IPR: Forecast Policy Scenario + Nature (FPS + Nature)

Preparing financial markets for climate- & nature-related policy & regulatory risks

January 2023

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INEVITABLE POLICY RESPONSE

Executive summary

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Executive summary: The decline of nature is beginning to lead to policy action, which could impact investors and financial institutions

X1,000

The natural world has been impacted to levels unprecedented in human history. Global extinction rates are 1,000 times higher than under natural conditions, with three quarters of Earth's land ecosystems significantly altered

90%

Land use change is the primary cause of nature loss due to conversion of land to agriculture, with 90% of tropical deforestation driven by expansion of agriculture

$3trn

Nature loss could pose material threats to the economy and to the financial sector, with an estimated global GDP loss of USD 3 trillion annually by 2030 if ecosystem tipping points are crossed

Government action on nature is increasing and a range of policies and regulations are being introduced to accompany action on climate. Over 190 countries agreed to adopt a global biodiversity framework at the COP 15 summit in Montreal in December 2022. Policy action to achieve these commitments may create new risks but lead to new opportunities for companies and investors.

Companies and investors are being asked to understand their impacts on nature and disclose these. Emerging frameworks, such as the Taskforce on Nature-related Financial Disclosures (TNFD), will encourage investors to take a forward-looking view on nature-related risks and report on how they are exposed to nature and biodiversity

FPS + Nature is the first integrated nature and climate scenario for use by investors. It fills a crucial gap that is required to conduct robust risk assessments, providing investors with an exploratory forward-looking view on how policy, technological and social trends could impact key value drivers. It represents a 'beta version' scenario of what might happen when nature-related policy is incorporated into a climate-related scenario.

Executive summary: FPS + Nature builds on assessments of climate-focused land use policy, incorporating protected areas, land restoration and emerging nature markets

IPR's FPS + Nature summaries global policy on nature and climate in the land use sector

It updates the previous IPR Forecast Policy Scenario (FPS), focused on climate policy and its interaction with land use, by including emerging policy action on nature

In FPS + Nature, key nature-related policy trends are explored in relation to three areas, along with climate drivers:

1. Protected areas. Governments could act to safeguard nature by strengthening regulation to protect land. **Current trends suggest 20% of total global land area of high biodiversity and carbon value could be protected by 2030**

2. Land restoration. Governments may consider significantly increasing efforts to restore degraded ecosystems through national programmes, supplemented by private sector action. **This could involve restoration on 4% of global land area by 2030**

3. Nature markets. Formalisation of nature-related targets, creation of market infrastructure and corporate demand could **support emergence of voluntary biodiversity credit markets initially at the local and regional scale, developing both independently and integrated with NBS-based carbon markets,** with more focus on nature outcomes also having the potential to increase the "quality" of nature-based carbon credits

4. Climate drivers. The scenario also **covers six other policy areas at the nexus of land use, climate and nature** (carbon pricing, bioenergy, diets, deforestation, sustainable agriculture and food waste) and **produces value drivers for investors to consider**

International goals established at COP 15 to protect 30% of land and sea by 2030 are not directly comparable to these figures given the precise nature of these targets has not yet been specified

Note: Statements are based on FPS + Nature scenario policy assessment and modelling outcomes. Modelling is performed using MAgPIE.

Executive summary: Nature-related risks and opportunities overlap with but are also additional to climate-related considerations, with implications for commodities, new products and markets

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Key outcomes from the FPS + Nature scenario, representing initial indications of nature- and climate-related impacts:

Food: The price of deforestation-linked commodities increases, with sustainable yield improvements potentially keeping prices for staple crops stable over time. Policy action and the development of alternative proteins could bend the demand curve for ruminant meat, with production peaking by 2035, also influencing production of animal feed

Energy: Transition to low-carbon energy together with nature-related goals supports a shift to second-generation bioenergy that changes the countries and specific locations of biomass production. Increased demand for metals and minerals and some infrastructure expansion may need to be reconciled with increased land protection

Nature-related goods, services and assets emerge as a new source of economic and financial value, driving the expansion of certified products, nature-based solutions and the emergence of new markets for biodiversity-rich land. New technologies designed to eliminate waste, reduce negative nature impacts and foster sustainability also emerge in tandem with the deepening of nature polices

Supply chains: Deforestation policies impact the production of tropical soft commodities as reputational, market access and liability risks could be passed down the value chain

Global environment: Planned policy action by governments would halt and reverse global biodiversity loss, potentially achieving 2000 levels of biodiversity intactness by 2045. Climate-related policies alone would be unlikely to improve biodiversity at a global scale and may only stabilise existing biodiversity loss

Note: Statements are based on FPS + Nature scenario policy assessment and modelling outcomes. Modelling is performed using MAgPIE.

Glossary: Abbreviations of key terms

- BAU - Business as usual
- BII - Biodiversity Intactness Index
- C - Celsius
- CAGR - Compound average growth rate
- CBD - Convention on Biological Diversity
- CCS - Carbon capture and storage
- CH_4 - Methane
- CO_2 - Carbon dioxide
- CO_2e - Carbon dioxide equivalent
- COP - Conference of the Parties
- DM - Dry matter
- ECB - European Central Bank
- EJ - Exajoule
- FAO - Food and Agriculture Organization of the United Nations
- FPI - Food price index
- FPS - Forecast Policy Scenario
- G - Billion (giga-)
- GBP - British pound
- GDP - Gross Domestic Product
- GHG - Greenhouse gas
- ha - Hectare
- HACE - High Ambition Coalition for Nature and People
- IEA - International Energy Agency
- IPBES - Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
- IPCC - Intergovernmental Panel on Climate Change
- IPR - Inevitable Policy Response
- IUCN - International Union for Conservation of Nature
- kcal - Kilocalorie
- MAgPIE - Model of Agricultural Production and its Impact on the Environment
- M - Million
- N_2O - Nitrous oxide
- NBS - Nature-based solution
- NDC - Nationally determined contribution
- NGFS – Network for Greening the Financial System
- OECD - Organization for Economic Cooperation and Development
- p.a. - Per annum
- PRI - Principles for Responsible Investment
- R&D - Research and development
- RPS - 1.5°C Required Policy Scenario
- SBTN - Science Based Targets Network
- SCA - IPR's Supply Chain Analysis
- SDG - Sustainable Development Goal
- t - Tonne
- TCFD - Task Force on Climate-related Financial Disclosures
- TNFD - Task Force on Nature-related Financial Disclosures
- UNCCD - United Nations Convention to Combat Desertification
- UNDP - United Nations Development Programme
- UNEP – United Nations Environment Programme
- UNFCCC - United Nations Framework Convention on Climate Change
- USD - United States dollar
- WBCSD - World Business Council for Sustainable Development
- WEF - World Economic Forum
- WRI - World Resources Institute
- WWF - World Wide Fund for Nature
- Yr - Year

The Inevitable Policy Response (IPR) is commissioned by the Principles for Responsible Investment (PRI) and supported by world class research partners

PRI commissioned the Inevitable Policy Response in 2018 to advance the industry's knowledge of climate transition risk, and to support investors' efforts to incorporate climate risk into their portfolio assessments

A research partnership led by Energy Transition Advisors conducts the initiative's research with scenario modelling by Vivid Economics, and contributions from Kaya Advisory, the Grantham Research Institute, the London School of Economics and Political Science, the 2Dii, the Carbon Tracker Initiative, the Climate Bonds Initiative and Planet Tracker

The consortium was given the mandate to bring analytic tools and an independent perspective to assess the drivers of likely policy action and their implications on the market

Financial institutions and philanthropic donors provide additional support for the IPR

Financial institutions have joined the IPR as Strategic Partners to provide more in-depth industry input and to further strengthen its relevance to the financial industry

Core philanthropic support has been received since IPR began in 2018. The IPR is funded in part by the Gordon and Betty Moore Foundation through The Finance Hub, which was created to advance sustainable finance, and the ClimateWorks Foundation, which strives to innovate and accelerate climate solutions at scale

The IPR helps the financial sector navigate the climate and nature transition by publishing policy forecasts, scenarios and value drivers

Markets face an unprecedented climate and nature transition

Policies combined with new technologies and consumer preferences continue to affect established industries and economies

Increasing understanding of this unfolding environment can help financial institutions manage their assets effectively

The IPR helps investors understand transition risks and opportunities by filling important gaps in scenarios currently available to investors for portfolio analysis

The IPR produces:

- **Policy projections** that account for emerging and forecast **policy action** to address climate change
- **Scenarios** that incorporate the energy sector and the **land use sector** in the context of the whole economy
- **Value drivers** that provide intelligence about the realistic **risks and opportunities** most critical to the financial sector

The IPR's Forecast Policy Scenario (FPS) adds value for investors seeking to understand transition risk

FPS is a forward-looking scenario modelling the impact of **policies** up to 2050 and can be used to reveal insights on emerging sources of transition risk

Inputs

Based on a detailed policy-based forecast, anchored in realistic policy, technology, and consumer preference expectations rather than hypothetical 'optimal' pathways

Underpinned by transparency around expected policy implementation and development of key technologies

Includes global coverage with policy forecasts available for regions

Outputs

Produced through a comprehensive modelling exercise that includes macroeconomic, energy and land use models linking crucial aspects of policy change across the entire economy

Applicable to reporting and regulatory stress testing through frameworks like the Task Force on Climate-related Financial Disclosures (TCFD) and the Taskforce on Nature-related Financial Disclosures (TNFD)

Includes global coverage with value drivers available for regions

Nature is in crisis: Natural habitats continue to shrink and levels of biodiversity reduce day by day

Nature underpins all life on Earth

Nature is in decline

Nature provides essential goods and services required to maintain life and productive economies

These include pollination, carbon capture and storage, soil formation, air quality, fresh water and raw materials[1]

-23%

Land degradation has reduced **productivity in** 23% of **global terrestrial area**[1]

1.6

Approximately 1.6 **Earths** are needed to maintain current levels of **resource consumption**[5]

Nature encompasses all animals, plants and organisms across land and aquatic areas.[2] It also includes geology, soil, air and water

Nature is sometimes measured in terms of stocks, **referred to as natural capital**[6]

-40%

The world's **stock of natural capital** declined by nearly 40% between 1992 and 2014[5]

3/4

Three quarters of **Earth's land ecosystems** have been **significantly altered** by human activity[1]

Biodiversity refers to the variety of life on earth that enables nature to function effectively

It is often used synonymously with nature but refers to the diversity within and between species & of ecosystems[1]

-69%

Global **wildlife populations** have decreased by 69% on average since 1970[3]

1,000x

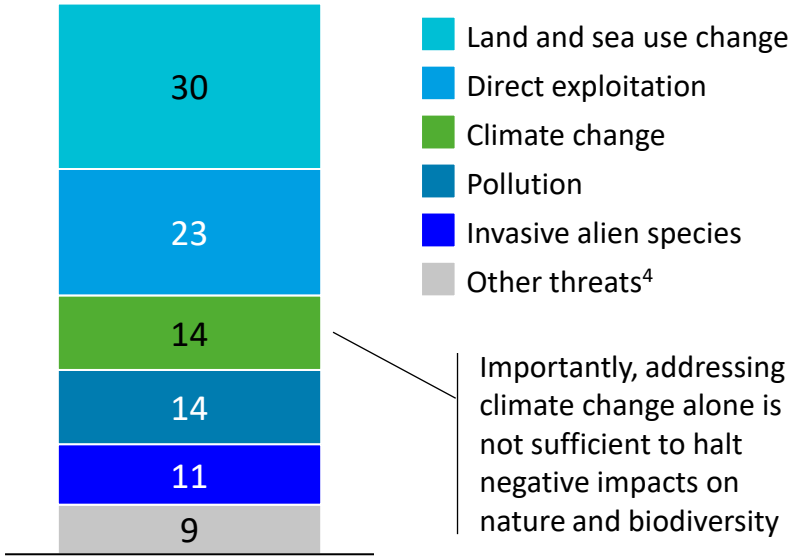
Global **extinction rates** are 1,000 times higher than under natural conditions[4]

1. IPBES 2. More broadly, nature includes all non-human living entities and their interaction with other living or non-living physical entities and processes (SBTN, based on IPBES). 3. WWF 4. Pimm et al. (2014) 5. Dasgupta Review 6. CBD
Note: More information on the ongoing sixth mass extinction can be found in Ceballos et al (2015). The most recent previous mass extinction event occurred when the Chicxulub asteroid wiped out the dinosaurs 66 million years ago (Chiarenza et al. (2020)). Research suggests that the world has already exceeded the planetary boundary for genetic diversity, a measure of biosphere integrity that accounts for extinction rates (Steffen et al. (2015)).

