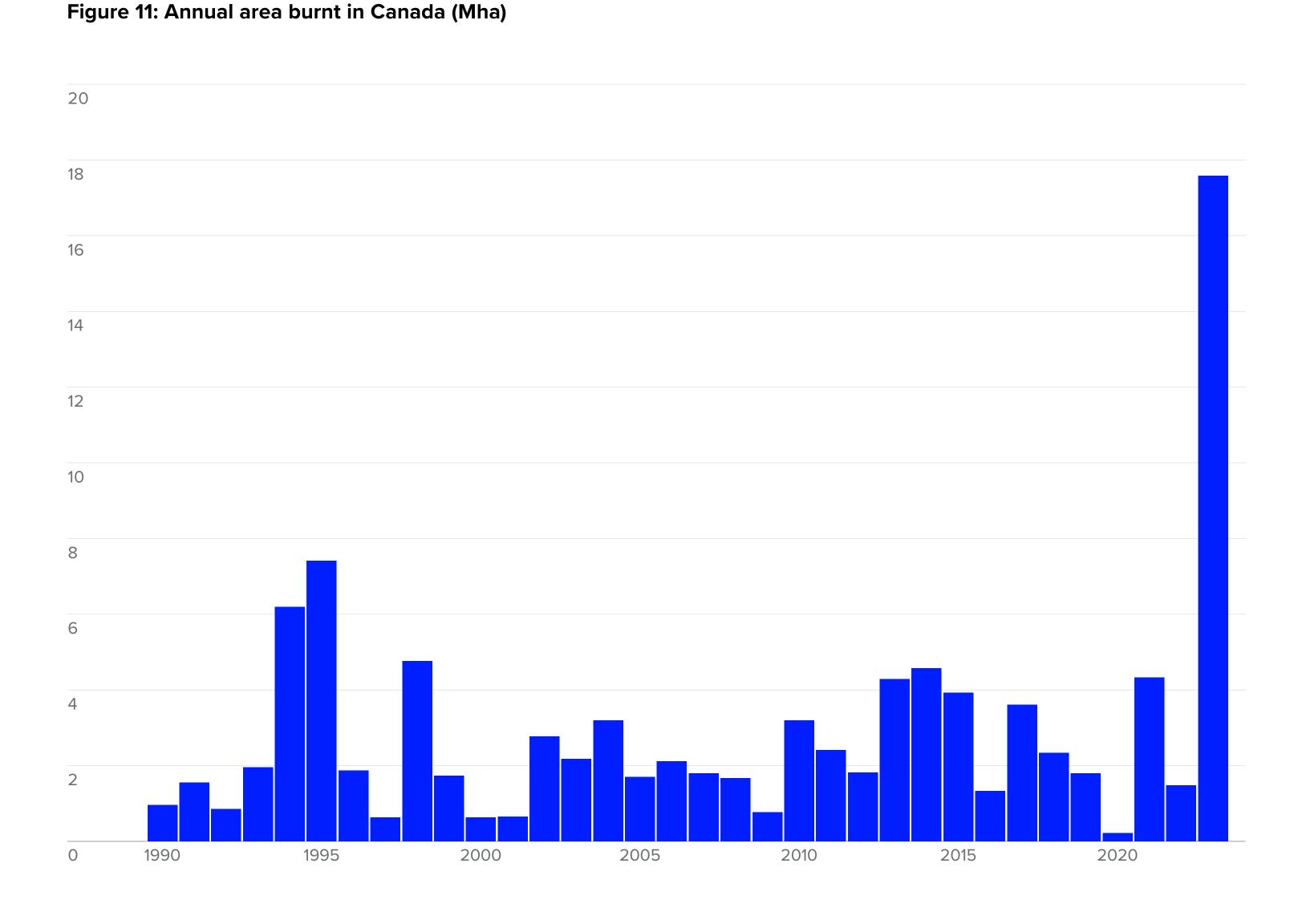
Record temperatures are already contributing to more frequent, longer-lasting and more extreme weather events as well as knock-on effects such as wildfires and crop yield losses. Insurers estimate that in the last three years the total cost of natural disasters has reached US\$800 billion;¹⁵ and that the combined cost of 2023 heatwaves in China (where temperatures reached as high as 52.2°C in the northwest), the US (with onequarter of the population exposed to excessive heat above 41°C), and Southern Europe (with temperatures as high as 48.2°C in Italy) could reach 0.6 percentage points of global GDP in 2023.¹⁶

There were 60,000 recorded deaths from heat-related causes in Europe's 2022 summer alone,¹⁷ highlighting that heatwaves are now one of the deadliest climate hazards. The effects of extreme temperatures are not restricted to health and productivity as there has also been increasing material damage, such as melted roads or destroyed infrastructure. In India, for example, heatwaves frequently occur, including for more than half of 2022, which could result in up to 4.5% of GDP being at risk, considering only lost labour due to rising heat and humidity, according to the World Bank.¹⁸

High temperatures also contribute to wildfire-prone conditions. In summer 2023 in Canada, the country faced its worst wildfire season ever: more than 18 million hectares (an area half the size of Italy) of forest burnt, more than double the previous record of 7.1 million hectares in 1995.¹⁹ At the time of writing this report in September 2023, there were more than 1,000 active fires, with almost 700 still out of control. At the same date, the 2023 Canadian fires had already released more than 1.7 Gt of CO₂e, the equivalent of three times Canada's annual typical emissions²⁰.

While most destruction occurred in sparsely populated boreal forest limiting material damages and human losses, the impacts can be devastating where such fires occur in more densely populated areas. Examples include Hawaii, where wildfires in August destroyed over 2,000 buildings, killing at least 106 people,²¹ and causing US\$4–6 billion in damages.²² In Greece, the largest wildfires ever recorded in the EU killed at least 28 people and forced mass evacuations of locals and tourists, with damages amounting to US\$1.8 billion.²³ In Europe, wildfire-related costs are estimated to be more than US\$4 billion for 2023 alone.²⁴





There have been many news reports about massive floods this year: Tropical Storm Daniel caused the deadliest floods in Libya for a century, resulting in at least 4,000 fatalities and more than 40,000 displaced individuals.²⁵ In July alone, floods and related geological disasters caused 142 deaths and disappearances, destroyed 2,300 homes and caused direct economic losses of US\$2.19 billion in China.²⁶ Greece was hit twice by massive floods in September, with more than 700mm of local rainfall in a single day²⁷ (more than the average annual precipitation over London), resulting in an estimated 180,000 animal casualties in the agriculture sector. On 29 September, heavy rainfall caused a flash flooding event in New York City, bringing chaos on the transport systems with grounded flights and flooded subway stations.²⁸ In India, torrential rains in October triggered a glacial lake outburst, leading to flash floods that caused at least 74 casualties in Sikkim.²⁹

Source: Canadian Wildland Fire Information System

Adaptation strategies move into focus as not all G20 countries are equally prepared for climate change

This year's climatic events would have been extremely rare without human-induced climate change.³⁰ However, such events are set to become increasingly common, longer lasting and more intense in the future — even if efforts to reduce emissions succeed in limiting global warming to 1.5°C by the end of the century.³¹ The cost of adapting to these challenges is still poorly understood, but a recent UN Environmental Programme study estimates US\$160–340 billion of annual adaptation costs by 2030, scaling up to US\$315–565 billion a year by 2050 just for developing countries.³²

Against this backdrop, there is a growing need for investors to monitor how governments and corporates are preparing to reduce vulnerabilities and manage these risks, which will become critical as both chronic and acute climate impacts begin to materialise ever more forcefully.

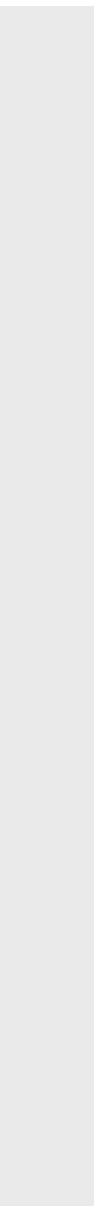
But although over 70 governments now publish some form of adaptation plans,³³ they still rarely systematically examined. Indeed, understanding what these adaptation plans entail and how credible they are will become as important for investors as assessing governments' emission reduction targets and transition strategies.

Box 3. Like transition risk, physical risk...

- ...creates the need for largescale adaptation finance as it requires trillions in both public and private investments over the coming decades to be effectively mitigated on a global scale (e.g. to adapt infrastructure and the built environment³⁴).
- ...will intensify over coming decades. But the greatest market dislocations are likely to occur much earlier, as forward-looking financial markets gain a better understanding of future risks and begin to factor these into asset valuations and investment decisions. If the pricing of long-term climate risks in equity markets is debated,³⁵ early signs are beginning to manifest in the real estate industry, where discount prices are observed for exposed properties.^{36,37}
- ...requires not only funding, but also creates pressures for technological innovation, behavioural change, and regulation (e.g. development of more resilient agricultural processes or crops, changes in urban planning and housing regulations, adaptation of working hours in exposed sectors).

However, unlike transition risk, physical risk...

- ... is much more complex and harder to plan for due to its uncertain, probabilistic nature. Critically, the extent of physical risk will depend on the success of transition efforts as even small changes in temperature outcomes drive exponential change in physical risks.
- ...cannot be 'solved'. Achieving net zero emissions will effectively remove transition risk. But heightened physical risk can only be managed and could potentially persist for centuries even after emissions are successfully reduced to net zero.
- ... requires highly localised and contextspecific responses. Similar actions can be carried out almost anywhere across the globe to reduce GHG emissions, but adaptation measures need to be designed and implemented in each context to account for local specificities. This means that adaptation implementation requires the implication of all levels of societies.



National adaptation strategies in G20 countries

In this year's Net Zero Atlas, we survey the status of these adaptation plans for G20 members, focusing on their publicly available National Adaptation Plans or Strategies — NAPs or NASs. We assess the breadth and depth of planning in each country on various criteria, such as the description of funding mechanisms or the existence of a monitoring and evaluation processes. Details for each country are provided in the Country Profiles section.

Almost all G20 countries have a plan or an adaptation strategy in place but their implementation efforts are highly heterogeneous. Our analysis now identifies adaptation strategies for 19 of the G20 countries. Saudi Arabia has yet to publish a dedicated national strategy, though its 2021 updated Nationally Determined Contribution (NDC) mentions adaptation measures.³⁸ However, these plans still vary hugely in scope, scale, and granularity, making it difficult to compare them systematically.

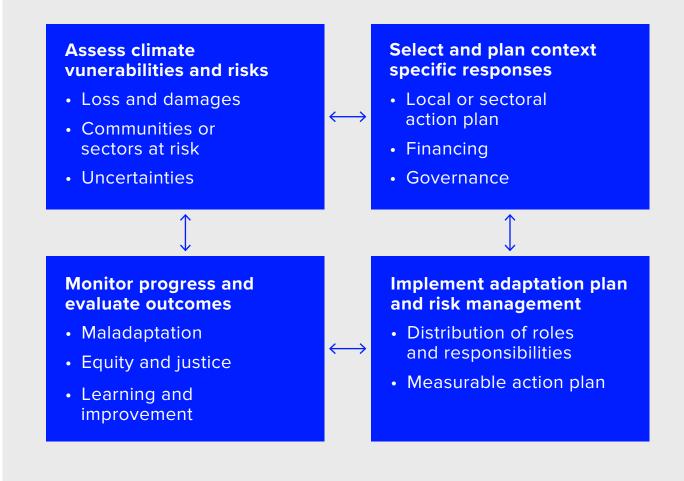
A few G20 members (France, the United Kingdom, Germany) have now developed both high-level strategies and more detailed implementation plans that are being monitored, revised and updated at regular intervals. The US has issued an Executive Order 14008 on Tackling the Climate Crisis at Home and Abroad, instructing 28 federal agencies to design their specific adaptation plan.³⁹ Most others have released only a single document, either called strategy or plan, which, in some cases, has not been updated for extended periods (for example, Mexico and Turkey have both announced updates to their 10-year-old plans in the coming months^{40,41}).

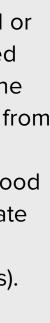
Plans also typically focus on adaptation efforts for specific sectors and natural ecosystems, but these breakdowns are difficult to compare across countries. Italy, for example, describes adaptation strategies for most economic sectors⁴² (e.g. health, agriculture, tourism and energy) as well as spatial ecosystems (e.g. marine and forests). South Africa, on the other hand, distributes actions among four generic clusters (human, economic, environment and ecological infrastructure, physical infrastructure).⁴³ A focus on coastal areas or marine environment is present in different plans (e.g. Australia, China, Indonesia and Germany), sometimes from a disaster risk management viewpoint (e.g. South Korea). If agriculture and food production is an area of focus for all plans, other sectors such as tourism or industries are less common.

Box 4. The concept of adaptation

The United Nations Framework Convention on Climate Change (UNFCCC) defines adaptation to climate change as 'adjustments in ecological, social or economic systems in response to actual or expected climatic stimuli and their effects'.44 In other words, the aim of adaptation is to minimise potential damages from climate change, either by reducing the exposure of population (e.g. reducing urban heat and building flood defences) or their vulnerability to weather and climate hazards (e.g. improved disaster risk management system and development of weather-resistant crops). In the Paris Agreement, governments committed to increasing the ability of all to adapt and build resilience and reduce vulnerability,⁴⁵ COP26 agreed a work programme to create a global goal on adaptation, and to assess collective needs and solutions.

Figure 12 – The key components of an adaptation strategy (adapted from IPCC⁴⁶ modified)







Key common elements of national adaptation policies

Despite the heterogenous nature of adaptation plans, various key features are starting to emerge, principally comprising:

Establishing robust monitoring and evaluation systems

A cornerstone of many adaptation strategies comprises improved monitoring and evaluation systems to identify climate hazards and track the implementation of adaptation measures. In France and the UK, independent agencies have been created to advise their governments and provide regular progress reports, while in South Korea, this is a task assigned to the Ministry of the Environment. South Africa, Brazil and Argentina have also defined a series of KPIs to track implementation, such as the number of persons that have access to insurance or live within flood protection measure. However, details on monitoring and evaluation implementation remain vague in many G20 countries, such as Turkey, India, Russia or Mexico.⁴⁷ In many cases, like India, this also includes targets for improved communication of climate risks to the public. Most G20 countries have already set up some online tools (e.g. online platform from the Canadian Centre for Climate Services, CoastAdapt in Australia and Mexico's National Atlas of Vulnerability to Climate Change), allowing local governments or the population to assess locally relevant data, and support their decision-making.

Improving early warning systems (EWS) and disaster response management (DRM)

Better early warning systems and disaster response management are another key component of national adaptation efforts, as extreme climate hazards become more frequent and intense. Canada's NAP has for example committed to further improve EWS for wildfires and floods, while Germany plans to adjust and expand information and EWS to new audiences and new hazards such as heat and air pollution. South Africa's NAP details a series of EWS developments at the local, provincial or national scale for different sectors (e.g. fisheries, health, agriculture). DRM is explicitly cited as a focus theme in some other NAPs, such as Brazil's or South Korea's.

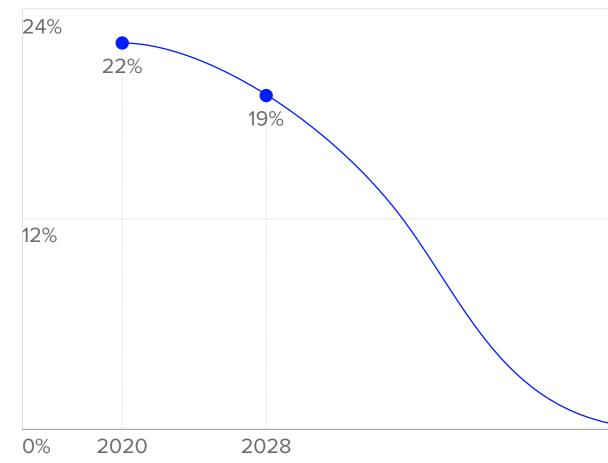
Developing robust EWSs have particularly high costbenefit ratios,⁴⁸ especially where current systems are rudimentary or non-existent — in Bangladesh, a recent study estimated that EWSs have contributed to a 100fold decline in cyclone-related mortality.⁴⁹ Japan's adaptive social protection and DRM systems are often cited as an example for early warning systems to postdisaster recovery.⁵⁰

Enhanced spatial planning including more climateresilient urban and infrastructure development

Adapting infrastructure and the built environment to changing climatic realities is perhaps the most complex and costly element of the adaptation agenda, for example, through adjusting zoning laws and building codes. In many cases, G20 country NAPs are still fairly vague on such measures, either focusing on generic notions such as 'water resilience', 'health and communities' or 'green infrastructure' or anecdotally mentioning specific measures and projects (e.g. South Africa, UK, Germany, Brazil).

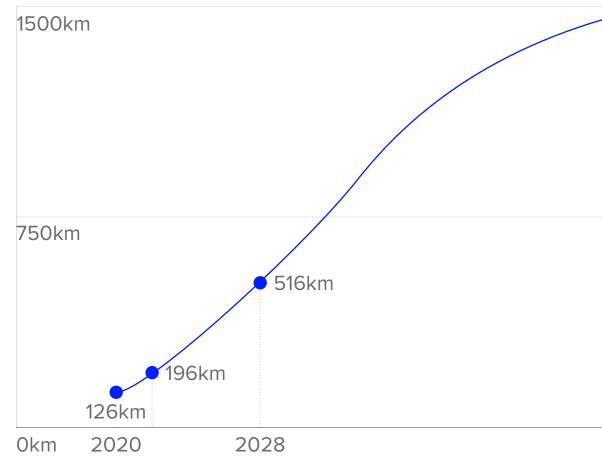
Developing greater resilience to floods and storm surges, particularly in densely populated urban areas where impervious surfaces often prevent natural drainage, is a critical element of spatial planning. The challenge is particularly acute in the large cities across the Asia-Pacific region, which have some of the highest concentration of water and storms-related risks globally.⁵¹ In China, the government has been supporting the development of 'sponge-cities' since 2014, where green infrastructure such as wetlands, parks, rain gardens and green roofs act as a buffer, storing excess stormwater and releasing it slowly.⁵² However, by 2022 only about 10% of China's over 650 large and medium-sized cities had implemented the concept. In some cases, sponge city measures had already proved insufficient to manage ever more extreme rainfall patterns, illustrating the complexity and scale of the challenge.⁵³

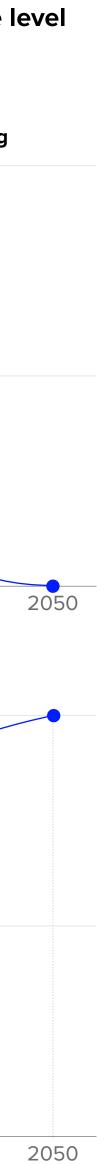
Several European countries are also working to adapt water management infrastructure to new climatic extremes. In the UK, the Environment Agency, for example, is implementing the Thames Estuary 2100 project,⁵⁴ defining how flood risk in the estuary will be managed through the Thames Barrier and other measures to the end of the century. In the Netherlands, the Delta programme⁵⁵ aims to ensure that by 2050 everyone in the Netherlands have the base level of protection, defined as the probability of mortality due to flooding not exceeding once in 100,000 years.⁵⁶ Figure 13: Progress of dyke upgrades in the Netherlands, share of population without a base level of protection from flooding



Population without a base level of protection from flooding

Kilometers of dyke upgrades





Emphasising the role of nature-based solutions in adaptation

So-called nature-based solutions (NBS) are a key component of many adaptation programmes, as better conservation of natural environments and sustainable use of natural resources can be major contributors to increasing resilience. In Indonesia, local communities and authorities have collaborated to restore coastal mangroves, introduced sustainable aquaculture, and reduced groundwater extraction, increasing resilience for 70,000 people.⁵⁷ Coral reef conservation efforts in Australia are another example as they can act as effective barriers against storm surges.⁵⁸ Programmes to promote forest conservation and enhance grassland ecology, such as China's Action Plan for Forestry to Adapt to Climate Change, can also make significant contributions to improving resilience to many climate hazards, from floods, to wildfires and droughts.⁵⁹

Agriculture is one of the sectors most vulnerable to climate change. Beyond technical and scientific improvements for more resilient and productive crops, as well as the improvement of information dissemination to farmers (e.g. in South Africa), a number of NBSs are designed specifically for the agriculture sector. Conservative agriculture and soil regeneration, for example, are being implemented for a sustainable agricultural productivity growth.⁶⁰

Adapting insurance systems to new climatic norms

Robust insurance systems are a critical resilience factor for societies and economies exposed to new climatic extremes. However, at the same time, climate change is pressurising insurance schemes across the globe and is beginning to test the insurability of a growing number of sectors and regions.⁶¹

An AXA study highlights that '70% of risk managers are not satisfied with the insurance market's response to growing climate risks'.⁶² while Munich Re estimates that in 2022, less than 45% of damages caused by natural catastrophes were insured.⁶³ In the US, State Farm, the largest property insurer, announced that they will almost entirely stop issuing new property insurance policies in California⁶⁴, followed by Allstate⁶⁵, while AAA is pulling back in Florida⁶⁶. In Australia, experts estimate that by 2030 one in 25 home owners will not be able to get insurance cover for their house.⁶⁷

The concern about the impact of climate change on the insurance sector concern is reflected in various national adaptation plans, especially as governments might come under pressure to directly or indirectly insure damages against weather and climate events.⁶⁸ Canada has committed to developing a low-cost flood insurance programme for high-risk, vulnerable communities, while India supports a crop insurance scheme for farmers. Argentina also mentions promoting access to insurance

mechanisms for small farmers, while Australia supports the establishing a reinsurance pool covering the risk of cyclone-related property damage. The European Commission is also emphasising the need for multi-risk policies, particularly for the agriculture sector.⁶⁹

Box 5. (Mal)adaptation

Second- and third-order effects of adaptation efforts can sometimes be difficult to predict and ultimately backfire by redistributing or even increasing vulnerabilities. This is the concept of maladaptation. Many factors, including non-climatic ones (e.g. economic, social and behavioural), define how efficient an adaptation strategy will be.⁷⁰ For instance, upstream irrigation in a watershed can reduce drought risk for farmers using the irrigation system but decrease water availability for farmers living downstream.

The main maladaptation categories are infrastructural (e.g. seawalls preventing water drainage and increasing flood vulnerability), institutional (e.g. farmers changing their process to focus on insured cash crops rather than drought-resistant crops) and behavioural (e.g. rural exodus leading to a shortage of farm workers).⁷¹ Maladaptation can also result in increasing GHG emissions, contributing to increased climate change and increasing adaptation needs. The adoption of air conditioning is a good example, as it can be highly effective and contribute to saving lives from heat exposure,⁷² but in the meantime warms outdoor air and increases GHG emissions, both due to energy consumption and the release of refrigerant gases.⁷³

S

Physical Risk

The international dimension of adaptation finance

The impacts of climate change do not stop at borders, and while this chapter has focused on G20 country national adaptation plans, there is an important transnational dimension to adaptation finance. While intrinsically highly localised, the impacts of climate hazards are global in reach, spanning supply chain disruptions to driving migration patterns⁷⁴ or geopolitical tensions. Increasing food insecurity, decreasing productivity and the growing impacts of extreme events, may, for example, act as a powerful driving factor for the migration of the most vulnerable populations. In many contexts, emigration is likely to occur in developing countries, with G20 countries as the destination.

Adaptation finance from developed to developing countries, most of which have contributed little to the emissions that cause climate change, has been discussed for decades. At COP15 in Copenhagen in 2009, developed countries committed to mobilising US\$100 billion of annual mitigation and adaptation funding per year by 2020 for developing countries.⁷⁵ However, despite the growing attention to climate change, including the Paris Agreement which renewed the US\$100 billion pledge, the 2020 goal was missed, with climate finance amounting to US\$83 billion that year according to the OECD, including US\$28 billion towards adaptation funding.⁷⁶ This shortfall prompted developed countries to adopt a new delivery plan to reaching the US\$100 billion objective by 2025 or before (approximately 0.05 and 0.15% of GDP for most developed countries).⁷⁷ The Glasgow Pact, signed at COP26, also committed developed countries to double the amount of adaptation-targeted funding from US\$20 billion in 2019 to US\$40 billion in 2025.⁷⁸

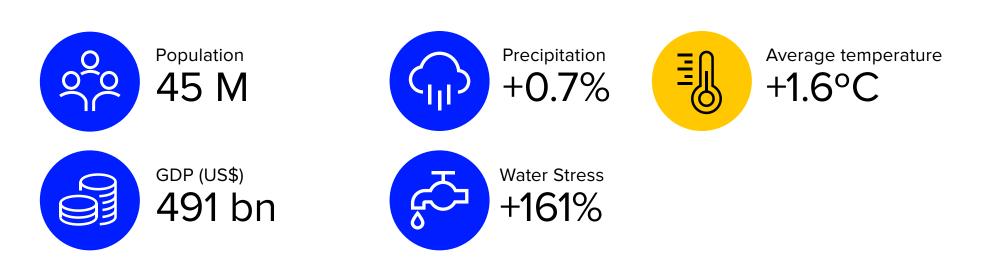
Despite recent progress, the financing gap still represents a major constraint for developing economies, especially as funding falls far short of actual adaptation needs, which might be up to 10 times higher than current pledges.⁷⁹ It is not surprising that the issue of 'Loss and Damage' took centre stage at COP27 in Sharm el-Sheik. Indeed, meeting and improving adaptation commitments and mobilising private finance to help bridge the adaptation gap are likely to remain a burning discussion point at upcoming climate negotiations.

Country Profiles



Overview

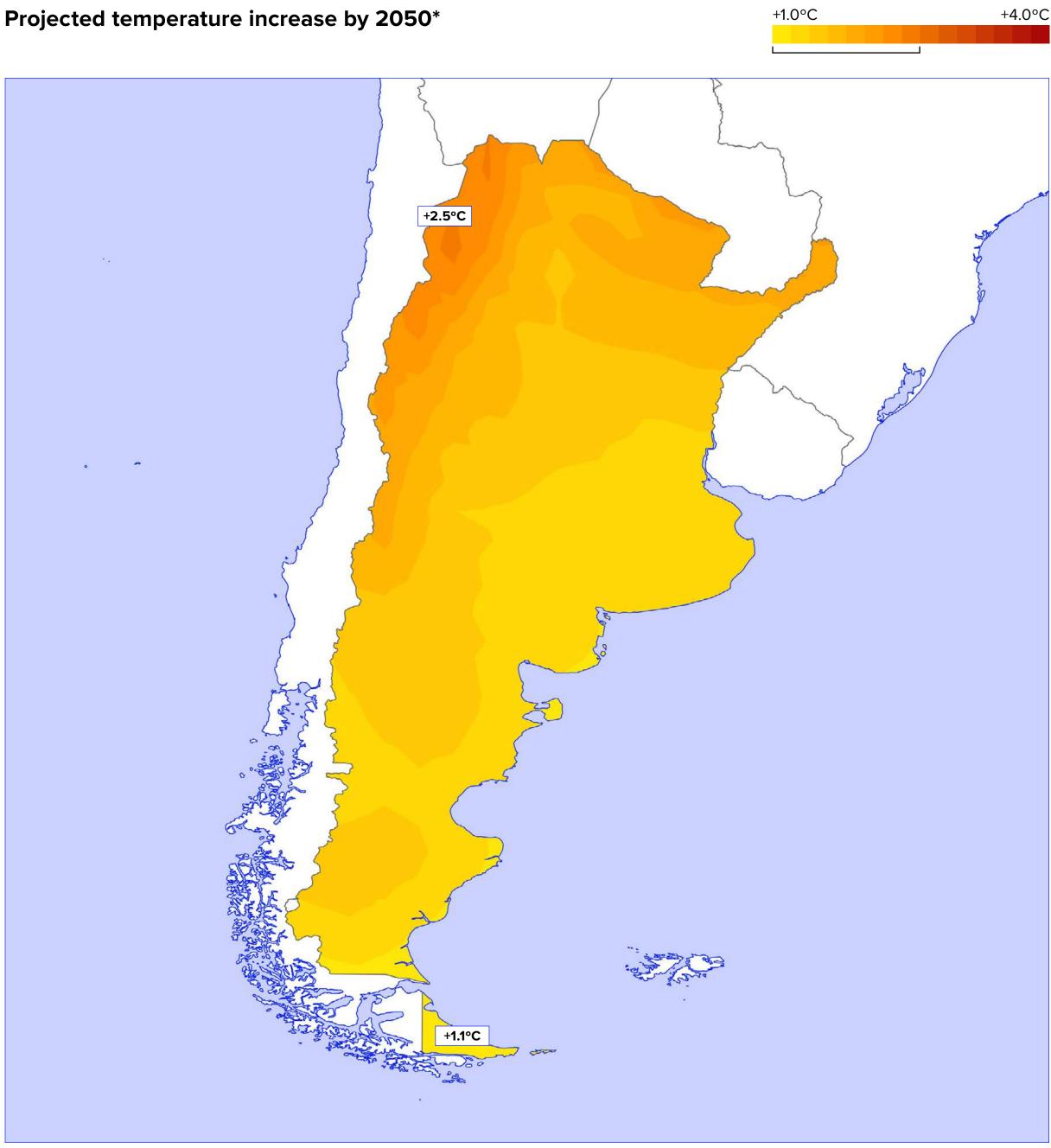
2050 projections*



Key climate-related policies:

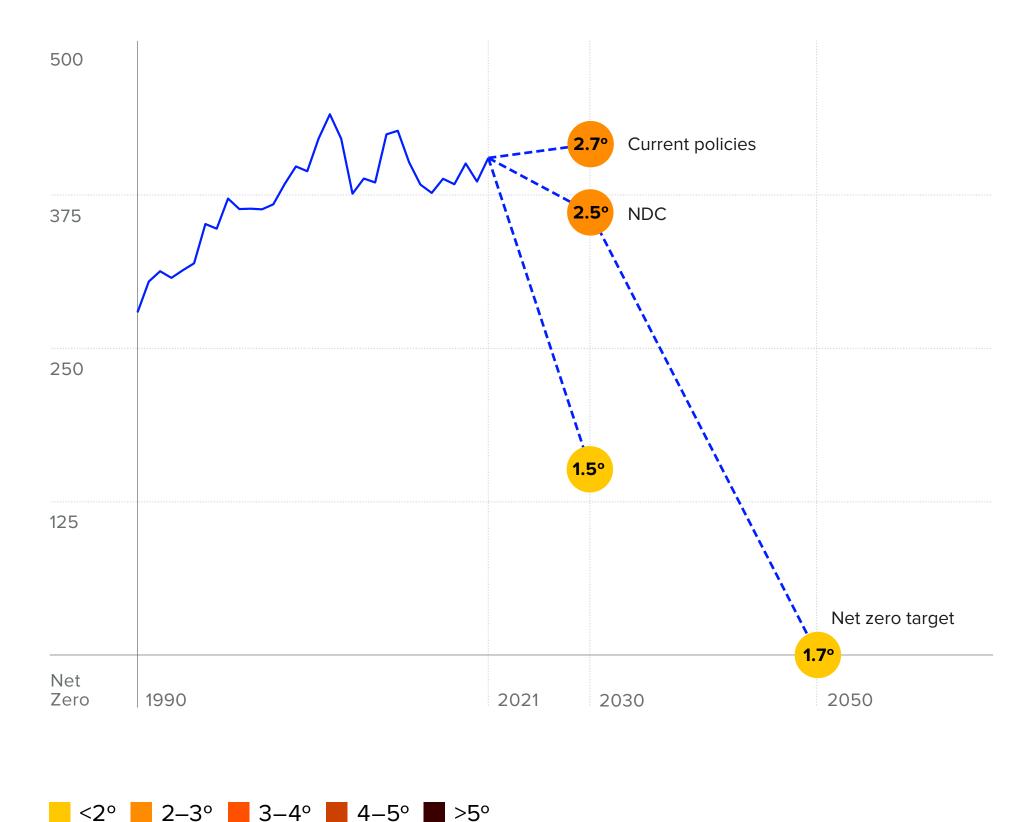
- **NDC**¹: Argentina commits to an economy-wide unconditional net emissions cap of 349 MtCO₂e in 2030.
- **National Climate Mitigation and Adaptation plan (2022)**²**:** This policy document was designed to support the implementation of Argentina's NDC and structure the transition along the following key thematic areas: the energy transition, the productive transition, sustainable mobility, sustainable and resilient territories, conservation of biodiversity and common goods, and sustainable management of food systems and forests.
- **Biofuels Law (2021)**³: The law mandates blending 5% biodiesel and 12% ethanol with gasoline.⁴
- National plan for the restoration of native forests (2019)⁵: By 2030, the plan aims to restore 20 million hectares of native forest.
- **Carbon tax on energy (2017)**⁶**:** The tax targets emissions from ٠ transportation fuels and coal — currently covering 15.8% of $CO_2e^{.7}$
- **Renewable Energy Law (2016)**⁸**:** The law mandates that 20% of the electricity supply should be from renewable sources by 2025.

*High-emissions scenario



We estimate Argentina's 2030 current policies emissions to be 64% higher than a 1.5° C-aligned trajectory.⁹ An abatement of 265 MtCO₂e between 2021 and 2030 implies alignment with a 1.5° C-aligned trajectory.

Implied temperature rise based on GHG Emissions (MtCO₂e)



Emissions and abatement potential

Argentina's highest potential source of abatement is the AFOLU sector, accounting for 37% of the total. This sector currently represents 49% of the country's emissions.

2021 emissions by sector¹⁰ (CO₂e)



Sectoral abatement potential for 1.5°C-alignment by 2030¹¹

Energy 28%			
Industry 16%			
Transport 8%			
Buildings 11%		_	
AFOLU 37%			



Timeline of released documentation

National Adaptation Plan¹²

2022

Summary of physical risk exposure:

Argentina's location and highly specific topography makes it prone to a wider range of weather extremes than most countries, with distinct physical risks facing different areas of the country.