Biodiversity loss is primarily driven by land use change or exploitation of organisms, with pollution, climate change and invasive species also contributing

Land and sea use change, as well as exploitation of species and habitats, drives most biodiversity loss on land and in oceans

Relative impact on global state of nature by key direct anthropogenic driver,[1] %



Drivers of biodiversity loss

Terrestrial biodiversity

Changes in land use include the conversion, degradation and modification of natural habitats from intactness to agricultural or industrial usage[1]

- **Agriculture** is estimated to cause more than 90% of forest loss in tropical regions[5]
- **Infrastructure** development (e.g., roads and railways) can fragment habitats and prevent species migration, despite requiring limited quantities of land[6]

Climate change includes long-term shifts in global temperatures and weather patterns[1]

- **Increasing temperatures** can transform habitats by contributing to desertification[7]
- **Extreme weather** can cause floods, wildfires and droughts that degrade land[7]

Marine and freshwater biodiversity

Direct exploitation of organisms includes the unsustainable extraction of resources from ecosystems before they can naturally regenerate[1]

- **Overexploitation** is estimated to be present in 34% of global fish stocks[3]

Pollution includes the introduction of harmful substances into the environment[1]

- **Plastic pollution** results in 11 million tonnes of plastic entering the oceans each year[2]

1. IPBES 2. UNEP 3. UN SDG Tracker 4. Other threats include fire or human disturbance. 5. Pendrill et al. (2022) 6. New Yorker, based on Haddad et al. (2015) 7. IPCC
Note: Direct anthropogenic drivers of nature and biodiversity loss are underpinned by indirect drivers, such as demographic, sociocultural, economic and technological change (IPBES)

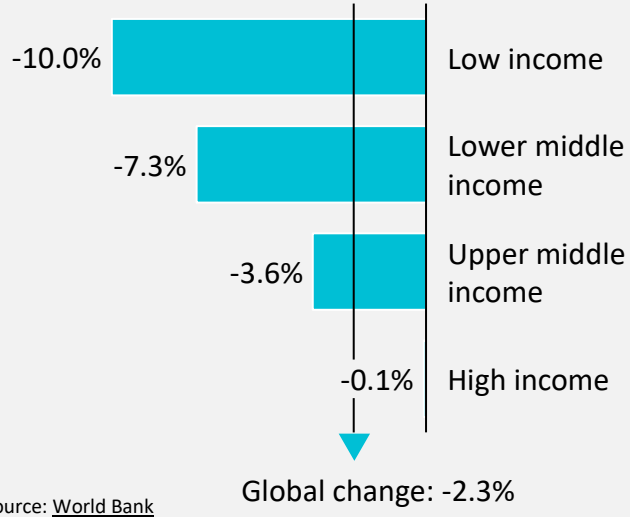
Loss of nature and ecosystem services could significantly impact the economy with potential global GDP loss of nearly USD 3 trillion annually by 2030

Direct effects

The World Bank has estimated that loss of ecosystem services could result in permanent global GDP loss of 2.3% or USD 2.7 trillion annually by 2030 if a set of potential tipping points are crossed[1]

- The estimate accounts for loss of economic output in sectors that rely on **three key ecosystem services**: wild pollination, food provision from marine fisheries, and timber provision from native forests
- The total economic **impact could be much higher** if losses in additional ecosystem services are included
- The impact is lower or later in the absence of reaching **tipping points**

Change in 2030 real GDP with ecosystem collapse, by income group, %



Source: World Bank

Indirect effects

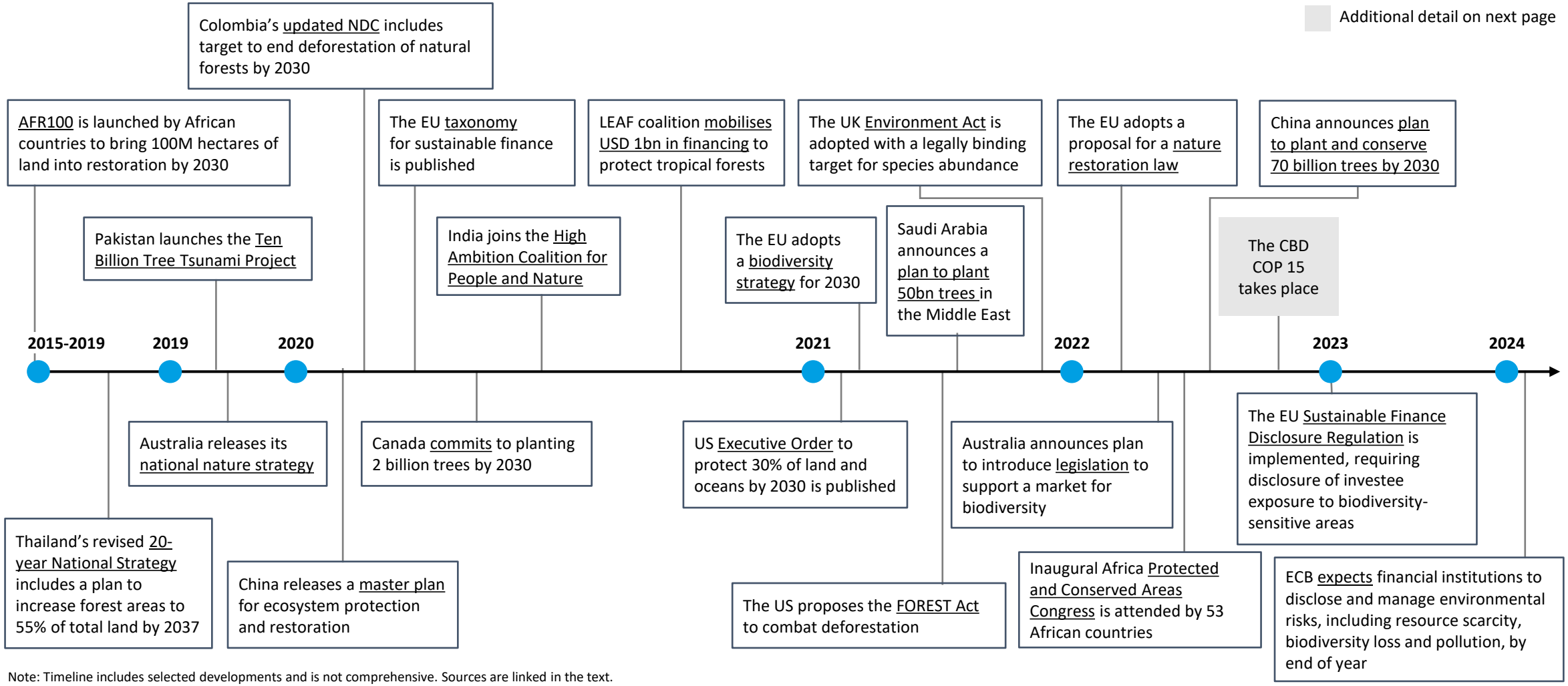
Nature loss can also contribute to a set of wider impacts with global implications

- **Nature loss via land use change is estimated to be a factor in cross-species pathogen transmission** as it can increase human interaction with wildlife.[2, 3] Increased frequency of contact can increase risk from zoonotic diseases,[4] which may catalyse pandemics (e.g., the COVID-19 pandemic)
- **Potentially irreversible climate change could be triggered by crossing critical nature system thresholds.** For example, reaching 20-25% deforestation of the Amazon rainforest could accelerate climate change as the rainforest becomes a savannah, releasing most of its stored carbon[5]

1. World Bank. The focus of the analysis is on physical risks. 2. Lawler et al. (2021) 3. Dobson et al. (2020) 4. Johnson et al. (2020) 5. Grist, citing Lovejoy and Nobre (2018)

INEVITABLE POLICY RESPONSE

Policy momentum is building to curtail biodiversity loss and address the decline of nature

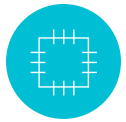


Note: Timeline includes selected developments and is not comprehensive. Sources are linked in the text.

COP 15 resulted in the adoption of the Kunming-Montreal global biodiversity framework, setting out a vision, mission, goals and targets to achieve by 2030

Over 190 countries have agreed to adopt a global biodiversity framework following the COP 15 summit in Montreal in December 2022. The framework "aims to catalyze, enable and galvanize urgent and transformative action by Governments, subnational and local governments, and with the involvement of all of society to halt and reverse biodiversity loss." It sets **23 global targets** to be achieved by 2030,[1] which include:

Protecting at least 30% of land and sea by 2030, focused on areas of importance for biodiversity and ecosystem functions and services, covering terrestrial land, inland water, coastal and marine ecosystems



Restoring at least 30% of degraded ecosystems by 2030, covering terrestrial land, inland water, coastal and marine ecosystems[2]

Taking action to halt biodiversity loss, including by bringing loss of areas of high biodiversity importance close to zero by 2030 and reducing rates of introduction and establishment of known or potential invasive species by at least 50% by 2030

Increasing financing for nature, through leveraging public and private sources, including via innovative schemes such as biodiversity offsets and credits, payments for ecosystem services and green bonds

Reducing nature-harmful subsidies, by at least USD 500 billion per year by 2030, starting with the most harmful incentives, whilst scaling up positive incentives for the sustainable use of biodiversity

Ensuring company-level disclosure on nature, through regular assessment and disclosure of risks, dependencies and impacts on biodiversity along operations, supply and value chains and portfolios[3]

1. The full framework is available here. 2. Target 2 covers land under effective restoration, which includes land on which restoration is underway or completed. 3. Target 15 includes encouragement and enabling of disclosure, ensuring disclosure for large and transnational companies and financial institutions.

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Citizen and consumer awareness of nature and sustainability topics as well as interest in sustainable products is increasing, according to certain studies

Growing awareness…

Over 159 million people have signed online petitions in support of nature since 2016[2]

For example, over 3 million people in nearly 100 countries have signed the **Global Deal for Nature petition** calling for protection and restoration of half of the Earth's land and ocean[1]

The popularity of Google searches relating to sustainable goods increased by 71% globally between 2016 and 2020[2]

Searches for **terms related to biodiversity and nature loss** also grew by 16% globally[2]

… could translate into behaviour shifts

In a global consumer survey, **more than 70% of people** reported making modest to significant **changes to their consumption behaviours** to live more sustainably[3]

The same survey found that **more than 30% of people** reported a **willingness to pay 20-40% more for sustainable** products,[3] while market research has shown that sustainability-marketed products enjoy an average price premium of more than 25% in the US[4]

Across certain categories, including coffee and skin care, **sustainably-labelled products** have come to represent **more than 20% of consumer goods produced and purchased**[5]

1. Global Deal for Nature 2. Relative to all searches. Economist Intelligence Unit 3. The study surveyed 11,711 consumers from the US, multiple European countries, Brazil, China, Singapore, Australia, UAE and India. 2022 Global Sustainability Study 4. Based on data from over 250,000 consumer products in the US. Sustainable Market Share Index 5. Sustainable Market Share Index (based on data from over 250,000 consumer products in the US), What is Sustainable Palm Oil (based on global palm oil supply), Coffee Prices and Sustainability (based on global coffee production)

Note: It is of course paramount for the development of a sustainable and inclusive economy that companies back any sustainability-related claims they make with genuine actions. "Greenwashing," which refers to empty or misleading claims about the environmental or social attributes of a product or service, poses reputational risks to businesses, erodes consumers' trust—as well as their ability to make more environmentally and socially responsible choices—and potentially undermines the role of regulators.