- The frequency of extreme rainfall and floods is expected to increase significantly by 2050, especially in the coastal east, likely generating significant losses in a country where floods historically represent 58% of economic losses.¹³ Sea-level rise and storm surges threaten the coast, particularly urban areas around the Plata River, including Buenos Aires.
- Paradoxically, average warmer and drier conditions are expected across the country. Argentina's agricultural sector is particularly vulnerable, with possible declines in livestock health (Argentina has some of world's largest cattle herds) and maize yields (Argentina's main crop).¹⁴
- Increasingly frequent heatwaves could have significant health impacts on Argentina's population, particularly given its rate of urbanisation 92% is among the highest among G20 countries.¹⁵

National Adaptation Plan

Assessment of:	Absent in plan	Mentioned in plan	Comprehensive
Risk & vulnerabilities			•
Financing mechanisms			•
Governance breakdown			•
Sectoral breakdown of actions		•	
Monitoring & evaluation implementaton			•

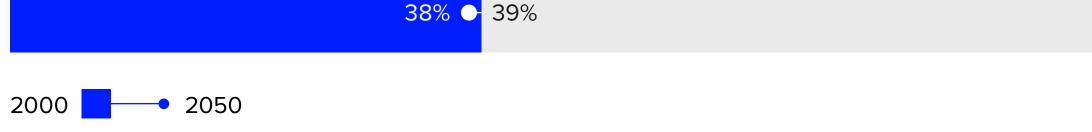
Change in share of population at risk, 2000–2050

Riverine flooding: no change



Heatwaves: 5% increase

				75%	• 80%
Water shortages: 1% decrease					
	38%	30%			



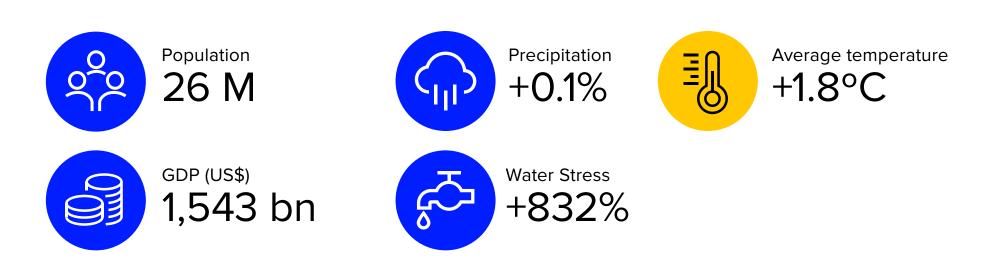
National Initiative

The Climate Change Risks Map System (SIMARCC) is an opensource interactive platform the enables to identify climate change risks and helps formulate adaptation public policies and actions.¹⁶

ve	in	plan	

Overview

2050 projections*



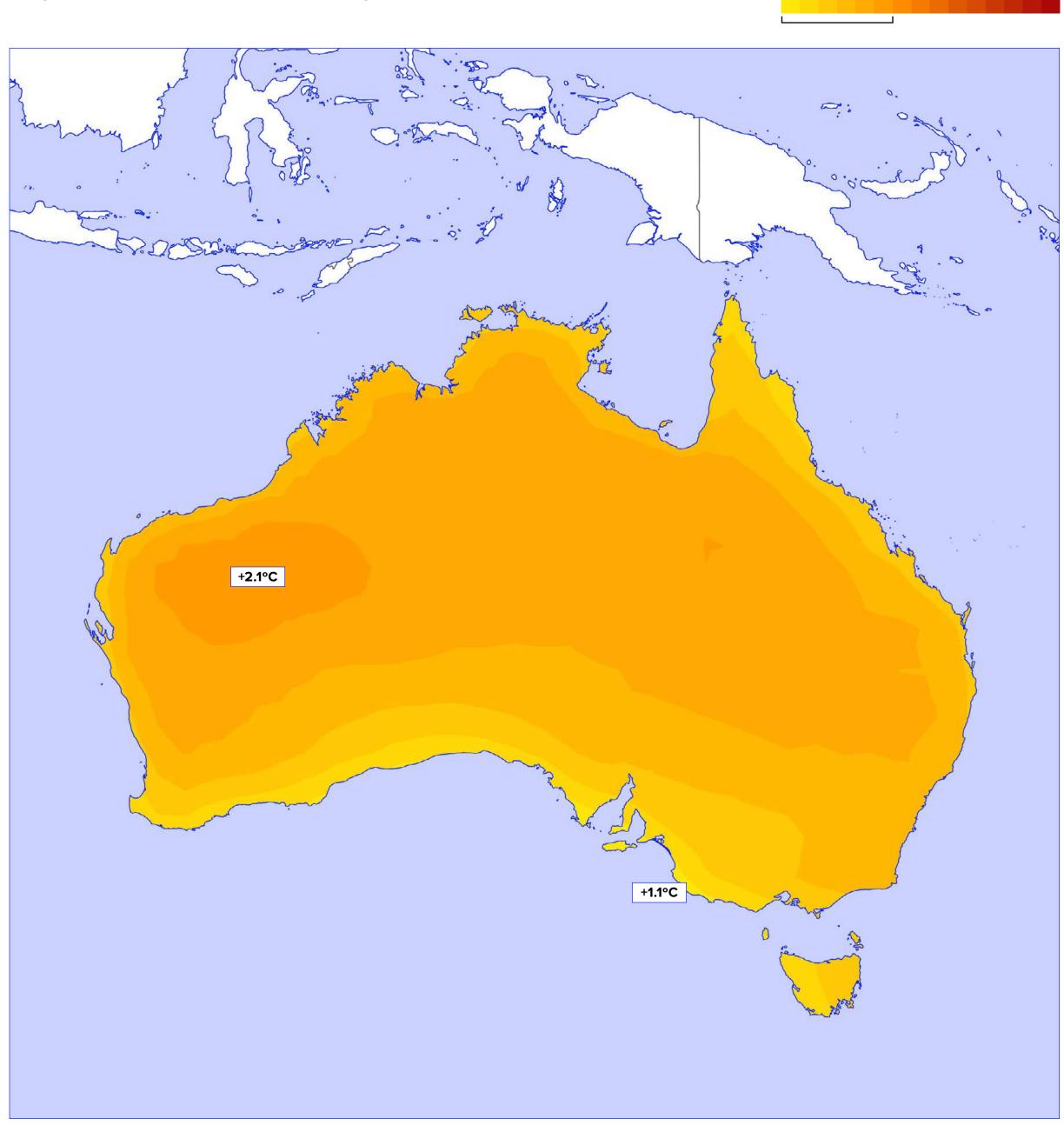
Key climate-related policies:

- NDC: Australia commits to reduce its greenhouse gas emissions to 43% below 2005 levels by 2030.¹⁷
- **Renewable energy targets (RET) (2023)**¹⁸**:** The country has a target of 82% renewable energy by 2030, up from 27% today.
- **Australian Federal Budget 2022-2023**¹⁹**:** The budget includes A\$1.3 billion of new investment to maintain energy security, keep downward pressure on energy prices, and reduce emissions.
- Australian Carbon Credit Unit (ACCU) (updated in 2022)²⁰: The credit system for voluntary carbon reduction measures. Government purchases carbon credits generated by companies that voluntarily reduce their emissions.
- Future Fuels and Vehicle strategy (2021)²¹: Hybrid, hydrogen, electric and biofueled vehicles development to tackle emissions in the transport sector plans to reduce 8 MtCO₂e by 2035²².
- Fuel tax (2006, last amendment in 2019)²³: A fuel tax for diesel and gasoline set at A\$0.46 per liter in September 2022. The fuel excise is indexed every six months.

*High-emissions scenario

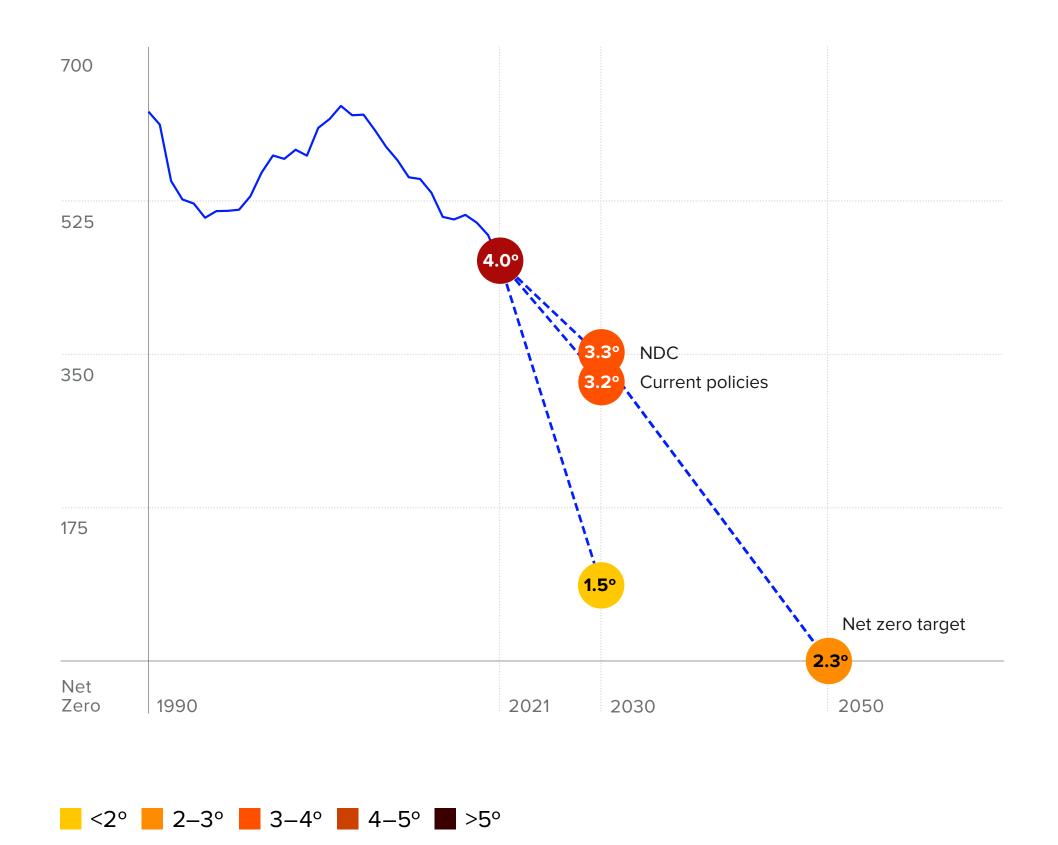
Projected temperature increase by 2050*

+4.0°C



We estimate Australia's 2030 current policies emissions to be 73% higher than a 1.5° C-aligned trajectory.²⁴ An abatement of 233 MtCO₂e between 2021 and 2030 implies alignment with a 1.5° C-aligned trajectory.

Implied temperature rise based on GHG Emissions (MtCO₂e)



THE COP28 NET ZERO ATLAS

Emissions and abatement potential

Australia's highest potential source of abatement is the Energy Sector accounting for 41% of the total. This sector currently represents 45% of the country's emissions.

2021 emissions by sector²⁵ (CO₂e)

Energy 258 Mt		Transport 98 Mt		AFOLU 9
	Industry 111 Mt		Βι	uildings 17

Sectoral abatement potential for 1.5°C-alignment by 2030²⁶

Energy 41%		
Industry 14%		
Transport 7%		
Buildings 4%		
AFOLU 34%		



Timeline of released documentation

National Adaptation Strategy I²⁷ 2015 Adaptation Communication to UNFCCC²⁸

2021

National Adaptation Strategy II²⁹ 2021

Summary of physical risk exposure:

Australia is home to a wide range of climates, with a large arid-to-semi-arid area in its centre and sub-tropical conditions in the north. Population and activities are concentrated along the western and southern coasts, with more temperate and oceanic conditions.

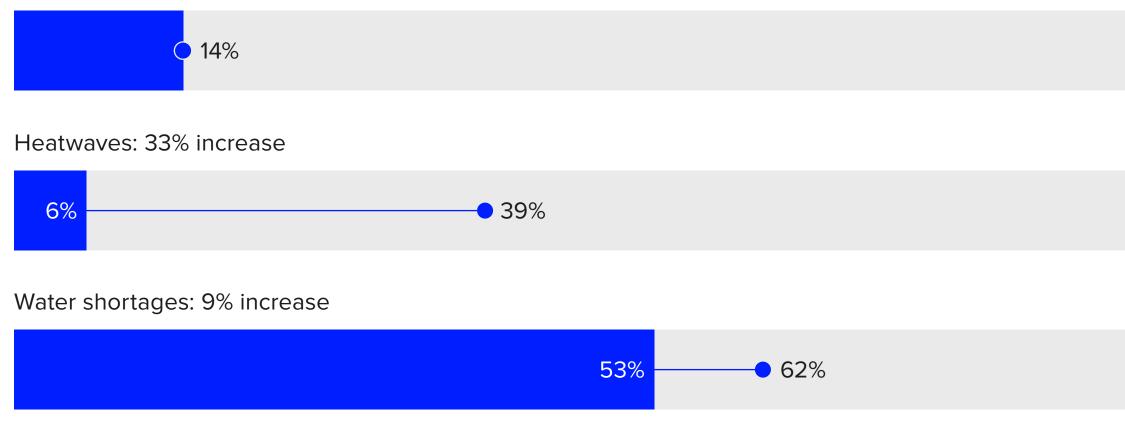
- Increased droughts and water stress are projected, particularly in the southern parts of the country. This can lead to a higher frequency of wildfires and intensity the average annual burned area has already increased four times over the past two decades.³⁰ Important heat-related impacts are also expected on the agricultural sector, with models indicating potential heat-related economic impacts could reach US\$151 billion by 2050.³¹
- Counterintuitively, drier conditions will also make Australia more vulnerable to more frequent extreme precipitation events and resultant flooding, as water infiltration is reduced on drier soils. This will lead to higher risk to property and populations, with the population at risk of river flooding expected to double by 2050.³²

National Adaptation Plan

Assessment of:	Absent in plan	Mentioned in plan	Comprehensive
Risk & vulnerabilities			•
Financing mechanisms	•		
Governance breakdown			•
Sectoral breakdown of actions		•	
Monitoring & evaluation implementaton		•	

Change in share of population at risk, 2000–2050

Riverine flooding: no change

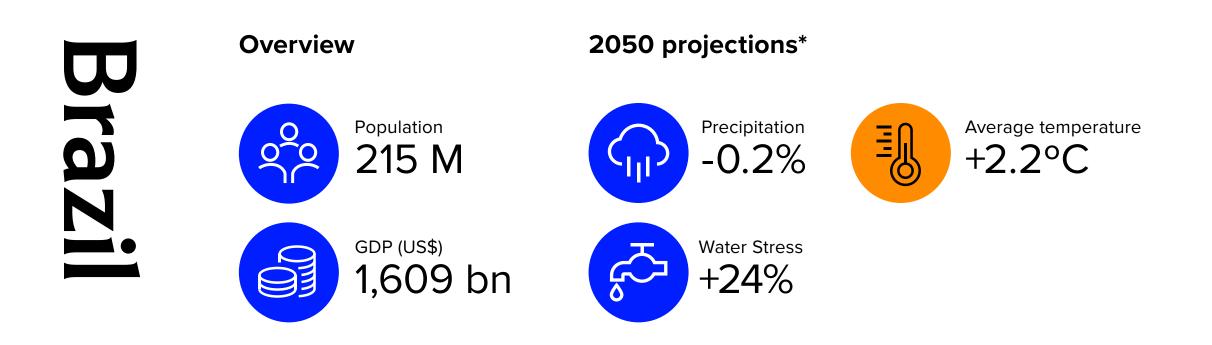


2000 2050

National Initiative

CoastAdapt is an online tool to help local governments and businesses identify, assess and respond to climate risks in the coastal areas.³³

ve	in	plan	



Key climate-related policies:

- NDC³⁴: Brazil commits to reduce emissions from 2005 levels by 37% in 2025, and by 50% in 2030.
- 10-Year Brazilian Expansion Plan (PDE) (2021-2031)³⁵: By 2031, the plan targets 48% of total primary energy supply to come from renewables and 88% of total electricity generation.
- **Biodiesel blending mandates (2020–2021 Updated 2023)**³⁶**:** These were raised to reach 12% from April 2023.
- National Plan on Climate Change (2008)³⁷ and Forest Code (2012)³⁸: These plans aim to reduce illegal deforestation rates in all Brazilian biomes to zero as well as restore 12 million hectares of forests by 2030.

*High-emissions scenario

Projected temperature increase by 2050*

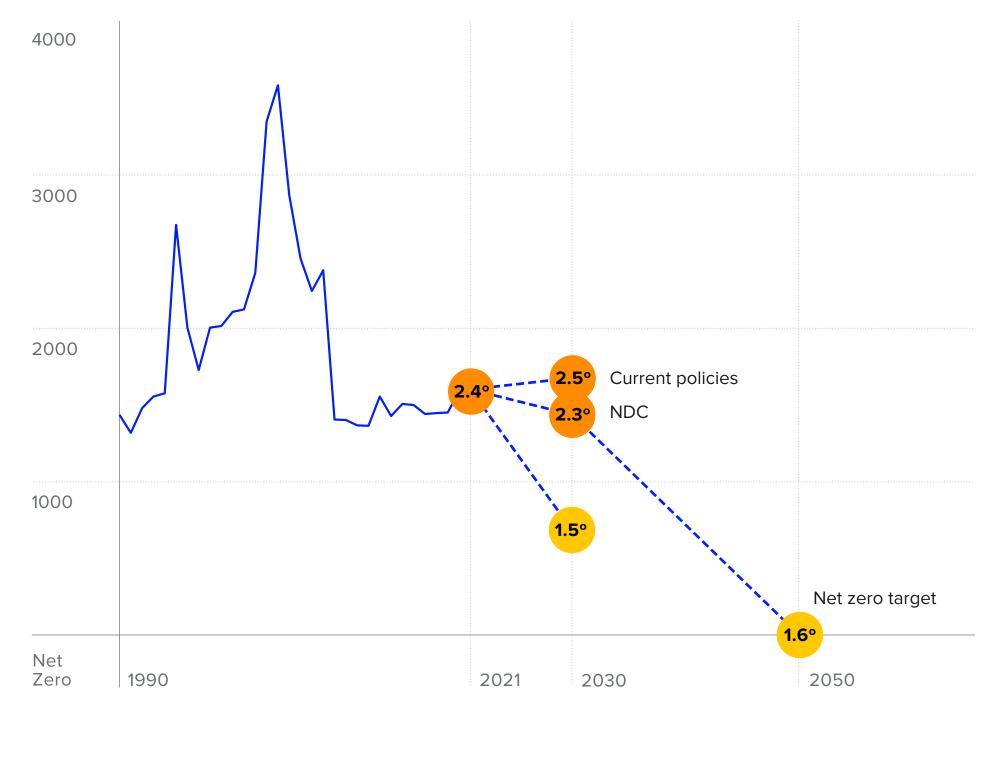






We estimate Brazil's 2030 current policies emissions to be 59% higher than a 1.5° C-aligned trajectory.³⁹ An abatement of 986 MtCO₂e between 2021 and 2030 implies alignment with a 1.5°C-aligned trajectory.

Implied temperature rise based on GHG Emissions (MtCO₂e)



<2° 2-3° 3-4° 4-5° >5°

Emissions and abatement potential

Brazil's highest potential source of abatement is in the AFOLU sector, accounting for 46% of the total. This sector currently represents 74% of the country's emissions.

2021 emissions by sector⁴⁰ (CO₂e)



Sectoral abatement potential for 1.5°C-alignment by 2030⁴¹

Energy 11%		
Industry 27%	_	
, ,		
T		
Transport 11%		
Buildings 5%		
AFOLU 46%		



Brazil

National Adaptation Plan Volume I⁴²

2016

National Adaptation Plan Volume II⁴³ 2016

Summary of physical risk exposure:

Brazil has a mostly tropical climate and is home to the largest rainforest in the world, the Amazon. Variable rainfall patterns can be observed across the country, with overall moderate rainfall concentrated in the summer and drier conditions in the northeast.

- More extreme precipitation events are expected, which could lead to severe flooding and landslides, and cause significant damage to urban areas. Coupled with increasing temperatures, extreme precipitation might result in the spread of vector-borne diseases such as Zika or dengue fever to new regions, and higher transmissibility in urban centers.⁴⁴ The lowlands of the Amazon delta are at risk from sea-level rise. Damages to coastal infrastructure, along with ecosystem degradation could also constitute a threat to Brazil's tourism industry, which currently represents more than 5% of the economy.⁴⁵
- Higher temperatures, increased droughts and water stress will also put Brazil's large agricultural sector at risk: Brazil is the world's largest sugarcane producer and the third largest producer of maize. Field losses could also contribute to intensifying competition for arable land and further deforestation.

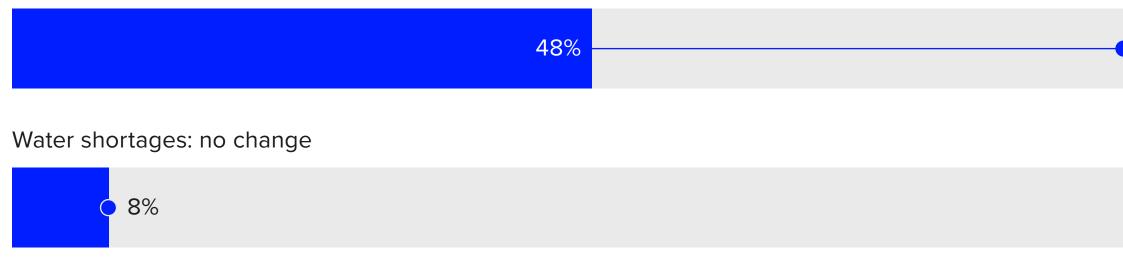
National Adaptation Plan

Assessment of:	Absent in plan	Mentioned in plan	Comprehensive
Risk & vulnerabilities			•
Financing mechanisms		•	
Governance breakdown			•
Sectoral breakdown of actions			•
Monitoring & evaluation implementaton			•

Change in share of population at risk, 2000–2050

Riverine flooding: 1% decrease

Heatwaves: 44% increase



• 2050

2000

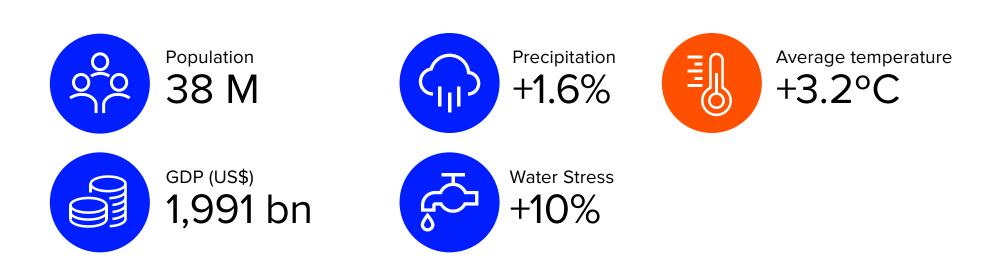
National Initiative

AdaptaBrasil MCTI is an online platform providing information and data on climate change impacts in the country, to help set up adaptation measures to increase resilience and minimise risks and costs.⁴⁶

Ve	e in	p <u>la</u>	n <u></u>	
	92	%		

Overview

2050 projections*



Key climate-related policies:

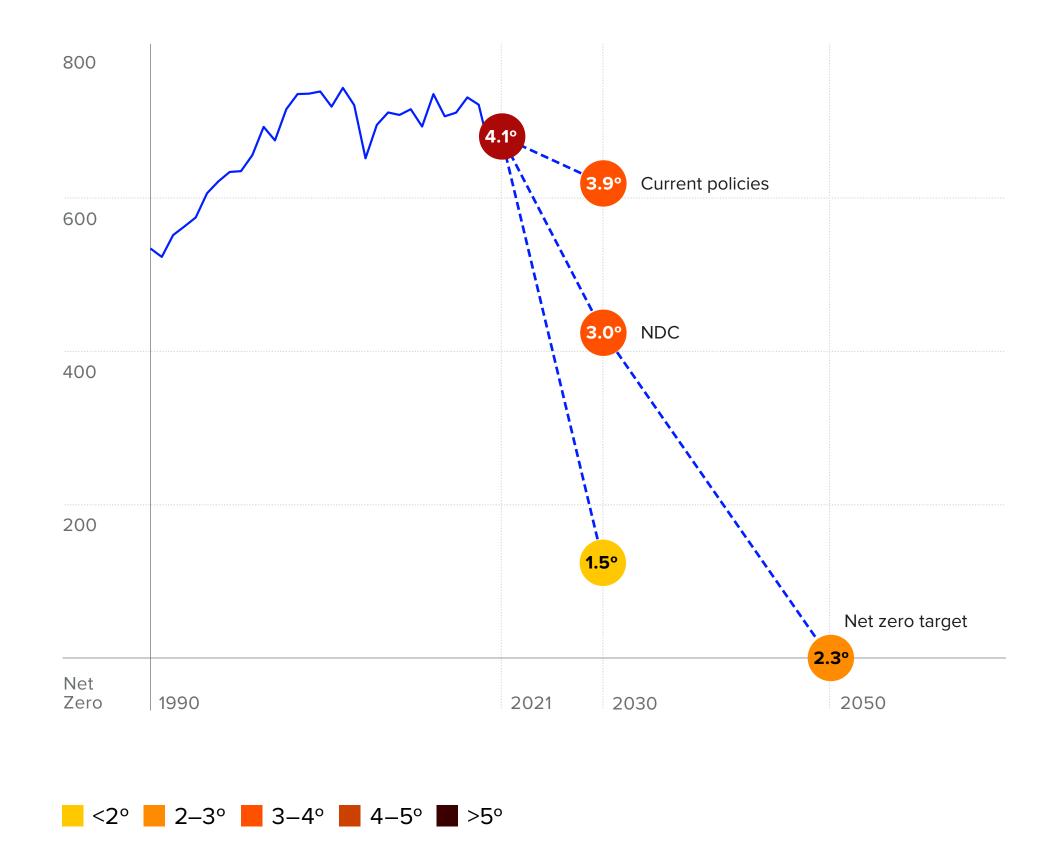
- **NDC**⁴⁷: Canada is committed to a 2030 target of 40–45% below 2005 levels.
- Sustainable Development Goal 7 (2023)⁴⁸: By 2030, 90% of electricity generation to be from renewables, reaching 100% in the long term.
- Faster and Further Methane Strategy (2022)⁴⁹: This strategy aims to • reduce domestic methane emissions by more than 35% by 2030, compared to 2020 levels.
- **Zero Emission Vehicle Infrastructure Deployment (updated in 2021)**⁵⁰: • Ensuring low-emissions vehicles comprise 30% of new light-duty vehicle sales by 2030, with an interim target of 10% by 2025 and a long-term goal of 100% by 2040⁵¹.
- Pan-Canadian Approach to Carbon Pollution Pricing 2023-2030 (updated in 2023)⁵²: Pollution pricing systems with a minimum carbon pollution price of at least US65/tGHG calculated in CO₂e in 2023, rising by US15 per year to US\$170 per tonnes of CO_2e in 2030.



Canada

We estimate Canada's 2030 current policies emissions to be 80% higher than a 1.5° C-aligned trajectory.⁵³ An abatement of 496 MtCO₂e between 2021 and 2030 implies alignment with a 1.5° C-aligned trajectory

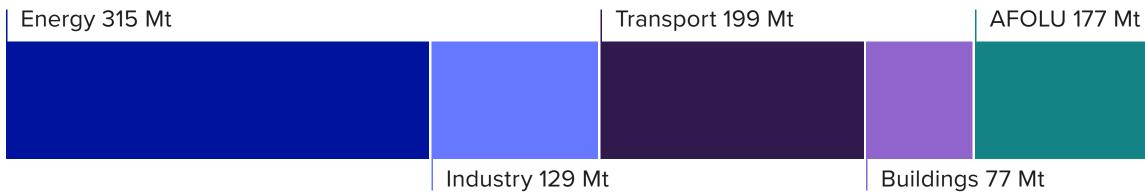
Implied temperature rise based on GHG Emissions (MtCO₂e)



Emissions and abatement potential

Canada's highest potential source of abatement is in the AFOLU sector, accounting for 33% of the total. This sector currently contributes 20% of the country's emissions, behind the Energy sector which represents 35%.

2021 emissions by sector⁵⁴ (CO₂e)



Sectoral abatement potential for 1.5°C-alignment by 2030⁵⁵

Energy 33%			
Industry 14%			
Transport 10%			
Buildings 10%			

AFOLU 33%



Timeline of released documentation

Canada

Adaptation Communication to UNFCCC⁵⁶ 2021 National Adaptation Strategy⁵⁷ 2023 National Adaptation Plan⁵⁸

2023

Summary of physical risk exposure:

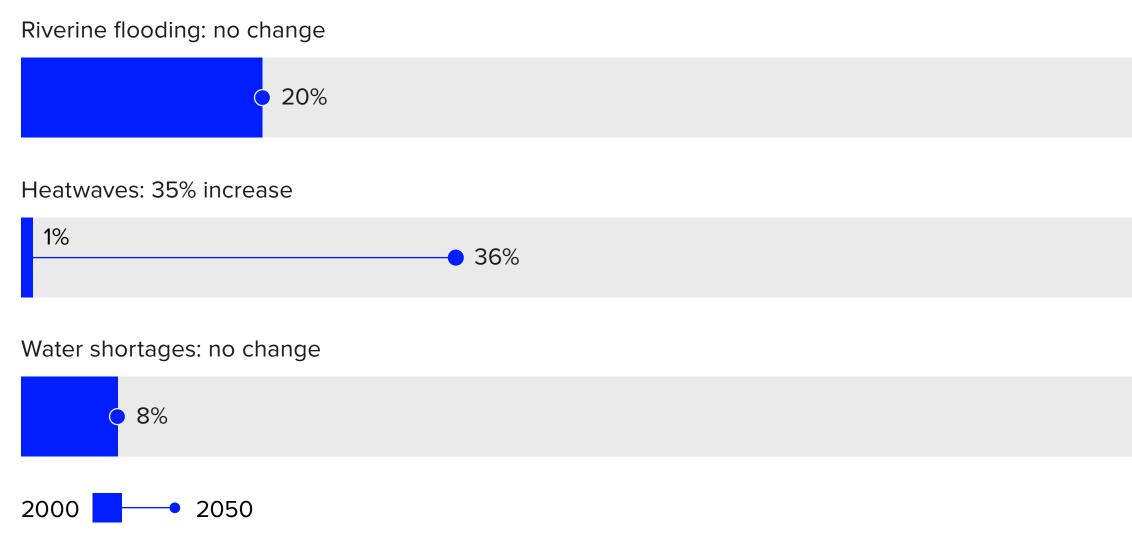
Canada is one of the coldest countries on Earth but is now warming twice as fast as the G20 average. Although the country will face milder winter conditions in the future, the economic impacts of climate change could be costly and disruptive.

- Warmer temperatures (of up to +4°C by 2050) will lead to shorter ice seasons.⁵⁹ Thawing permafrost represents an increasing risk to infrastructure, including winter transportation routes in the north. Shrinking glacier will lower freshwater availability and impact hydropower production, which currently accounts for almost 60% of Canada's electricity generation.⁶⁰
- More extreme precipitation events are expected, as snowfall more readily transforms to rain. Damages from inland flooding over the past 10 years are being estimated at more than US\$7 billion.⁶¹ Overall, the potential economic impact from extreme events has been projected to exceed US\$50 billion by 2050.⁶²
- Increasingly frequent wildfires are transforming Canada's boreal forest in into a carbon net source,⁶³ as well as negatively impacting biodiversity and timber production levels. In 2023, wildfires might have released up to 2 billion tonnes of CO₂, three times the country's average GHG emissions.⁶⁴

National Adaptation Plan

Assessment of:	Absent in plan	Mentioned in plan	Comprehensive
Risk & vulnerabilities			٠
Financing mechanisms			•
Governance breakdown			•
Sectoral breakdown of actions		•	
Monitoring & evaluation implementaton		•	

Change in share of population at risk, 2000–2050



National Initiative

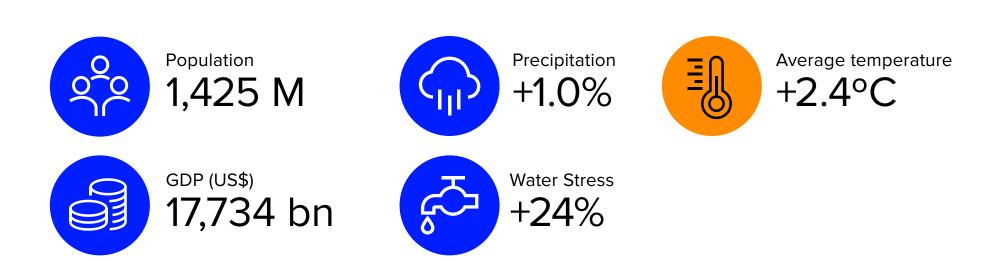
The Canadian Centre for Climate Services (CCCS) created an online platform providing locally relevant climate and weather data, information and tools to support the integration of climate change into adaptation decision-making.⁶⁵

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Overview

2050 projections*



Key climate-related policies:

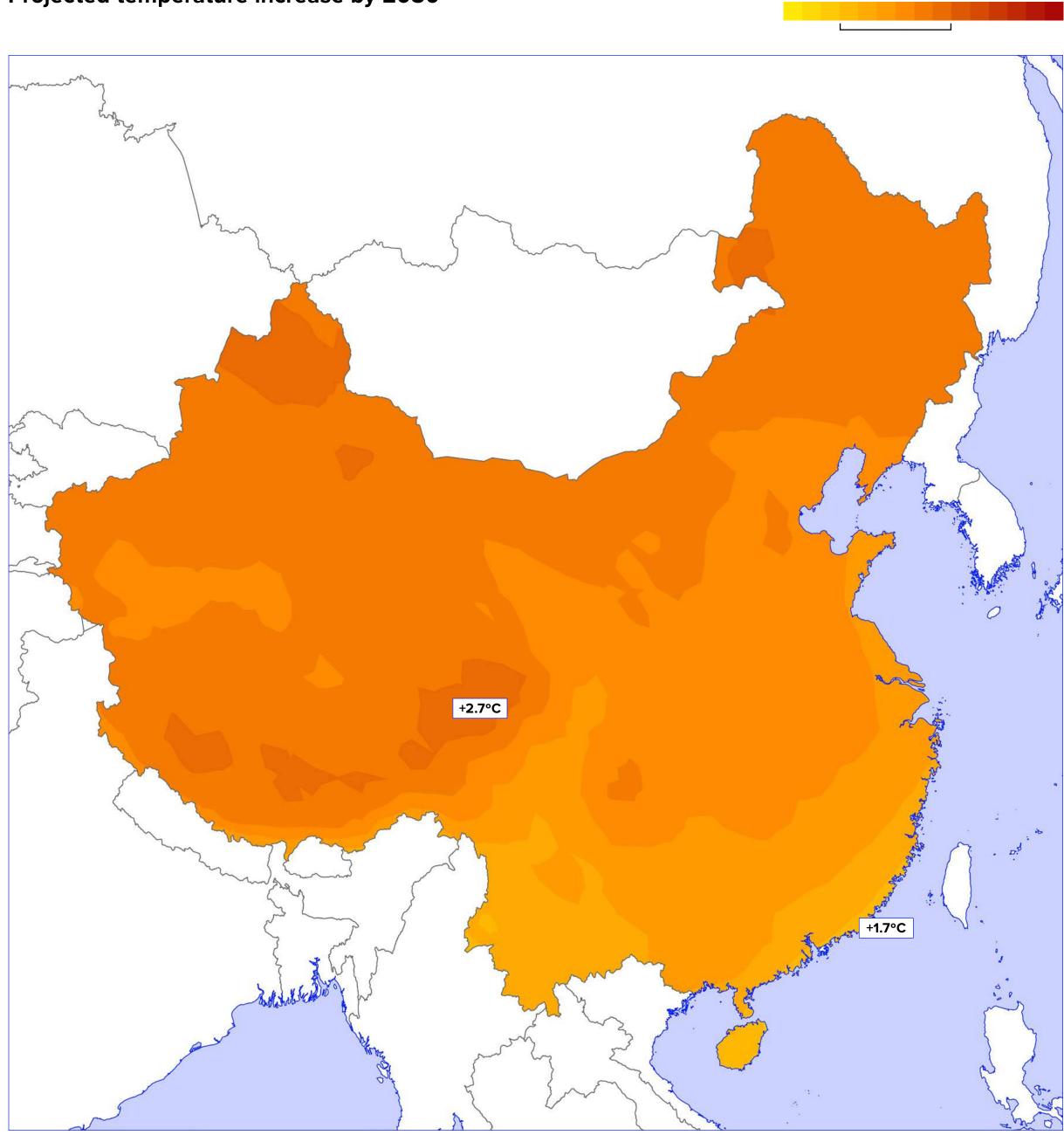
- **NDC**⁶⁶: China will lower its emissions per unit of gross domestic product (GDP) by over 65% from the 2005 level.
- 14th Five-Year Plan [2021–2025] (2021)⁶⁷: The target aims to reduce energy intensity by 13.5% and carbon intensity by 18% over the period. There is a target of 33% renewable electricity consumption by 2025: a reduction of 2.6 Gt per year over the period.
- China National ETS (2021)⁶⁸: Initially covering coal and gas-fired power plants alone, it has now been expanded to cover 40% of the country's carbon emissions and is set to expand to 7 other sectors, covering a seventh of global emissions from fossil-fuel combustion.
- 15-year plan [2021–2035] to protect ecosystems (2020)⁶⁹: The plan includes targets to increase forest cover to 26% by 2035, to expand grassland vegetation cover to 60%, and increase the nature reserve areas to 18% of total national area.
- Plan for carbon peaking in the steel sector (2022)⁷⁰: The plan accounts for carbon dioxide emissions to peak in the steel sector by 2030.

*High-emissions scenario

Projected temperature increase by 2050*



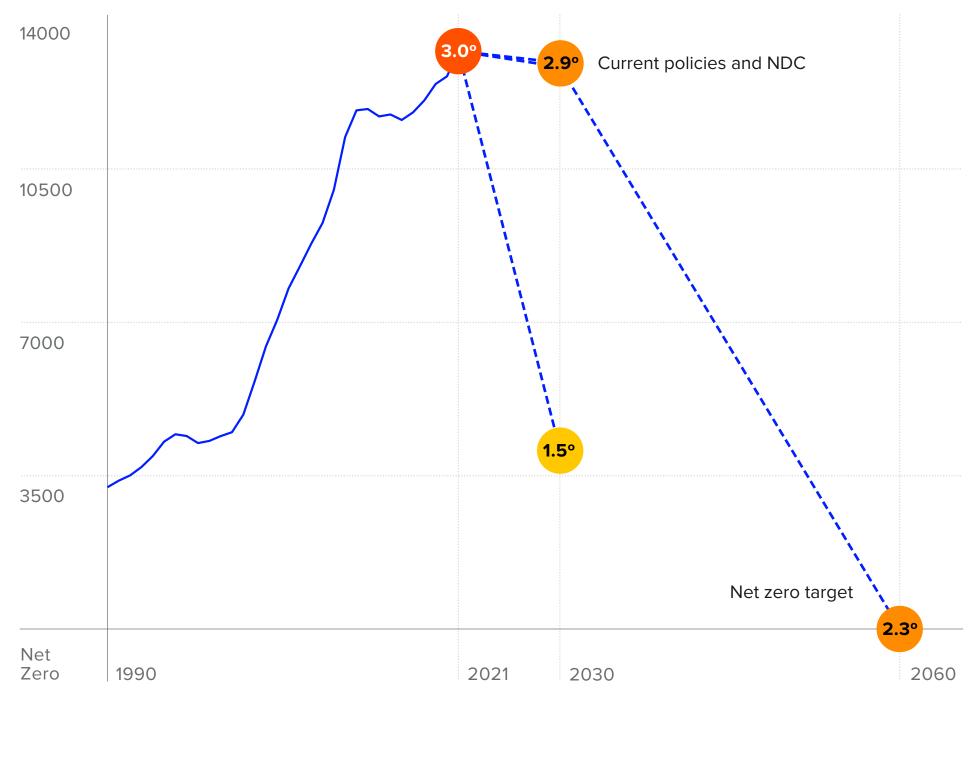
+4.0°C

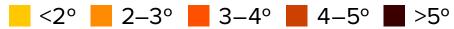


China

We estimate China's 2030 current policies emissions to be 68% higher than a 1.5° C-aligned trajectory.⁷¹ An abatement of 8.8 GtCO_2 e between 2021 and 2030 implies alignment with a 1.5° C-aligned trajectory.

Implied temperature rise based on GHG Emissions (MtCO₂e)





Emissions and abatement potential

China's highest potential source of abatement is in the energy sector, accounting for 44% of the total. This sector currently represents 46% of the country's emissions, followed by the Industrial sector with 35%.

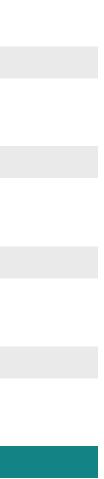
2021 emissions by sector⁷² (CO₂e)

Energy 6,800 Mt	Т	ransport 1,200 Mt	AFOL	LU
	Industry 5200 Mt	Buildings	649 Mt	

Sectoral abatement potential for 1.5°C-alignment by 2030⁷³

Energy 44%	
Industry 33%	
Transport 5%	
Buildings 6%	
AFOLU 12%	





National Adaptation Strategy I⁷⁴ 2013 National Adaptation Strategy II⁷⁵ 2022

Summary of physical risk exposure:

China is home to a large variety of climate conditions, from the temperate north to the subtropical south, strongly influenced by monsoons. This exposes China to the full range of physical risks.

- Temperature averages and extremes are both expected to increase more rapidly than the global average, reaching up to +2.5°C by 2050.⁷⁶
 This will reduce labour productivity and impact human health, especially in China's nine megacities, which each have populations of over 10 million people.
- More frequent droughts are expected in the western and central regions, affecting agricultural production in one of the world's largest breadbaskets. Regionally, crop yields have decreased by 15% over the last decade, and this trend is expected to continue.⁷⁷
- Existing high flood risk often triggered by the East Asian monsoon season — will increase further with higher intensity of rainfall events. Growing urban centres are especially vulnerable - urbanisation rates have tripled in the last 40 years.⁷⁸ Rising sea levels and potentially more intense tropical cyclones bring an additional risk, especially in western coastal regions (including Shanghai's 25 million inhabitants).

National Adaptation Plan

Assessment of:	Absent in plan	Mentioned in plan	Comprehensive
Risk & vulnerabilities			•
Financing mechanisms	•		
Governance breakdown		•	
Sectoral breakdown of actions			•
Monitoring & evaluation implementaton	•		

Change in share of population at risk, 2000–2050

Riverine flooding: no change

O 15%			
Heatwaves: 16% increase			
		70% 86	%
Water shortages: 2% increase			
	50% – 52%		

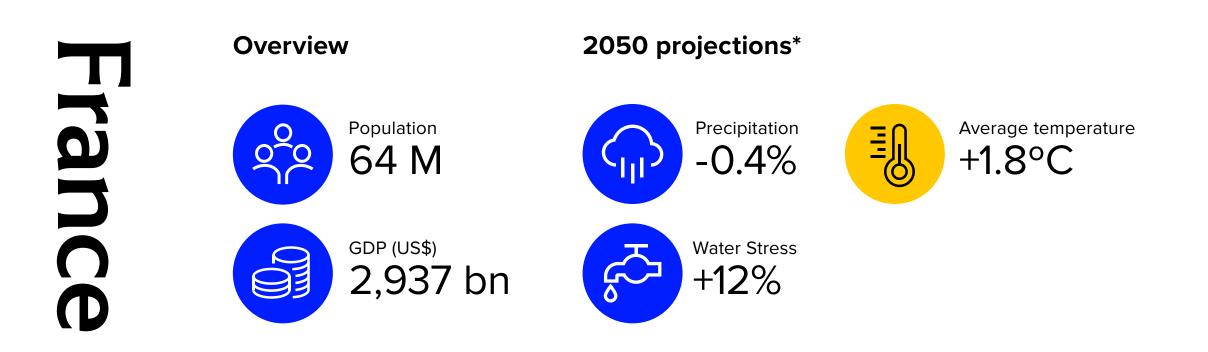
National Initiative

2050

2000

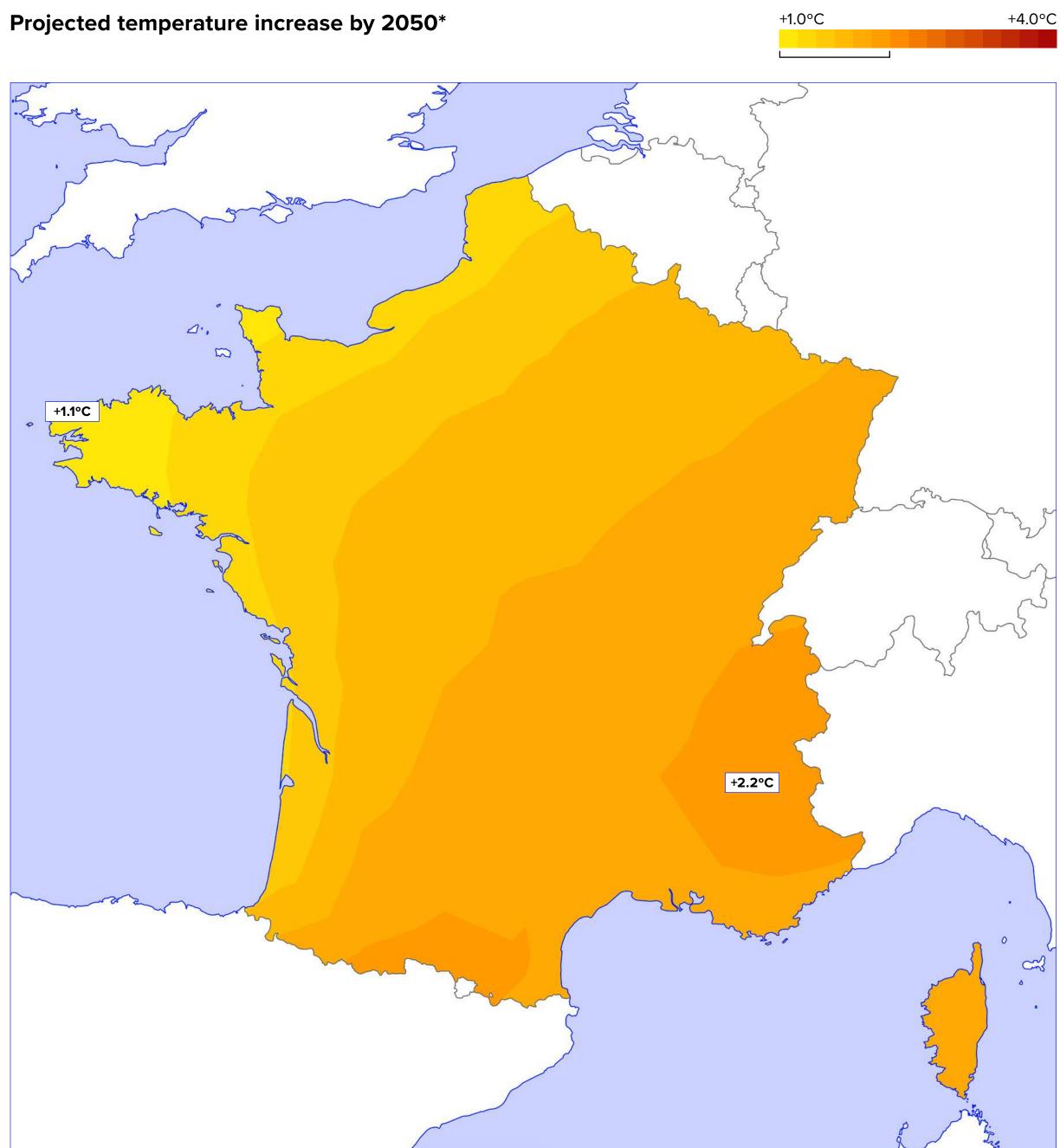
The Action Plan for Forestry to Adapt to Climate Change is a sectoral initiative with objectives such as strengthening the sustainable management of forests, promoting grassland ecology, and increasing ecological protection.⁷⁹

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Key climate-related policies:

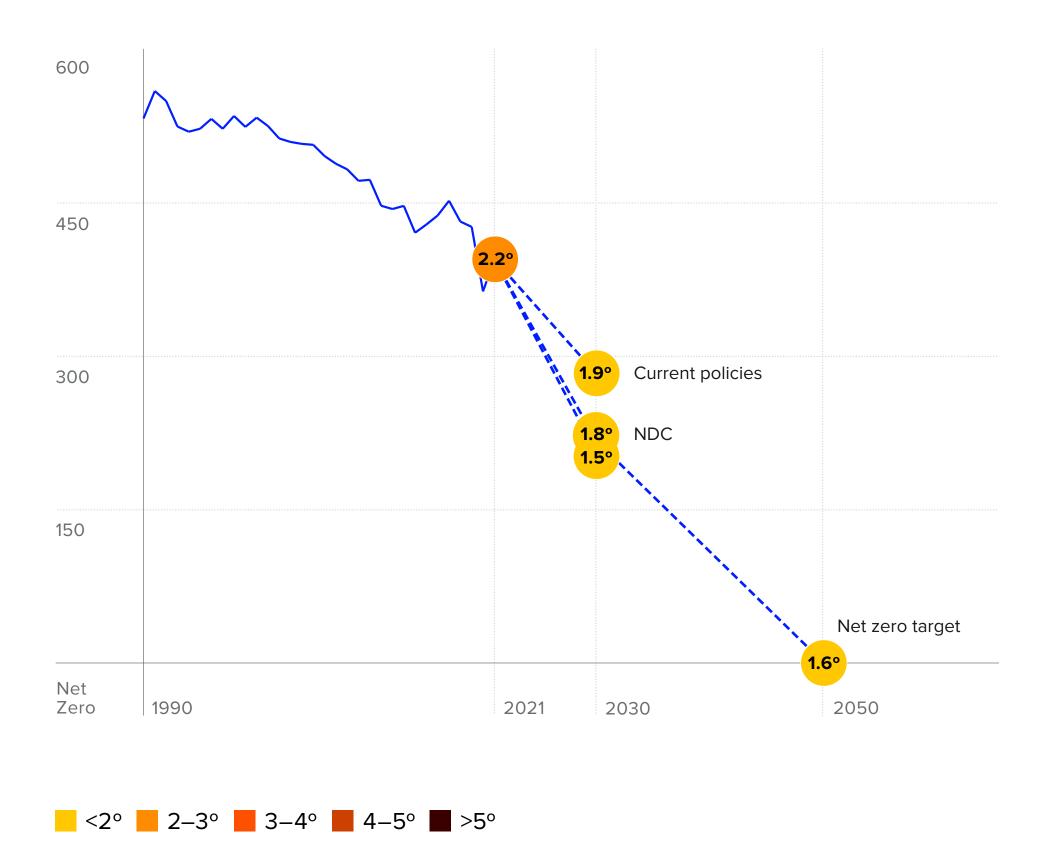
- **European Union's NDC**⁸⁰: 55% reduction in greenhouse gas emissions by 2030 compared to 1990.
- As an EU member state (see EU ambition profile): Relevant policies include • the 'Fit for 55' package (2022), the European Green Deal (2019), the EU Farm to Fork Strategy (2019) and the REPowerEU (2022).
- **'France Relance' plan⁸¹:** €30 billion has been allocated to building energy retrofitting, transport infrastructure and investment in low carbon innovation. Allocation of €150 million to a 'the forest fund for renewal and adaptation to climate change'⁸².
- France's 2020 National Low-Carbon Strategy and Multiannual Energy **Plan)**⁸³: The plan aims to phase out coal by 2022, reduce emissions from power generation by 33% before 2030 (compared to 2015), reduce energy consumption from the building sector by 28% in 2030 (compared to 2010) and achieve carbon neutrality for buildings by 2050 supported by mandatory building codes.
- Carbon tax on energy products (2018)⁸⁴: The carbon tax was initially set at €7/t in 2014 and was intended to rise to €100/t by 2030. Since 2018 it has been frozen at €44.6/t.



France

We estimate France's 2030 current policies emissions to be 27% higher than a 1.5° C-aligned trajectory.⁸⁵ An abatement of 76 MtCO₂e between 2021 and 2030 implies alignment with a 1.5° C-aligned trajectory.

Implied temperature rise based on GHG Emissions (MtCO₂e)



Emissions and abatement potential

France's highest potential source of abatement is in the AFOLU sector, accounting for 36% of the total. This sector currently represents 13% of the country's emissions; Transport makes up the largest proportion of emissions at 32%.

2021 emissions by sector⁸⁶ (CO₂e)



Sectoral abatement potential for 1.5°C-alignment by 2030⁸⁷

Energy 14%			
Industry 24%			
2			
Transport 8%			
·			
Buildings 18%			
C			
AFOLU 36%			



National Adaptation Strategy⁸⁸ 2006 National Adaptation Plan I⁸⁹ 2011 National Adaptation Plan II⁹⁰ 2018

Summary of physical risk exposure:

Despite having a temperate climate, France's diverse geography makes it prone to a large range of hazards, from Atlantic winter storms and floods to heatwaves and droughts.

- Heatwaves are expected to become at least twice as frequent by 2050.⁹¹
 Coupled with increased incidence of drought, these changes significantly threaten France's agricultural production, from staple crops to symbolic products such as wine, champagne and cheese.
- Homes and infrastructure are already being damaged, with wildfire risks spreading in many regions and expected to triple by 2050.⁹² Shrinkage and swelling of soils, currently causing almost as much damage as flooding, is becoming more prevalent, with 10 million houses⁹³ already exposed and damages expected to increase with more frequent droughts.
- Intensifying heatwaves⁹⁴ will also cause significant health impacts in large and densely populated cities and particularly in the Paris region, home to almost 20% of the French population.⁹⁵

National Adaptation Plan

Assessment of:	Absent in plan	Mentioned in plan	Comprehensive
Risk & vulnerabilities		•	
Financing mechanisms	•		
Governance breakdown			•
Sectoral breakdown of actions			•
Monitoring & evaluation implementaton		•	

Change in share of population at risk, 2000–2050

Riverine flooding: no change



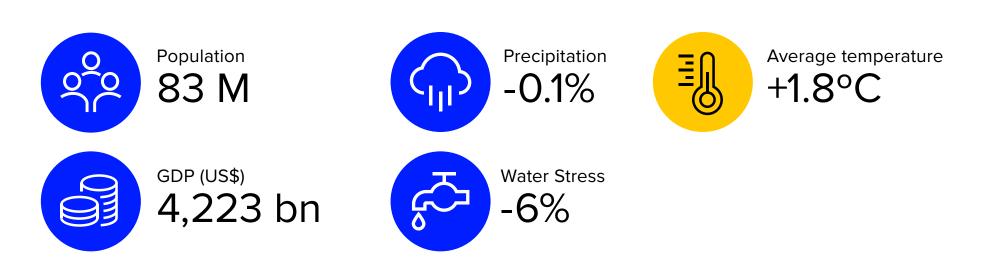
National Initiative

The National Observatory on the Effects of Global Warming (ONERC) is a national organism tasked explicitly with handling adaptation to climate change.⁹⁶

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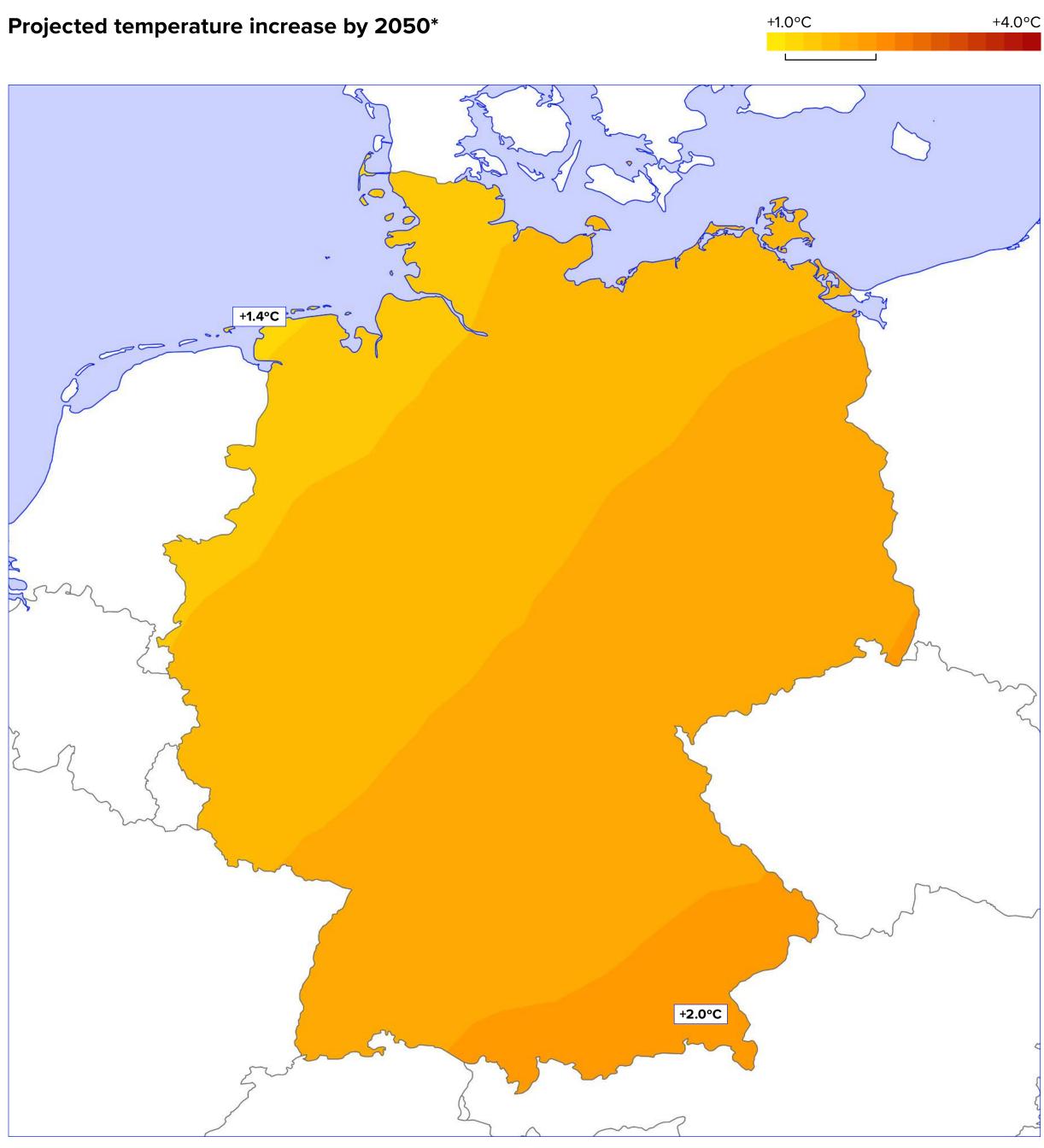
Overview

2050 projections*



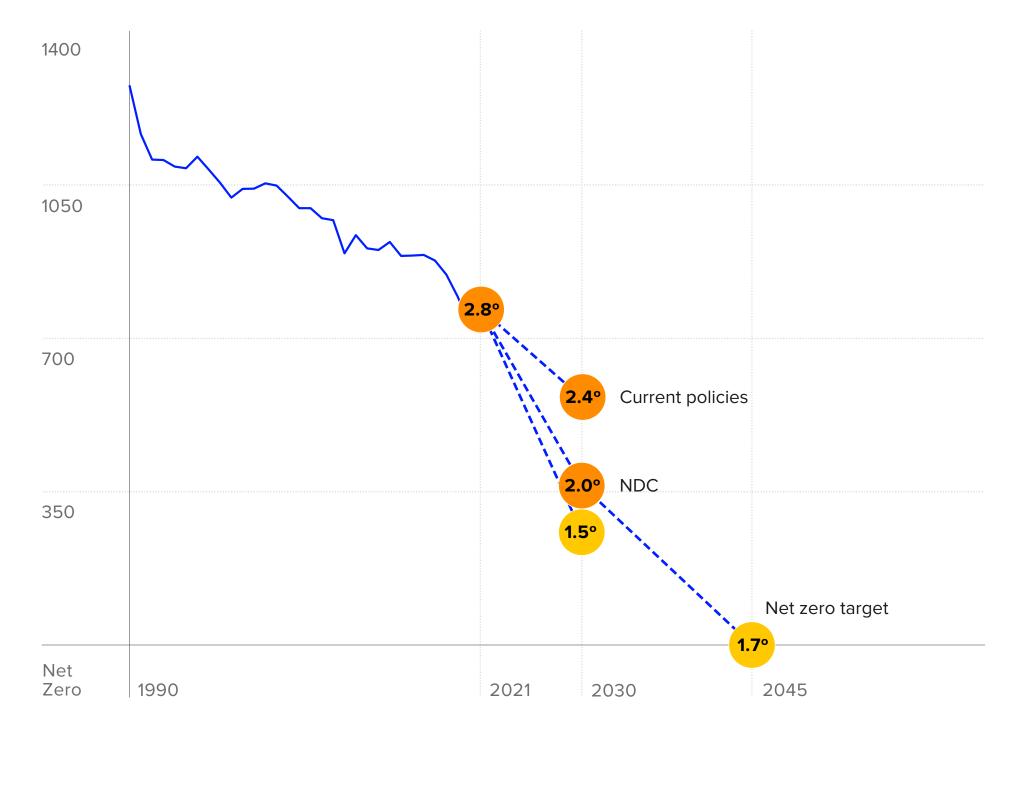
Key climate-related policies:

- **European Union's NDC**⁹⁷: The aim is a 55% reduction in greenhouse gas emissions by 2030 compared to 1990.
- As an EU member state (see EU ambition profile): Relevant policies include • the 'Fit for 55' package (2022), the European Green Deal (2019), the EU Farm to Fork Strategy (2019) and the REPowerEU (2022), as well as the National Energy and Climate Plan (2019)⁹⁸.
- **Germany's Renewables Energy Act (2020)**⁹⁹**:** The act targets 65% electricity production from clean sources from 2030, and both electricity supply and electricity consumption become carbon-neutral before 2050.
- **Energy Efficiency Strategy 2050 (2020)**¹⁰⁰**:** A 30% reduction in primary energy consumption by 2030 (vs. 2008) and includes policies such as carbon pricing in the Heating and Transport sector, and an energy efficiency strategy for buildings.
- **Pricing for fossil fuels (2021)**¹⁰¹**:** Companies trading in heating oil, gas, petrol, or diesel are required to pay a carbon price in Germany as of January 2021.¹⁰²



We estimate Germany's 2030 current policies emissions to be 55% higher than a 1.5° C-aligned trajectory.¹⁰³ An abatement of 307 MtCO₂e between 2021 and 2030 implies alignment with a 1.5°C-aligned trajectory.

Implied temperature rise based on GHG Emissions (MtCO₂e)



<2° 2-3° 3-4° 4-5° >5°

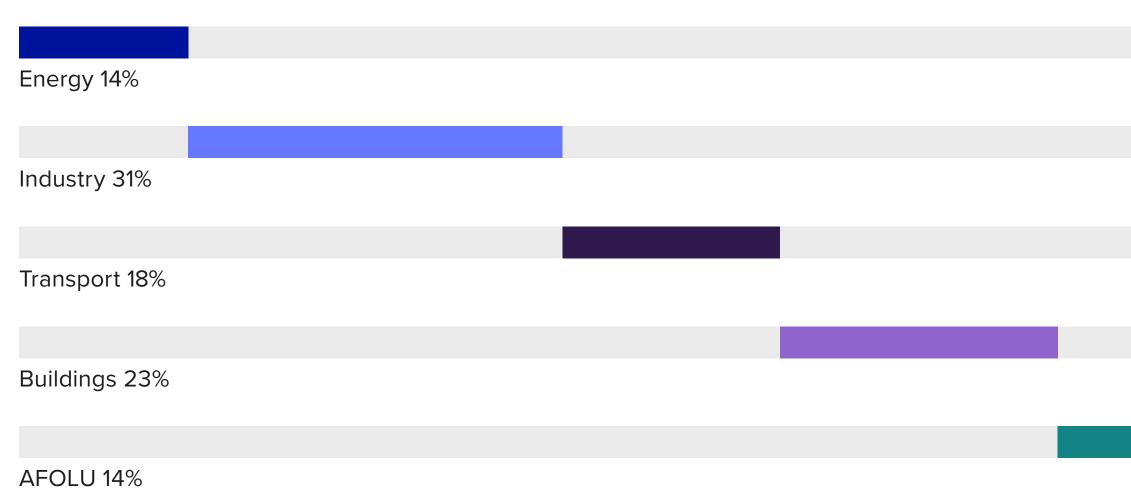
Emissions and abatement potential

2021 emissions by sector¹⁰⁴ (CO₂e)

Germany's highest potential source of abatement is in the Industrial sector, accounting for 31% of the total. This sector currently represents the second largest proportion of the country's emissions with 24%. The Energy sector is the main contributor with 31% of the emissions.

Energy 231 Mt Transport 145 Mt AFOLU Image: State of the state of

Sectoral abatement potential for 1.5°C-alignment by 2030¹⁰⁵







Timeline of released documentation

National Adaptation Strategy ¹⁰⁶	National Adaptation Plan I ¹⁰⁷	National Adaptation Plan II ¹⁰⁸
2008	2011	2015
National Adaptation Plan III ¹⁰⁹		
2020		

Summary of physical risk exposure:

Germany has a temperate climate with abundant precipitation. It is already at risk from flooding events, especially in the west, and will face increasing water-related challenges.

- Large-scale floods are expected due to more frequent and intense precipitation events. This will disrupt and damage critical assets for the German industrial sectors (27% of Germany's GDP in 2022¹¹⁰). By 2050, up to five times more population could be exposed to riverine floods.¹¹¹
- The northern coast is exposed to rising sea levels, threatening to damage property and infrastructure. Hamburg is particularly vulnerable, with an estimated 20% of its 2.5 million population at risk of displacement.¹¹²
- Although water stress may ease by up to 40%, severe summer droughts and subsequent disruption to economically important fluvial transport remain a threat, as seen in the Rhine Valley.¹¹³ Shrinking Alpine glaciers will further reduce river flows, with potential impacts on agriculture and energy production.
- Exposure to heatwaves remains moderate, Germany's population is particularly vulnerable to strong heat episodes, given the country has the second highest median age globally.¹¹⁴

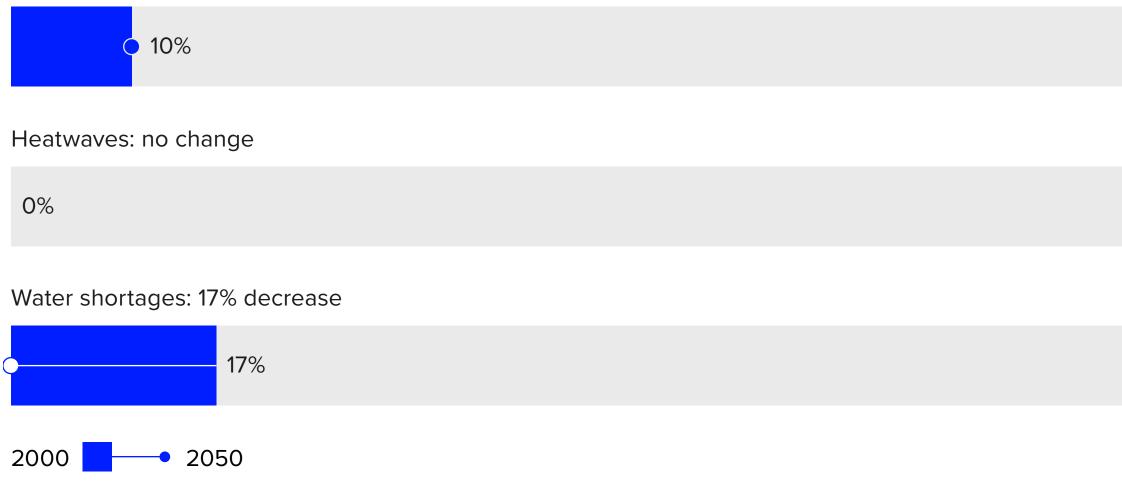
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National Adaptation Plan

Assessment of:	Absent in plan	Mentioned in plan	Comprehensive
Risk & vulnerabilities			•
Financing mechanisms			•
Governance breakdown			•
Sectoral breakdown of actions			•
Monitoring & evaluation implementaton			•

Change in share of population at risk, 2000–2050

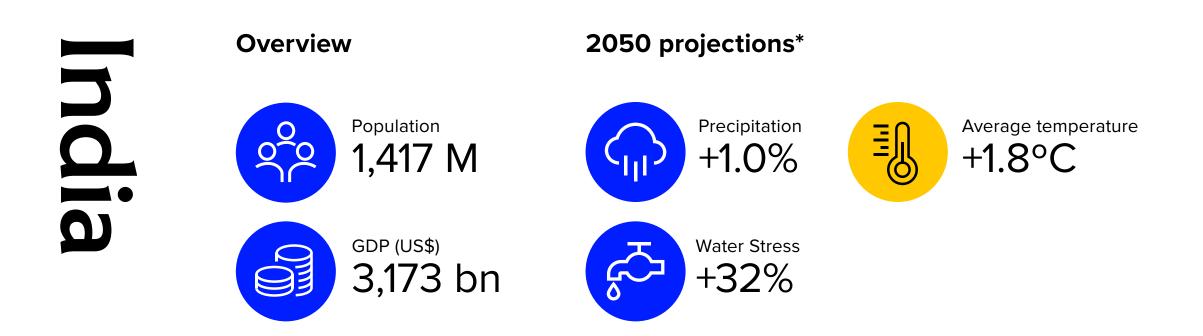
Riverine flooding: no change



National Initiative

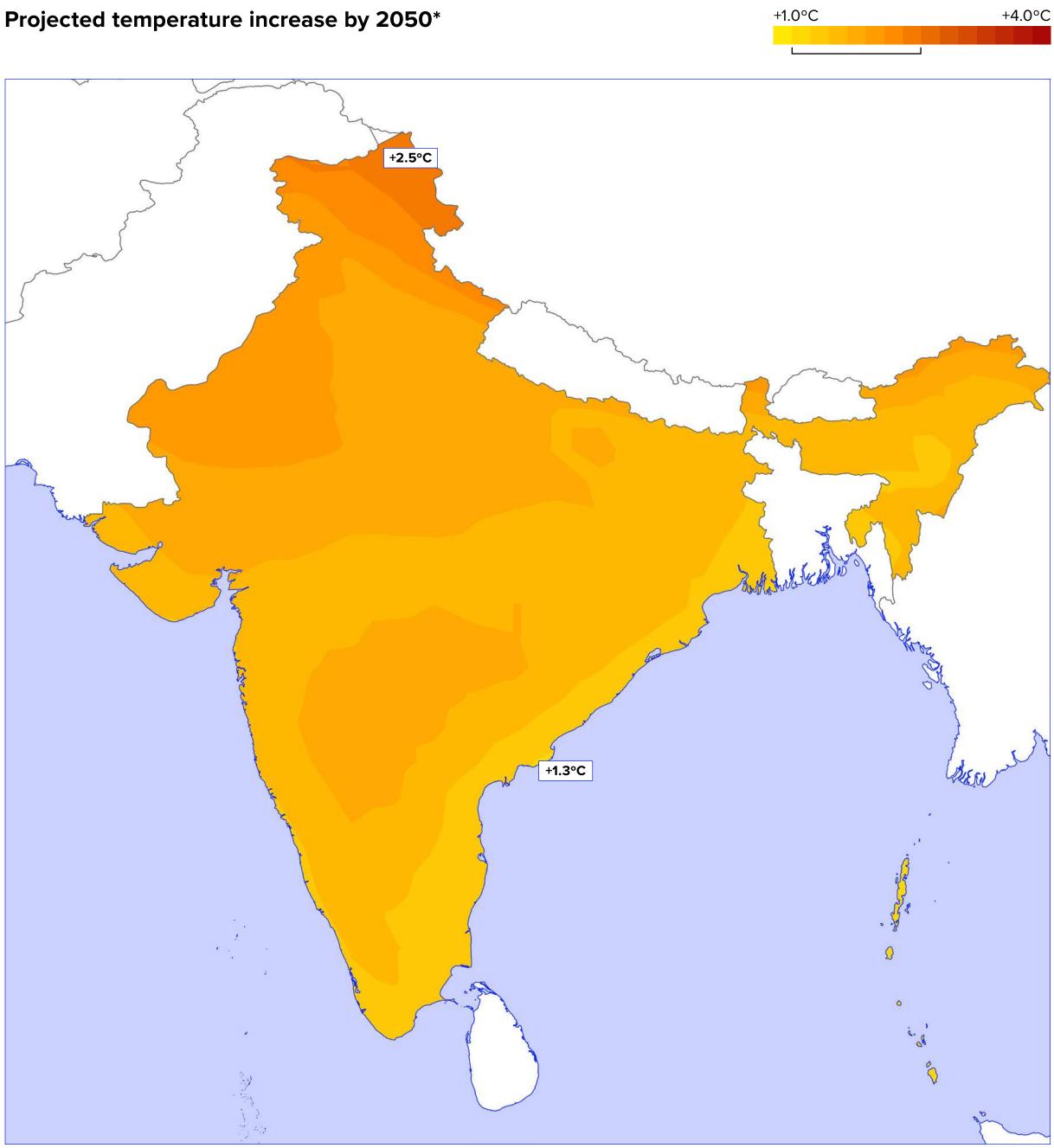
The Competence Centre on Climate Impacts and Adaptation (KomPass) is an environment agency platform, presenting impacts of climate change and adaptation measures at national, regional or local level, as well as maps.¹¹⁵

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Key climate-related policies:

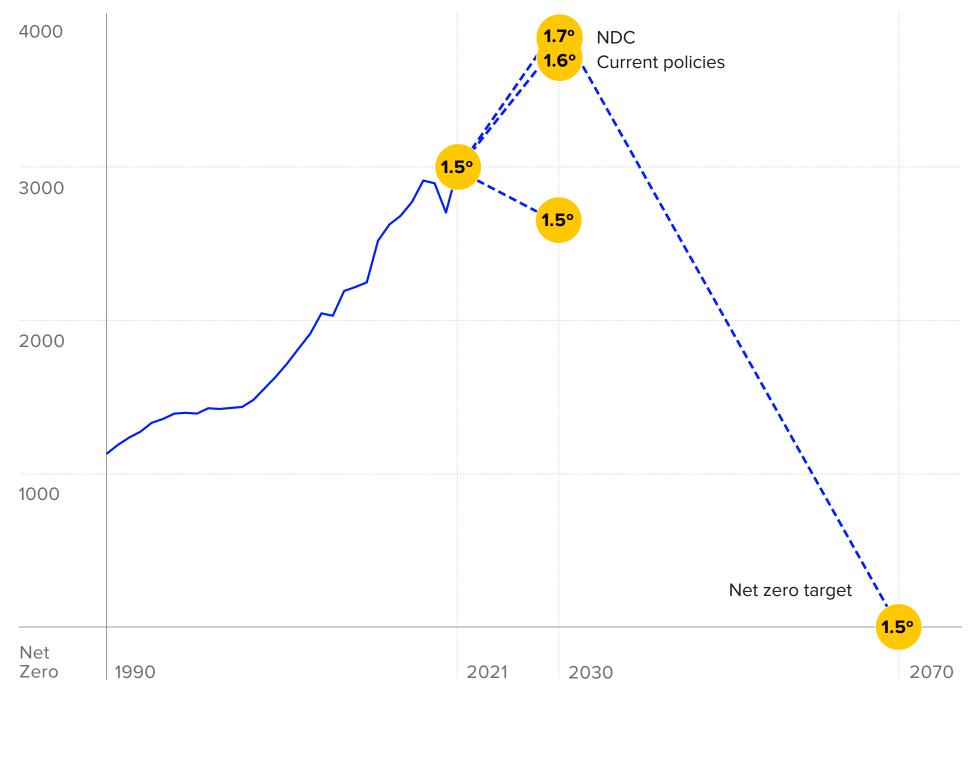
- **NDC 2030¹¹⁶:** India commits to reducing its emissions intensity by 45% by 2030 compared to 2005 levels.
- National Electricity Plan (Update in 2022)¹¹⁷: The plan targets adding considerable solar and wind capacity by 2031–32 (333GW and 134GW respectively). Coal will also continue to play a significant role in the country's energy mix.
- Green Hydrogen Policy (2022)¹¹⁸: Target of five million tonnes per annum • of green hydrogen production by 2030, more than 80% of the current hydrogen demand in the country.
- Energy efficiency in industry (PAT scheme) (2012)¹¹⁹: The PAT (Perform, Achieve and Trade) mechanism resembles an emissions trading scheme (ETS), though it differs from traditional cap-and-trade systems as it sets intensity-based energy targets.¹²⁰

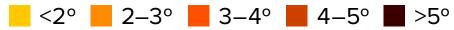


India

We estimate India's 2030 current policies emissions to be 31% higher than a 1.5° C-aligned trajectory.¹²¹ An abatement of 1.2 GtCO_2 e between 2021 and 2030 implies alignment with a 1.5° C-aligned trajectory.