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Efforts to improve terrestrial biodiversity have typically been aimed at reducing the footprint of agriculture, as well as on habitat protection and restoration

Examples of actions to reduce the environmental impact of agriculture could include:[1]

- **Reducing food waste to increase consumption efficiency** could reduce the land footprint of agriculture. One-third of food is currently wasted, such that an agricultural area larger than China is used to produce food that is not eaten each year[5]
- **Improving agricultural yields in sustainable ways** could produce more food with less land.[7] Agricultural land is estimated to need to expand by more than 3 billion hectares by 2050 to feed the world if yields remained at 2010 levels[5]
- **Shifting diets away from ruminant meat consumption** could free up pasture and cropland. Ruminant meat production is estimated to use 20x more land per gram of protein than plant-based protein sources[5]

Examples of actions to restore and manage land to improve habitats and biodiversity could include:[1]

- **Increasing the proportion of land under protection** could preserve vital habitats. Scientists call for 30% of land to be protected, at minimum, with some researchers advocating for 50% globally or up to 80% in specific ecosystems[2]
- **Taking action against deforestation** could preserve forests and species. 10 million hectares of forest were lost annually from 2015 to 2020,[3] but maintaining forests is estimated to have the potential to safeguard more than half of terrestrial biodiversity[3]
- **Boosting efforts to restore land** that is degraded could improve biodiversity outcomes. Up to 40% of land is currently degraded,[6] and restoration could increase biodiversity by an average of 20%[4]

1. Selected actions are based on WRI. 2. Nature Beyond 2020 3. FAO 4. Relative to biodiversity in degraded sites. Atkinson et al. (2022) 5. WRI 6. UNCCD 7. This could be complemented by regenerative agricultural processes that could benefit biodiversity (Levin (2022)) and improve soil quality and fertility (Bradford et al. (2019)), with potential to increase yield resilience (Qiao et al. (2022)). Furthermore, effective management of fertiliser runoff could help reduce impacts on aquatic biodiversity (Jwaideh et al. (2022)).
Note: In addition to the actions listed above, the CBD's COP 15 biodiversity framework recognises the importance of phasing out harmful incentives and subsidies that can negatively impact biodiversity. A report by FAO, UNDP and UNEP finds that price incentives and fiscal subsidies in the agricultural sector "incentivize production practices and behaviours that might be harmful to the health, sustainability, equity and efficiency of food systems."

INEVITABLE POLICY RESPONSE

Policy on nature is primarily driven by government expenditure but could be supplemented by private sector investment via nature and related carbon markets

Current state of nature financing

UNEP estimates that investment in nature needs to increase by more than four times by 2050, climbing from USD 154 billion annually to USD 674 billion annually[1]

The public sector is today's primary funder of nature-related action:

- **83% of investment comes from governments**, with nearly half of this money used to protect biodiversity and landscapes[2]
- **Just 17% is supplied by the private sector**, primarily though investment in sustainable supply chains and mandatory biodiversity offsets[2]

	Potential cost	Example policy with funding
Land protection	Implementing protection for 30% of land and sea could cost **USD 103-178 billion/yr**, including effective management of existing protected areas, according to the Waldron report[6]	**Costa Rica's Payments for Environmental Services programme[3]** pays landholders to protect forestland and is funded by a fuel tax and the sale of certified carbon offsets
Land restoration	Restoration of just 5% of global land could cost **USD 26-82 billion/yr**, based on restoration costs of USD 1,200-3,800/ha for forest restoration, which are cited by the Trillion Trees initiative[7]	**Guatemala's PROBOSQUE programme[4]** uses government funds to pay landholders to reforest their land and for each tree grown within their farms in agroforestry systems
Markets for nature and carbon	Nature markets (via biodiversity credits) and carbon markets (via NBS-based carbon credits) could **direct private sector finance toward land conservation** that could drive positive nature and carbon outcomes	**Australia's Threatened Species Action Plan** aims to work with the financial sector to **increase private financing of landscape conservation and restoration** through development of a market for biodiversity[5]

1. Investment in nature is defined as finance flows that positively contribute to nature-based actions to protect biodiversity and/or sequester and store greenhouse gases and/or sustainably manage and/or restore degraded land and seascapes. Required investment is based on a scenario in which the world acts immediately to limit warming to 1.5°C, stabilise biodiversity intactness, and achieve land degradation neutrality by 2030 (UNEP). 2. UNEP 3. CBD 4. WRI 5. Australian government 6. Waldron et al. (2020) 7. Assumed restoration costs are based on a range of CAPEX required for forest restoration in Brazil, with the global average of USD 2,328/ha falling within this range (Trillion Trees, which is supported by BirdLife International, WCS and WWF). The calculation assumes a linear increase in the quantity of land restored from 2020 to 2050.

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Policy action on nature could add additional risk considerations for investors who are increasingly incorporating climate risks into decision making

Potential transition risks can be grouped into four categories:

ILLUSTRATIVE

	Policy risk	Demand risk	Reputational risk	Supply chain risk
Description	Policies may **directly impose costs** on specific activities	Demand may be affected by **changing consumer preferences**, impacting product-specific revenue	Consumer **perceptions of a brand may impact demand** for a company's products	Risks **derived from the supply chain** may impact a company's market access or increase the cost of inputs
Example climate impacts	**Carbon pricing** may increase costs as firms pay a tax or upgrade operations to reduce emissions (e.g., NZ land use emissions pricing proposal) **Reporting and disclosure requirements** may impose data collection costs	Consumer concerns about emissions and health may reduce **demand for ruminant meat** in some regions (e.g., Finland's dietary guidelines for meat consumption) Shifts to electric vehicles may reduce **demand for first-generation bioenergy used for fuel**	Consumers could purchase equivalent products from competitors with **deforestation-free supply chains** (e.g., consumer petition that led to the provisional EU due diligence framework) A company's lack of action on reducing its emissions may lead to **perceptions of environmental-unfriendliness**[1]	Increased costs due to **carbon pricing may be passed on** to downstream companies in the same jurisdiction (e.g., Singapore's carbon tax) Carbon border taxes may **affect costs for importers** of carbon intensive products (e.g., the EU's provisional CBAM)
Example nature impacts	**Additional dimensions to reporting** and disclosure may also increase costs (e.g., TNFD) **Operation in protected areas** may result in additional costs or fines, potentially requiring changes in operating location (e.g., EU expansion of protected areas via biodiversity strategy)	Declines in **ruminant meat demand** may be reinforced by concerns about habitat destruction Concerns about habitat destruction from feedstock production may reinforce reduction in **demand for first-generation bioenergy** (e.g., EU policy action to phase-out palm and soy-based biofuels before 2030)	Consumer **demand for transparency** may encompass additional dimensions like the impact of company operations on biodiversity, especially in sectors with high public scrutiny (e.g., the consumer goods sector) Companies with adverse nature impacts may experience relatively **higher cost of capital**[2]	Relocation costs or disruptions in supply may result from protected areas legislation and could be **passed down the value chain** (e.g., for tropical commodities) A company with **deforestation in its supply chain** may not be able to sell its products on certain markets (e.g., US proposed FOREST Act)

1. An international survey found that most consumers say that it is important for brands to operate with environmental sustainability, incl. cutting carbon emissions (Stifel) 2. Lenders may charge higher interest rates on loans to companies with environmental concerns (Chava (2014)).
Note: Transition risk categories and examples are not exhaustive.

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Tackling the climate and nature transition in an integrated fashion is consistent with the direction of government and private sector action

Climate change and nature loss are interlinked crises

- **Climate change threatens 11,000 species** already at risk of extinction[1]
- **Protecting, conserving and restoring nature and ecosystems is vital for effective and sustainable climate action**, as underlined in agreement text from the UNFCCC's COP 27[2]
- **Habitat loss is estimated to exacerbate climate change** by producing GHG emissions, with deforestation responsible for 10% of anthropogenic emissions in 2019[4]

Many carbon offsets could be required to account for nature

- **Natural climate solutions can deliver one-third of the net emissions reduction** needed for Paris-aligned warming[5] (e.g., through habitat improvement via land restoration, potentially resulting in benefits to biodiversity)
- **Nature-based solution carbon credit guidance and standards are increasingly requiring the safeguarding of biodiversity** as a minimum requirement[6]

Reporting on nature is becoming aligned with climate standards

- **The TNFD will release a framework** for nature-related risk disclosure (in 2023) that may become increasingly mandatory, building on the TCFD framework for climate-related risk[7]
- **100+ financial institutions have committed to** "assessing their own biodiversity impact, setting targets and reporting on biodiversity matters by 2024" as part of the Finance for Biodiversity Pledge[8]

1. IUCN 2. UNFCCC 3. Race to Zero 4. IPCC AR6 WG Deforestation accounts for 45% of AFOLU emissions and AFOLU emissions were responsible for 22% of global anthropogenic greenhouse gas emissions in 2019 5. WEF 6. WRI 7. Geographies like the UK, EU, and US have taken steps to mandate elements of TCFD reporting. 8. Finance for Biodiversity

INEVITABLE POLICY RESPONSE

The newest IPR scenarios and value drivers have been released

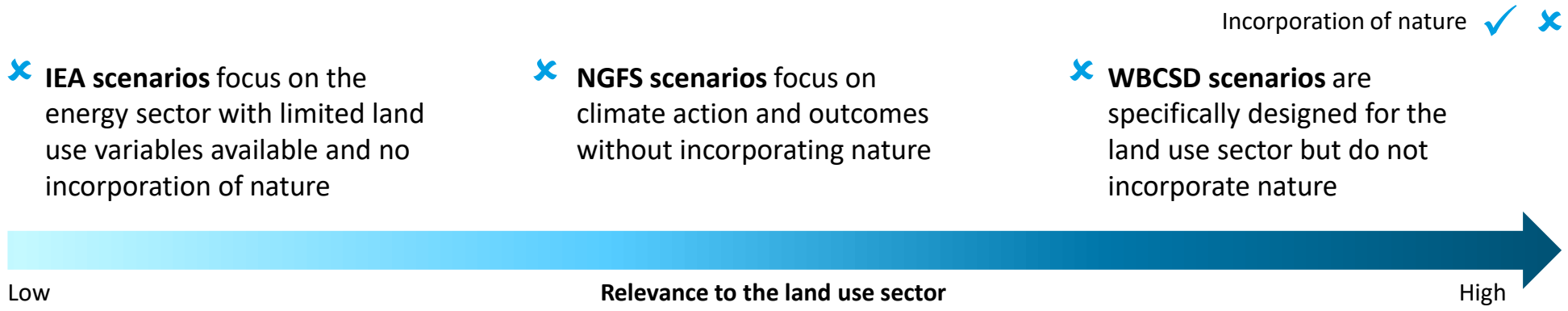
Please visit the **PRI website** here for more information

IPR FPS + Nature and FPS 2022 value drivers can be found here

Scenarios are not yet available for investors to fully engage with the integrated climate and nature transition, limiting the ability to conduct risk analysis

	Mainstream scenarios focus primarily on climate	Scenarios often overlook the land use sector
Relationship to nature	Nature-related policy is **increasing and could be additional** to action to address the climate crisis	**Nature-related policies** and outcomes often focus heavily on the land use sector given its impact on biodiversity
Gap for investors	A scenario that neglects nature **may be incomplete**. Output variables do not account for nature-related action	**Few scenarios are available** for assessing risks and opportunities for companies that use land or land-intensive products as an input
Consequences of gap	Investors have limited resources outlining the **consequences of nature-related action** and how it might affect value	Investors have limited resources outlining the transition impacts on **portfolios tied to the land use sector**

Although some scenarios are relevant to the land use sector, no existing scenarios incorporate nature[1]



1. NGFS recognises the need to develop integrated climate and nature scenarios, advocating for "an integrated approach to scenario construction." TNFD, in its proposed approach to scenario analysis, sets a goal to "work towards an approach to the use of scenarios that fully integrate considerations of climate and nature."

FPS + Nature is the first integrated, exploratory nature and climate scenario ever published for use by investors

The release of the IPR's FPS + Nature adds an additional module to augment the IPR's existing climate scenarios

The IPR's existing scenarios focus on forecast (FPS 2022) and required (1.5°C RPS 2021) **climate-related policies**, tracing their impact on the energy and land use sectors to produce investor-relevant value drivers

FPS + Nature (2023) explores the impact of forecast **climate- and nature-related policies**, focusing on the land use sector to produce a new database of value drivers to capture initial indications of the potential effect of action on nature

Note: Modelling of energy-related value drivers has not been updated since IPR FPS 2021; energy-related value drivers are underpinned by Quarterly Forecast Trackers that confirm policy momentum towards FPS

The IPR's FPS + Nature incorporates key additional policy levers that support the nature transition – land protection, land restoration and nature markets

Included in FPS

Energy-related policy levers

Carbon pricing

Carbon taxes and emission trading systems, along with border carbon adjustments

Coal phase-out

Regulations prohibiting coal, emissions performance standards, and electricity market reforms

100% clean power

Targets for 100% clean power, along with renewables capacity auctions and other support policies

Low-carbon buildings

Laws prohibiting fossil fuel heating, subsidizing low-carbon heating and requiring thermal efficiency; for appliances, minimum energy performance standards

Clean industry

Emissions performance standards for industrial plant, along with subsidies for new or retrofit clean industrial processes

Zero emission vehicles

ZEV consumer subsidies along with legislation requiring 100% zero emission vehicle (ZEV) sales and implementing manufacturer ZEV obligations

Land-related policy levers

Forestry

Incentives for reforestation and afforestation, along with penalties for deforestation, supported by consumer pressure

Low-emissions agriculture

Subsidies for low-emissions practices and technologies; emissions regulation incl. via tax or cap-and-trade systems; farmer education and technical assistance programmes

Included in FPS + Nature

Nature-related policy levers

Land protection and restoration

Policies to protect biodiversity hotspots and additional habitats, along with regulation mandating restoration of degraded land

Nature markets

Emerging legislation and targets for biodiversity outcomes that support the development of voluntary biodiversity credit markets

Note: Key policy levers are listed here, but additional policy levers related to food waste, bioenergy, and diets are also incorporated when assessing the climate and nature trends that feed into the FPS + Nature modelling.

INEVITABLE POLICY RESPONSE

FPS + Nature attempts to help investors understand how the effects of both nature and climate policies could shape the future of land use

By using granular value drivers from FPS + Nature, investors can potentially understand:

Impacts and effects: how the low carbon transition and nature-related policy action could interact

Related risks and opportunities: how existing climate-related considerations could evolve and be affected by nature policy

Additional nature impacts: Explore the price of agricultural commodities as land conservation measures are implemented along with anti-deforestation action

Nature tradeoffs: Examine region-specific changes in production of commodities influenced by land under conservation

Risks: Conduct risk assessments using geographically-granular value drivers that incorporate the effects of both nature and climate action on commodity production

Opportunities: Identify potential new opportunities that may not result from climate policies alone

FPS + Nature is a first-of-a-kind integrated, exploratory scenario

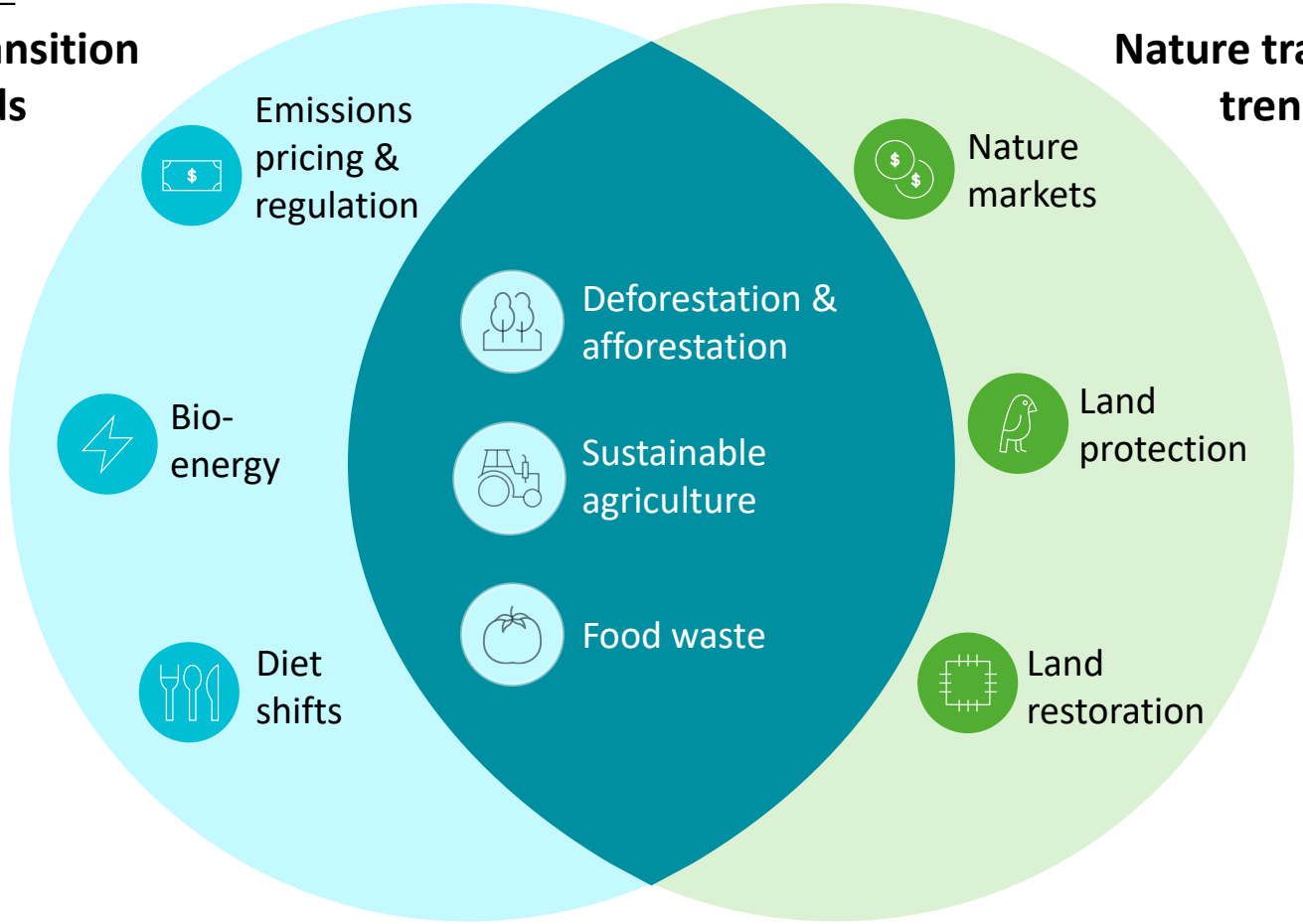
- **FPS + Nature accounts for action addressing both the climate and nature crises** to explore a synergistic perspective of the possible future as a ‘beta version’ scenario
- **FPS + Nature helps investors broaden their view of the future** that does not account for significant and accelerating policies that address nature loss, additional to (and overlapping with) policy action on climate

INEVITABLE POLICY RESPONSE

INEVITABLE POLICY RESPONSE

FPS + Nature incorporates interrelated, policy-supported climate and nature trends that could be material to investors

NOT EXHAUSTIVE



Assessed trends are:

Driven by policy action to address both the climate and nature crises

Underpinned by technological development and readiness indicating plausibility

Supported by market shifts demonstrating complementary action and support by firms, consumers, and citizens

Note: Because climate and nature are highly interrelated, the distinction depicted in this diagram is a simplification.

INEVITABLE POLICY RESPONSE

FPS + Nature focuses on policy related to the land use sector, which is the largest contributor to global biodiversity loss

FPS + Nature scope

IN SCOPE: FPS + Nature includes a comprehensive assessment of the impact of land use-related policies

- Land use change has the **largest impact on terrestrial ecosystems**, compared to other key drivers of biodiversity loss[1]
- Land use and human population change alone have **substantially impaired ecosystem function** across nearly 30% of terrestrial surface area.[2] 75% of deforestation is caused by the food system, which **threatens 86% of species at risk** of extinction[3]

FPS + Nature also considers policies that address climate change and direct exploitation of organisms (especially trees in forests)

OUT OF SCOPE: FPS + Nature focuses on land use impacts and thus does not account for:

- **Policies regulating the marine and freshwater environment** (e.g., the UN Convention on the Law of the Sea regulates the location of fishing activities)
- **Policies regulating pollutants not related to agriculture** (e.g., the EU's Directive on single-use plastics restricts the sale of certain products that cause pollution)
- **Regulations on invasive species** (e.g., the US National Invasive Species Act prevents the spread of specific species found to be harmful)

6 direct drivers of nature & biodiversity loss[1]

Changes in land use – modification and destruction of habitats

Climate change – temperature and precipitation changes to which species are not adapted

Direct exploitation of organisms – removal of species and habitats for their direct use

Changes in sea use – modification and destruction of habitats

Pollution – degradation of the quality of soil and water, which disrupts habitats

Invasion of alien species – competition with native species, spread of disease and removal of niches

1. IPBES 2. Newbold (2018) 3. Edie, citing Chatham House

FPS + Nature focuses on transition risks, in line with the IPR's objectives

Focus of FPS + Nature

	Transition risks	Physical risks
Definition	**Result from developments that aim to address nature and climate issues**, such as government regulation and policy[2]	**Result from dependence on the stability of nature and climate**; arise when planetary systems are compromised; can be event-driven (acute) or longer-term shifts (chronic)[2]
Example	**Regulatory requirements**; changes in market demand; mandated reporting; reputational impacts; technology availability[2]	**Acute:** Extreme weather[2] **Chronic**: Increases in global temperatures; loss of ecosystem services (e.g., pollination); changes in soil quality[2]
Relation to FPS + Nature	**Transition risks are modelled** (e.g., the impact of emissions regulation in the land use sector is assessed)	**Acute physical risks are held constant in the modelling** (e.g., the impact of increased frequency of extreme weather on crop yields is not incorporated) while climate-related chronic physical risks are included[3]

- **The IPR focuses on an acceleration of policy responses** to environmental issues with the aim of preparing investors for resulting portfolio risks and opportunities[1]
- **Nevertheless, both physical and transition risks are relevant to investors**, and additional work is required to provide investors with a better understanding of such physical risk

1. UNPRI 2. TCFD; TNFD 3. Modelled chronic physical risks include changes in average temperature and average precipitation rates, both of which impact crop yields; modelling does not account for nature-related chronic physical risks, such as loss of pollination. For more information on physical risks modelled in MAgPIE, please see a description of the underlying LPJmL model here.

FPS + Nature follows a rigorous approach to assess emerging trends, underpinned by policy development as well as technological and market shifts

Geographic variation is considered throughout the process, with research and parameterization occurring at the regional level

1 Compile existing legislation and announced commitments

Collect information on nature-related legislation, commitments and initiatives related to **protected areas, land restoration, and nature markets**

Incorporate climate-related information from the IPR's ongoing policy tracking (summarised in Quarterly Forecast Trackers), focusing on **agriculture and forestry**

2 Evaluate credibility of announced commitments

Collect **source** of announcements

Account for **track record** of previous environmental action

Account for **historical trends** to ensure announced changes are realistic

Evaluate geography-specific **quality of governance**

3 Assess development of technology and market shifts

Evaluate progress of **technology** development

Examine emerging **markets** for sustainable goods and services

Account for direction and magnitude of **citizen attitudes** towards environmental action, suggesting civil society support for new policies

4 Define policy-related trends and trajectories

Use **existing and future policy** to define trajectories of policy development

Consider development of technology and market shifts to ensure that assessed trends are **realistic and supported** by citizens

5 Parametrize key trends for scenario modelling

Incorporate assessed policy trends along with technological and market trends to **estimate change** in the value of modelling levers

Assign a **quantitative value** to key modelling levers

1. FPS + Nature refreshes policy assessments from FPS 2021 to incorporate new developments on climate and emerging commitments on nature