Implied temperature rise based on GHG Emissions (MtCO₂e)





Emissions and abatement potential

India's highest potential of abatement is in the Energy sector, accounting for 35% of the total potential. This sector is the largest contributor with 39% of the country's emissions, followed by the Industrials sector accounting for 29%.

2021 emissions by sector¹²² (CO₂e)



Sectoral abatement potential for 1.5°C-alignment by 2030¹²³

Energy 35%		
Industry 26%		
Transport 3%		
Buildings 3%		
AFOLU 32%		



India

National Action Plan on Climate Change¹²⁴

2008

Summary of physical risk exposure:

India's mainly tropical climate is strongly influenced by the summer monsoon season. The northeast has among the highest precipitation rates in the world. High poverty rates and population densities make India highly vulnerable to climate change.

- India regularly experiences some of the world's highest temperatures, and heatwaves are expected to increase in magnitude and frequency by 2050. Episodes of potentially lethal temperatures will become very likely in the northwest, putting 310–480 million people at risk. Heat could also significantly decrease labor productivity by 10–40% by 2050.¹²⁵
- Floods due to intense monsoon precipitation and coastal tropical cyclones endanger on average five million people each year, by far the highest number on the planet.¹²⁶ With the country's rapid economic development, flood-related damages could rise exponentially
- India is also increasingly at risk of drought and water scarcity. The gradual retreat of Himalayan glaciers, on which India is highly dependent, will reduce the amount of freshwater available over the years. India's agricultural share of GDP (17% in 2022¹²⁷) makes it particularly vulnerable to the impact of heat and drought on crop yields.

National Adaptation Plan

Assessment of:	Absent in plan	Mentioned in plan	Comprehensive
Risk & vulnerabilities			٠
Financing mechanisms	•		
Governance breakdown		•	
Sectoral breakdown of actions		•	
Monitoring & evaluation implementaton		•	

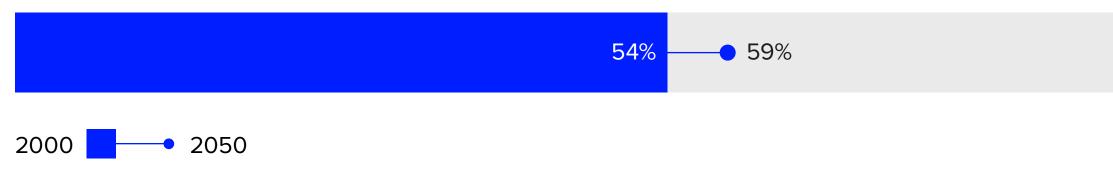
Change in share of population at risk, 2000–2050

Riverine flooding: 1% increase



Heatwaves: 1% increase

Water shortages: 5% increase



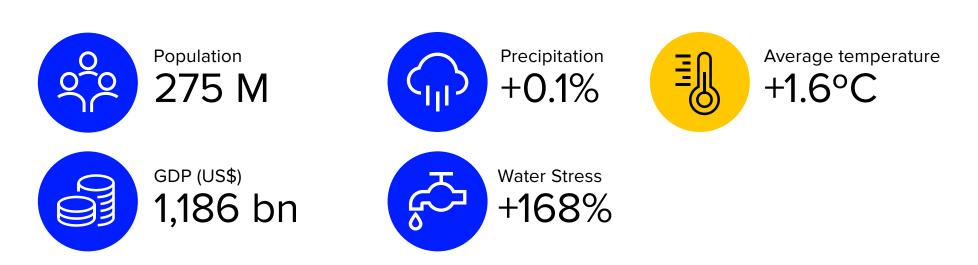
National Initiative

The National Adaptation Fund for Climate Change (NAFCC) is a government funding to support adaptation measures of States/ Union Territories in areas particularly vulnerable to the adverse impacts of climate change.¹²⁸

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98%	•

Overview

2050 projections*



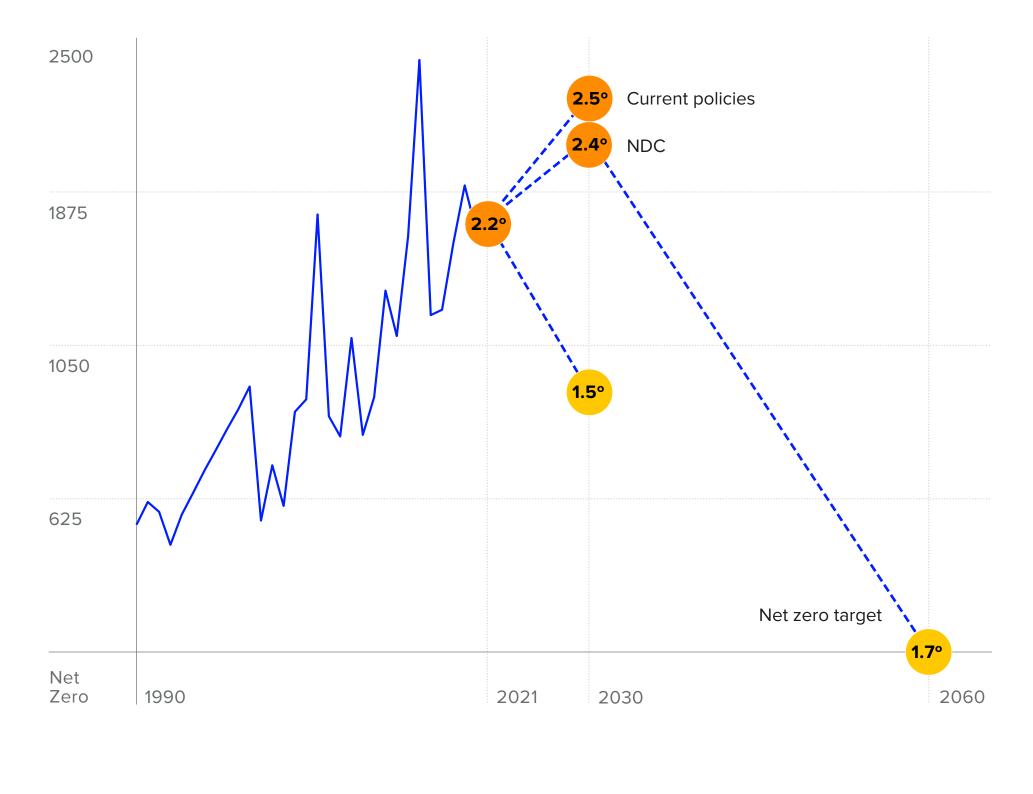
Key climate-related policies:

- **NDC 2030**¹²⁹**:** Emissions reductions of 31.89% unconditional below BAU by 2030.
- Carbon Trading Market implementation (September 2023)¹³⁰: Intensitybased emissions trading system which covers coal-fired power plants¹³¹, alongside the carbon tax that was announced in 2021.¹³²
- Indonesia's AFOLU Net Sink 2030 (2022)¹³³: The plan targets a 60% reduction in national GHG emissions through GHG reduction in the forestry and other land use sectors.
- Electricity Supply Business Plan (RUPTL 2019–2028)¹³⁴: The plan aims to bring total share of NRE in the energy mix to 24.8% by 2030.¹³⁵ A new presidential regulation¹³⁶2022) set a deadline to end unabated coal power generation by 2050.
- **Biofuel targets (2013)**¹³⁷**:** The policy aims for all transport fuels to have a 15% share of biofuels by 2025. The biodiesel blending rate was raised to 30% in 2020 with a plan to achieve 40% by 2022.



We estimate Indonesia's 2030 current policies emissions to be 59% higher than a 1.5° C-aligned trajectory.¹³⁸ An abatement of 1.3 GtCO_2 e between 2021 and 2030 implies alignment with a 1.5° C-aligned trajectory.

Implied temperature rise based on GHG Emissions (MtCO₂e)

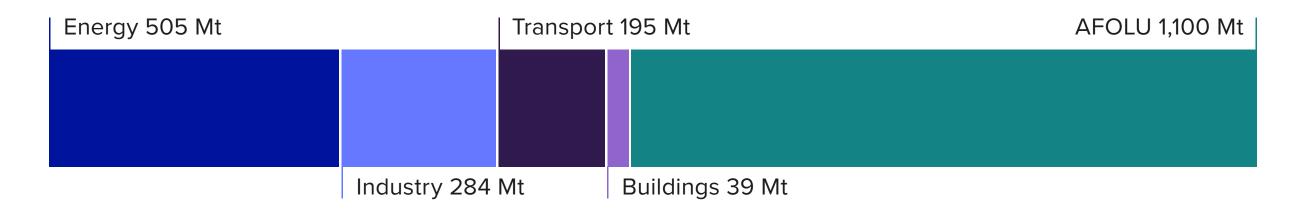


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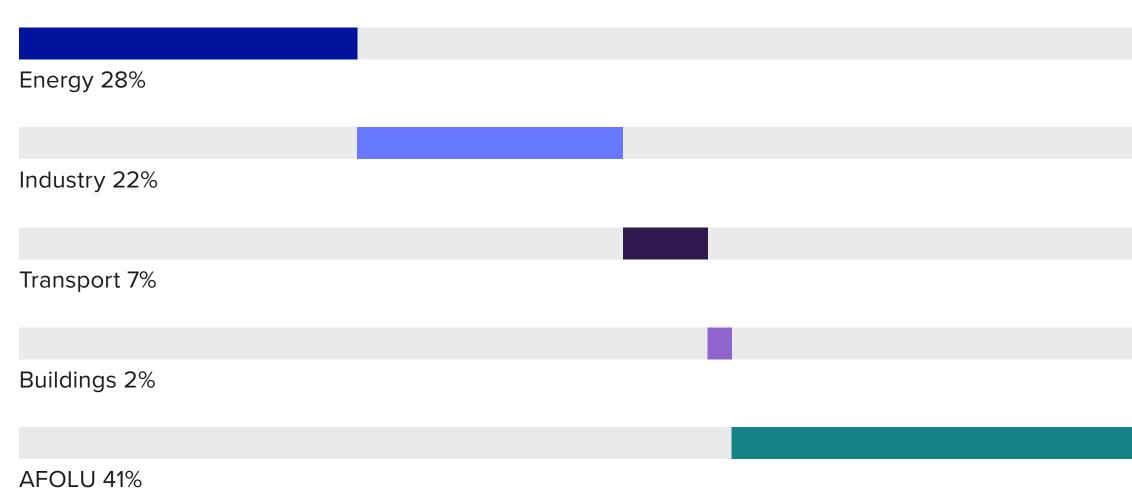
Emissions and abatement potential

Indonesia's highest potential source of abatement is in the AFOLU sector, accounting for 41% of the total. This sector currently represents the largest proportion of the country's emissions with 52%, followed by the Energy sector with 24%.

2021 emissions by sector¹³⁹ (CO₂e)



Sectoral abatement potential for 1.5°C-alignment by 2030¹⁴⁰





Timeline of released documentation

National Action Plan on Climate Change ¹⁴¹	National Adaptation Strategy ¹⁴²	National Adaptation Plan ¹⁴³
2007	2011	2012
National Adaptation Plan (update) ¹⁴⁴	National Adaptation Plan (update) ¹⁴⁵	
2014	2019	

Summary of physical risk exposure:

Indonesia's tropical climate is characterised by high rainfall and stable temperatures throughout the year.

- Floods are the main natural hazard in Indonesia. More frequent high rainfall events and more intense storms will increase the risks of inland flooding. Indonesia is especially threatened by sea-level rise as 42 million people are already living at least 10 meters below sea level.¹⁴⁶ Jakarta is particularly at risk, as the region is sinking rapidly: its northern part could be submerged by 2050. Tourism, highly concentrated on shorelines and small islands, could also be severely impacted by accelerated coastal erosion and the loss of beaches.
- A combination of warmer temperatures, enhanced evapotranspiration and changes in precipitation patterns, could severely impact Indonesia's agricultural output, which represented 12% of its GDP in 2022.¹⁴⁷ The impacts could be around US\$7 billion per year, mainly driven by strong decreases in rice yields.¹⁴⁸
- Warmer temperatures are also increasing the risk of tropical diseases such as malaria and dengue fever. By 2050, this public health outcome could cost around US\$450 million, with 40% arising in the Jakarta region alone.¹⁴⁹

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National Adaptation Plan

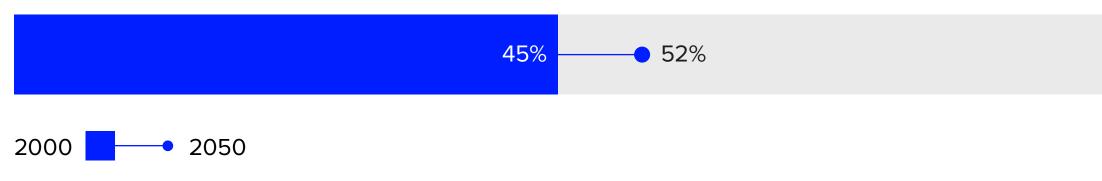
Assessment of:	Absent in plan	Mentioned in plan	Comprehensive
Risk & vulnerabilities			۲
Financing mechanisms			۲
Governance breakdown		•	
Sectoral breakdown of actions			۲
Monitoring & evaluation implementaton			۲

Change in share of population at risk, 2000–2050

Riverine flooding: no change



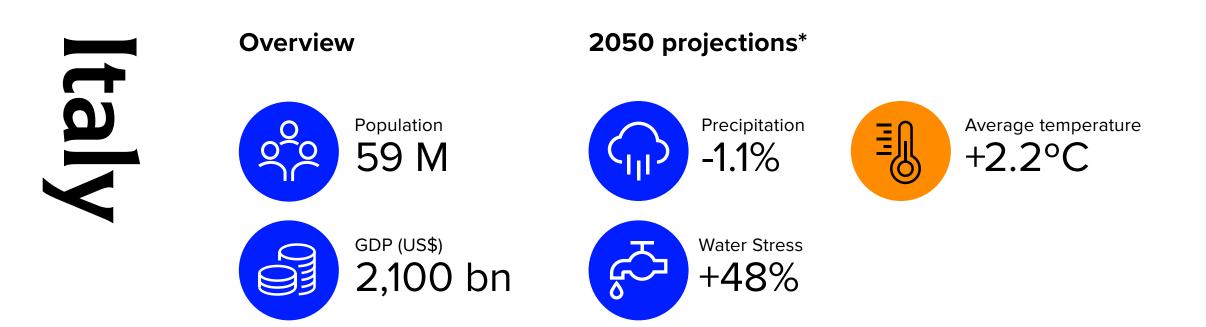
Water shortages: 7% increase



National Initiative

The National Capital Integrated Coastal Development (NCICD) is a mega adaptation project of 20–30 years, focusing on the extreme land subsidence in the northern part of Jakarta, with the aim to reduce and prevent floods.¹⁵⁰

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98%	•



Key climate-related policies:

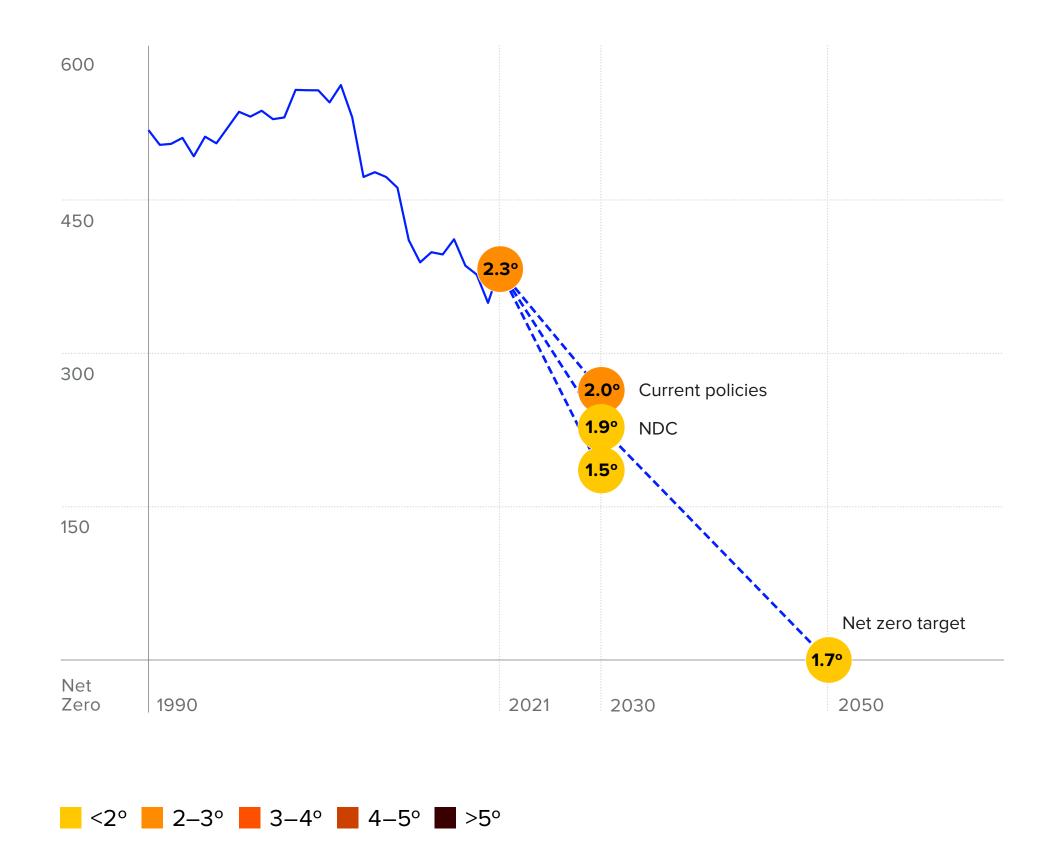
- **European Union's NDC 2030**¹⁵¹**:** A 55% reduction in greenhouse gas emissions by 2030 compared to 1990.
- As an EU member state (see EU ambition profile): Relevant policies include • the 'Fit for 55' package (2022), the European Green Deal (2019), the EU Farm to Fork Strategy (2019) and the REPowerEU (2022).
- **Integrated National Energy and Climate Plan (2019)**¹⁵²: This plan targets phasing out coal by 2025, with 30% of gross final energy consumption coming from renewables and a 43% reduction in primary energy consumption by 2030.
- National Plan for Electric Vehicle Charging Infrastructure (PNIRE approved in 2012, updated in 2023)¹⁵³: More than 21,000 charging stations for electric vehicles (EV) are intended to be operational by 2026.¹⁵⁴
- National Energy Efficiency Action Plan (2017)¹⁵⁵: The plan includes a 'white certificates' mechanism, which is designed to encourage energy efficiency gains via tradable certificates, as well as tax deductions for building renovations designed to improve energy efficiency.



taly

We estimate Italy's 2030 current policies emissions to be 29% higher than a 1.5°C-aligned trajectory.¹⁵⁶ An abatement of 77 MtCO₂e between 2021 and 2030 implies alignment with a 1.5°C-aligned trajectory.

Implied temperature rise based on GHG Emissions (MtCO₂e)



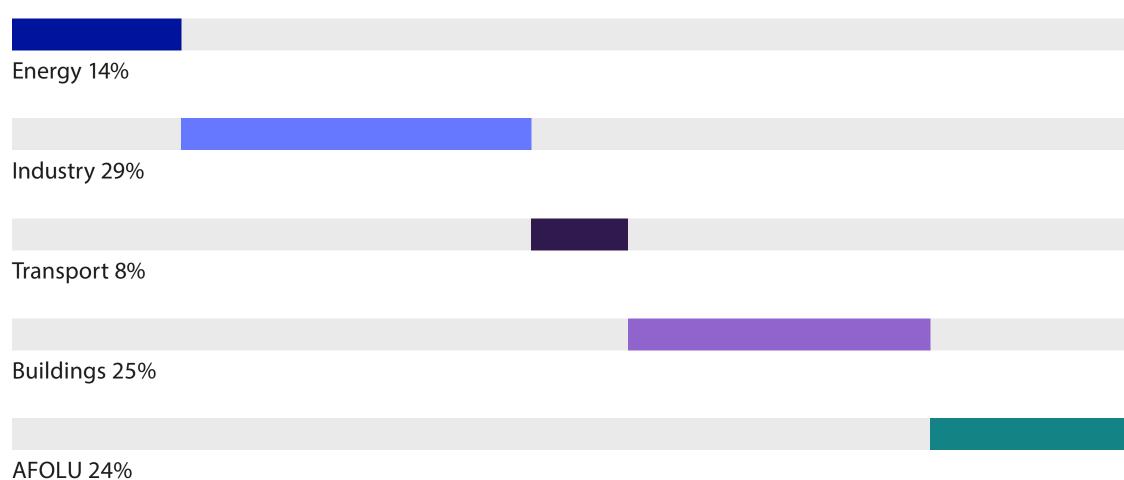
Emissions and abatement potential

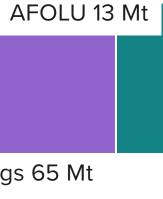
Italy's highest potential source of abatement is in the Industrial sector, accounting for 29% of the total. This sector currently represents the third largest proportion of the country's emissions with 21%. The Energy and Transport sectors are the joint highest contributors with 29% of the emissions.

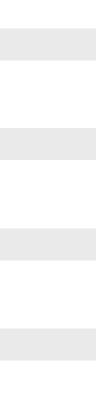
Transport 105 Mt Energy 106 Mt Industry 76 Mt Buildings 65 Mt

2021 emissions by sector¹⁵⁷ (CO₂e)

Sectoral abatement potential for 1.5°C-alignment by 2030¹⁵⁸







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National Adaptation Strategy¹⁵⁹ 2015 Adaptation Communication to UNFCCC¹⁶⁰ 2021

National Adaptation Plan¹⁶¹

2022

Summary of physical risk exposure:

Italy faces warm and dry conditions, especially in the southern part of the country, with higher rainfall in the northern and central mountains.

- The frequency of droughts is expected to double by 2050,¹⁶² leading to potential disruption of industrial production in the north. Agriculture may be strongly impacted in the south, already experiencing high levels of water stress. Restrictions on water use could also impact the tourism sector (10% of Italy's GDP¹⁶³).
- More heatwaves will also impair agricultural yields, and the strong economic discrepancies between the richer north and poorer south may be further exacerbated. Tropical diseases such as malaria or dengue fever are already on the rise.¹⁶⁴
- Flash floods and riverine inundations are already frequent, especially in the Po Valley where 40% of the economy and 30% of the population are clustered.¹⁶⁵ The estimated cost of landslides and floods is about €1 billion per year,¹⁶⁶ and expected to continue to increase. Sea-level rise threatens infrastructure in densely populated coastal areas. Annual expected damages from coastal floods could reach €1.4 billion per year in 2050.¹⁶⁷

National Adaptation Plan

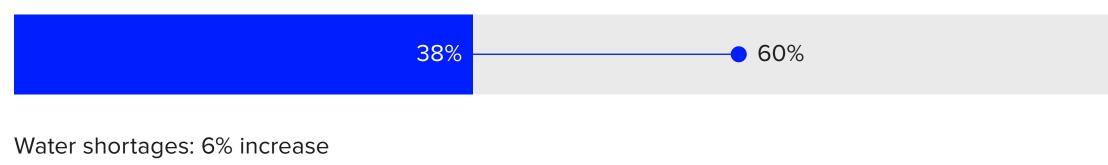
Assessment of:	Absent in plan	Mentioned in plan	Comprehensive
Risk & vulnerabilities			•
Financing mechanisms		•	
Governance breakdown			•
Sectoral breakdown of actions			•
Monitoring & evaluation implementaton		•	

Change in share of population at risk, 2000–2050

Riverine flooding: no change

<mark>o</mark> 12%

Heatwaves: 22% increase

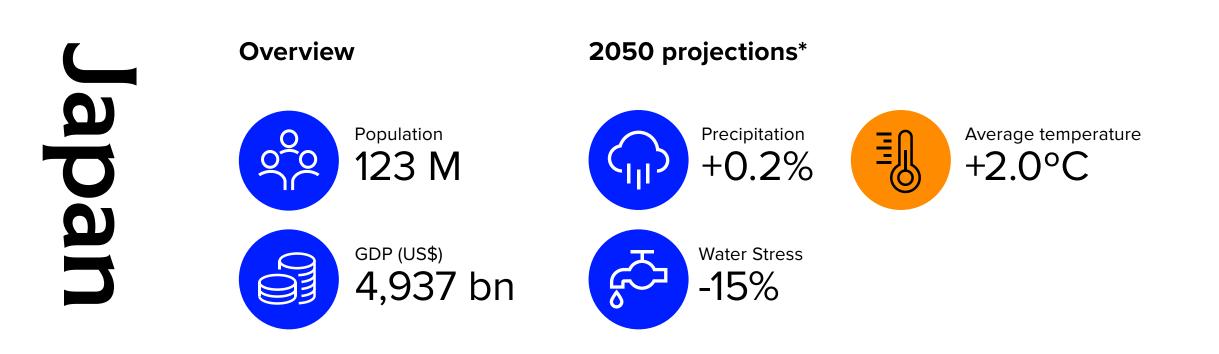




National Initiative

The National Platform for Climate Change Adaptation is an online tool intending to foster the exchange of information between the Central Administration, Local Authorities and all stakeholders on the issue of climate change adaptation.¹⁶⁸

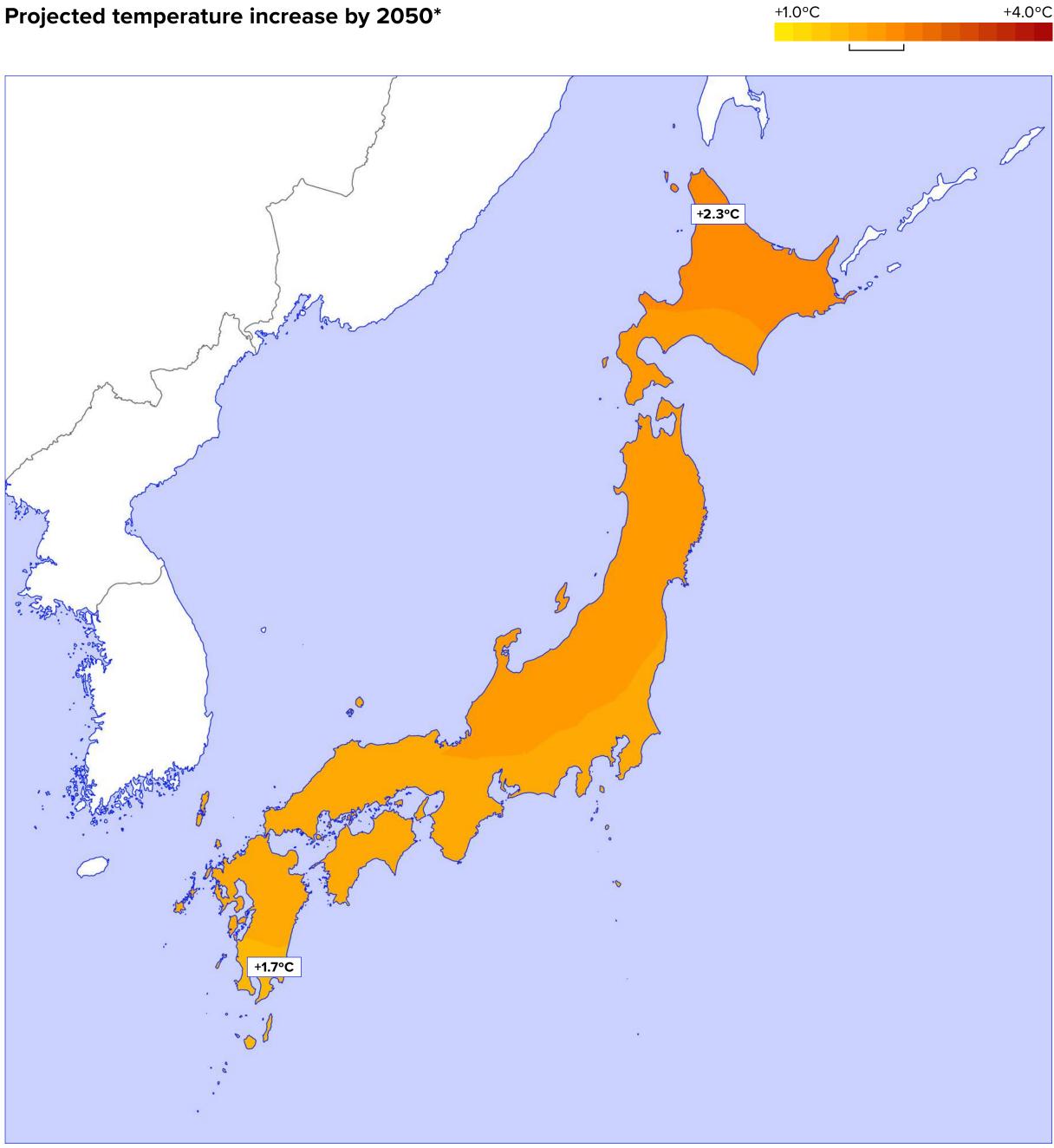
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Key climate-related policies:

- **NDC**¹⁶⁹: Japan commits to reduce GHG emissions by 46% by 2030 compared to 2013 levels.
- **Basic Energy Plan (2021)**¹⁷⁰**:** The plan aims to diversify the energy mix by increasing the share of electricity from renewable sources to 36%-38% by 2030 (including large hydro).
- Green Transformation (GX) Basic Policy (2023)¹⁷¹: The plan aims to ramp up decarbonisation efforts in the Industrial sector through a transition to clean-energy, alongside additional measures for a stable energy supply and a 'growth-oriented' carbon pricing schemes.¹⁷²
- **Green Growth Strategy (2021)**¹⁷³**:** Targets for electrified vehicles (including fuel cell vehicles and non-plugin hybrids) to make up 100% of new passenger car sales by 2035.
- Phase-out old and inefficient coal-fired power plants (2020)¹⁷⁴: The government is considering shutting down or mothballing about 100 (of 110) existing inefficient coal plants by 2030.

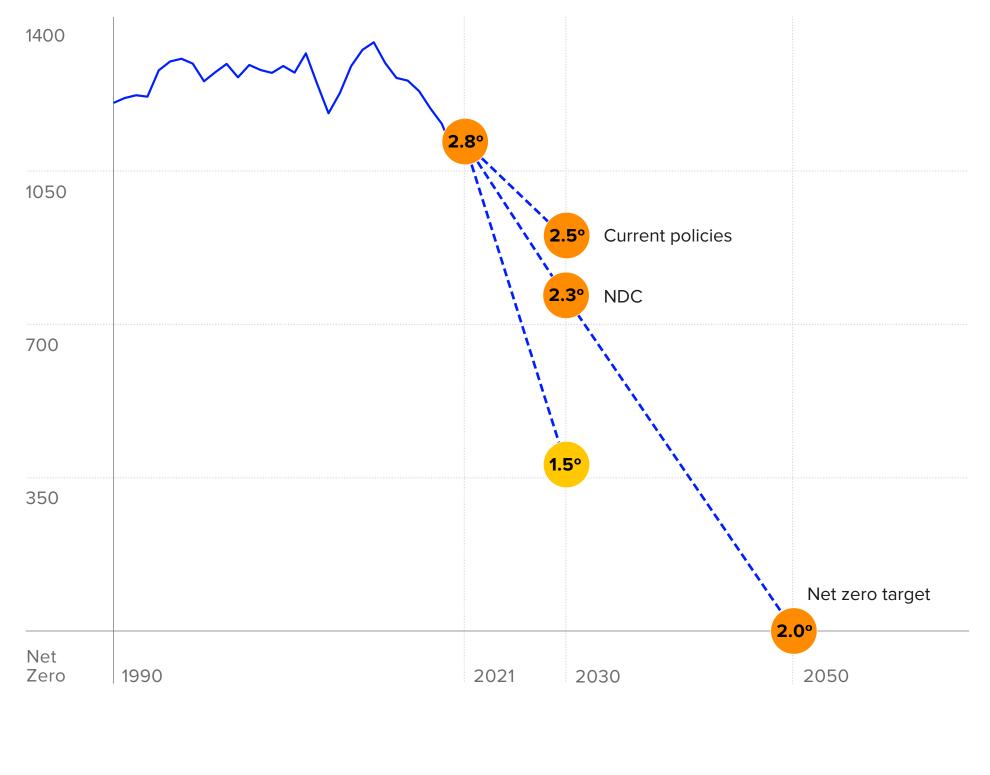




Japan

We estimate Japan's 2030 current policies emissions to be 58% higher than a 1.5° C-aligned trajectory.¹⁷⁵ An abatement of 519 MtCO₂e between 2021 and 2030 implies alignment with a 1.5° C-aligned trajectory.

Implied temperature rise based on GHG Emissions (MtCO₂e)

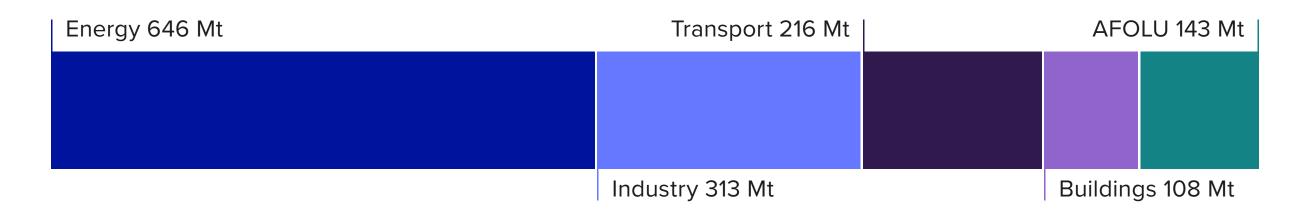


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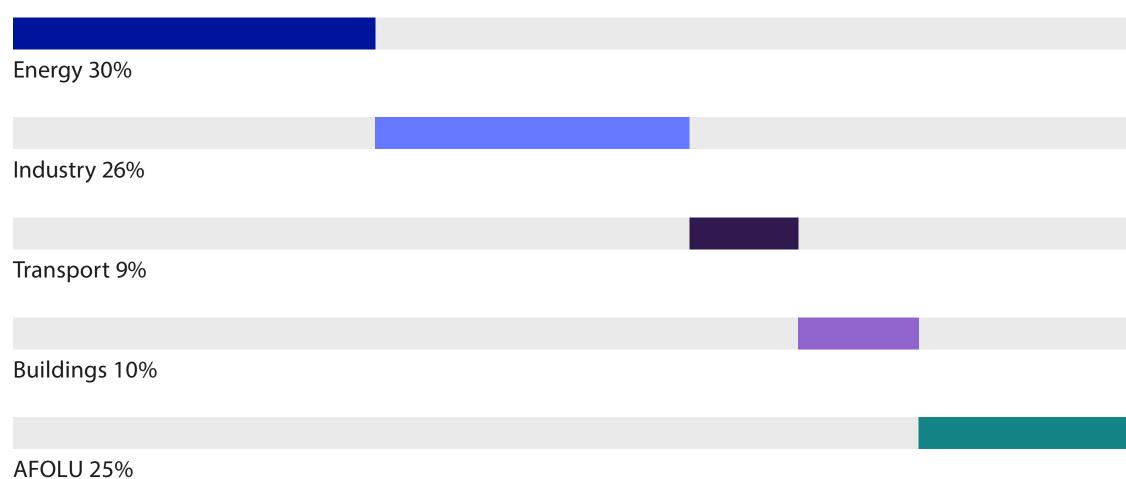
Emissions and abatement potential

Japan's highest potential source of abatement is in the Energy sector, accounting for 30% of the total. This sector currently represents the largest proportion of the country's emissions with 45%, followed by the Industrial sector with 22%.

2021 emissions by sector¹⁷⁶ (CO₂e)



Sectoral abatement potential for 1.5°C-alignment by 2030¹⁷⁷



Timeline of released documentation

National Adaptation Plan I ¹⁷⁸	National Adaptation Plan II ¹⁷⁹	National Adaptation Plan III ¹⁸⁰
2015	2018	2021
Adaptation Communication to UNFCCC ¹⁸¹		
2023		

Summary of physical risk exposure:

Japan's climate is influenced by the East Asian monsoon season. The country is especially exposed to tropical cyclones and flooding, which can impact its Industrial sector, the second largest in the world.

- Sea and air temperature rises cause conditions that both trigger and exacerbate tropical storms and cyclones. In addition, higher sea levels are likely to cause more frequent and stronger storm surges, leading to largescale coastal flooding damage. Japan is particularly exposed, as most of the population resides in high-density coastal communities, especially in the south.¹⁸²
- More frequent extreme precipitation events are also expected, causing major floods and landslides, with severe consequences to properties and transport infrastructure. Currently, 1,500 landslides occur every year, an increase of 50% from the previous decade.¹⁸³
- Increasing temperatures are a significant threat to Japan's population.
 Almost 30% of the population are 65+ years old¹⁸⁴ (the highest proportion in the world). The existing vulnerability to heat-related mortality is expected to worsen by two or three times by mid-century.¹⁸⁵

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National Adaptation Plan

Assessment of:	Absent in plan	Mentioned in plan	Comprehensive
Risk & vulnerabilities			•
Financing mechanisms	•		
Governance breakdown			•
Sectoral breakdown of actions			•
Monitoring & evaluation implementaton			•

Change in share of population at risk, 2000–2050

Riverine flooding: 1% decrease

10% 🔶 11%

Heatwaves: 40% increase



Water shortages: 2% decrease



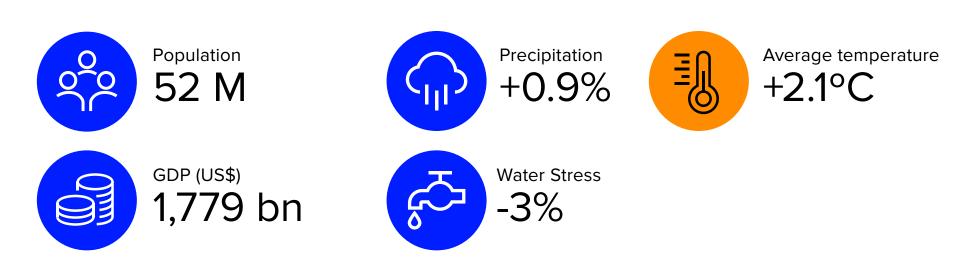
National Initiative

The Climate Change Adaptation Information Platform (A-PLAT) is an online platform that offers easily understandable information to promote "adaptation measures" to build resilience to climate change.¹⁸⁶

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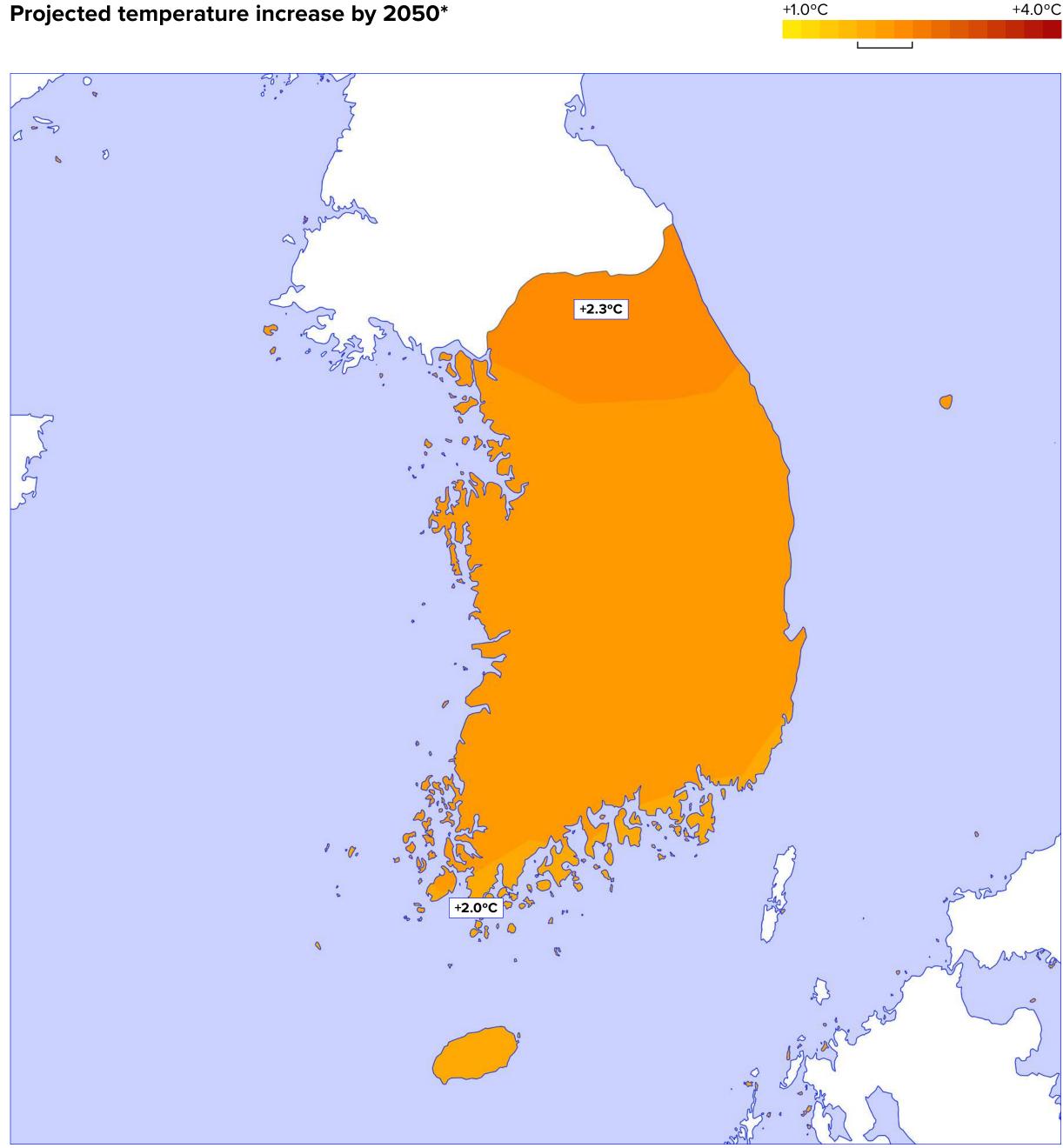
Overview

2050 projections*



Key climate-related policies:

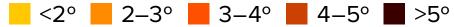
- **NDC:** Republic of Korea commits to reduce GHG emissions by 40% by 2030 compared to 2018 levels.¹⁸⁷
- **10th Basic Electricity Plan (2023)**¹⁸⁸: The Plan aims to reach 21.6% of • renewables in the energy mix by 2030, and 30.6% by 2036.
- The 1st National Carbon Neutrality and Green Growth Master Plan (2023-2042) (2023)¹⁸⁹: The plan reaffirms the goal of a 40% reduction in GHG and develops specific reduction policies in 10 sectors and 6 implementation areas between now and 2042.
- Emissions Trading System (2015 updated in 2021)¹⁹⁰: System covers 73.5% of the national GHG emissions involving nearly 685 companies from 69 sub-sectors. The current caps for 2021–2025 are set to align with the government's 2030 emissions target.
- 2050 Carbon Neutral Forest Sector Promotion Strategy (2021)¹⁹¹: The strategy is to plant three billion trees over 30 years and thereby increase the annual LULUCF removals by 34 MtCO₂e.



We estimate the Republic of Korea's 2030 current policies emissions to be 74% higher than a 1.5°C-aligned trajectory.¹⁹² An abatement of 447 MtCO₂e between 2021 and 2030 implies alignment with a 1.5°C-aligned trajectory.

Implied temperature rise based on GHG Emissions (MtCO₂e)





Emissions and abatement potential

The Republic of Korea's highest potential source of abatement is in the Energy sector, accounting for 42% of the total. This sector currently represents the largest proportion of the country's emissions with 56%, followed by the Industrial sector which accounts for 27%.

2021 emissions by sector¹⁹³ (CO₂e)

Energy 425 Mt	Transport 101 Mt	AFOLU
	Industry 200 Mt Bu	ildings 48 Mt

Sectoral abatement potential for 1.5°C-alignment by 2030¹⁹⁴

Energy 42%		
Industry 31%		
Transport 11%		
•		
Buildings 7%		
AFOLU 9%		



Timeline of released documentation

National Adaptation	National Adaptation	National Adaptation
Master Plan ¹⁹⁵	Plan I ¹⁹⁶	Plan II ¹⁹⁷
2008	2010	2015
National Adaptation	Adaptation Communication	National Adaptation
Plan III ¹⁹⁸	to UNFCCC ¹⁹⁹	Plan III (update) ²⁰⁰
2020	2023	2023

Summary of physical risk exposure:

The climate of the Republic of Korea is characterised by cold, dry winters and hot, humid summers with intense rainfall during the summer monsoon season.

- More intense precipitation events, especially in the south and during the monsoon season, will result in more frequent inland flooding, damaging property and infrastructure. Monsoon rains and water availability are also expected to become more variable, affecting the country's water systems.
- Sea level rise and more intense storms and cyclones are also expected to impact densely populated coastal areas, with estimated losses amounting to €41 billion to €87 billion for coastal floods alone.²⁰¹
- The Republic of Korea's average temperature trend is rising faster than the global average, with an increase of up to 2°C by mid-century.²⁰² The supply of energy could be affected, as cooling needs would grow, impacting electricity prices. Extreme heat events will harm the health of the country's ageing population, because heatwave-related excess deaths could rise by two or three times by 2050.²⁰³

National Adaptation Plan

Assessment of:	Absent in plan	Mentioned in plan	Comprehensive
Risk & vulnerabilities			•
Financing mechanisms	•		
Governance breakdown			•
Sectoral breakdown of actions			•
Monitoring & evaluation implementaton		•	

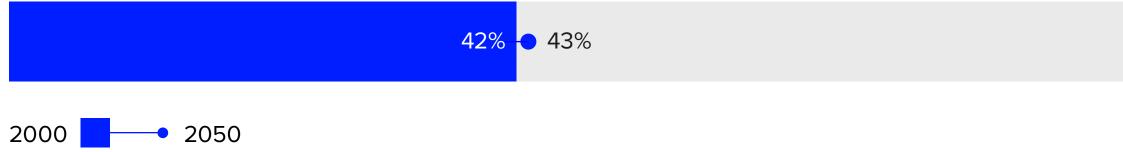
Change in share of population at risk, 2000–2050

Riverine flooding: no change



Heatwaves: 5% increase

Water shortages: 1% increase



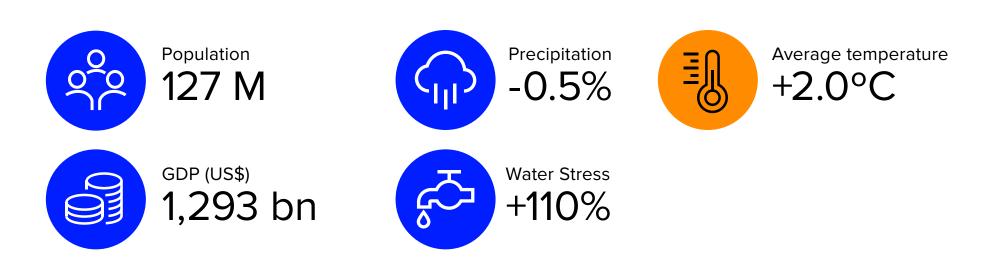
National Initiative

The Vulnerability Assessment Tool to Build Climate Change Adaptation Plan (VESTAP) is a policy decision support tool to help municipal & regional governments evaluate their vulnerability to major climate impacts & assess their adaptation capacity.²⁰⁴

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5%	-	

Overview

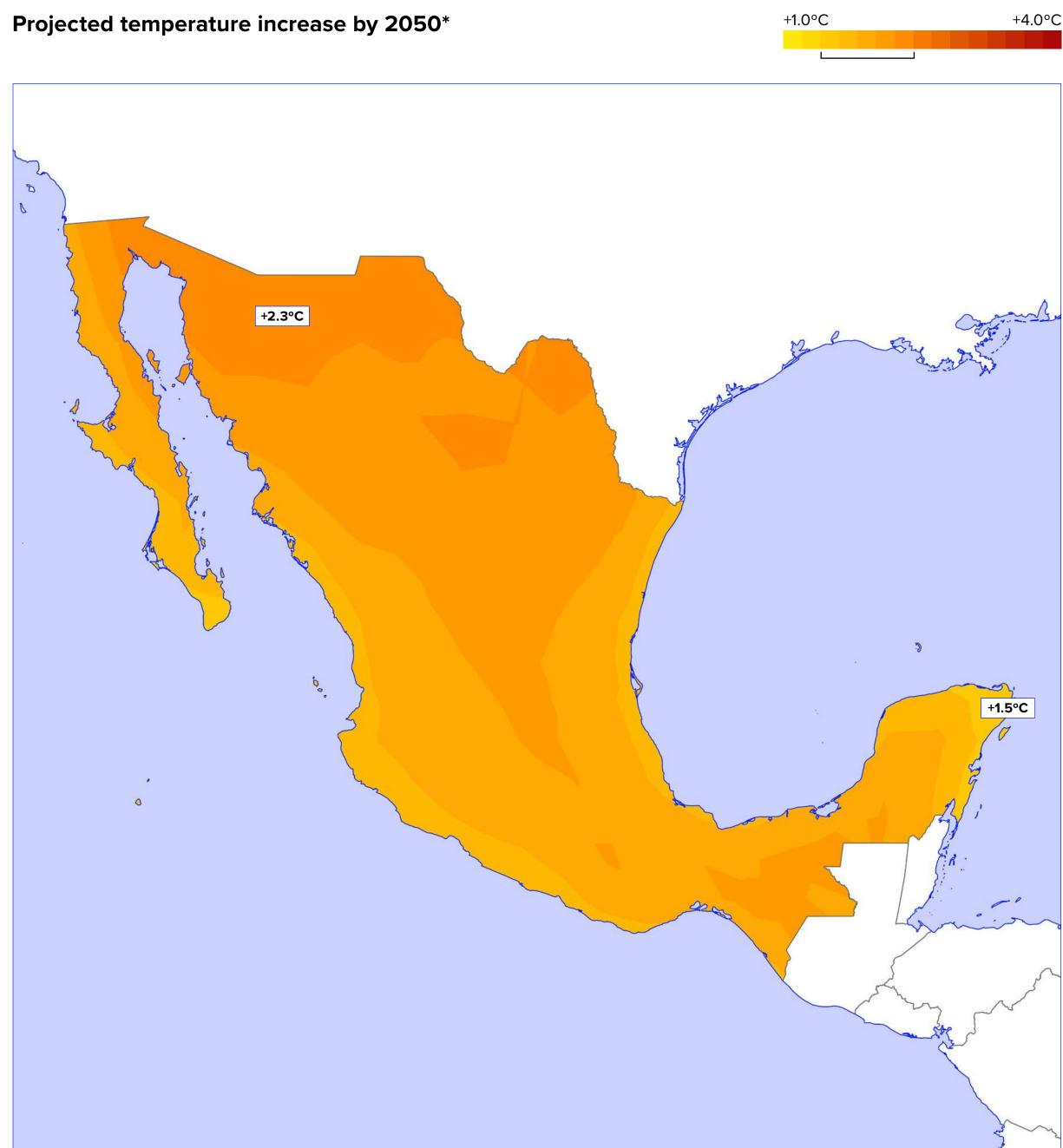
2050 projections*



Key climate-related policies:

- **NDC 2030**²⁰⁵: Mexico commits to reducing its emissions by 35% by 2030 compared to BAU.
- **Emissions Trading Scheme (ETS) (2018)**²⁰⁶**:** A national pilot ETS began in 2020, teeing up its final regulatory framework to be fully operational in 2023.
- **Program for the development of the National Electric System 2020-2034** (PRODESEN) (2022)²⁰⁷: This strategic document sets out clean energy targets up to 2036, including 25.5% for solar, and 12.8% for wind.²⁰⁸
- Support for sustainable forestry development (2021)²⁰⁹: It supports the actions contributing to the protection, conservation, restoration, and incorporation of sustainable management of forest, which in turn contribute to the adaptation and mitigation of the effects of climate change.
- **National Strategy to Reduce Short-Lived Climate Pollutants (2020)**²¹⁰: This strategy presents a roadmap to reduce short-lived climate pollutants including black carbon, methane, tropospheric ozone and hydrofluorocarbons (HFCs).

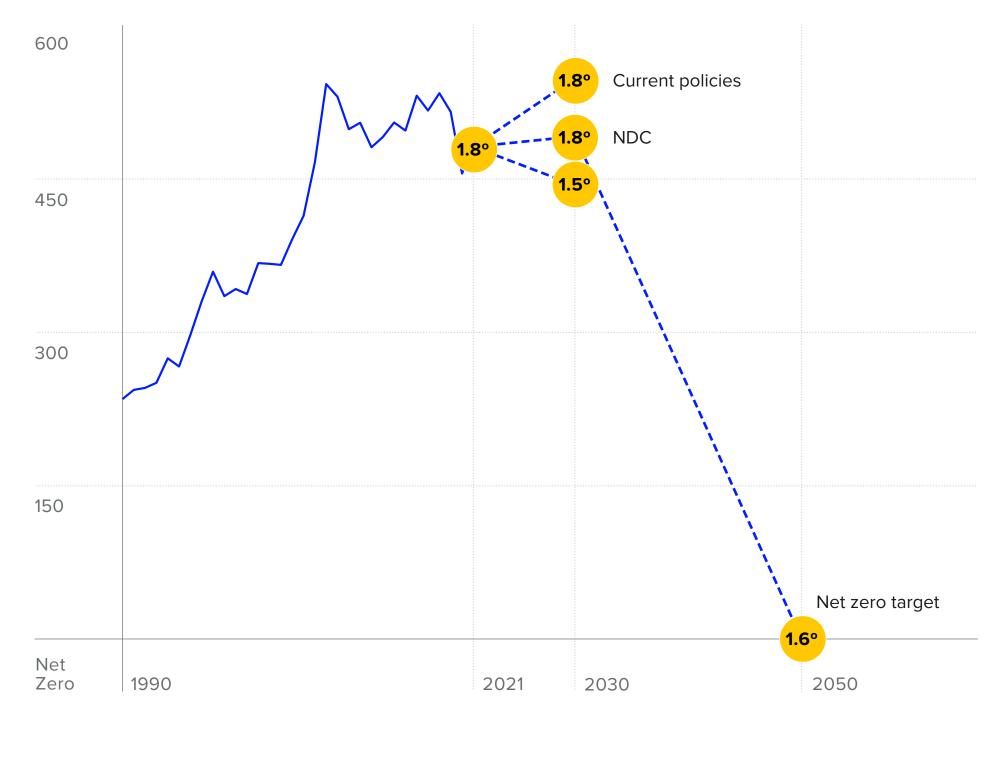
+1.0°C	

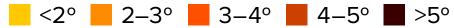


Mexico

We estimate Mexico's 2030 current policies emissions to be 18% higher than a 1.5° C-aligned trajectory.²¹¹ An abatement of 101 MtCO₂e between 2021 and 2030 would imply alignment with a 1.5° C-aligned trajectory.

Implied temperature rise based on GHG Emissions (MtCO₂e)





Emissions and abatement potential

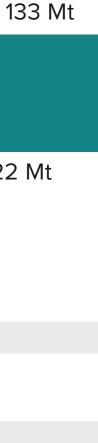
Mexico's highest potential source of abatement is in the AFOLU sector, accounting for 46% of the total potential. This sector currently represents the fourth largest proportion of the country's emissions with 16%. The Industrial sector is the largest contributor with 34%.

Energy 220 Mt Transport 180 Mt AFOLU 133 Mt Imdustry 289 Mt Imdustry 289 Mt Buildings 22 Mt

2021 emissions by sector²¹² (CO₂e)

Sectoral abatement potential for 1.5°C-alignment by 2030²¹³

Energy 25%		
Industry 20%		
Transport 5%		
Buildings 4%		
AFOLU 46%		



National Climate Change Strategy²¹⁴ 2007 National Climate Change Strategy (update)²¹⁵

2013

Adaptation Communication to UNFCCC²¹⁶

2022

Summary of physical risk exposure:

Already one of the driest countries in the G20, Mexico is strongly impacted by climate and physical risks, with variations from north to south.

- The population and industrial centres in the north are most exposed to droughts and water scarcity. While still severe, the aggravation of these risks²¹⁷ is less of a threat for the lower-temperature mountainous central area and tropical south, where most of the population are clustered.
- In turn, agriculture will be severely impacted, with some studies projecting a 26-35% decrease in crop yields — potentially triggering large migratory waves due to lower agricultural employment and reduced access to basic resources.²¹⁸
- Mexico is strongly affected by both Atlantic and Pacific tropical storms and hurricanes. More than half of its population live along the coast, where there are significant levels of tourist-related infrastructure. A 50% projected increase in the frequency of the most intense events, their associated increased rainfall²¹⁹ and rising sea levels are expected to put more people and resorts at risk of extreme floods.

National Adaptation Plan

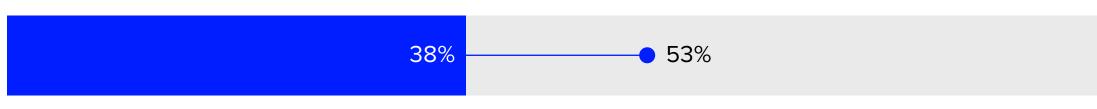
Assessment of:	Absent in plan	Mentioned in plan	Comprehensive
Risk & vulnerabilities			•
Financing mechanisms	•		
Governance breakdown			•
Sectoral breakdown of actions			•
Monitoring & evaluation implementaton		•	

Change in share of population at risk, 2000–2050

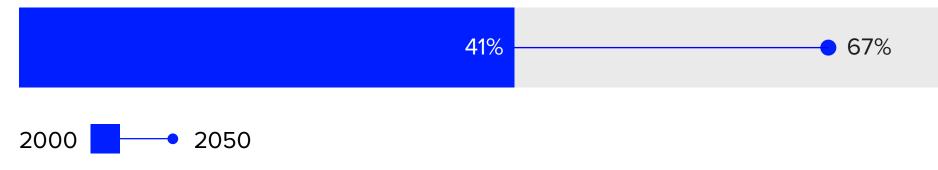
Riverine flooding: no change



Heatwaves: 15% increase



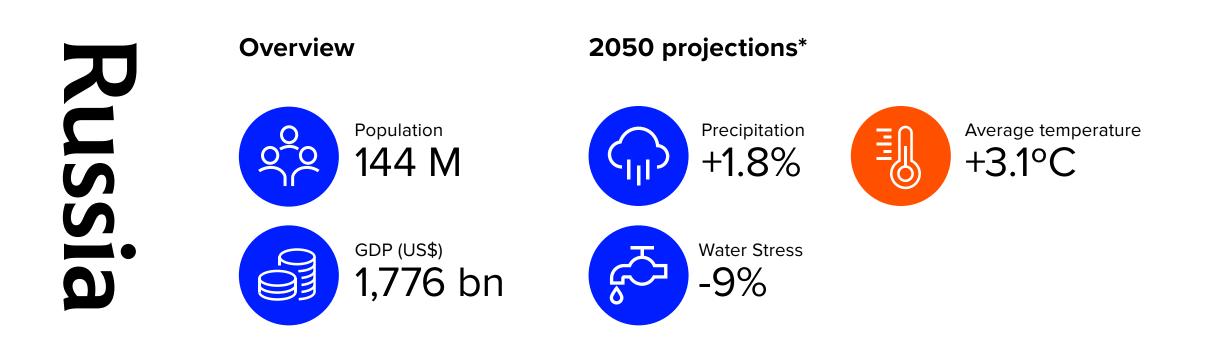
Water shortages: 26% increase



National Initiative

The National Atlas of Vulnerability to Climate Change (ANVCC) is a systematic set of maps showing the territorial vulnerability to climate change, to guide development strategies in the adaptation process, besides being an input for decision-making for development planning.²²⁰

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Key climate-related policies:

- **NDC 2030**²²¹: The Russian Federation commits to reduce greenhouse gas emissions to 70% relative to the 1990 level by 2030.
- **System of Green Project Financing (2021)**²²²**:** The system prepares the launch of schemes to finance green projects and initiatives, including sustainable development and mitigating the emission of pollutants and greenhouse gases.
- Energy Strategy 2035 (2021)²²³: This latest energy strategy describes the expected development of the country's energy sector over the next 15 years²²⁴. The strategy includes the target to increase the share of renewable energy sources in primary energy consumption from 11% to 13–14% by 2030.
- **Transport strategy until 2030 (2021)**²²⁵**:** The Russian Federation expects to • reduce transportation emissions by 1.2% compared to 2017.

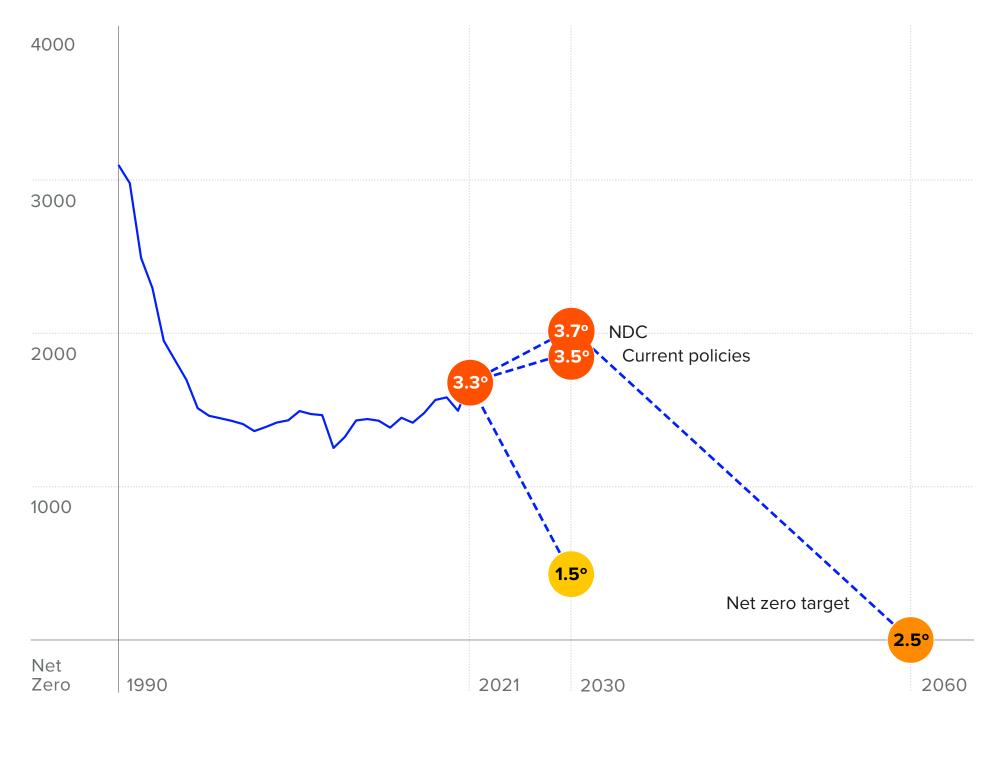




Russia

We estimate Russia's 2030 current policies emissions to be 77% higher than a 1.5° C-aligned trajectory.²²⁶ An abatement of 1.4 GtCO_2 e between 2021 and 2030 would imply alignment with a 1.5° C-aligned trajectory.

Implied temperature rise based on GHG Emissions (MtCO₂e)

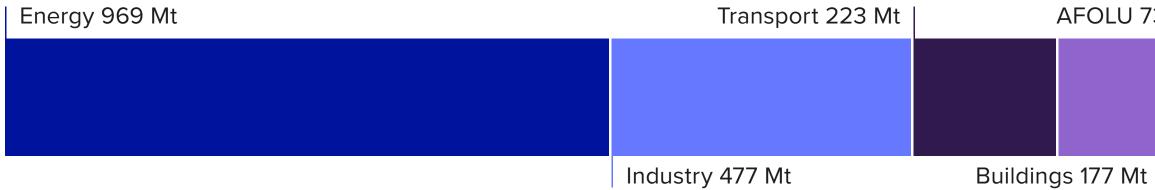


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Emissions and abatement potential

Russia's highest potential source of abatement is in the Energy sector, accounting for 55% of the total. This sector currently represents the largest proportion of the country's emissions with 50%, followed by the Industrial sector with 25%.

2021 emissions by sector²²⁷ (CO₂e)



Sectoral abatement potential for 1.5°C-alignment by 2030²²⁸

Energy 55%	
Industry 20%	
Transport 5%	
Buildings 7%	
AFOLU 13%	



Timeline of released documentation

Russia

National Adaptation Plan I²²⁹ 2019 National Adaptation Plan II²³⁰ 2023

Summary of physical risk exposure:

As the biggest country in the world by landmass, almost all types of climates can be found there, with mean temperatures ranging from -19°C to 15°C. Consequently, climate change will impose a diverse set of physical risks.

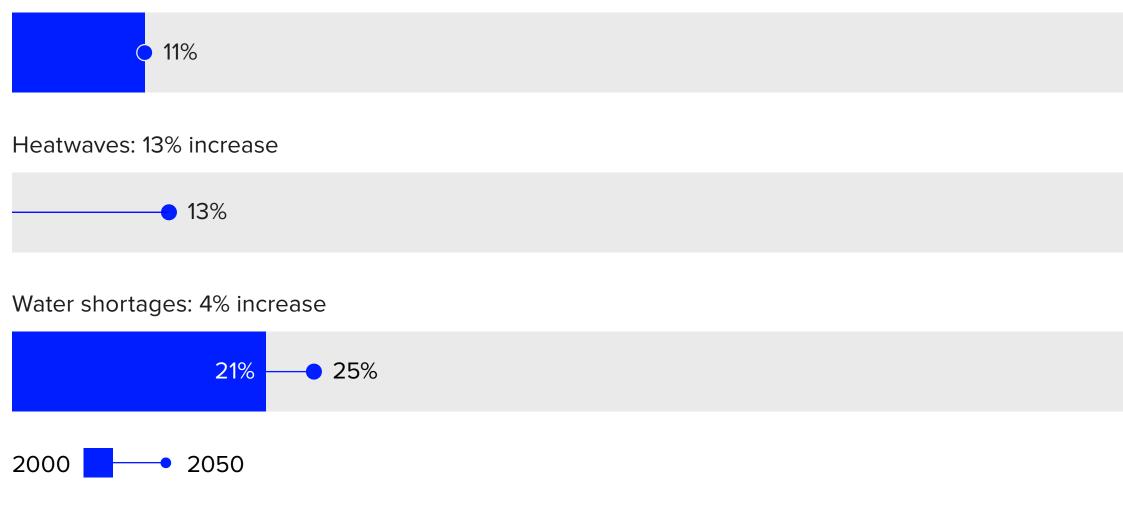
- Temperatures are rising more quickly than almost all other G20 countries, with up to +4°C expected by 2050.²³¹ This will increase the risk of heatwaves and wildfires, leading to air pollution and health impacts, especially in urban centres, and affecting Russian large boreal forests, which act as a carbon sink of global significance.
- The melting of permafrost will destabilise soils and damage infrastructure across large parts of the country. Annual damage could reach US\$1 billion to US\$2 billion. Large quantities of methane — a significant GHG with a warming potential almost 30 times higher than — could also be released.²³²
- Some sectors may temporarily benefit from climate change (e.g. slight increase in crop yields or new shipping routes in the Arctic), but this is unlikely to outweigh the potentially large negative impacts of climate change on the Russian economy.²³³

National Adaptation Plan

Assessment of:	Absent in plan	Mentioned in plan	Comprehensive
Risk & vulnerabilities			•
Financing mechanisms	•		
Governance breakdown			•
Sectoral breakdown of actions			•
Monitoring & evaluation implementaton		•	

Change in share of population at risk, 2000–2050

Riverine flooding: no change



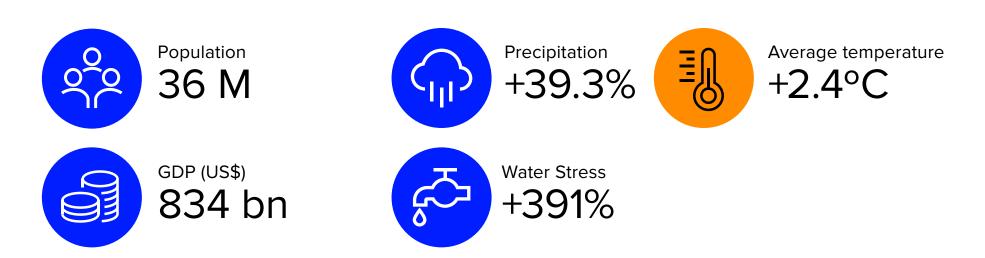
National Initiative

The Permafrost Monitoring System is a project of 140 monitoring stations, planned to be fully deployed by the end of 2025, to monitor Russia's permafrost (frozen soil covering two-thirds of the nation) threatened by warming temperatures.²³⁴

ve	in	plan	

Overview

2050 projections*



Key climate-related policies:

- **NDC 2030**²³⁵: Saudi Arabia commits to implementing measures which aim to reduce its emissions by 278 $MtCO_2$ e annually from 2020 to 2030.
- National Renewable Energy Program (NREP) (revised 2019)²³⁶: This policy aims to implement the 'Vision 2030' renewable energy targets of 27.3 GW of renewable power capacity by 2023 and 58.7 GW by 2030. Renewable power capacity is auctioned through competitive tenders.
- Saudi Green Initiative (2022)²³⁷: The main objective of the initiative is planting 10 billion trees across the country. Other targets include decarbonising the transport sector through rail investments, increasing energy efficiency and upscaling renewables.
- **Fossil fuel price reform (2017)**²³⁸**:** This is a series of reforms to the country's fiscal policies towards fossil fuels. The reforms include reducing cuts to fossil fuel subsidies to reach parity with international petrol prices, increasing the price of diesel via taxes up to 90% of international prices, as well as raising the price of other fuels between 2018 and 2025.

*High-emissions scenario

Projected temperature increase by 2050*





+4.0°C

We estimate Saudi Arabia's 2030 current policies emissions to be 84% higher than a 1.5° C-aligned trajectory.²³⁹ An abatement of 645 MtCO₂e between 2021 and 2030 would imply alignment with a 1.5° C-aligned trajectory.