		Source of information	Example of policy or commitment
Climate	**Emissions pricing and regulation**	Carbon pricing schemes, including taxation and emissions trading schemes; net zero targets; national emissions-reduction strategies and commitments	US: USDA plan to reduce 50% of emissions in the agricultural sector by 2050; New Zealand: proposal to price emissions in the agricultural sector from 2025; 125 countries: Global Methane Pledge to target 30% reduction in CH_4 emissions (2020-30)
	Bioenergy	National renewable energy regulation; national renewable energy strategies; net zero targets	UK: 2021 policy paper setting out a key role for sustainable biomass in a transition away from fossil fuels; multiple countries, including the US and EU: subsidies for bioenergy and biofuels
	Diet shifts	National regulatory policy on alternative proteins; national alternative protein investment strategies; proposed legislation related to conventional animal meat	EU: Farm to Fork strategy prioritising development of alternative proteins; Germany: proposed 'animal welfare levy' on meat, dairy and eggs; US: USDA and FDA plan to create a joint regulatory framework for cell-based meat product approval
Overlapping climate and nature	**Deforestation and afforestation**	National legislation regulating forests and logging; Nationally Determined Contributions (NDCs); commodity-specific laws; trade and public procurement policies	US: proposed FOREST Act to prohibit entrance of agricultural commodities produced with illegal deforestation; EU: Timber Regulation to prohibit entrance of illegally sourced wood; Brazil, DRC and Indonesia: strategic alliance on forest conservation
	Sustainable agriculture	National climate strategies; NDC commitments; national agricultural strategies and objectives; government-led programmes to reduce emissions from agriculture	Turkey: NDC aiming to control the use of fertilisers; EU: Farm to Fork Strategy targeting 20% reduction in fertiliser use by 2030; UK: 2018 Clean Growth Strategy aiming to encourage the use of low-emissions fertiliser
	Food waste	UN goals; national policies and commitments related to food waste; national food waste regulation	UK: commitment to halve per capita food waste by 2030, with action such as rolling out separate household food waste collection by 2023; Italy: tax rebates for retailers donating food about to be wasted
Nature	**Nature markets**	UN goals; emerging biodiversity and nature targets; national nature strategies; government announcements related to biodiversity credit markets	Australia: proposed government support for a voluntary biodiversity credit market; UK: Environment Act including a legally binding target for species abundance; nearly 200 countries: National Biodiversity Strategies and Action Plans under CBD
	Land protection	National nature strategies; NDC commitments; other national commitments, e.g., in support of CBD's 30x30 target; national legislation	More than 190 countries: CBD's COP 15 commitment to protect 30% of global land and sea by 2030; US: President Biden's commitment to conserve 30% of national land by 2030; EU: Biodiversity Strategy to enlarge protected areas
	Land restoration	National nature strategies; NDC commitments; national restoration commitments; target setting under the UNFCCC, CBD and UNCCD; global and regional initiatives	More than 190 countries: CBD's COP 15 commitment for 30% of global land and sea to be under restoration by 2030; Latin America: Initiative 20x20 to bring more than 50M hectares of degraded land into the process of conservation and restoration by 2030; China: Master Plan for the Protection & Restoration of Important National Ecosystems

2. Due to their uncertainty, announced commitments are evaluated based on source, track record, historical trends and geography-specific quality of governance

Evaluate policy ambition based on source of announcement

Announced commitments are taken as an upper bound for policy ambition

Commitments are evaluated based on whether they are supported by a published strategy or enacted legislation

Evaluate policy ambition based on track record

The assessment is adjusted according to:

A region's nature-related track record of developing and implementing policies to protect nature

A region's climate-related track record in reducing emissions and implementing environmental action

Evaluate historical trends

Historical trends in progress on nature outcomes are used to establish a likely upper bound for increases in nature outcomes, based on historical outcomes (e.g., the largest regional increase in the area of land under protection in FPS + Nature is 12 percentage points by 2030, slightly exceeding the increase in area under protection in Developed East Asia between 2016 and 2021[1])

Adjust assessment based on geography-specific quality of governance

A region-specific quality of governance index is constructed based on the World Bank's Worldwide Governance Indicators[2]

Assessed policy outcomes are adjusted according to a region's value on the governance index. A region's progress is capped based on its score on the governance index

1. Data is not available prior to 2016. Developed East Asia is the region with the highest increase in land under protection for this period, thus is taken as an upper bound for feasibility. Data is provided by the World Bank. 2. World Bank

INEVITABLE POLICY RESPONSE

3. Market shifts and technological developments are also assessed to understand how broader global trends could interact with policy

Developed trend Emerging trend

NOT EXHAUSTIVE

	Trend	Supporting market and technological developments	Related policy action
Diet shifts	Consumer behaviour may signal a **shift away from ruminant meat consumption** in some regions while technology to produce alternative proteins may improve	**Decreases in per capita meat consumption** have been observed in New Zealand, Paraguay, Canada, Switzerland, Nigeria, and Ethiopia[1] (source) **The cost of lab grown-meat** is decreasing due to improvements in technology (source) **Price parity for plant-based meat** has been achieved in the Netherlands (source)	Research & development and commercialisation support for alternative proteins Implementation of emission pricing and regulation in the land use sector
Deforestation and afforestation	Consumer and private sector awareness and action on deforestation may increase, potentially indicating **increased support for more anti-deforestation action** from governments	**1.2 million EU citizens** demanded a strong law against deforestation (source) **Financial institutions** with USD 8.9 trillion in assets under management have signed the Commitment on Eliminating Agricultural Commodity-Driven Deforestation, targeting 2025 (source) **Commodity-specific certified production** area under the Roundtable on Sustainable Palm Oil, which combats deforestation, has increased 140% since 2017 (source)[5]	Bans on the sale of products linked to deforestation More stringent enforcement of policies that regulate forests and logging
Food waste	Private sector commitments may be supported by technology aimed at consumers and corporates to **reduce food waste further**	**The Consumer Goods Forum**, representing 400 companies across 70 countries, resolved in 2015 to halve food waste from within the operations of its members by 2025 (source) **Technology designed to reduce food waste** is emerging[3] with USD 1.9 billion in funding for solutions raised by technology companies in 2021 alone (source)	Bans on the discarding of unsold food for restaurants and supermarkets Policies to collect food waste separately from household waste
Nature markets	**Increasing private sector action** on biodiversity may be supported by emerging certifications and regulatory standards along with consumer sentiment	**Private sector companies** are setting biodiversity targets: 51% of Fortune 500 companies acknowledge biodiversity loss and 5% have set quantified targets[2] (source) **Verra** has certified over 200 projects according to its Climate, Community & Biodiversity (CCB) Standards (source), **South Pole** has developed EcoAustralia™ credits that leverage Australian Biodiversity Units (source), and **GreenCollar** has launched NaturePlus™ credits for biodiversity outcomes (source) **82% of people[4]** believe that companies have a moral obligation to assure positive impacts on people and biodiversity (source)	Mandated no harm principles for corporate sector actions that impact biodiversity levels Support for voluntary markets for high-quality biodiversity credits to deliver positive biodiversity outcomes

1. For the period of 2000 to 2019. 2. In comparison, 83% of companies have set quantified climate targets. 3. This could include apps that suggest recipes given available ingredients or AI-based sales forecasting for food retailers and restaurants.
4. Underpinning this statistic, 6,000 people from Brazil, France, Germany, Switzerland, the UK, and the US were surveyed by the Union for Ethical Biotrade's 2020 Biodiversity Barometer. 5. Zero deforestation standards have been developed for other commodities as well, including soy and paper.

INEVITABLE POLICY RESPONSE

4. FPS + Nature assesses possible policy trajectories based on existing and future commitments, influenced by technology and market shifts

Expected positive impact

Expected negative impact

NOT EXHAUSTIVE	FPS + Nature trend	Indicative impact on nature
Emissions pricing and regulation	**Emissions regulation and reduction policies could emerge in the land use sector**, with some developed countries implementing forms of carbon pricing in the land use sector before 2030	**Incentivises habitat preservation and restoration** in carbon-rich natural environments through NBS
Bioenergy	Governments could regulate the use of less sustainable first-generation bioenergy and shift towards **production of second-generation bioenergy**	**Reduces land available for habitats and species** due to increased demand for land
Diet shifts	Government action in developed countries could increase the **cost of ruminant meat production** in comparison to other protein sources, through emissions regulation and support for alternative protein development	Reduces demand for ruminant meat consumption, which **reduces pressure on land available for habitats**
Deforestation & afforestation	**Increased policy stringency on deforestation-linked commodities in importing countries** could increase international momentum to halt deforestation in exporting countries	Reduces production of deforestation-linked commodities, which **reduces habitat destruction**
Sustainable agriculture	Government funding for sustainable agricultural practices underpinned by commitments to reduce fertiliser use could **increase nitrogen uptake efficiency in crop production**	**Reduces habitat degradation** resulting from fertiliser run-off and overapplication
Food waste	Governments could act to **scale and augment initiatives to reduce consumer and private sector food waste**, resulting in a smaller proportion of food being wasted	Reduces demand for agricultural land, which **reduces land conversion** caused by agricultural expansion
Nature markets	**Increasing formalisation of biodiversity targets and nature-related regulation** could support the emergence of voluntary biodiversity credit markets	Increases implementation of **market-based incentives to improve biodiversity** outcomes
Land protection	Government action to safeguard biodiversity could involve introducing and **strengthening regulation to protect land**, including biodiversity hotspots	Increases quantity of land that is safeguarded with **increased protection of vital ecosystems**
Land restoration	Governments across the world could **increasingly act to restore degraded ecosystems** through public restoration programmes, supplemented by private sector financing (e.g., through carbon credits for afforestation)	Increases number of land restoration initiatives to **improve quality of degraded habitats**

INEVITABLE POLICY RESPONSE

5. FPS + Nature estimates changes in key policy-related trends at the global and regional level

In comparison to FPS 2021: Update[1] Addition

		FPS + Nature		
		2020	2030	2050
Climate **Update:** Diet shifts are adjusted to better account for regional variation, consumer responses to prices, and slower-than-initially-anticipated alternative protein market growth	**Emissions pricing and regulation**[2] USD/tCO_2 in the land use sector, implicit[3]	<1	54	105
	Bioenergy EJ production of second-generation bioenergy	8	17	90
	Diet shifts Ruminant meat production (Mt DM/yr)	38	40	37
Overlapping climate and nature **Update:** Sustainable agriculture levers account for emerging policy ambition to improve nitrogen fertiliser use efficiency while food waste reduction ambition increases	**Deforestation and afforestation** Forest land (Mha)	4,000	4,100	4,300
	Sustainable agriculture Nitrogen uptake efficiency (%)[4]	56	60	65
	Food waste % of food wasted	26	24	20
Nature **Addition:** New modelling levers are added to account for nature-related policy action	**Nature markets** USD/ha/yr for a biodiversity credit	<1	12	45
	Land protection[5] % global terrestrial protected surface area	15	20	24
	Land restoration % global terrestrial surface area under restoration[6]	0	4	6

1. Updated levers are aligned with the most recent release of FPS (FPS 2022 – see Appendix) 2. Weighted average of modelled implicit carbon price 3. Implicit carbon prices proxy for a range of policies/regulations targeting a reduction in land use emissions 4. Average across regions 5. FPS 2022 accounts for current protected areas and protection of biodiversity hotspots only, after 2025 and limited to a subset of countries 6. Additional restored terrestrial land compared to 2020 (intentional restoration only, occurring due to human intervention)

Note: All values shown here are at the global level

INEVITABLE POLICY RESPONSE

FPS + Nature uses the MAgPIE model to produce indicative value drivers based on assessed policy, technology and market trends

The Model of Agricultural Production and its Impact on the Environment (MAgPIE) is a world class open-source land use model

INPUTS

Food demand
- Population
- GDP
- Dietary choices
- Demand elasticities

Policies and climate & nature action
- Carbon or biodiversity prices
- Action to combat deforestation
- Bioenergy demand
- Land protection and restoration

Biophysical and climate data
- Temperature increase associated with RCP scenario
- Biophysical constraints of crops and vegetation

MAgPIE

Investments
- Technological change, such as new crop varieties or farm machinery
- Irrigation investments

Land conversion
- Investments to convert to new land use type

Optimisation

Technical mitigation
- Investments into mitigation measures such as R&D for yield improvements

Trade
- Regional demand is met by domestic production and imports, with some constraints on trade

OUTPUTS

- Emissions and biodiversity levels
- Production of key commodities
- Food and land prices
- Land use change
- Costs of afforestation, technology change and production inputs

Note: The model is represented linearly for simplicity. More information on the model can be found here and here.