Implied temperature rise based on GHG Emissions (MtCO₂e)

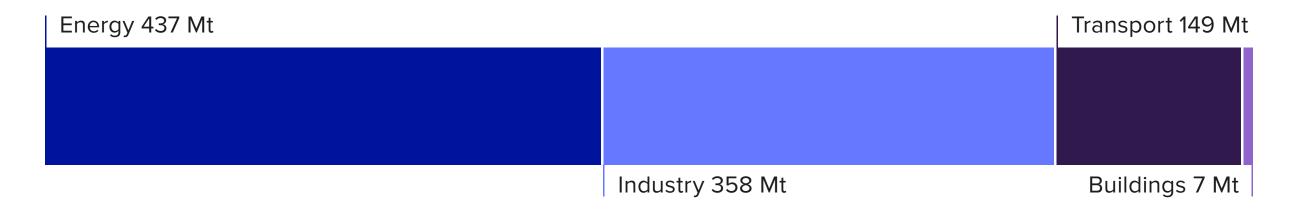


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Emissions and abatement potential

Saudi Arabia's highest potential source of abatement is in the Energy sector, accounting for 45% of the total. This sector currently represents the largest proportion of the country's emissions with 46%, followed by the Industrial sector with 38%.

2021 emissions by sector²⁴⁰ (CO₂e)



Sectoral abatement potential for 1.5°C-alignment by 2030²⁴¹

Energy 45%		
Industry 26%		
Transport 15%		
Buildings 3%		
AFOLU 11%		



Saudi Arabia is yet to develop a national adaptation strategy or plan.

Summary of physical risk exposure:

Mostly covered by desert, Saudi Arabia is highly exposed to hot and dry conditions, with limited rainfall over the year.

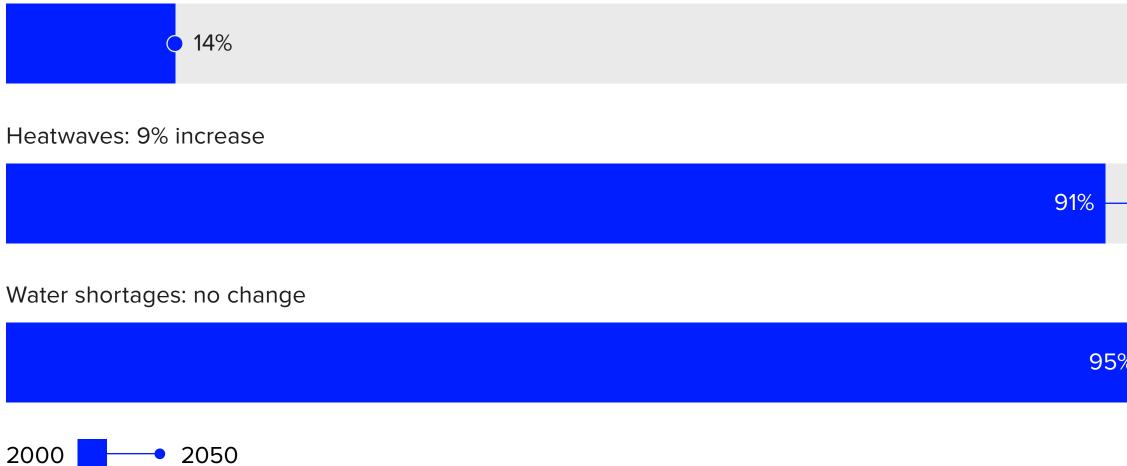
- Water stress levels are extremely high and rising temperature will further strain resources.²⁴² Droughts will occur more frequently, especially in the north. Saudi Arabia regularly experiences sandstorms, generated by a combination of strong winds, dry conditions and a lack of vegetation; their frequency and intensity are expected to further increase, with significant economic consequences on infrastructure, transportation, agriculture and health. In the whole MENA region, sand and dust storm-related costs have been estimated at US\$13 billion annually.²⁴³
- The country can be impacted by irregular flash floods from intense precipitation events, which can cause damage and human casualties in urban centers. The lack of a natural drainage system in Saudi Arabia, with no permanent river, increases its vulnerability.
- Sea-level rise threatens to damage energy-focused port infrastructure, a unique vulnerability for Saudi Arabia, which GDP in 2021 was 24% generated from oil rents.²⁴⁴

National Adaptation Plan

Assessment of:	Absent in plan	Mentioned in plan	Comprehensive
Risk & vulnerabilities	N/A	N/A	N/A
Financing mechanisms	N/A	N/A	N/A
Governance breakdown	N/A	N/A	N/A
Sectoral breakdown of actions	N/A	N/A	N/A
Monitoring & evaluation implementaton	N/A	N/A	N/A

Change in share of population at risk, 2000–2050

Riverine flooding: no change



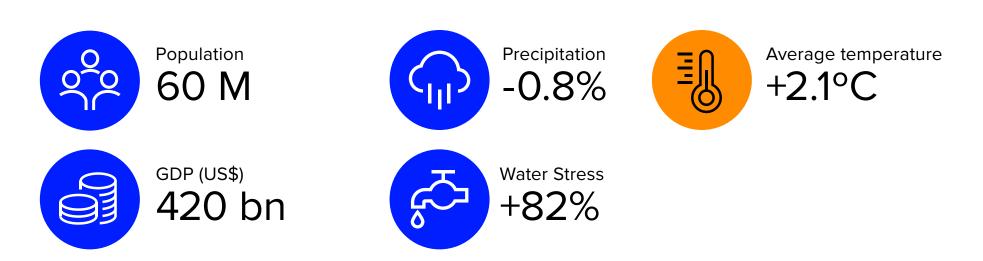
National Initiative

The Climate Change Adaptation and Mitigation Partnership (CAMP) is a project dedicated to investigating climate conditions over Saudi Arabia, the sectoral impacts of adaptation measures, low-carbon pathways and circular carbon economy concepts.²⁴⁵

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Overview

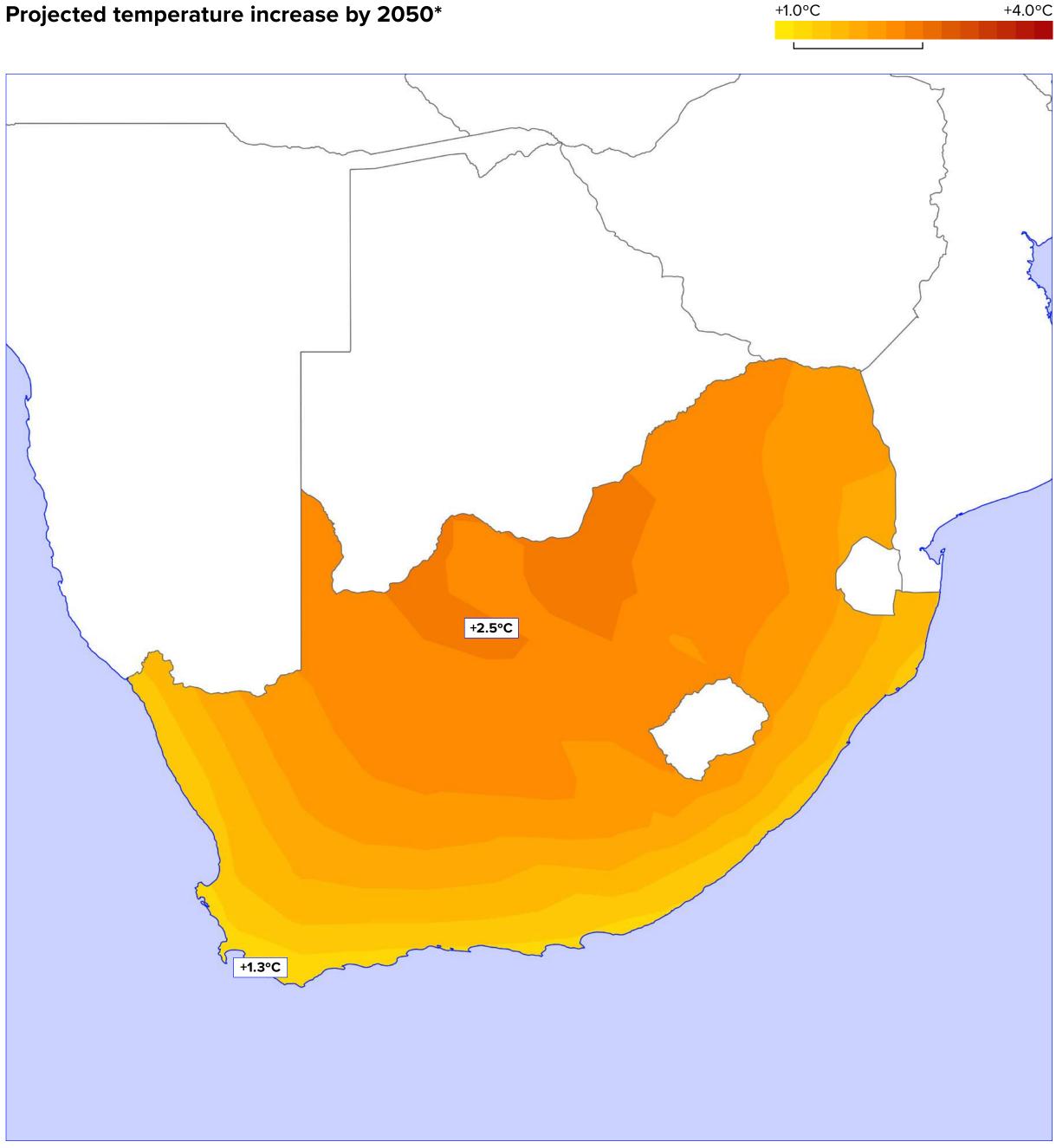
2050 projections*



Key climate-related policies:

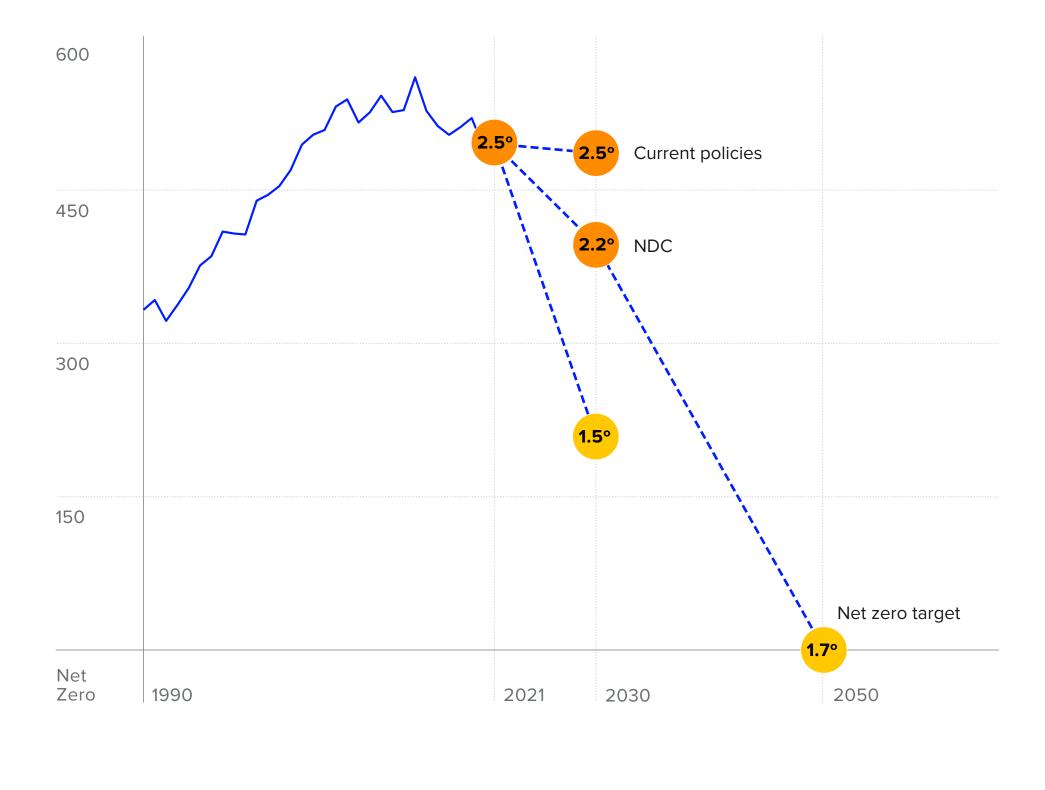
- **NDC 2030**²⁴⁶: South Africa commits to reducing its GHG emissions to between 398 and 510 MtCO₂e by 2025, and between 350 and 420 MtCO₂e by 2030.
- Just Transition Framework (2022)²⁴⁷: A planning tool for achieving a 'just transition' in South Africa, setting out the outcomes to be realised in the short, medium, and long term.
- Integrated Resource Plan for electricity (2011/2019)²⁴⁸: The Integrated Resource Plan (2019) is the first update of the original 2011 plan. It aims to replace much coal based electricity generation capacity with renewables.²⁴⁹
- **Carbon Tax South Africa (2019)**²⁵⁰**:** The official carbon tax rate was set at R120/tCO₂e (US\$7) and increased to R159t/tCO₂e in 2023 (US\$8.23).²⁵¹
- Petroleum Products Act (Biofuels Industrial Strategy) (2007)²⁵²: The Act mandates specific standards for blending biofuels from 2015: a 2–10% blend for bioethanol and a minimum of 5% blend for biodiesel.

*High-emissions scenario



We estimate South Africa's 2030 current policies emissions to be 58% higher than a 1.5° C-aligned trajectory.²⁵³ An abatement of 283 MtCO₂e between 2021 and 2030 would imply alignment with a 1.5° C-aligned trajectory.





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Emissions and abatement potential

South Africa's highest potential source of abatement is in the Energy sector, accounting for 57% of the total potential. This sector currently represents the largest proportion of the country's emissions with 62%, followed by the Industrial sector with 19%.

2021 emissions by sector²⁵⁴ (CO₂e)

Energy 325 Mt	Transport 56 Mt	AFOLU
	Industry 98 Mt	Buildings 3

Sectoral abatement potential for 1.5°C-alignment by 2030²⁵⁵

Energy 57%			
Industry 11%			
Transport 3%			
Buildings 4%			
AFOLU 25%			





Timeline of released documentation

National Adaptation Strategy²⁵⁶ 2020

Summary of physical risk exposure:

South Africa's warm and temperate climate is strongly influenced by its position between the Atlantic Ocean and the Indian Ocean. The country is on average relatively arid, with most rain on the eastern coast bordering the Indian Ocean.

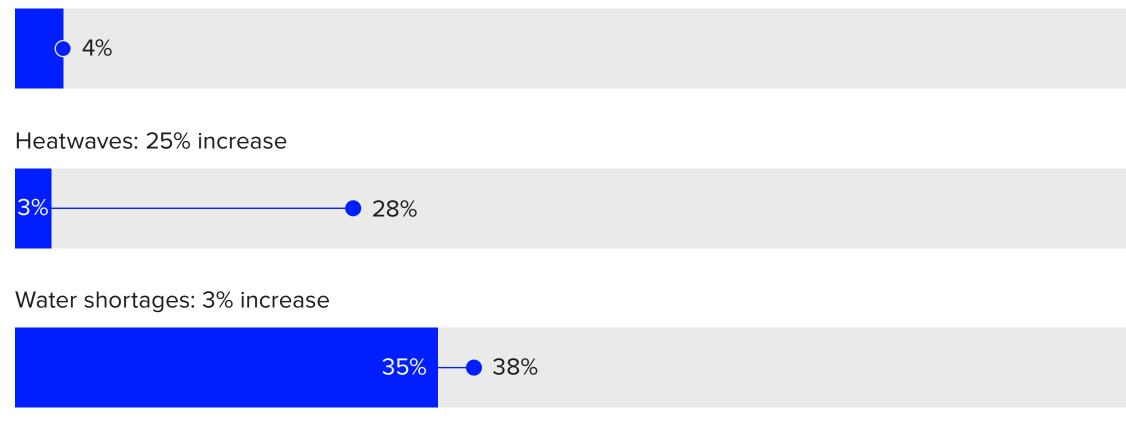
- The likelihood of severe drought is expected to rise by 39% by 2050,²⁵⁷ threatening its agricultural sector. Although crop diversity may limit the risk of catastrophic failure, negative impacts are projected for all major crops. Maize production, for example, is projected to decrease by 10–16% without adaptation measures.²⁵⁸ Multi-annual droughts can strongly limit water availability and could result in recurrent water use restrictions in densely populated areas, with potential impacts on livelihoods, industry and tourism.
- South Africa is also exposed to occasional flash floods and riverine inundations, mainly due to heavy rains and cyclone events from the oceans, with their intensity and frequency expected to increase in terms of wind speed and rainfall. This will continue to damage infrastructure, notably in coastal areas.

National Adaptation Plan

Assessment of:	Absent in plan	Mentioned in plan	Comprehensive
Risk & vulnerabilities			٠
Financing mechanisms		•	
Governance breakdown			۲
Sectoral breakdown of actions		•	
Monitoring & evaluation implementaton			۲

Change in share of population at risk, 2000–2050

Riverine flooding: no change

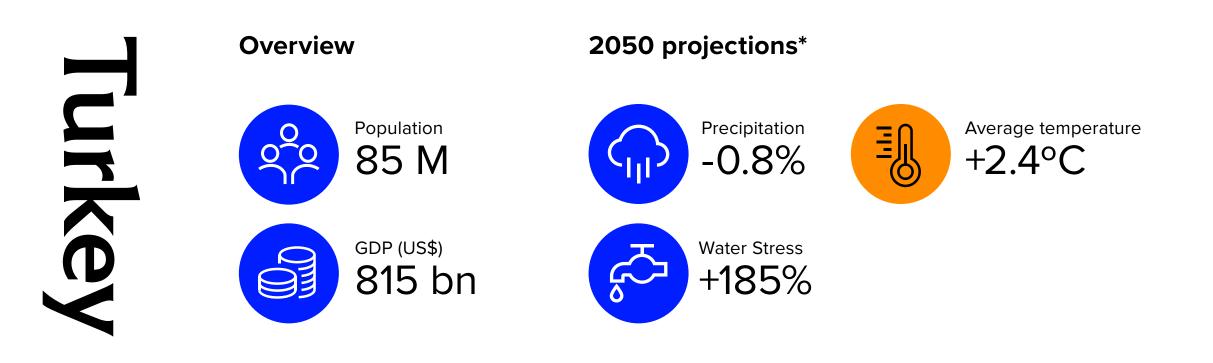


2000 2050

National Initiative

The South African Risk and Vulnerability Atlas (SARVA) is an online system providing decision-ready data on vulnerability and risk according to location in the country, covering a wide range of hazards such as climate change and biodiversity loss, to help set relevant adaptation measures.²⁵⁹

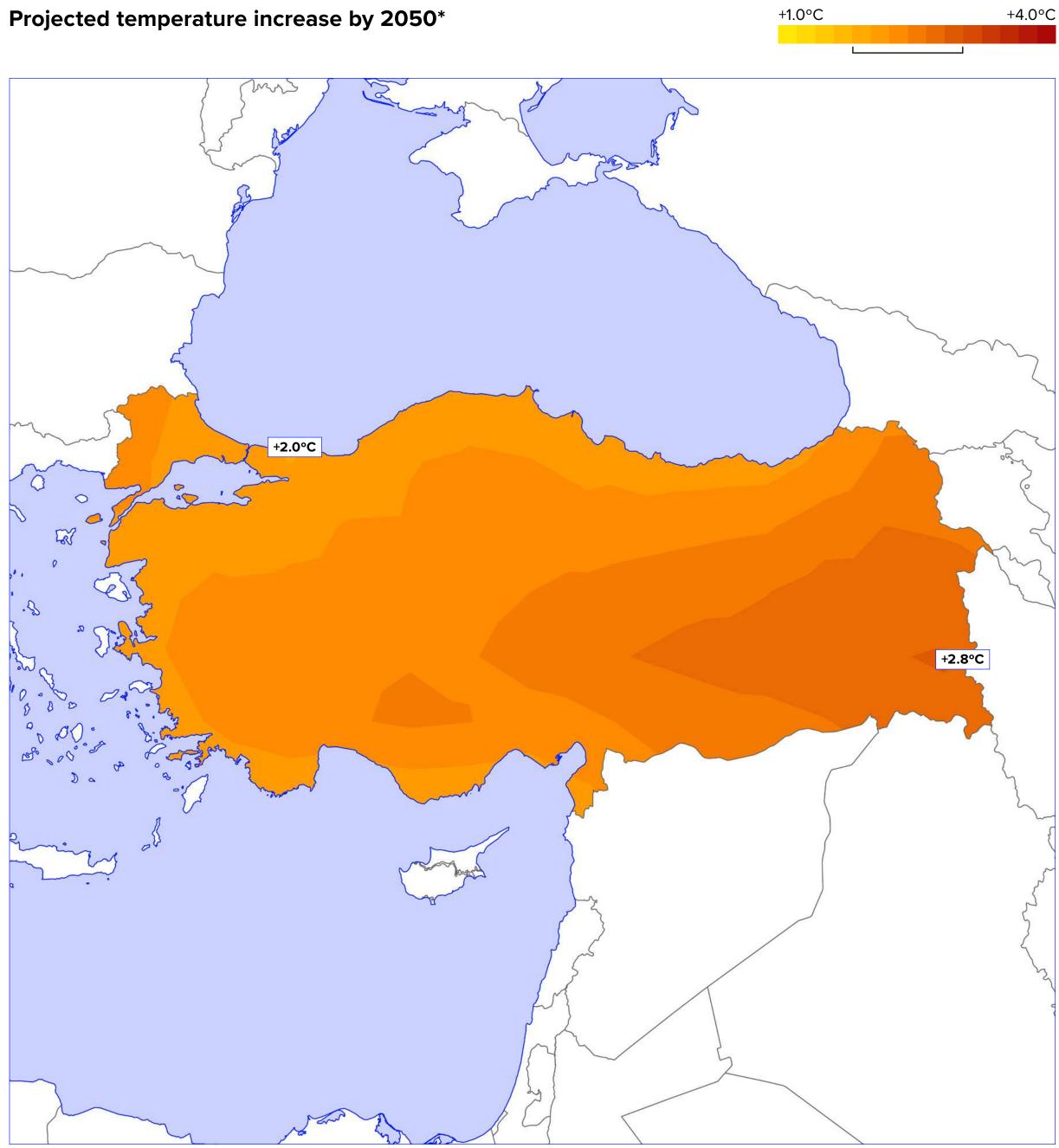
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Key climate-related policies:

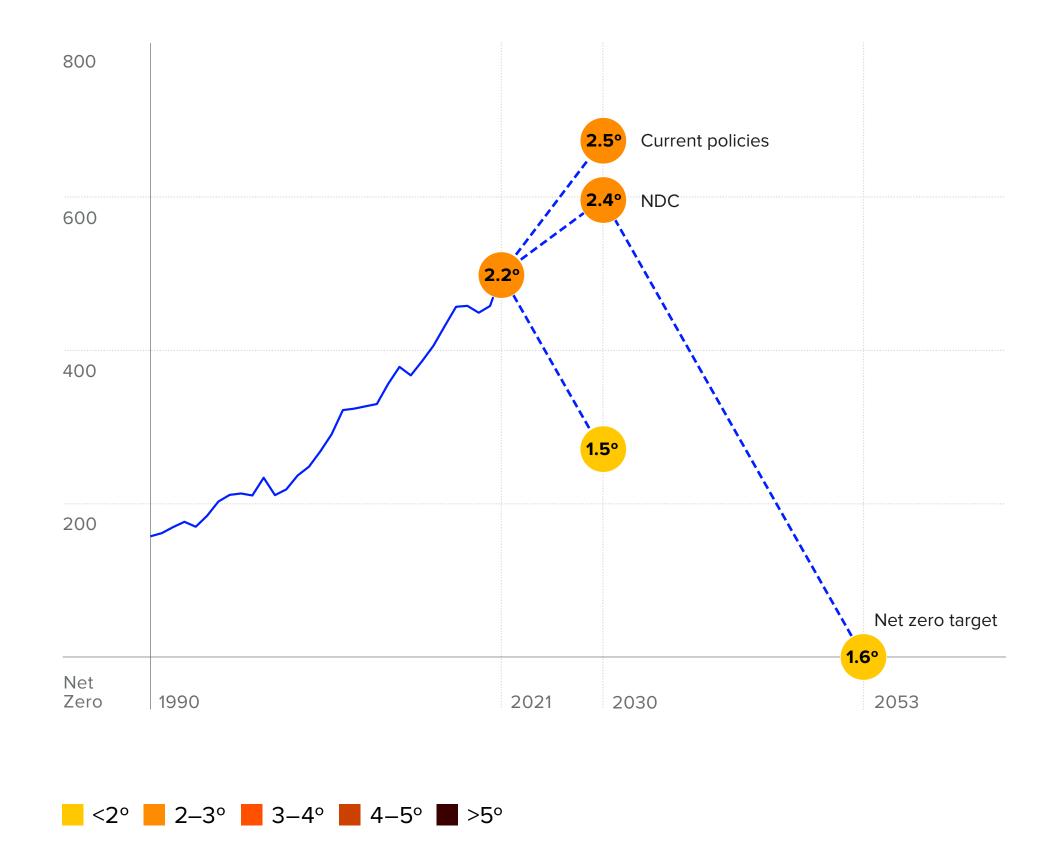
- **NDC 2030**²⁶⁰: Turkey commits to reduce its GHG emissions by 41% compared to BAU by 2030.
- **National Energy Plan (2022)**²⁶¹**:** Turkey's installed capacity will go from 99.9 GW in 2021 to 189.7 GW in 2030, with renewables accounting for 64.7% by 2035 (54% in 2021), and 80% by 2053.²⁶²
- Green Deal Action Plan (2021)²⁶³: The action plan mainly aims to establish Turkey's compliance with the European Green Deal issued by the European Union.
- Motor Vehicle Tax Law (2021)²⁶⁴: Presidential Decree No. 3471 determines special consumption tax rates for electric passenger cars. The rates increase proportional to engine power — engines up to 85 kW increase from 3% to 10%, 85-120 kW from 7% to 25%, and for over 120 kW from 15% to 60%.

*High-emissions scenario



We estimate Turkey's 2030 current policies emissions to be 60% higher than a 1.5° C-aligned trajectory.²⁶⁵ An abatement of 407 MtCO₂e between 2021 and 2030 would imply alignment with a 1.5° C-aligned trajectory.

Implied temperature rise based on GHG Emissions (MtCO₂e)



Emissions and abatement potential

Turkey's highest potential source of abatement is in the Energy sector, accounting for 41% of the total potential. This sector currently represents the second largest proportion of the country's emissions with 33%, following the Industrial sector with 36%.

2021 emissions by sector²⁶⁶ (CO₂e)



Sectoral abatement potential for 1.5°C-alignment by 2030²⁶⁷

Energy 41%		
Industry 27%		
Transport 11%		
Buildings 13%		
AFOLU 8%		



Timeline of released documentation

National Climate Change Adaptation Strategy & Action Plan²⁶⁸

2012

Summary of physical risk exposure:

Turkey's climate is varied, with most of the country experiencing dry and warm conditions, except for some regions along the northern coast.

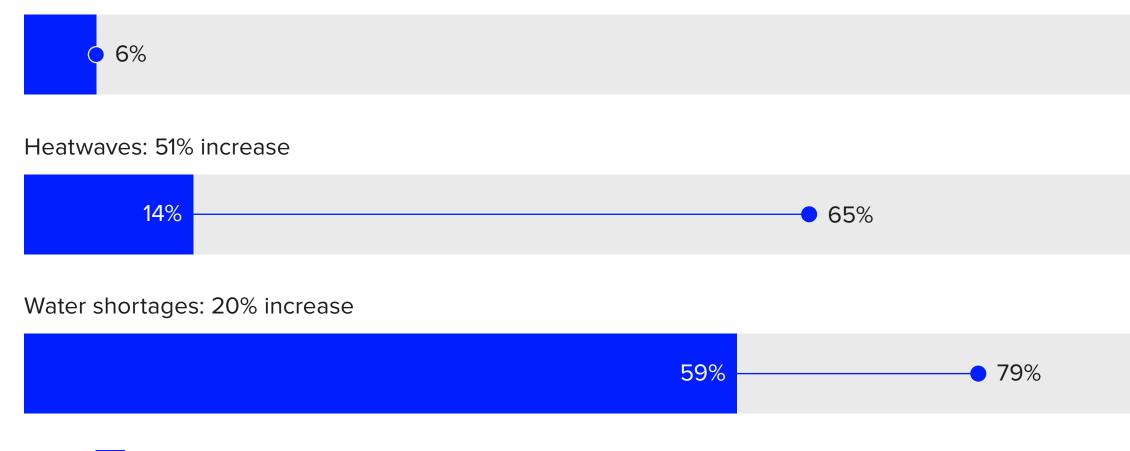
- Water stress levels in Turkey are among the highest in the G20 and are expected to increase with rising temperatures. Severe droughts will become more likely in the centre of the country, intensifying competition for water use between agriculture and other sectors.
- Warmer and drier conditions will increase wildfire risk across the country, with potential to causing damage to infrastructure and ecosystems, as well as health risk due to air pollution. Heat-related mortality and tropical diseases are on the rise, especially Zika virus and dengue fever.²⁶⁹
- Drier conditions and potential water restrictions could damage the country's image and tourism industry. The high density of tourist resorts in coastal areas also puts the industry at risk from sea-level rise, where coastal flooding of low-lying plains and the erosion of rocky shores can damage key infrastructure. Expected annual damages rise could amount to US\$1.1 to US\$1.8 billion by 2050.²⁷⁰

National Adaptation Plan

Assessment of:	Absent in plan	Mentioned in plan	Comprehensive
Risk & vulnerabilities			•
Financing mechanisms		•	
Governance breakdown			•
Sectoral breakdown of actions		•	
Monitoring & evaluation implementaton		•	

Change in share of population at risk, 2000–2050

Riverine flooding: no change



2000 2050

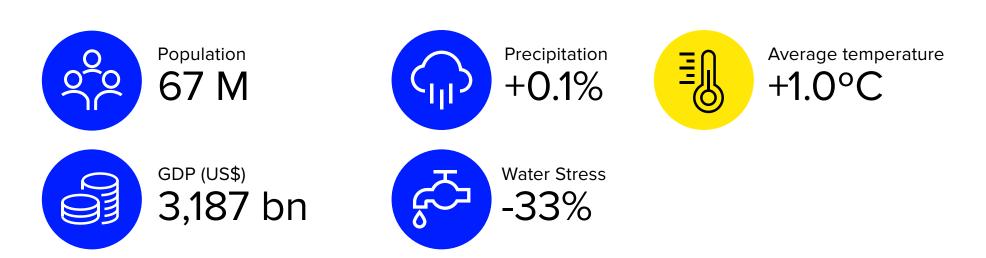
National Initiative

The Climate Change Adaptation Grant Programme (CCAGP) is a call for proposals for projects enhancing climate change adaptation in Turkey, such as improving communities' resilience, protecting natural ecosystems and enhancing adaptation capacity.²⁷¹

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Overview

2050 projections*



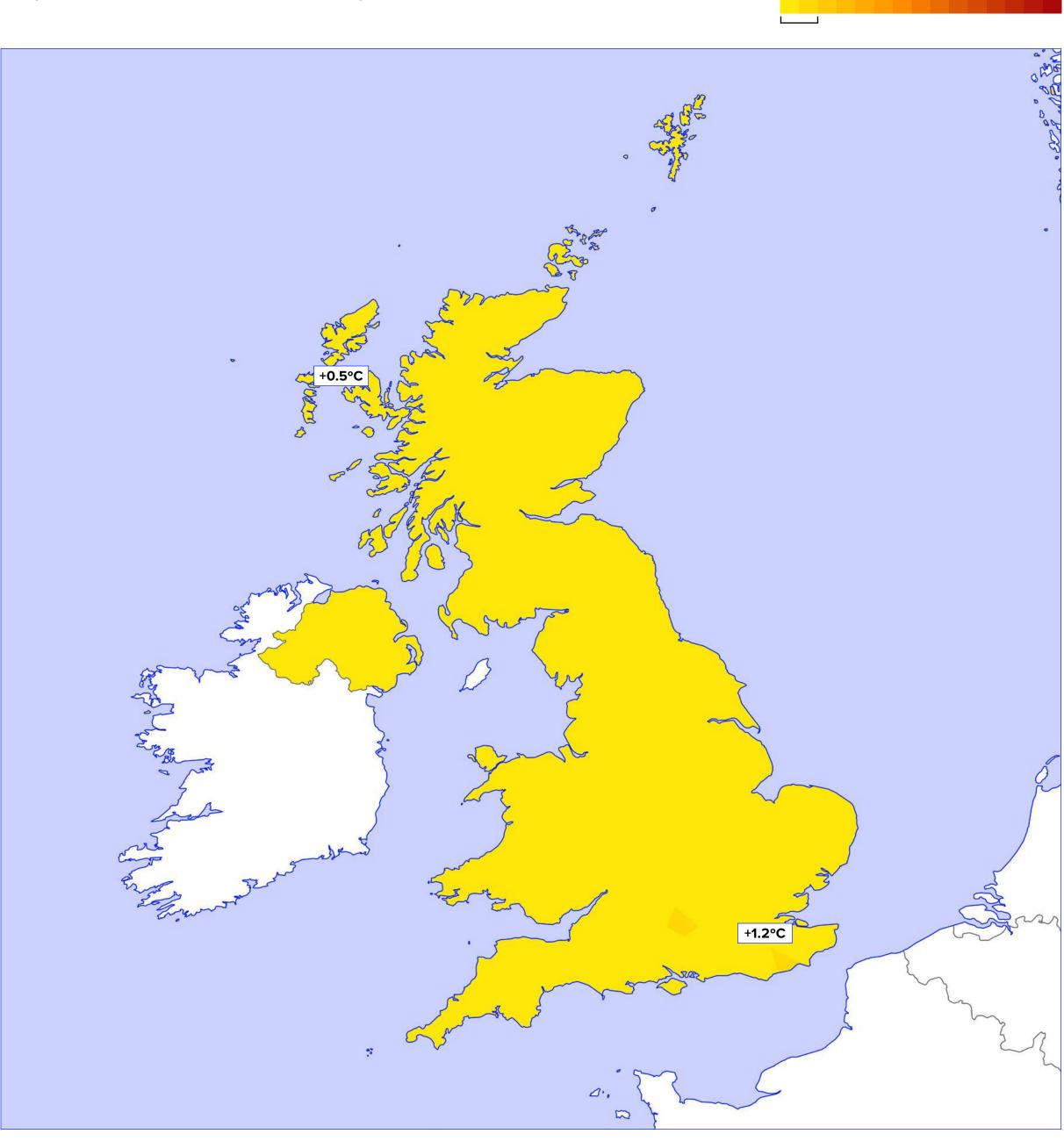
Key climate-related policies:

- **NDC 2030**²⁷²: The UK commits to reduce economy-wide greenhouse gas emissions by at least 68% by 2030, compared to 1990 levels.
- Net Zero Strategy: Build Back Greener (2021 updated in 2022)²⁷³: This strategy sets out policies and proposals for decarbonising all sectors of the UK economy to meet the net zero target by 2050.
- **Ten Point Plan for a Green Industrial Revolution (2020)**²⁷⁴**:** The plan outlines policy interventions in the Energy, Buildings, Transport, Nature and Technology sectors.
- **Transport Decarbonisation Strategy (2021)**²⁷⁵**:** The strategy sets out a framework to decarbonise the UK's transport sector.²⁷⁶
- Energy White Paper (2020)²⁷⁷: The main objective is to transform the energy system by moving away from coal and investing in clean sources for energy supply, such as offshore wind energy, pledging to generate carbon-free electricity by 2050. The document also lays out a plan to establish the UK-ETS to replace the EU-ETS.