Source: Dietrich J, Bodirsky B, Weindl I, Humpenöder F, Stevanovic M, Kreidenweis U, Wang X, Karstens K, Mishra A, Beier F, Molina Bacca E, von Jeetze P, Windisch M, Crawford M, Klein D, Singh V, Ambrósio G, Araujo E, Biewald A, Lotze-Campen H, Popp A (2022). "MAgPIE - An Open Source land-use modeling framework - Version 4.5.0." doi: 10.5281/zenodo.1418752, https://github.com/magpiemodel/magpie.

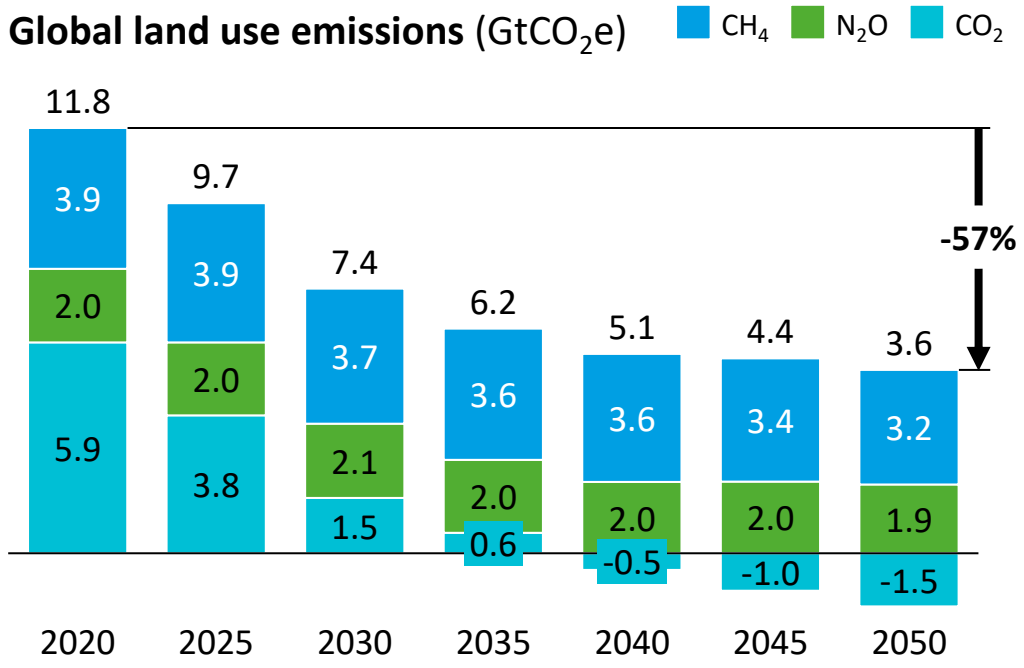
INEVITABLE POLICY RESPONSE

INEVITABLE POLICY RESPONSE

Emissions pricing and regulation: Governments in developed countries are beginning to introduce policies to reduce land use emissions

Policy trend: Government policies regulating land use emissions could increase in number, with some developed countries likely to implement forms of carbon pricing in the land use sector before 2030

Global land use emissions ($GtCO_2e$)



Existing action

There are a small number of countries with carbon pricing in the land use sector, e.g., land-based carbon offsets are permitted under California's cap-and-trade system[5] and Australia's carbon credit system;[6] explicit carbon pricing schemes for agriculture have been proposed in New Zealand[1] and Denmark[2, 8]

Legally binding emissions targets for agriculture have been introduced in some developed countries including Denmark, New Zealand and Ireland, e.g., Ireland's agricultural sector must reduce emissions by 25% by 2030[4, 3]

Trajectory in FPS + Nature

Developed countries could begin to introduce carbon pricing in the land use sector before 2030 via explicit pricing schemes (incl. through fuel taxes) or inclusion of land-based offsets in mandatory carbon markets; developing countries could move more slowly

Accelerating emissions regulation could incentivise the use of nature-based solutions (NBS) to produce carbon credits, with large potential for production of NBS-based carbon credits at lower costs in developing countries; NBS-based carbon markets may be supplemented by emerging nature markets[7]

Emissions regulation may also encourage adoption of low-emissions agricultural practices, such as nitrogen-fixing crop rotations and livestock feed additives, while making emissions-intensive commodities more expensive to produce

1. New Zealand government 2. Council on Economic Policies 3. Non-binding global targets such as the Global Methane Pledge also impact agricultural emissions. 4. Irish government. Compared to 2018 levels 5. Center for Climate and Energy Solutions 6. Australian government 7. See subsequent slides for more information on biodiversity credit markets. 8. In addition, some countries, including Iceland, Mexico, and Ireland, impose carbon taxes on fossil fuels used across sectors (World Bank).

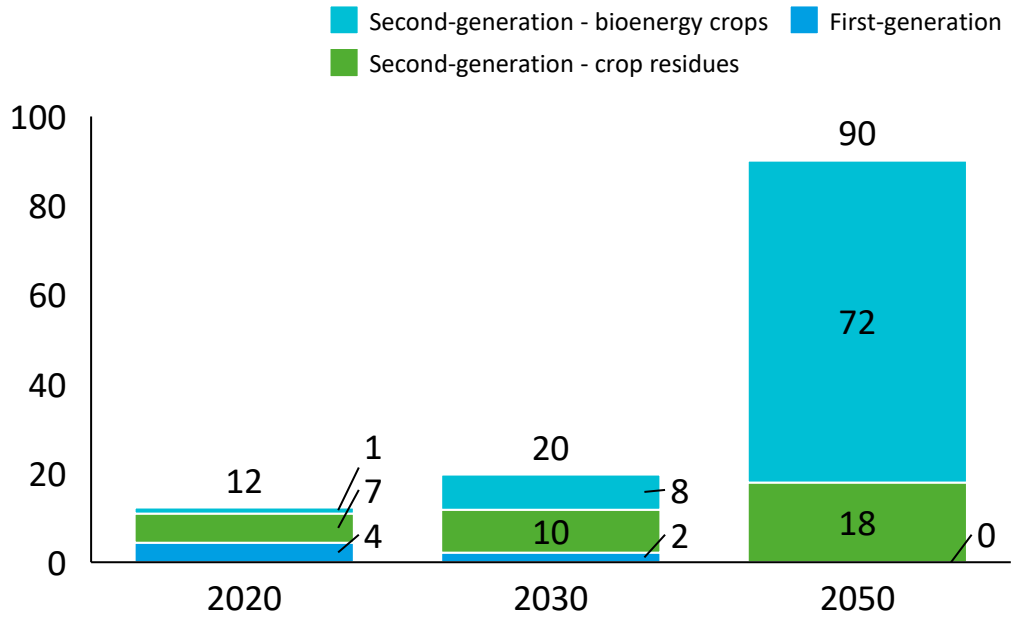
Note: 2020 baseline CO_2 land use emissions are aligned with the Global Carbon Project; N_2O and CH_4 emissions are aligned to FAO agriculture emissions, from FAO.

INEVITABLE POLICY RESPONSE

Bioenergy: Governments may incentivise second-generation bioenergy through R&D support and regulation, helping to meet decarbonisation goals

Policy trend: Second-generation bioenergy production could reach 90 EJ in 2050, as governments increase the stringency of bioenergy sustainability regulation and fund research and development

Global bioenergy production, by feedstock (EJ)



Existing action

Bioenergy accounts for one-tenth of global primary energy supply, with approximately half of this being traditional biomass (not pictured on graph)[4]

National strategies and sustainability criteria are emerging in developed countries, particularly the EU,[1] shifting bioenergy production towards more sustainable sources, including second-generation bioenergy

Government funding for second-generation bioenergy R&D is available in some developed countries, including Australia[2] and the US[3]

Trajectory in FPS + Nature

Second-generation bioenergy production could grow at 8.5% p.a. to 90 EJ in 2050, reflecting global policy support for second-generation bioenergy as an alternative to fossil fuels, through:

- **Carbon pricing in the energy sector**, which could increase the cost of fossil fuels, making bioenergy more attractive
- **Increases in government funding for R&D for second-generation bioenergy**, which could drive reductions in the cost of producing bioenergy
- **Stricter sustainability regulation,** which could promote a shift away from first-generation bioenergy, where feedstocks can be grown where food is produced

Second-generation biomass could primarily be used for power production and heating in conjunction with carbon capture and storage (CCS), with a relatively small proportion converted to liquid biofuels for use in hard to abate sectors[5]

1. European Commission 2. IEA 3. Tax credits for second-generation biofuel production are available as part of the IRA. 4. IEA 5. Hard to abate sectors include aviation and shipping

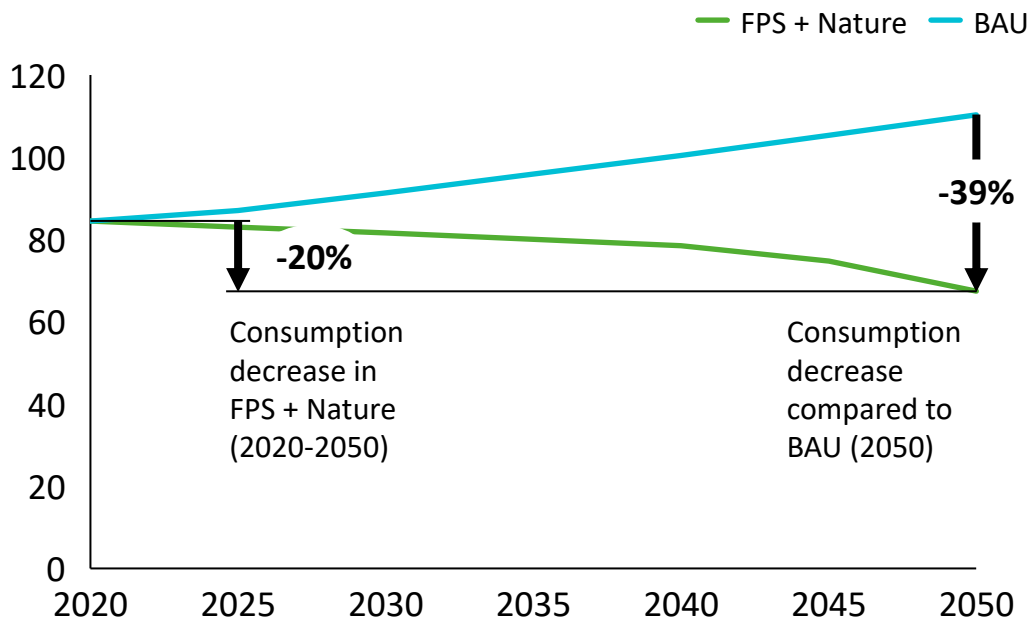
Note: First-generation bioenergy is produced from food crops. Second-generation bioenergy is produced from crop residues and dedicated bioenergy crops. Third-generation bioenergy is not considered and is produced from algae and wastes (Nanda et al. 2018). Traditional bioenergy is also not considered and refers to combustion of biomass such as wood, animal waste, and traditional charcoal (IRENA). 2020 baseline numbers are generally in line with IEA numbers for liquid biofuels and modern solid bioenergy use, although definitional differences make it difficult to establish perfect alignment (e.g., modern solid bioenergy is a broader category than the specific first- and second-generation bioenergy categories included in FPS + Nature).

INEVITABLE POLICY RESPONSE

Diet shifts: Decreases in ruminant meat consumption could occur over the long term if consumers switch towards alternative protein sources

Policy trend: The relative price of ruminant meat compared to other protein sources could increase through emissions regulation while policy support for alternative protein development could encourage consumers to shift away from ruminant meat consumption

Global ruminant meat consumption (kcal/person/day)



Existing action

Current global ruminant[1] meat consumption per capita is 85 calories per day,[2] reaching over 250 calories per day in Latin America's Southern Cone

Targets to reduce meat consumption have not been widely implemented, but exist in countries such as China[3] and Finland[4]

Alternative protein strategies and public investment are emerging primarily in developed countries, e.g., the UK has identified alternative proteins as a priority area for funding[6] and China will invest in R&D of alternative proteins as part of its 14th Five-Year Plan[8]

Taxes on meat and dairy have been proposed in a few developed countries, including Switzerland and New Zealand[5]

Trajectory in FPS + Nature

Per capita global ruminant meat consumption could fall by 20% (2020-2050), driven by an increase in the relative price of animal protein, due to:

- **R&D and commercialisation support for alternative proteins,** as governments create an enabling environment, accelerating technology development and decreasing prices, which could increase substitution of animal protein with alternative proteins, especially in developed countries
- **Policies that increase the cost of agricultural emissions**, which could impact the relative price of ruminant meat and accelerate consumer trends of decreases in per capita ruminant meat consumption, especially in developed countries[7]

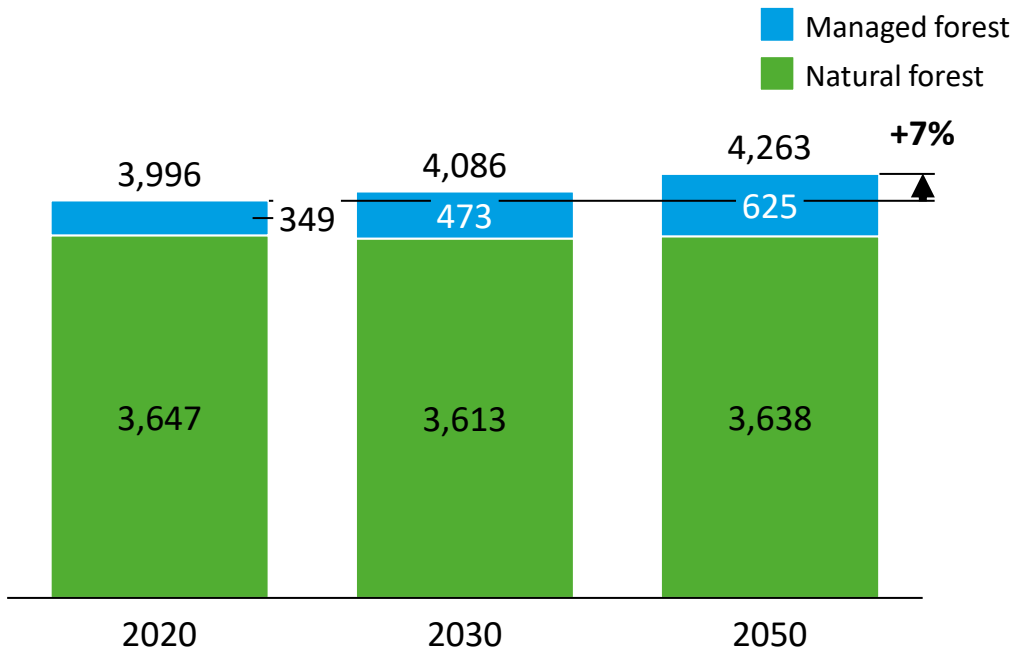
1. Ruminants are herbivores with three- or four-chambered stomachs, such as cows and sheep. 2. FAO 3. Guardian 4. Finnish government 5. TAPPC 6. UK government 7. Whitton et al. (2021) 8. AFN
Note: 2020 baseline per capita food demand is calculated by Bodirsky et al (n.d.), using dietary data such as incomes, age distributions and BMI, calibrated against historical food demand data from FAO.

INEVITABLE POLICY RESPONSE

Deforestation and afforestation: Increasing policy stringency on forest protection and anti-deforestation legislation may end net deforestation by 2030

Policy trend: Policies banning the sale of deforestation-linked commodities in major importing countries could increase international pressure to halt deforestation in exporting countries, with net zero deforestation by 2030

Global forest land (Mha)



Existing action

From 2010 to 2020, global net forest loss was 4.7 million hectares per year[1], driven by significant deforestation in tropical regions

There are widespread commitments to halt deforestation[2] **and increase forest land**, through international initiatives[3] and national pledges, such as China's pledge to plant and conserve 70 billion trees by 2030,[4] reflecting global ambition to end net deforestation

Leading commodity-importing regions are targeting deforestation-associated commodities through laws regulating their sale, such as the EU's provisional mandatory due diligence protocol[5]

Trajectory in FPS + Nature

Global forest land could increase by 273 Mha by 2050, with net deforestation ending by 2030, achieving levels of forest cover equivalent to levels in the early 1990s[6] and reflecting strong enforcement of legislation protecting forests in countries with high levels of deforestation

Regulation to prevent the sale of deforestation-linked commodities in leading commodity importing regions, such as the US and the EU, could drive more stringent forest protection policy in commodity-exporting regions, to maintain positive trade flows

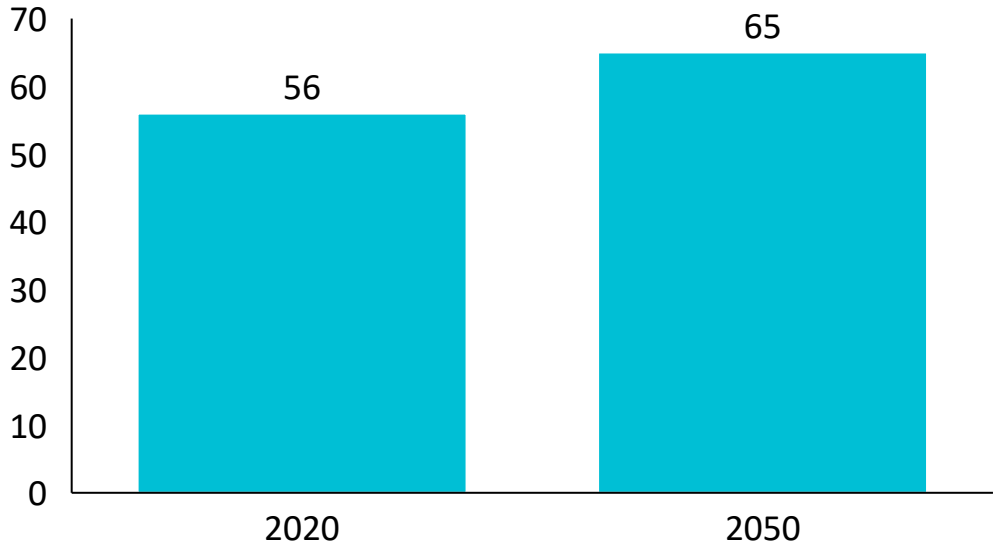
1. FAO 2. Nearly 150 countries have signed the Glasgow Leaders' Declaration on Forests and Land Use to halt and reserve forest loss by 2030. 3. International initiatives include the Bonn Challenge 4. WEF 5. European Commission 6. Our World in Data
Note: For additional information on policies targeting deforestation, please refer to the IPR's Supply Chain Analysis work. 2020 baseline managed forest area is taken from the FRA (2020) dataset. Natural forest area, by the sub-land-types primary forest, secondary forest and other natural land is based on the LUH2 data set (Hurtt et al. 2018).

Sustainable agriculture: Implementation of national strategies to reduce fertiliser use along with funding for implementation of sustainable agricultural practices could improve nitrogen uptake efficiency

INEVITABLE POLICY RESPONSE

Policy trend: Government funding for sustainable agricultural practices, underpinned by commitments to reduce fertiliser use, could increase nitrogen uptake efficiency in crop production

Global nitrogen uptake efficiency (%)



Existing action

Annual global demand for nitrogen used in fertilisers is around 110 million tonnes/yr.[1] This can contribute to food security by improving crop yields but can also result in degradation of habitats when the nitrogen is not absorbed by plants

Several countries have made commitments to reduce and improve fertiliser application, such as the EU Farm to Fork Strategy which targets a 20% reduction by 2030 and Mexico's Climate Change Mid-Century Strategy aspiring to more calculated fertiliser application to reduce greenhouse gas emissions from agriculture[2]

Funding for development and implementation of precision agriculture technology is emerging around the world, although its use is more prevalent in wealthier nations, e.g., Australia announced an investment towards a New Centre for Digital Agriculture[3] and the OECD has committed to investing in innovation for sustainable productivity growth[5]

Trajectory in FPS + Nature

Global average nitrogen uptake efficiency could improve by 9% from 2020 to 2050, in part due to mandated limits on nitrogen application rates, which could emerge in developed countries first, facilitate reductions in overapplication and be supplemented by use of nitrogen enhancing products

Public investment in the development of precision agriculture technology, from R&D through to commercialisation support, could drive down technology costs of emerging practices and contribute to increased uptake

Government-led farmer education programs may also emerge in lower-yield areas to teach farmers about efficient fertiliser application, particularly in developing countries[4]

1. FAO 2. UNFCCC 3. Australian government 4. Global implementation of farm-level practices is difficult, but farmer education may take the form of programs like India's Ration Balancing Programme for livestock farmers 5. OECD

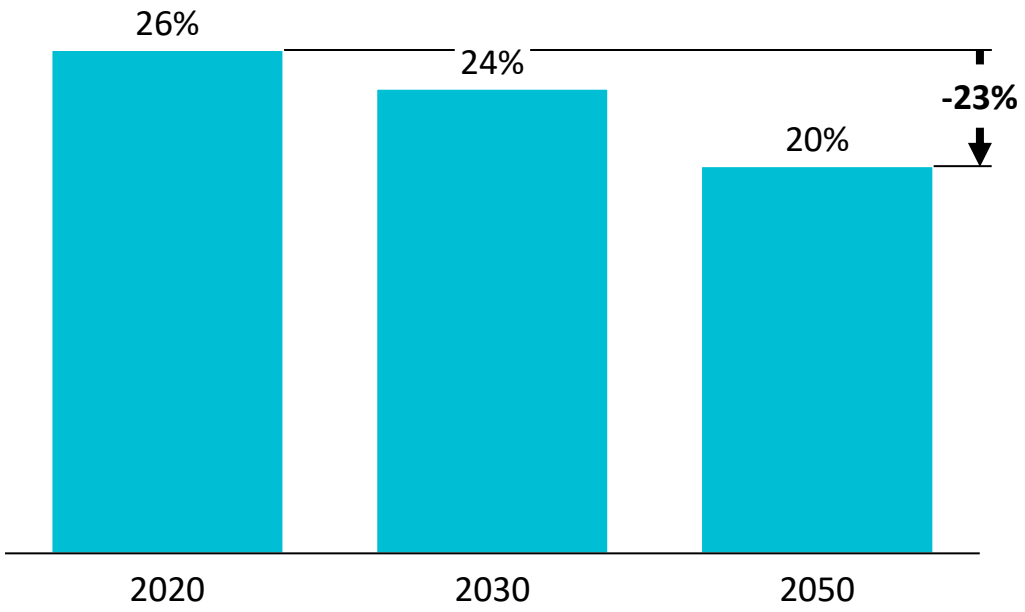
Note: This slide focuses on reducing fertiliser use, but other sustainable agricultural practices exist, such as livestock production with diet and feed management to reduce emissions (e.g., incentivized via grants in the US IRA Environmental Quality Incentives Program). The CBD's COP 15 biodiversity framework also recognises the need to manage agricultural areas sustainably. 2020 baseline nitrogen uptake efficiency data are taken from PIK, based on Zhang et al. (2015).

INEVITABLE POLICY RESPONSE

Food waste: Policies and new technologies that impact food waste could reduce the amount of consumer and retail waste

Policy trend: Governments may act to reduce consumer and private sector food waste, resulting in a smaller proportion of food being wasted

Average global food waste (% of food wasted)



Existing action

Global average food waste stands at 26%, reflecting relatively high rates of food waste in most countries[1]

Several countries, particularly higher income countries, have introduced mandates or incentives to donate unsold food to reduce food waste, e.g., French supermarkets are required to partner with charity organisations to donate unsold food[2]

There is significant global ambition to reduce food waste, reflected in the UN Sustainable Development Goal 12.3, which aims to reduce global food waste and loss by 50% by 2030,[3] the '123 Pledge' introduced at the UNFCCC's COP 27, which establishes a framework for country and corporate commitments to reduce food waste[4], and the CBD's COP 15 framework target to halve food waste by 2030[8]

Trajectory in FPS + Nature

Food waste could fall by up to a quarter by 2050[5], a reduction of over 200m tonnes/yr,[6] consistent with decreases in household food waste through measures such as targeted and better funded education programs, alongside:

- **Widespread policy action targeting retail waste**, including incentives to donate (e.g., tax exemptions) or mandatory donation of unsold food that remains edible
- **The development of waste reduction technology** applied in the retail and hospitality industries, such as AI-based sales forecasting[7]

1. UNEP 2. Zero Waste Europe 3. UN 4. Champions 12.3 5. This is similar to the reduction under WRI's 'Highly ambitious' scenario, which has some similar assumptions to FPS + Nature 6. Based on 931m tonnes of food being wasted each year (WEF) 7. Ellen MacArthur Foundation 8. CBD

Note: Baseline 2020 global food waste estimates are taken from PIK, based on FAO food waste shares and conversion factors.