*High-emissions scenario

Projected temperature increase by 2050*

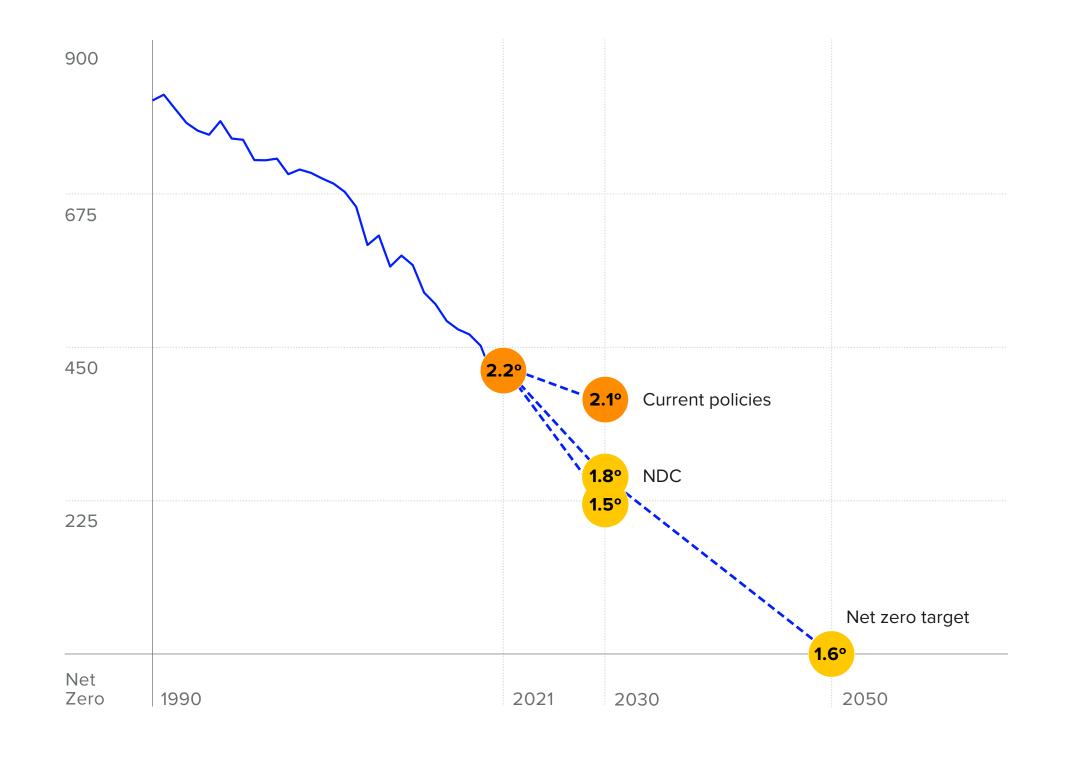
+4.0°C

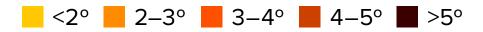


United Kingdom

We estimate the United Kingdom's 2030 current policies emissions to be 39% higher than a 1.5° C-aligned trajectory.²⁷⁸An abatement of 144 MtCO₂e between 2021 and 2030 would imply alignment with a 1.5° C-aligned trajectory.

Implied temperature rise based on GHG Emissions (MtCO₂e)





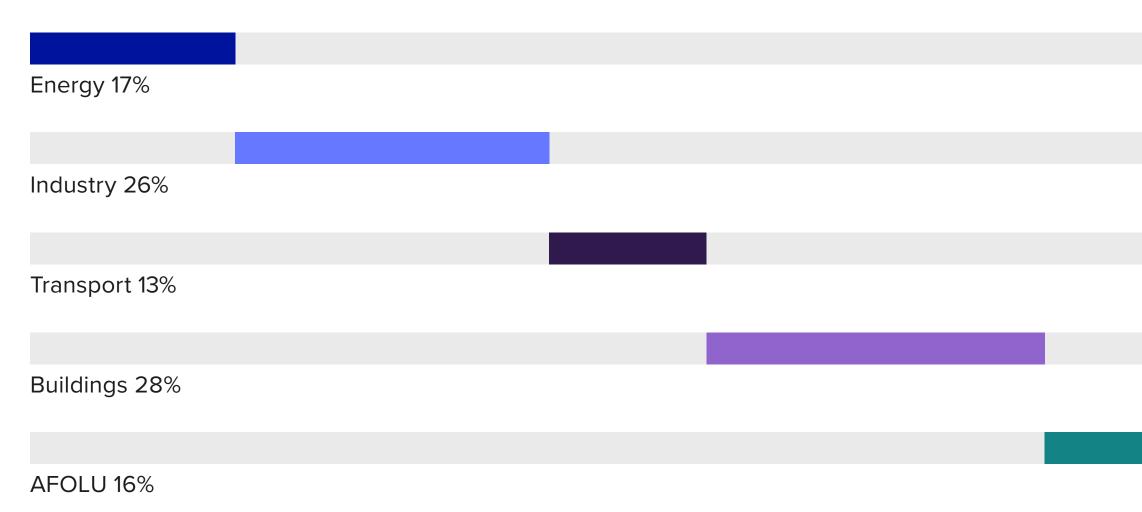
Emissions and abatement potential

United Kingdom's highest potential source of abatement is in the Buildings sector, accounting for 28% of the total potential. This sector currently represents the fourth largest proportion of the country's emissions with 14%, following the Transport, Energy and AFOLU sectors accounting for 21%, 22% and 30% respectively.

2021 emissions by sector²⁷⁹ (CO₂e)



Sectoral abatement potential for 1.5°C-alignment by 2030²⁸⁰





Timeline of released documentation

National Adaptation Plan I ²⁸¹ 2013	National Adaptation Plan II ²⁸² 2018	Adaptation Communication to UNFCCC ²⁸³ 2020
Adaptation Communication to UNFCCC (update) ²⁸⁴	National Adaptation Plan III ²⁸⁵	
2021	2023	

Summary of physical risk exposure:

The United Kingdom has a temperate climate with mild winters and relatively cool summers.

- Exposure to heat will remain moderate overall, but the low preparedness of the country to acute heat events (as observed in 2022 and 2023²⁸⁶) will impact many sectors, disrupting public transport (e.g. via rail buckling) and raising health concerns among the elderly (almost 20% of the population²⁸⁷).
- Flood risks are expected to increase due to more frequent and more intense precipitation events (the wettest day may become 10% wetter by 2050²⁸⁸). Already, high rainfall events and storms in the south and west are a yearly occurrence and large-scale riverine floods disrupt transport and damage property. 5.2 million properties are currently at risk,²⁸⁹ a number expected to double in the next 50 years, while up to 160,000 properties are at risk of forced relocation due to storm surges by 2050.²⁹⁰

National Adaptation Plan

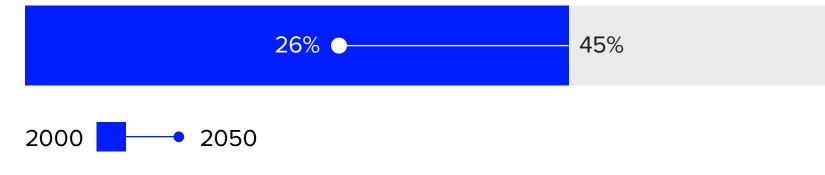
Assessment of:	Absent in plan	Mentioned in plan	Comprehensiv
Risk & vulnerabilities		•	
Financing mechanisms			•
Governance breakdown			•
Sectoral breakdown of actions			•
Monitoring & evaluation implementaton			•

Change in share of population at risk, 2000–2050

Riverine flooding: 1% decrease



Water shortages: 19% decrease



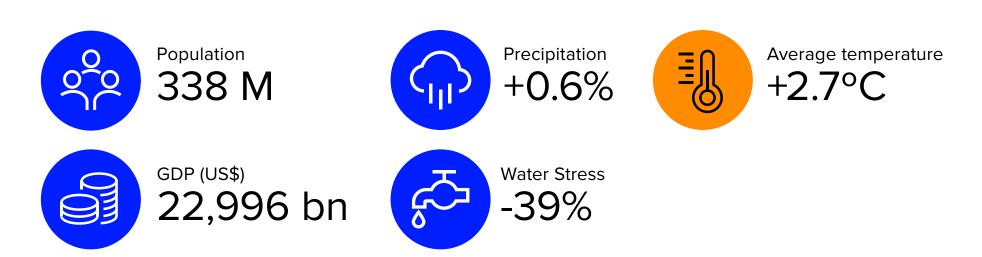
National Initiative

The Nature for Climate Fund makes over GBP 640 million available to support adaptation actions such as tree planting, woodland cover expansion or better peatland management, until 2025.²⁹¹

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Overview

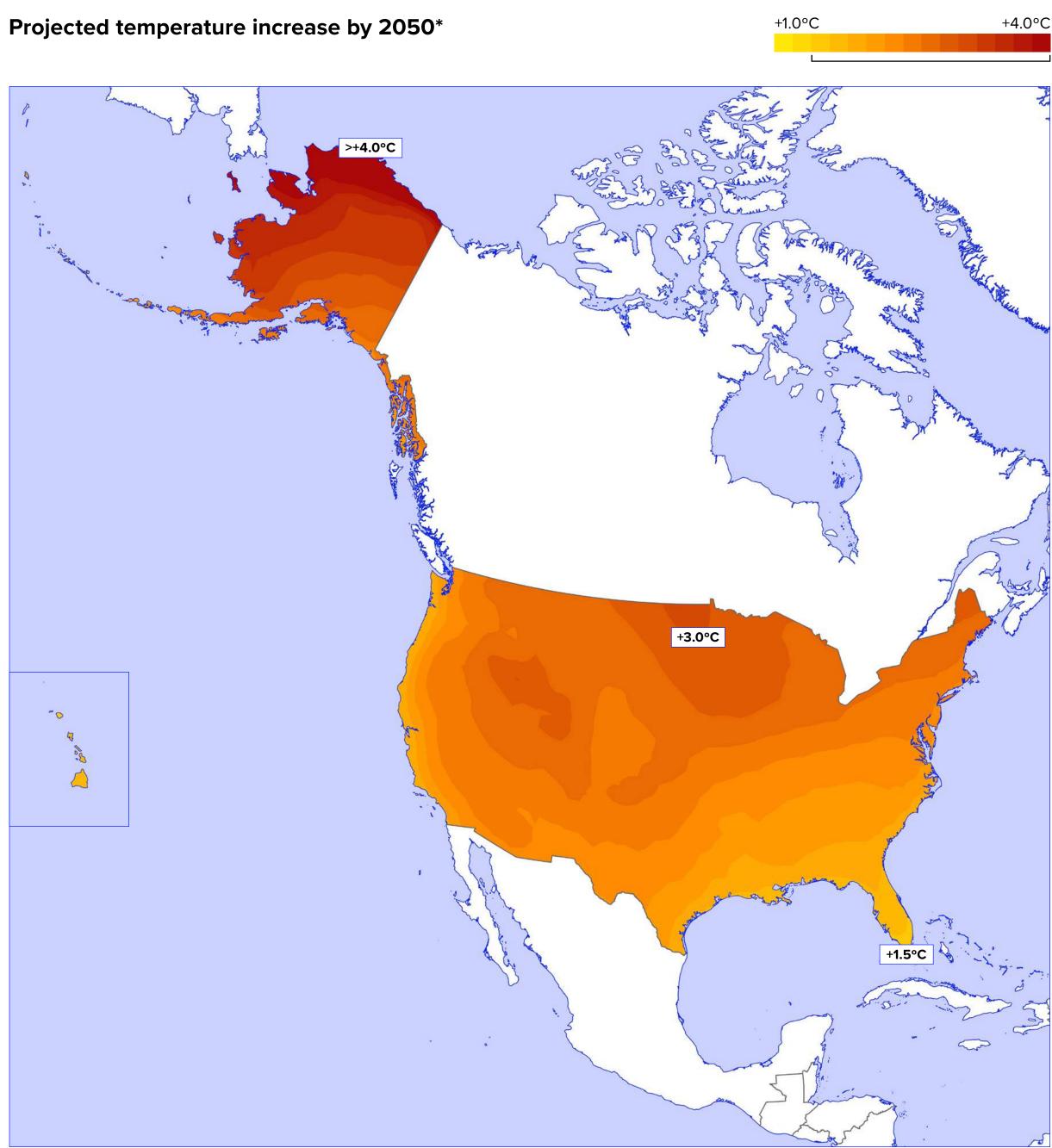
2050 projections*



Key climate-related policies:

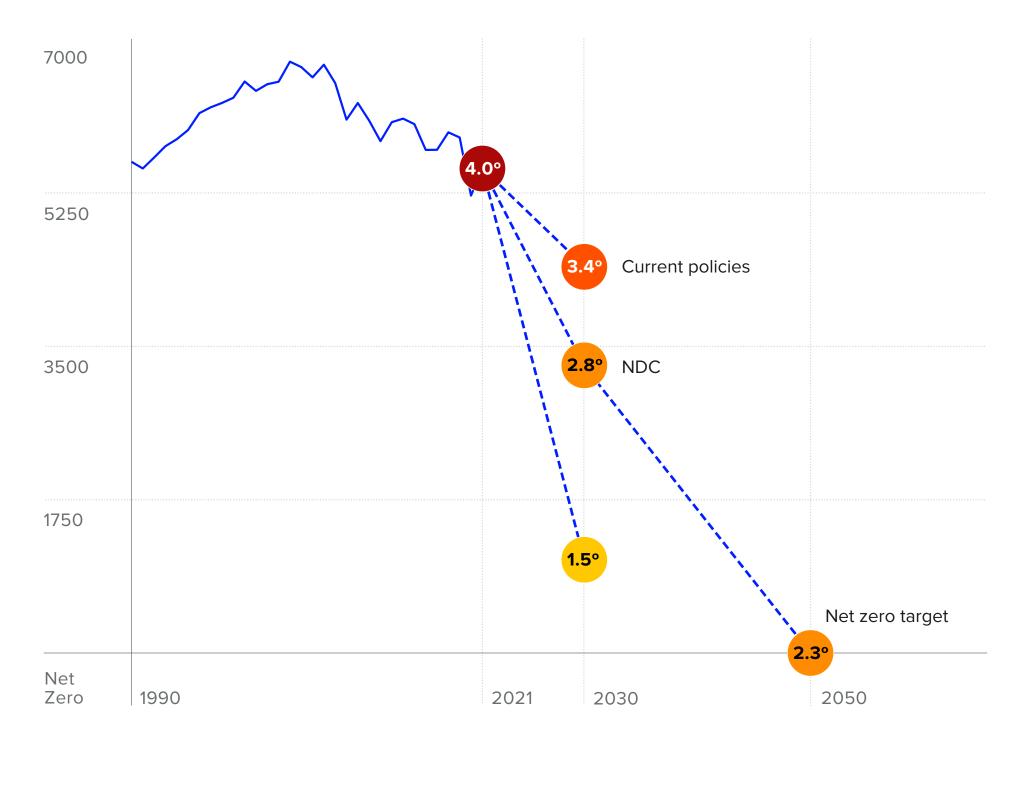
- **NDC 2030**²⁹²: United States commits to reduce net GHG emissions by 50– 52% by 2030 compared to 2005 levels.
- Inflation Reduction Act (IRA) in 2022)²⁹³: The IRA injects US\$369 bn in the form of tax credits, grants and loans directed to develop and deploy the clean energy technologies and investments that will be essential to decarbonisation of the economy.
- **Infrastructure Investment and Jobs Act (2021)**²⁹⁴: The act provides investments in energy modernisation, transport, workforce development, and building decarbonisation.
- Methane Emissions Reduction Action plan (2022)²⁹⁵: Created by the Inflation Reduction Act (IRA) in 2022, it provides US\$1.55 to reduce methane emissions, targeting emissions from oil and gas, abandoned coal mines and waste.
- Light-duty vehicles GHG Emissions Standard (2021 updated in 2023)²⁹⁶: In 2021, the EPA revised the GHG emissions standards for passenger cars and light trucks for model years 2023-2026, aiming for a fleet average of 52 miles per gallon by 2026. It is projected to avoid more than three billion tonnes of GHG emissions through 2050.

*High-emissions scenario



We estimate the United States' 2030 current policies emissions are 76% higher than a 1.5° C-aligned trajectory.²⁹⁷ An abatement of 3.3 GtCO_2 e between 2021 and 2030 would imply alignment with a 1.5° C-aligned trajectory.

Implied temperature rise based on GHG Emissions (MtCO₂e)

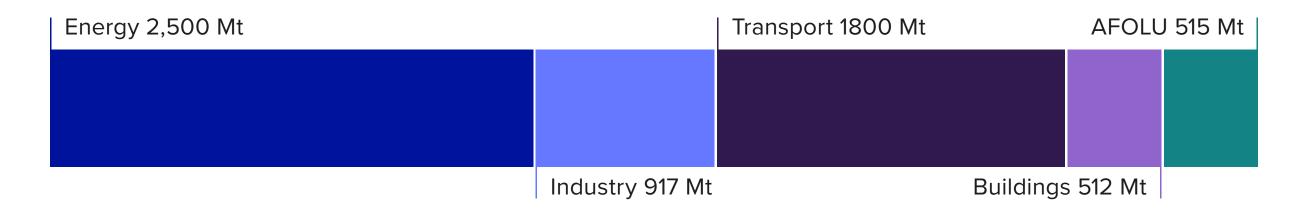


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Emissions and abatement potential

The United States's highest potential source of abatement is in the Energy sector, accounting for 36% of the total potential. This sector currently represents the largest proportion of the country's emissions with 40%, followed by the Buildings sector with 29%.

2021 emissions by sector²⁹⁸ (CO₂e)



Sectoral abatement potential for 1.5°C-alignment by 2030²⁹⁹

Energy 36%		
Industry 20%		
Transport 21%		
Buildings 12%		
5		
AFOLU 12%		

Timeline of released documentation

Executive Order³⁰⁰

2021

Adaptation Communication to UNFCCC³⁰¹ 2021

Summary of physical risk exposure:

The United States has a variety of climates across its large landmass and can expect highly diverse impacts of climate change.

- As a result of rising temperatures, the increase in energy consumption for cooling is expected to be most significant (almost 90% of households use air conditioning³⁰²), costing up to US\$600 million annually in Florida alone.³⁰³ Labor productivity could decrease by 5% to 10% in the southern states.³⁰⁴ In the absence of adaptation, maize yields could significantly decrease (possibly by up to 18% by 2050³⁰⁵). As the US is one of the main global food exporters, agricultural impacts will push up food prices, and potentially destabilise global food security.
- An increase in wildfire risk from drier conditions is expected to cause more destruction of properties in populated areas. 14 of the 20 most intense
 Californian wildfires have occurred in the past 10 years.³⁰⁶
- The south and western coasts will be highly exposed to increasingly intense storms and hurricanes, bringing stronger winds and higher rainfall accumulation. In turn, recovery periods between events may become too short to fully repair damages, and lead to significant population moves.

National Adaptation Plan

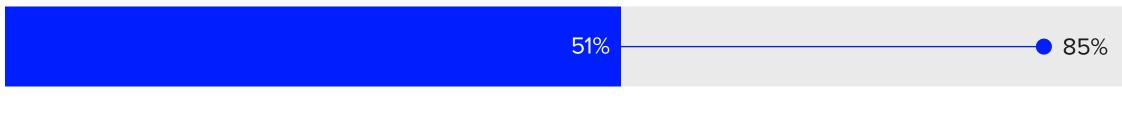
Assessment of:	Absent in plan	Mentioned in plan	Comprehensiv
Risk & vulnerabilities		•	
Financing mechanisms	•		
Governance breakdown		•	
Sectoral breakdown of actions		•	
Monitoring & evaluation implementaton		•	

Change in share of population at risk, 2000–2050

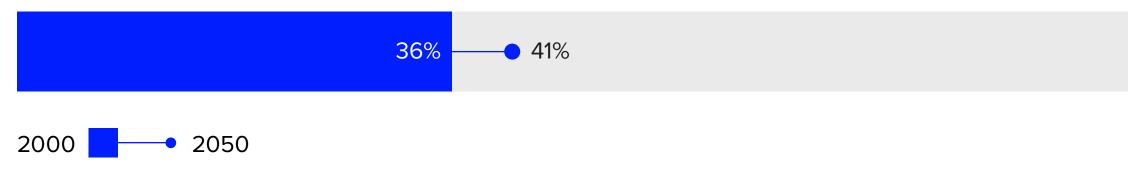
Riverine flooding: no change

0 11%

Heatwaves: 34% increase



Water shortages: 5% increase



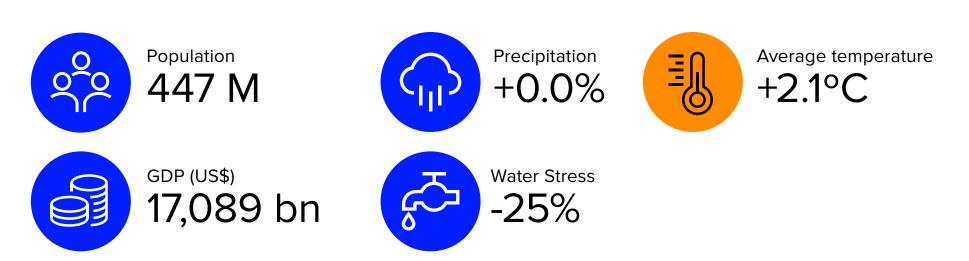
National Initiative

The EPA's Climate Change Adaptation Resource Center (ARC-X) is an interactive resource that delivers information to communities about climate change risks, relevant adaptation strategies, case studies from successful initiatives, and funding opportunities.³⁰⁷

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Overview

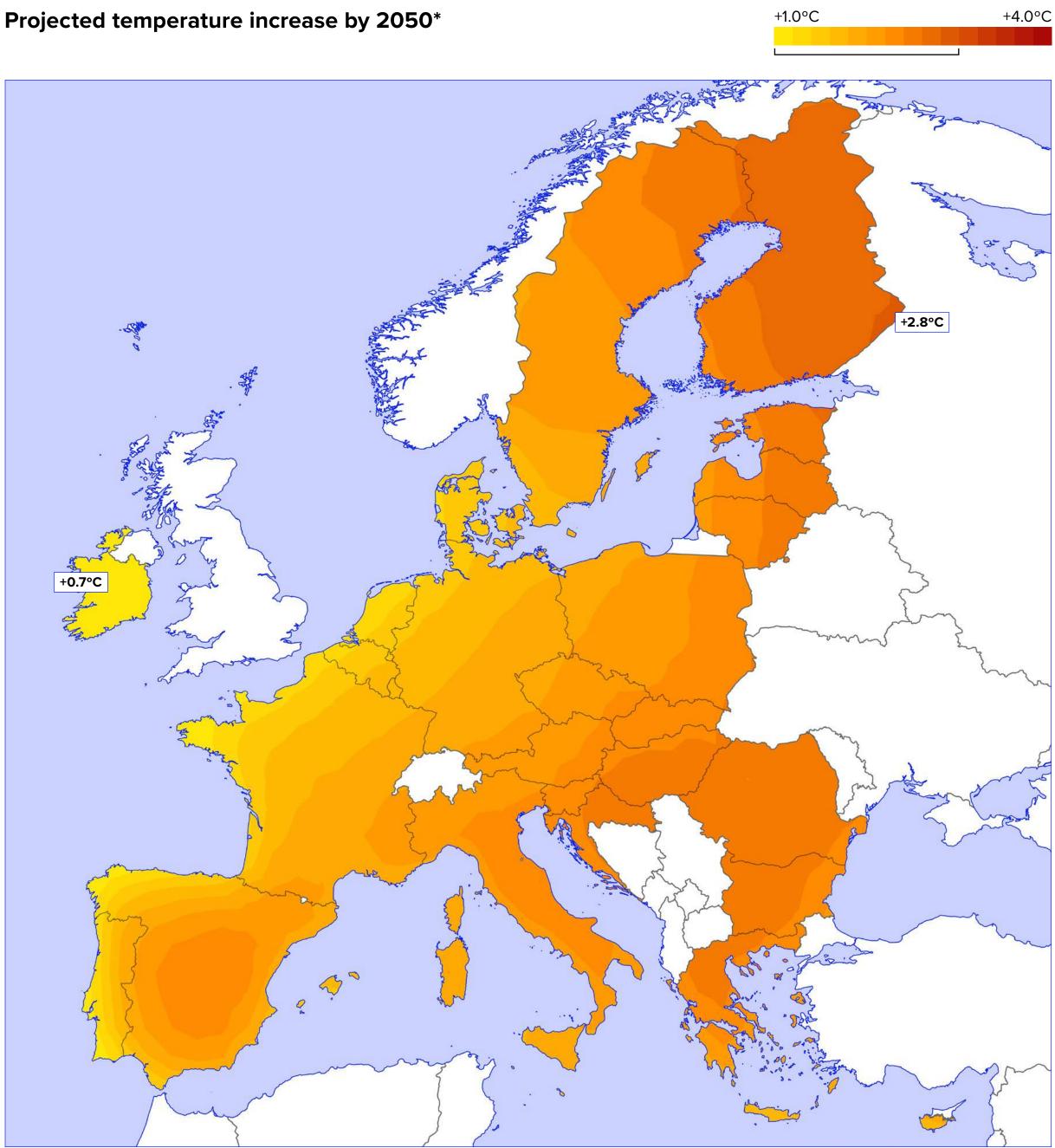
2050 projections*



Key climate-related policies:

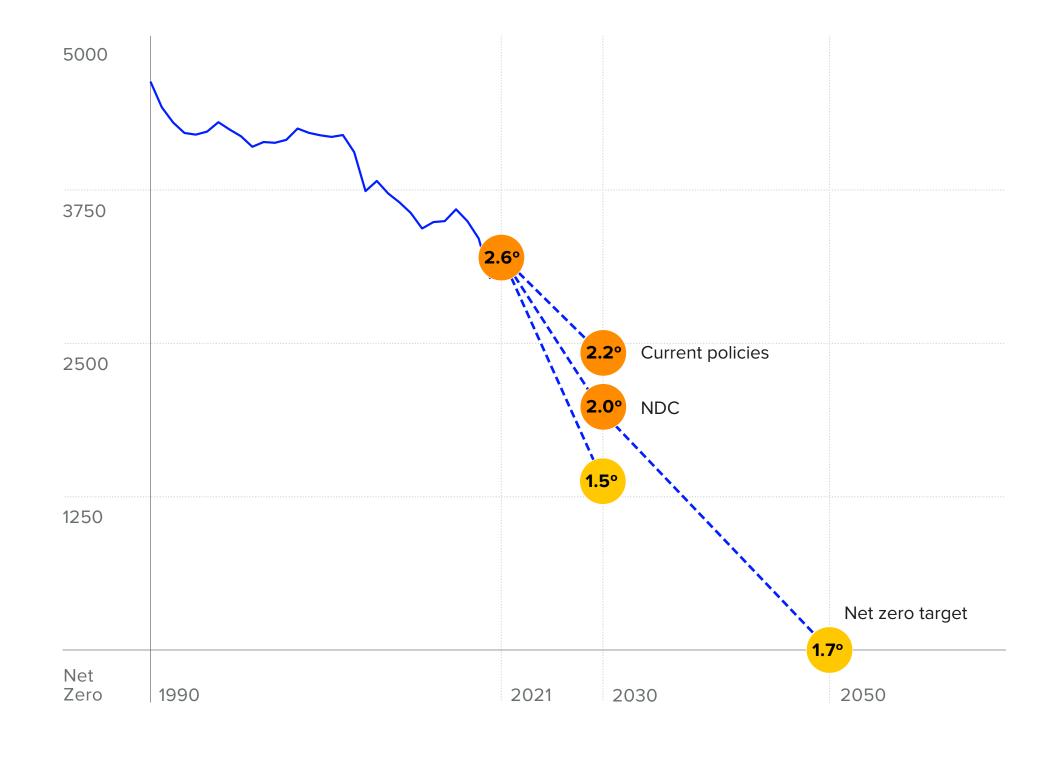
- **NDC 2030**³⁰⁸: A 55% reduction in greenhouse gas emissions by 2030 compared to 1990.
- Fit for 55 package (2022)³⁰⁹: The package sets out a wide range of legislative proposals to achieve the 2030 emissions reduction target. It includes the expansion of the current Emissions Trading System to cover additional sectors, updates to the Effort Sharing Regulation, improvements in the renewables and energy efficiency targets and a carbon border adjustment mechanism.
- **REPowerEU³¹⁰ (2022):** REPowerEU is an EU plan aimed at reducing Europe's dependence on fossil-fuel and accelerating the transition to green energy.
- **European Green Deal (2019)**³¹¹: This is a roadmap of key policies for achieving a transition to a low-carbon and sustainable economy, including the EU's climate neutrality by 2050 target.
- **3 Billion Trees Pledge map tree counter (2021)**³¹²**:** Under the European Green Deal, the EU biodiversity strategy for 2030 commits to planting at least three billion additional trees in the EU by 2030 in respect of ecological principles.

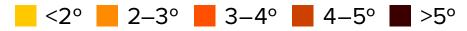
*High-emissions scenario



We estimate the European Union's 2030 current policies to be 43% higher than a 1.5° C-aligned trajectory.³¹³ An abatement of 1 GtCO₂e between 2021 and 2030 implies alignment with a 1.5°C-aligned trajectory

Implied temperature rise based on GHG Emissions (MtCO₂e)





Emissions and abatement potential

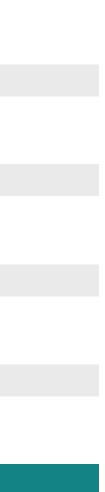
The EU's highest potential source of abatement is in the AFOLU sector, accounting for 30% of the total. This sector currently represents the smallest proportion of emissions with 12%. The Transport sector is the main contributor accounting for 24% of emissions.

2021 emissions by sector³¹⁴ (CO₂e)



Sectoral abatement potential for 1.5°C-alignment by 2030³¹⁵

Energy 28%		
Industry 18%		
Transport 8%		
Buildings 16%		
AFOLU 30%		



Timeline of released documentation

National Adaptation Strategy I³¹⁶ 2013 National Adaptation Strategy II³¹⁷ 2021

Adaptation Communication to UNFCCC³¹⁸

2021

Summary of physical risk exposure:

With 27 different countries, the European Union has many climates, and will therefore experience a variety of heterogenous impacts from climate change.

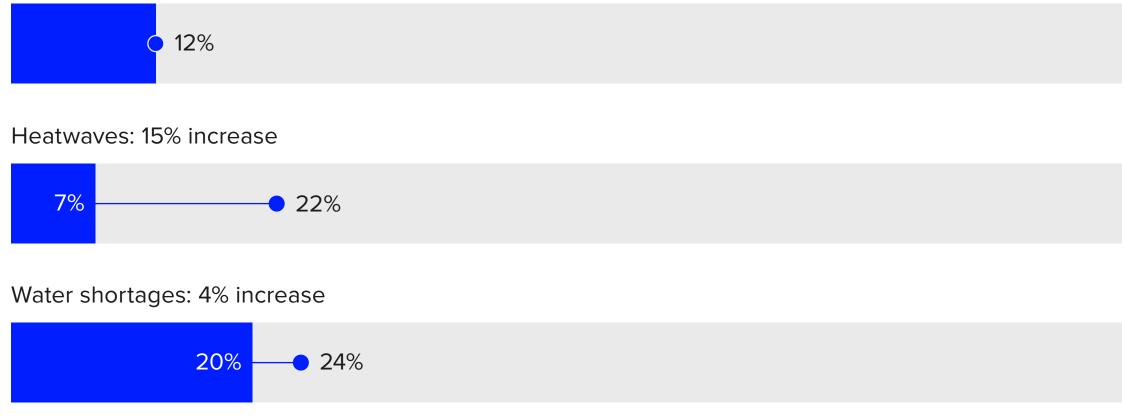
- Warmer temperatures might bring potential short-term benefits (e.g. increased crop yields) in the north and strong negative impacts in the south. In the southern and central regions, warmer and drier conditions can decrease food production and jeopardise the economy of highly specialised agricultural sectors. More frequent life-threatening heat conditions are expected in the Mediterranean region, with temperatures reaching 50°C. This could widen the inequality gap between north and sourth and contribute to political instability.
- Furthermore, inland and coastal flood risks are expected to increase, especially in northern Europe. Annual expected damages from floods (currently estimated at €1.25 billion), could reach hundreds of billions of euros in the absence of efficient adaptation measures.³¹⁹ Adaptation planning to minimise the risk currently varies greatly across the EU, as well as the scale (e.g. national in the Netherlands, local in Venice).

National Adaptation Plan

Assessment of:	Absent in plan	Mentioned in plan	Comprehensiv
Risk & vulnerabilities		•	
Financing mechanisms		•	
Governance breakdown			٠
Sectoral breakdown of actions	•		
Monitoring & evaluation implementaton		•	

Change in share of population at risk, 2000–2050

Riverine flooding: no change



National Initiative

Climate-ADAPT is an online platform to support adaptation to climate change by sharing information on expected climate change in Europe, sectoral and regional vulnerabilities, adaptation strategies and actions, case studies, and supporting tools.³²⁰

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Annex



This annex includes a description of the data, methodologies and references used in our Implied Temperature Rise (ITR) evaluations and physical risk assessments.

A) CLAIM model

The methodology to define the national carbon budgets is critical in the determination of the Implied Temperature Rise (ITR). We rely on the CLAIM methodology developed by Beyond Ratings.¹ It enables the computation of national GHG budgets compliant with any average temperature target and time horizon (for this report a 2°C compliant scenario is selected). The global budget sharing among countries is a source of scientific and diplomatic controversy. There are two main methodologies: the egalitarian approach and the grandfathering approach. Hybrid approaches are also possible (See Giraud et al. 2017 for further details²). The egalitarian approach consists of allocating the same right to emit carbon dioxide to every human being, while the grandfathering approach relies on the idea that the global carbon budget should be divided along the criterion of current carbon emissions, meaning that the weight of each country in global emissions remains stable over time. The CLAIM approach does not assign a national budget following a unique criterion, such as "capacity" or "responsibility." It offers a statistical, and non-normative, approach, which avoids choosing between egalitarian or grandfathering sharing that would be seen as non-consensual.

B) Updating the relationship between temperature due to non-CO₂ emissions and carbon budget

In the first two editions of our Net Zero Atlas (ahead of COP26 and COP27), we measured the temperature associated with sovereign climate commitments and policies according to an approach and equation adapted from IPCC (2018) and Rogelj et al. (2019), and laid out in a 2019 paper.³ For this year's report, we continue to draw on the same high-level approach, but have updated our ITR methodology to better reflect (i) the relationship between country-level carbon budgets and temperature due to CO_2 emissions, and (ii) the relationship between CO₂ and non-CO₂ emissions in the context of global warming.

Updating the relationship between GHG emissions and global temperature rise:

A key component of the ITR methodology is calculating the gap between a country's projected emissions (for their NDC, Net Zero Target, and/or Current Policies individually) and their 'allowable' emissions under a specific warming scenario (e.g. 2°C) as assigned by the CLAIM model. This gap is then translated into a global budget equivalent (assuming that all countries have the same gap as the specified country) used to determine a corresponding global temperature variation. This step relies on a physical relationship between emissions and temperature estimated in the scientific literature and consolidated in the IPCC reports. This relationship is mainly based on The Transient Climate Response to Cumulative Emissions (TCRE) coefficient which helps to quantify the global temperature rise in response to a certain amount of carbon dioxide emissions (T_i).

For this year's report, we have updated the TCRE value, the global carbon budget consistent with a 2° warming $(B_{tot 2}^{\circ})$ in GtCO₂), and the global warming induced by the GHG already emitted in the atmosphere due to human activities (T_{hist} in °C) to reflect the latest IPCC report.⁴

Updating the relationship between CO₂ and non-**CO**₂ emissions in the context of global warming: The most recent IPCC report illustrated the differing impact of CO₂ and non-CO₂ emissions on global surface temperatures across five illustrative scenarios based on varying levels of socioeconomic development and climate mitigation efforts. (SSP1-1.9, SSP 1-2.6, SSP 2-4.5, SSP 3-7.0, and SSP 5-8.5).⁵ By amalgamating and analysing these multiple scenarios, we are better able to establish the relationship between temperature rise attributed to CO_2 gases (T_{cO2}) compared with non- CO_2 gases $(T_{NON-CO2})$. We reflect our enhanced understanding of this relationship through the addition of a term $T_{NON-CO2}$ (T_{CO2}) within our ITR calculation.

As a result, the following temperature equation is applied in our new methodology:

$$T_{i} = T_{CO2} + T_{NON-CO2}(T_{CO2})$$
With $T_{CO2} = TCRE * (GAP_{i} * B_{tot,2})$

$$T_{i} = TCRE * (GAP_{i} * B_{tot,2}) + T_{hist} + T_{NON-CO2}(T_{CO2})$$

Figure 12: National Net Zero commitments⁶

	Law			Policy Document						Oral Pledge
2030				Barbados Maldives						
2035	Finland									
2040	Austria Iceland			Antigua and Barbu	da					
2045	Germany Sweden			Nepal						
2050	Australia Canada Chile Colombia Denmark EU27 Fiji	France Greece Hungary Ireland Japan South Korea Luxembourg	New Zealand Norway Portugal Spain Switzerland United Kingdom	Andorra Argentina Belgium Belize Brazil Cabo Verde Cambodia	Costa Rica Croatia Cyprus Georgia Italy Lao PDR Latvia	Lithuania Malaysia Malta Marshall Islands Monaco Namibia Nauru	Papua new Guinea Peru Seychelles Singapore Slovak Republic Slovenia Solomon Islands	South Africa Sri Lanka Thailand The Gambia United Arab Emirates United States Uruguay	Vietnam	Bulgaria Estonia Micronesia
2053				Turkey						
2060	Russia			China Kazakhstan Nigeria Ukraine						Bahrain Kuwait Saudi Arabia
2070				India						Ghana Mauritius



C) Database of decarbonisation targets, trajectories, policies and sectoral abatement potentials

The ambition assessments presented within this report focus on the G20 countries. However, we rely on a database covering a wider set of countries, which allows for greater accuracy in the estimation of global ITR.

Historical emissions

Our historical GHG emissions inventories includes the land use, land-use change and forestry (LULUCF) sector. The emissions inventories from this sector are collected by IIASA based on UNFCCC and FAO reported emissions.⁷ The emissions from the other sectors are based on the Primap-hist⁸ database of the Potsdam Institute (mostly emissions from energy-use, industry and agriculture).

Net Zero targets

Our database currently covers 86 countries that have already set net zero commitments (See Figure 12 of this annex), representing 85% of global GHG emissions.⁹ The database builds on information from 'Net Zero Tracker' from ClimateWatch.¹⁰ These net zero targets can appear in a number of forms, with most countries presenting them as formal submissions to the UNFCCC or as national policy documents. However, commitments from several countries (including Saudi Arabia, for example) are currently only based on verbal pledges from political leaders. Our net zero emissions trajectories are harmonised on our historical inventories and are calibrated on the 'end point' announced by the countries, namely the horizon of their net zero target. (This is most often 2050, but some countries committed to achieve net zero emissions by 2060, like China, or 2045 like Germany.)

NDC targets

The 194 country parties to the Paris Agreement have submitted a Nationally Determined Contribution (NDC), as required. However only 132 of these NDCs are concrete enough to be quantifiable, representing 95% of global emissions. The commitments of some developing countries have both conditional (to financing) and unconditional parts. In our assessments, we consider only the unconditional component of the NDC targets.

As part of the Paris Agreement,¹¹ countries had committed to update their initial NDCs by 2020 (and every five years thereafter). At the time of writing,¹² only 135 countries¹³, representing 90% of global emissions, have submitted a new or updated NDC, of which 122 are quantifiable. Additionally, since our last report (prior to COP27), 9 entities submitted new NDCs (including the European

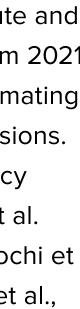
Union and the ratification of the Fit for 55 in April 2023), representing 10% of global emissions. Our NDC emissions trajectories are harmonised on our historical inventories and are calibrated on the 'end point' in 2030 deduced from the information provided by the countries in their NDCs.

Current policies trajectories

In this report, we use 'current policies' emissions trajectories constructed by the NewClimate Institute and IIASA that provide annual emissions estimates from 2021 to 2030. Both institutes have a long history in estimating the impact of current policies on future GHG emissions. The methods used for developing the current policy scenarios are presented in detail in Nascimento et al. (2021)¹⁴ and described in detail elsewhere (Kuramochi et al., 2018¹⁵, 2021¹⁶; den Elzen et al., 2019¹⁷; Fekete et al., 2021¹⁸), see also our COP26 Net Zero Atlas¹⁹.

The NewClimate Institute/IIASA database of current policy trajectories update for this report covers the G20 countries, accounting for 79% of global emissions. Our 'current policies' emissions trajectories are based on the growth rates (between 2021 and 2030) deduced from the trajectories provided by NewClimate and IIASA and harmonised on our historical inventories. See Figure 13.





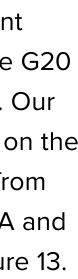
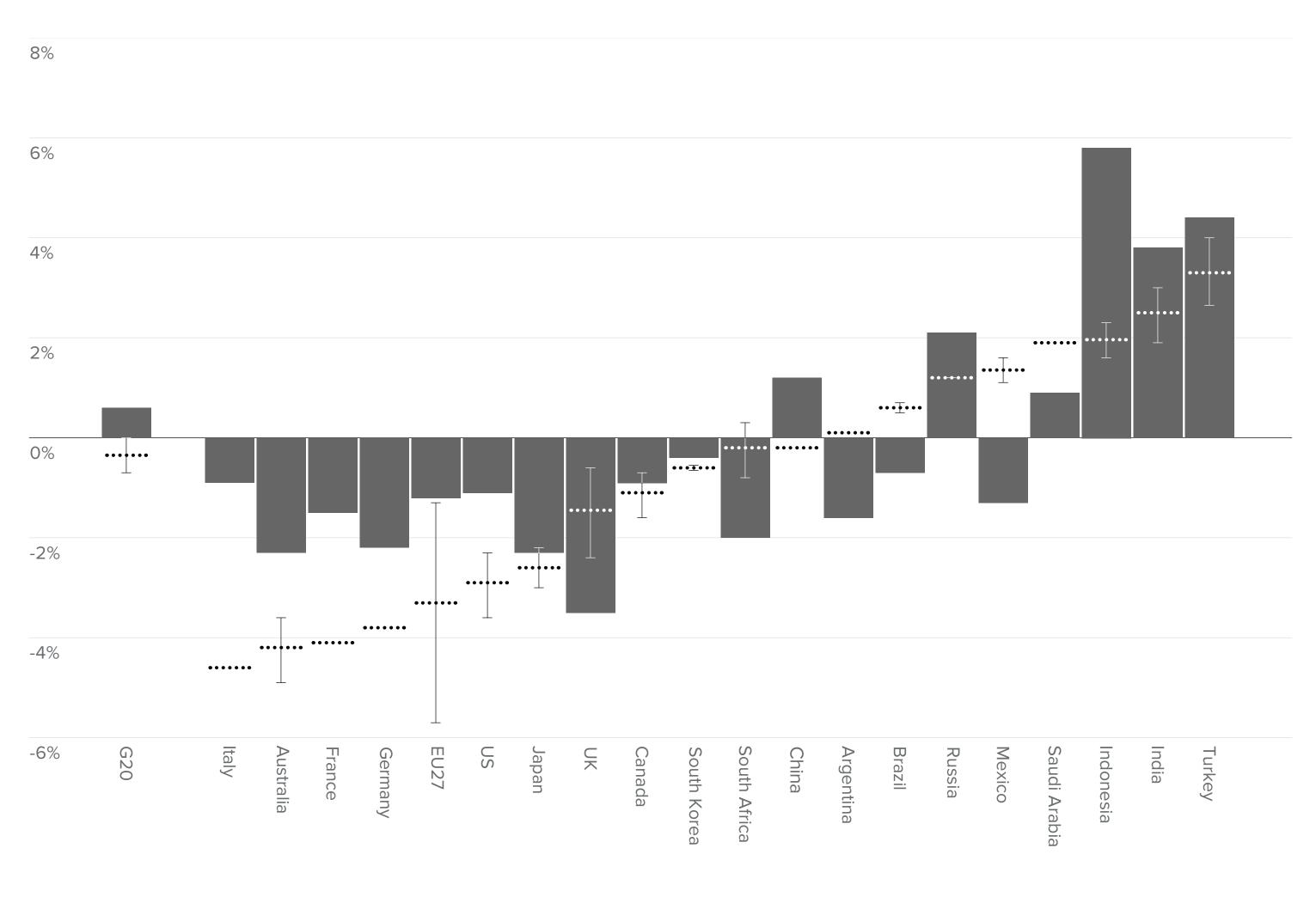


Figure 13: Comparing projected emissions growth in the G20 countries based on current policies with historical trends

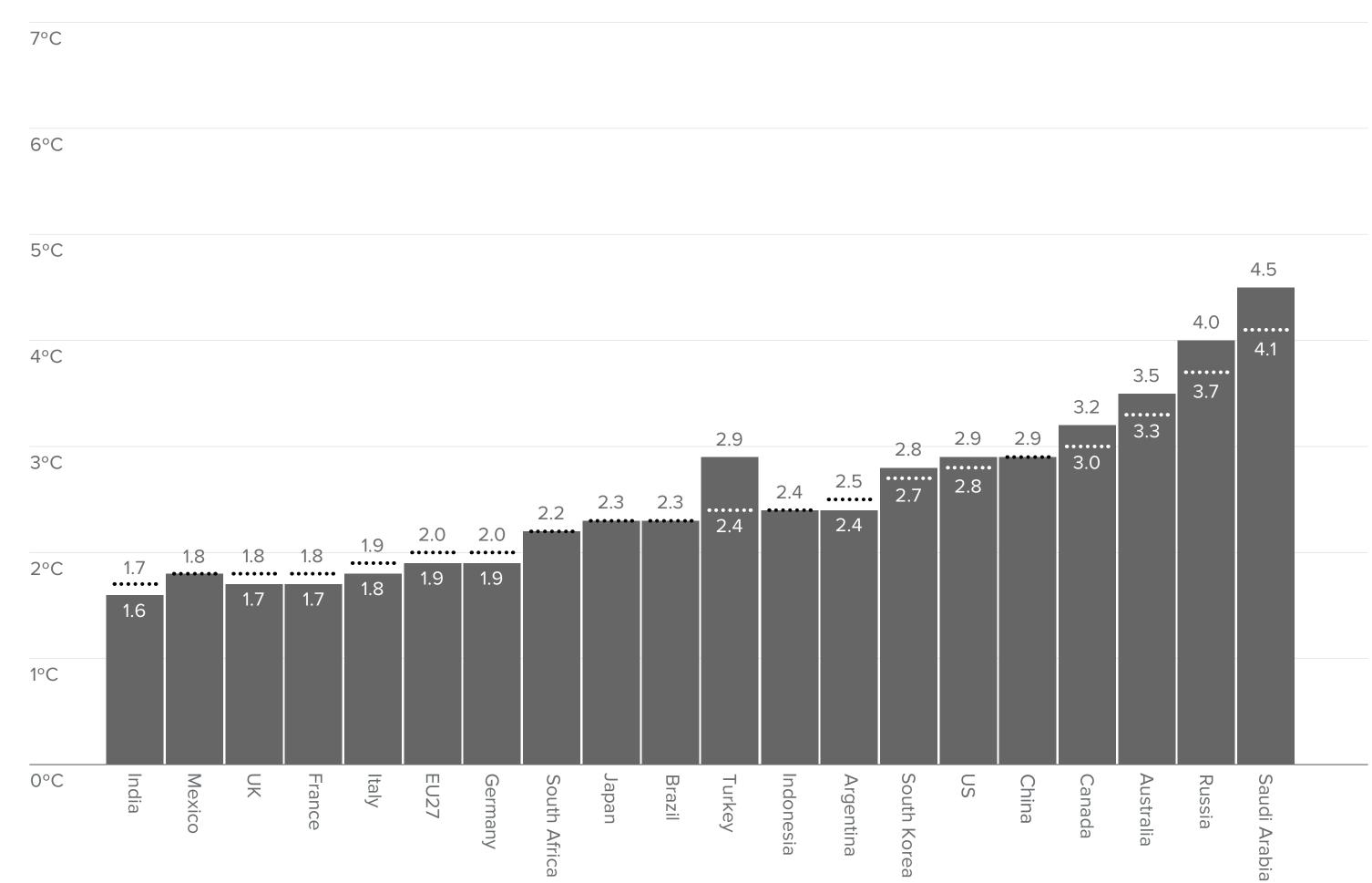


Source: Research from IIASA and NewClimate Institute, update from Nascimento et al., 2021.²⁰

Figure 14: Implied Temperature Rise for G20 countries from the COP28 values (°C)

Country	NDC Targets (2030)	Current policies (2030)	Net Zero Targets (2050)
India	1.7	1.6	1.5
Mexico	1.8	1.8	1.6
United Kingdom	1.8	2.1	1.6
France	1.8	2.0	1.6
Italy	1.9	2.0	1.7
European Union	2.0	2.1	1.7
Germany	2.0	2.4	1.7
South Africa	2.2	2.5	1.7
Japan	2.3	2.5	2.0
Brazil	2.3	2.5	1.6
Turkey	2.4	2.5	1.6
Indonesia	2.4	2.5	1.7
Argentina	2.5	2.7	1.7
South Korea	2.7	3.3	2.2
United States	2.8	3.4	2.3
China	2.9	2.9	2.3
Canada	3.0	3.9	2.3
Australia	3.3	3.2	2.3
Russia	3.7	3.5	2.5
Saudi Arabia	4.1	4.6	2.8

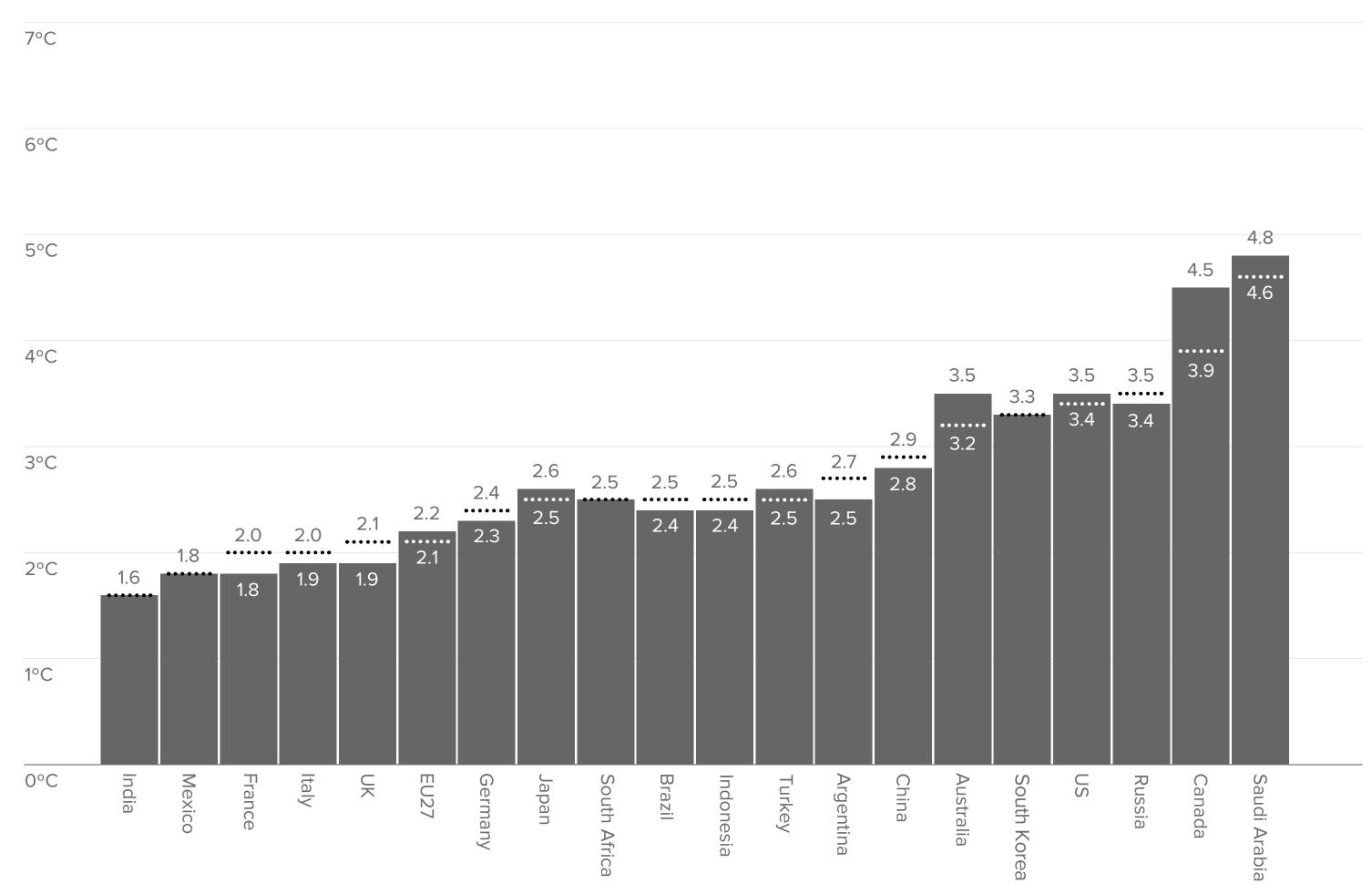
Figure 15: Implied Temperature Rise for selected countries based on NDCs from the COP27 and COP28 for the G20 countries



ITR NDC COP27 ••• ITR NDC COP28

Source: FTSE Russell & Beyond Ratings Research

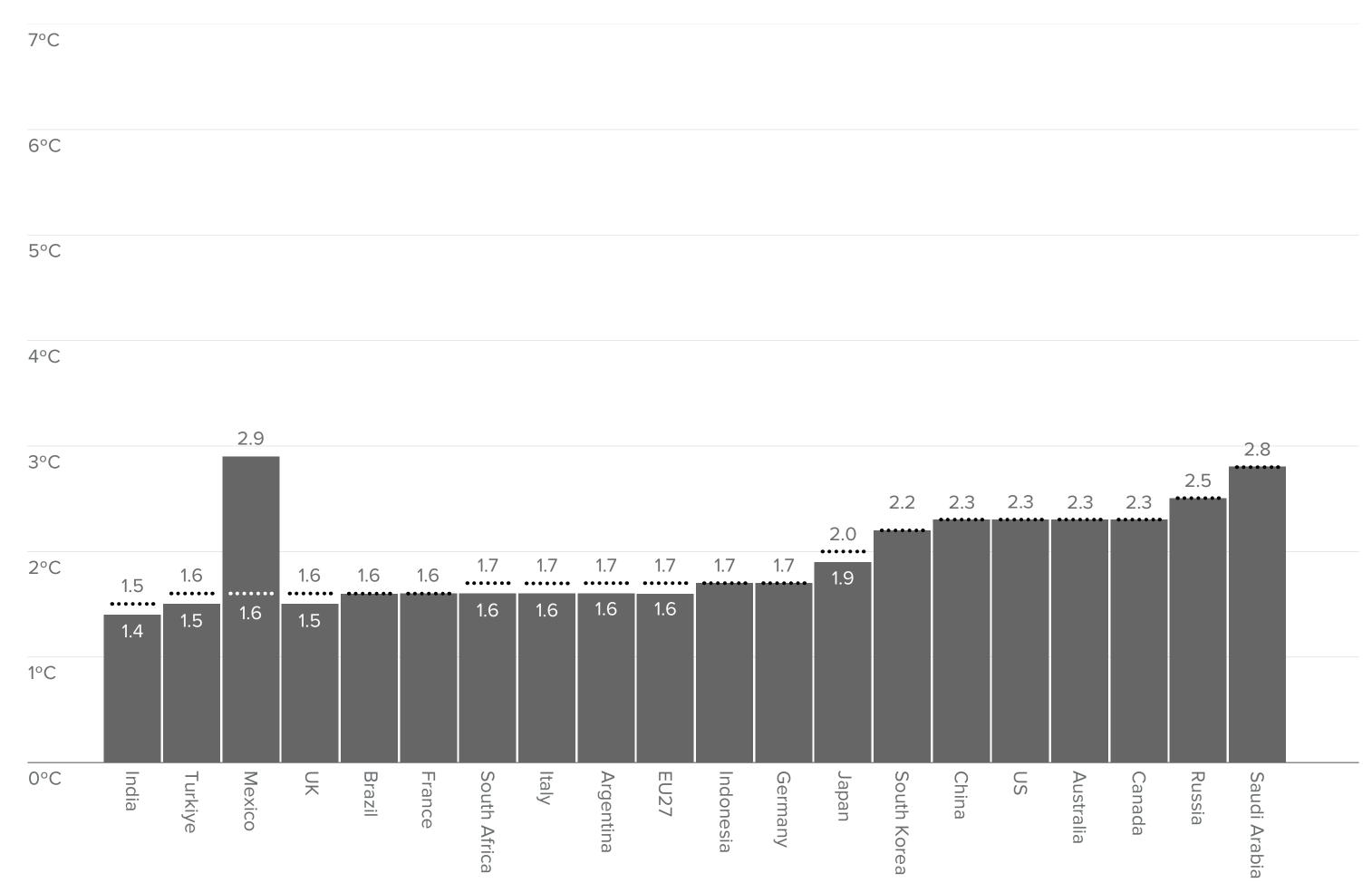
Figure 16: Implied Temperature Rise for selected countries based on current policies from the COP27 and COP28 for the G20 countries



ITR Current Policies COP27 ••• ITR Current Policies COP28

Source: FTSE Russell & Beyond Ratings Research

Figure 17: Implied Temperature Rise for selected countries based on net zero targets from the COP27 and COP28 for the G20 countries



ITR net zero target COP27 ••• ITR net zero target COP28

Source: FTSE Russell & Beyond Ratings Research

Climate data processing

For each hazard described in the country profiles (average temperature, frequency of very hot days, precipitation and frequency of dry days), we use raw climate data to calculate specific indicators that describe the hazard's frequency and/or intensity. For instance, raw data describing the daily maximum temperature are processed into a frequency of heatwaves. We analysed both past and forward-looking exposures to climate hazards for each country. Details of the periods of interest for each hazard can be found in Figure 19.

Forward-looking data is based on the IPCC SSP5-8.5 climate scenario, following a 'hope for the best, plan for the worst' type of approach. It is worth noting that, before 2050, the choice of scenario is not the main driver of climate uncertainty, since the different scenarios start to diverge around mid-century. However, to account for the climate models uncertainty and to avoid relying on a single model, we perform a multi-model analysis. For each country and each indicator, we extract the multimodel average value for the country and all climate models used for the analysis.

National adaptation plans and strategies

The NAPs assessment was carried out by reading national adaptation documents as well as secondary literature. The analysis is only valid at the time this report was written and does not take into account potential updates after September 2023.

The description of the national adaptation components in the country profiles is based on a 0 to 2 scale:

Level 0 means that the component is not or barely mentioned in the adaptation document.

Level 1 means that the component is briefly described in the document (but no specific details available) or detailed in a separate document.

Level 2 means that the component is either qualitatively or quantitatively described and that a sufficient level of details is provided in order to understand the country's adaptation policies.

Data sources

Raw climate data are taken from global climate models or specific models for floods and water stress. To account for short-term variations of the climate system, long-term average values are required to adequately represent past and future climate. Here, we use averages over 20-year time segments: the climate indicators for the historical and 2050 periods are the result of the average over 1995-2014 and 2041-2060, respectively.

Population data are taken from the Socio Economic Data and Application Center (SEDAC) dataset: Gridded Population of the World (GPW), v4.

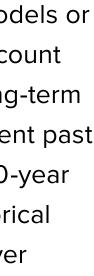




Figure 19: List of climate indicators used to describe current or recent and future climate hazards

Hazard	Climate indicator	Historical	Future
Heatwaves	Number of days with temperature higher than 35°C in a year Number of days with heat index (WBGT) higher than 28°C in a year	2005	2050
Droughts	Number of dry days in a year	2005	2050
Water stress	Water stress index (ratio of water demand over water supply)	2020	2040
Coastal floods	Inundation depth for a 1/100-year event (inundation caused by storm surge)	2020	2050
Temperature	Average annual temperature	NA	2050

Raw climate data source

CMIP6 climate modelling initiative Download from ESGF platform (see Figure 20 for details of the models)

CMIP6 climate modelling initiative Download from ESGF platform (see Figure 20 for details of the models)

World Resources Institute

World Resources Institute

CMIP6 climate modelling initiative Download from ESGF platform (see Figure 20 for details of the models)

Source: Beyond Ratings.

Figure 20: List of climate models

Data	Source	
CMCC-ESM2	Centro Euro-Mediterraneo sui Cambiamenti Climatici (Ita	
MPI-ESM1-2-HR	Max Planck Institute for Meteorology (Germany)	
NorESM2-MM	Norwegian Meteorological Institute and NORCE Norweg	
EC-Earth-3	30 research institutes from 12 European countries	
HadGEM3-GC31-MM	Met Office Hadley Centre (UK)	
MIROC6	Center for Climate System, University of Tokyo, Japan A Technology, and National Institute for Environmental Stu	

(Italy)

egian Research Centre AS (Norway)

Agency for Marine-Earth Science and Studies (Japan)

Source: Beyond Ratings.

Executive Summary

- i Copernicus, 2023. July 2023 sees multiple global temperature records [Copernicus]
- ii United Nations, 2023. It's official: July 2023 was the warmest month ever recorded [UN News]
- iii Allianz Trade, 2023. Global boiling: Heatwave may have cost 0.6pp of GDP [Allianz Trade]
- iv Canadian Interagency Forest Fire Centre Inc, 2023. Data: Fire Statistics [CIFFC]
- v The Guardian, 2023. Wildfires turn Canada's vast forests from carbon sink into super-emitter [The Guardian]
- Vi United Nations Environment Programme, 2022. Adaptation Gap Report 2022: Too Little, Too Slow – Climate adaptation failure puts world at risk [UNEP]
- vii UNFCCC. COP26 Outcomes: Finance for Climate Adaptation [UNFCCC]
- viii Technical dialogue of the first global stocktake [UNFCCC]

- We calculate these emissions projections based on the IPCC 2021 assessment, which indicates that a Net Zero target for 2050 equates to an 84% reduction in emissions compared to the levels observed in 2019.
- 2 Based on research from IIASA and NewClimate Institute, updating emissions projections from Nascimento, L.et al., 2021, Tracking climate mitigation efforts in 30 major emitters: Economy-wide projections and progress on key sectoral policies
- The CLAIM model enables the computation of national GHG budgets 3 complaint with any average temperature target and time horizon (2°C compliant scenario here.) The method does not assign a national budget following a unique criterion – such as 'capacity' or 'responsibility'. It offers a statistical, and non-normative, approach which avoids choosing between either egalitarian or 'grandfathering' sharing that would be seen as nonconsensual (see Giraud et al. 2017) for further details
- See FTSE Russell, 2021, How to measure the temperature of sovereign assets. Note that when calculating the Implied Temperature Rise for an entity including multiple countries, such as the EU or the G20, we compute an average of each country's ITR, weighted by the country's emissions ratio within the group
- IPCC, 2018: Global Warming of 1.5°C.An IPCC Special Report on the impacts 5 of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. In Press [IPCC]
- 6 Rogelj, J., Forster, P. M., Kriegler, E., Smith, C. J., & Séférian, R. (2019). Estimating and tracking the remaining carbon budget for stringent climate targets. <u>Nature</u>, 571(7765), 335-342
- We also remedy a calculation error for the ITR for Mexico for 2050, which previously was assessed with a 2.9°C-aligned temperature. Last year, we calculated Mexico's carbon budget for 2100 instead of 2050, resulting in a significantly smaller value than accurate
- Apart from the 2050 target for Mexico, see footnote 10 for details 8

- 9 [UNFCCC]
- 10
- 11
- 12 UNFCCC, 2015. The Paris agreement [UNFCCC]
- 13
- 14
- 15

16

- temperature increase
- 17
- Based on data from the Global Stocktake 18
- 19 [Climate Laws]

Republic of Türkiye, 2023. Updated First Nationally Determined Contribution

Mexico is the only G20 country yet to disclose a net zero target (it currently targets a 50% emissions reduction by 2050 compared to 2000 level)

Our methodology to calculate the implied temperature rise of a group of countries is by using a weighted average over the 2021 emissions

Article 14.2 of the Paris Agreement: 'The Conference of the Parties serving as the meeting of the Parties to this Agreement shall undertake its first global stocktake in 2023 and every five years thereafter unless otherwise decided by the Conference of the Parties serving as the meeting of the Parties to this Agreement.' - see footnote 12

UNFCCC, 2023. Technical dialogue of the first global stocktake. Synthesis report by the co-facilitators on the technical dialogue [UNFCCC]

UNFCCC, 2023. Technical dialogue of the first global stocktake. Synthesis report by the co-facilitators on the technical dialogue [UNFCCC]

This concept of a remaining carbon budget serves to quantify the quantity of CO2 emissions that can be discharged into the atmosphere for a given

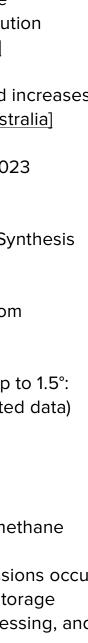
UNFCCC, 2023. Addendum to the synthesis report for the technical assessment component of the first global stocktake [UNFCCC]

In June 2023, the 5th phase of The Action Plan for the Prevention and Control of Deforestation in the Legal Amazon formalised a net zero deforestation goal in a government document, as well as outlining delivery mechanisms through the strengthening of forestry legislation and a raft of economic incentives for conservation and sustainable forest management

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21 Government of Canada, 2022. Faster and further: Canada's methane strategy [Goverment of Canada]

- 22 Canada Gazette, 2023. Regulations Amending Schedule 2 to the Greenhouse Gas Pollution Pricing Act, Amending the Fuel Charge Regulations and Repealing the Part 1 of the Greenhouse Gas Pollution Pricing Act Regulations (Alberta): SOR/2023-62 [Canada Gazette]
- 23 Hitherto the Safeguard mechanism had required facilities to avoid increases in emissions beyond business-as-usual levels [Government of Australia]
- 24 UK Government, 2023. PM speech on Net Zero: 20 September 2023 [Government of UK]
- 25 UNFCCC, 2023. Technical dialogue of the first global stocktake. Synthesis report by the co-facilitators on the technical dialogue [UNFCCC]
- 26 FTSE Russell, 2023. Closing the gap to 1.5°: What can we learn from Marginal Abatement Cost Curves? (updated data) [FTSE Russell]
- For the full methodology, see FTSE Russell, 2023. Closing the gap to 1.5°: 27 What can we learn from Marginal Abatement Cost Curves? (updated data) [FTSE Russell]
- Based on data from the World Emissions Clock [WEC] 28
- Methane fugitive emissions refer to the unintentional release of methane 29 gas into the atmosphere during various stages of the production, transportation, and use of natural gas, oil, and coal. Fugitive emissions occur due to leaks or unintended releases from equipment, pipelines, storage tanks, or other infrastructure associated with the extraction, processing, and distribution of these fossil fuels
- Climate Transparency, 2022. Climate Transparency Report 2022 (South Africa) [Climate Transparency]
- Based on our calculation, the methane fugitive emissions represent roughly 31 half of the abatement potential of the Energy System, which itself accounts for c. 45% of total abatement potential in the nation
- See for example: IEA (2021), France 2021, IEA, Paris https://www.iea.org/ 32 reports/france-2021 or IEA (2023), Brazil Energy Profile, IEA, Paris https:// www.iea.org/reports/brazil-energy-profile [IEA]



IPCC, 2023. Sections. In: Climate Change 2023: Synthesis Report. 15 MunichRe, 2023. Climate change and La Niña driving losses: the natural Contribution of Working Groups I, II and III to the Sixth Assessment Report disaster figures for 2022 [Munich Re] of the Intergovernmental Panel on Climate Change [Core Writing Team, Lee, H. and Romero, J. (eds.)]. IPCC, Geneva, Switzerland, pp. 35-115, doi: Allianz Trade, 2023. Global boiling: Heatwave may have cost 0.6pp of GDP 16 10.59327/IPCC/AR6-9789291691647 [IPCC] [Allianz Trade] FTSE Russel, 2022. The Cop27 Net Zero Atlas [FTSE Russell] The Guardian, 2023. Heatwave last summer killed 61,000 people in Europe, 17 2 research finds [The Guardian] Newman, R. and Noy, I., 2023. The global costs of extreme weather that are 3 attributable to climate change. Nature Communications 14.1: 6103 18 World Bank, 2022. Climate Investment Opportunities in India's Cooling Sector [World Bank] [Nature Communications] Canadian Interagency Forest Fire Centre Inc, 2023. Data: Fire Statistics 4 Swiss Re, Sigma, 2022. Natural catastrophes in 2021: the floodgates are 19 [CIFFC] open [Swiss Re] Vousdoukas, M.I. et al., 2018. Climatic and socioeconomic controls of future The Guardian, 2023. Wildfires turn Canada's vast forests from carbon sink 5 20 coastal flood risk in Europe Nature Climate Change 8.9: 776-780 [Nature] into super-emitter [The Guardian] 21 Euronews, 2023. Hawaii wildfires: What caused the deadly blazes and is World Meteorological Organisation, 2023. State of the Global Climate in 6 climate change to blame? [Euronews] 2022 [WMO] 22 RMS, 2023. Moody's RMS Estimates USD 4 to 6 Billion in Economic Losses Copernicus, 2023. July 2023 sees multiple global temperature records 7 from Hawaii Wildfires [RMS] [Copernicus] 23 Bloomberg, 2023. Wildfires Cost Europe €4.1 Billion as Greece Suffers Most Copernicus, 2023. July 2023: Global air and ocean temperatures reach new 8 record highs. Press release [Copernicus] Damage [Bloomberg] United Nations, 2023. It's official: July 2023 was the warmest month ever Bloomberg, 2023. Wildfires Cost Europe €4.1 Billion as Greece Suffers Most 9 24 recorded [UN News] Damage [Bloomberg] World Meteorological Organization, 2023. September smashes monthly ReliefWeb, 2023. Libya: Flood update Flash Update No.6 (21 September 10 25 temperature record [WMO] 2023) [ReliefWeb] Reuters, 2023.What are China's sponge cities and and why aren't they National Centers for Environmental Information, 2023. Global Time Series -11 26 Climate at a Glance [NOAA] stopping floods [Reuters] World Meteorological Organization, 2023. WMO Global Annual to Decadal NASA Earth Observatory, 2023. A Deluge in Greece [NASA] 12 27 Climate Update [WMO] 28 Reuters, 2023. New York deluge triggers flash floods, brings chaos to NASA, 2022. Data: Ocean Warming [NASA] subways [Reuters] 13 14 NASA Earth Observatory, 2023. Exceptionally Low Antarctic Sea Ice [NASA] 29 CNN, 2023. India floods: Death toll from glacial lake burst in Himalayas climbs to 74, at least 100 still missing [CNN]

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- Instituto Nacional de Ecología y Cambio Climático (INECC), 2022. Primera Comunicación sobre la Adaptación de México ante la Convención Marco de las Naciones Unidas sobre el Cambio Climático. Pp. 219 [INECC]
- 41 TRTHABER, 2023. Türkiye'nin 2030 iklim hedefleri için eylem planları hazır [TRTHABER]

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46	IPCC, 2023: Sections. In: Climate Change 2023: Synthesis Report.		Nationally Deter
	Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Lee, H. and Romero, J. (eds.)]. IPCC, Geneva, Switzerland, pp. 35-115, doi: 10.59327/IPCC/AR6-9789291691647 [IPCC]	60	FAO & OECD, 20 and the hidden p [FAO]
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7		21	Australian Gov
1	The tax targets emissions from transportation fuels and coal at a rate of US\$5/tCO2 by 2020. It excludes natural gas consumption and shale gas production, and it is reviewed each trimester. It covers 15.8% of GHG emissions in CO2e.	22	This strategy s transport secto and biofueled
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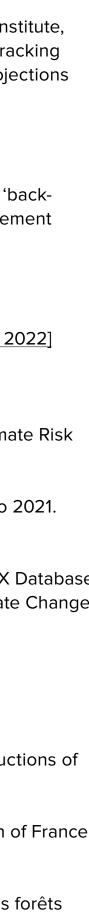
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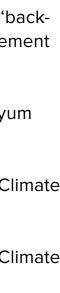
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Annex: Data & Methodologies

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- Notes: 1) Mexico has set a 50% emissions reduction target by 2050 6 compared to 2000 levels. We do not include this within this diagram but use this to compute a temperature associated with it as part of our 'net zero' mid-century targets. 2) A number of countries (Bhutan, Benin, Comoros, Guyana, Suriname) have proclaimed that they have already reach net zero or carbon neutrality but are not included in this chart. 3) Turkey's net zero target has a target data of 2053. 4) There are a four EU member states that do not have domestic net zero targets (i.e., in addition to the EU's target) and so do not appear on this chart
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- 12 4 October 2023
- member states
- 14
- 16
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