INEVITABLE POLICY RESPONSE

Nature markets: Voluntary biodiversity credit markets could emerge by 2030 underpinned by emerging public and private sector initiatives

	Public sector action	Private sector action
Past experience	**Establishment of mandatory biodiversity offsetting requirements** in the context of urban and industrial development[5]	**Familiarity with carbon markets** as a way to support emission reduction, avoidance, and sequestration goals[7]
Nature targets	**Recognition of the need to halt and reverse biodiversity loss**; development of national strategies to safeguard and restore nature, including via market mechanisms[4]	**Formalization of nature-related target-setting procedures** (e.g., via initiatives such as SBTN); emergence of 'nature positive' commitments
Market development	**Support for the market**[9] by establishing funds or pilots for project implementation; development of market infrastructure or encouragement of market participation by the private sector	**Development of pilots** and best-practice methodologies for creation and purchase of credits;[6] demand for credits to meet nature-related corporate commitments[6]

Emergence of voluntary biodiversity credit markets

Momentum is building

Awareness of nature is increasing

- Nearly 200 countries have developed a National Biodiversity Strategy and Action Plan[2]
- 51% of Fortune 500 companies acknowledge biodiversity loss and 5% have set targets in this area[3]

Formalisation of nature-related targets could support growth of market-based mechanisms

- Existing and emerging action on nature suggest a role for markets in helping meet nature-related commitments[8]
- Achieving nature-related targets requires nature-related investment, potentially catalyzing biodiversity credit markets that could help fund land protection and restoration[1]
- Voluntary biodiversity credit markets could contribute to positive nature outcomes by channeling private sector funding to high-quality, verified biodiversity-related projects[6]

1. This is similar to the way that targets on climate helped catalyze carbon markets. 2. Convention on Biological Diversity 3. McKinsey 4. For example, Australia's Threatened Species Action Plan explicitly states a goal to "support innovative market mechanisms for increasing biodiversity and conservation of remnant native vegetation in productive landscapes." 5. 100+ countries require, enable or are considering the use of biodiversity offsets (OECD) 6. WEF 7. McKinsey 8. WEF 9. Support could be analogous to carbon market support: e.g., tax incentives like 45Q in the US to help fund projects (WRI) or development of a voluntary market in Malaysia (Bursa Malaysia)
Note: Nature markets could be additional to carbon markets that involve sale of NBS-based carbon credits.

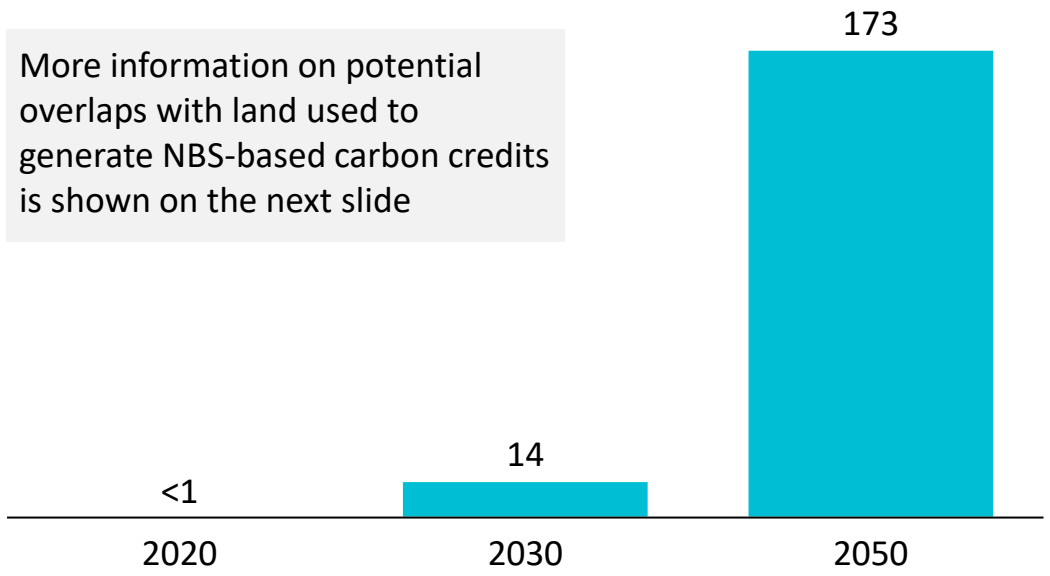
INEVITABLE POLICY RESPONSE

Nature markets: Government action to articulate nature-related commitments could spur the development of voluntary biodiversity credit markets

Policy trend: Formalisation of nature-related targets and creation of market infrastructure at scale could support emergence of voluntary biodiversity credit markets by 2030, independent from NBS-based carbon markets

Land used to generate biodiversity credits, independent of land used to generate NBS-based carbon credits (Mha)

More information on potential overlaps with land used to generate NBS-based carbon credits is shown on the next slide



Existing action

Biodiversity is increasing in importance for policymakers. 177 countries have revised or developed biodiversity strategies and action plans since 2010,[3] with a legally binding target for species abundance recently established in the UK[4]

Biodiversity credits are being considered by certain countries as one way to deliver biodiversity improvement, with the Australian government announcing plans to create a voluntary market. Parallel private sector action includes the development of markets via local individual pilot programmes and the creation of methodologies to define and produce credits[1]

Trajectory in FPS + Nature

Independent biodiversity credit markets may emerge by 2030 due to:

- **An acceleration of commitments and legally binding targets to improve biodiversity** to facilitate achievement of targets agreed at the CBD's COP 15
- **Explicit support from governments for market development**, such as funding for creation of market infrastructure or pilot projects
- **Corporate interest in biodiversity enhancement** in response to consumer concerns about sustainability[2]

1. WEF. For example, biodiversity credit creation and sale has occurred in Colombia and New Zealand. 2. 150+ UK companies, including Barclays, Nestle, SAP and Unilever, have joined the 'Get Nature Positive' framework to halt and reverse biodiversity decline
3. CBD. Note that more than 190 countries have also agreed to the CBD's COP 15 biodiversity framework that articulates global biodiversity-related goals. 4. UK Government
Note: According to WEF, 'Biodiversity credits are an economic instrument that can be used to finance actions that result in measurable positive outcomes for biodiversity through the creation and sale of biodiversity units'. In contrast to biodiversity offsets, which compensate for residual adverse biodiversity impacts, biodiversity credits invest in nature recovery and nature-positive outcomes (WEF (2022)). 100+ countries require, enable or are considering the use of biodiversity offsets (OECD), but schemes and standards are localised.

INEVITABLE POLICY RESPONSE

Nature markets: Desirable biodiversity outcomes could also be achieved on land used to generate NBS-based carbon credits

Biodiversity premia in carbon credit markets

Observed price premia show willingness to pay for positive biodiversity outcomes when purchasing NBS-based carbon credits, based on analysis of the carbon credit market[1]

More stringent criteria for carbon credits

Poorly-planned **NBS-based carbon credits** can cause negative biodiversity impacts[2] or fail to seize opportunities to improve biodiversity[4]

Best-practice guidance on corporate use of NBS-based carbon credits emphasises the need to **ensure credibility by preserving environmental integrity and safeguarding biodiversity**[3]

Corporate demand for biodiversity outcomes

Companies adhering to best practice when purchasing NBS-based carbon credits may demand **high-quality credits** that do not harm biodiversity or have clear biodiversity co-benefits

Growing appetite for biodiversity enhancement could also be met in **separate biodiversity credit markets**, which are emerging at the local level[5] and could scale up by 2030

Relationship between markets

Land used to generate NBS-based carbon credits could also be used to generate biodiversity credits, **contingent on best-practice standards** that will articulate the form of this overlap

Land used for NBS could **create revenue** based on its carbon sequestration potential as well as its biodiversity value (i.e., one asset being valued for producing multiple commodities)

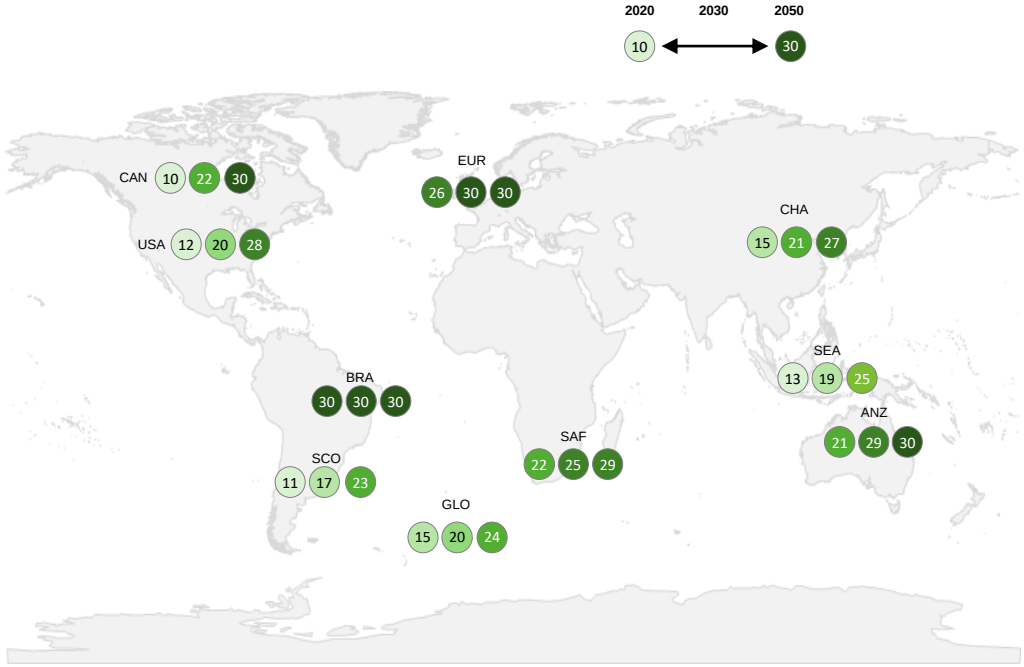
1. Based on analysis of afforestation/reforestation carbon credit prices in the B2B market in May 2022, with premium for credits certified under Verra's Climate, Community and Biodiversity (CCB) standard. (Source: Vivid Economics analysis). 2. Nature Based Solutions Initiative 3. WRI. This is also supported by the IUCN's Global Standard for Nature-based Solutions, which includes net gain to biodiversity and ecosystem integrity as a core criterion for NBS projects (IUCN). 4. For example, monoculture tree planting could produce desirable carbon outcomes but support less biodiversity than tree planting that mimics natural forest (Hua et al. (2016)). 5. WEF. For example, biodiversity credit creation and sale has occurred in Colombia and New Zealand.

Land protection: Governments are likely to increase the area of land under protection in line with international commitments, although meeting global targets may require fast implementation

INEVITABLE POLICY RESPONSE

Policy trend: Governments could act on the need to safeguard biodiversity by introducing and strengthening regulation to protect land

Percentage of terrestrial land protected (%)



Existing action

15% of global terrestrial land area was classified as protected in 2021[1]

International support is behind protecting 30% of global land and sea area[2], a target supported by more than 190 countries at the CBD's COP 15[3]

Targets to protect 30% of national land have emerged in some developed countries, including introduction of binding legislation in the EU[4]

Protected areas are recognised by the CBD as the 'cornerstone of biodiversity conservation'[5], as land use change is a key driver of biodiversity loss

Trajectory in FPS + Nature

Protected areas could reach 20% of global land by 2030[6], with the largest increases seen in Canada and Australia and New Zealand, where there are existing frameworks for protection

Global increases could be driven by emerging regulation in developed countries with lower existing rates of protection, alongside the strengthening of policy in biodiverse regions such as Southeast Asia and Latin America

Natural areas with high biodiversity and carbon sequestration potential are likely to be the highest priorities for protection, as governments seek to meet existing climate targets and emerging biodiversity targets[7]

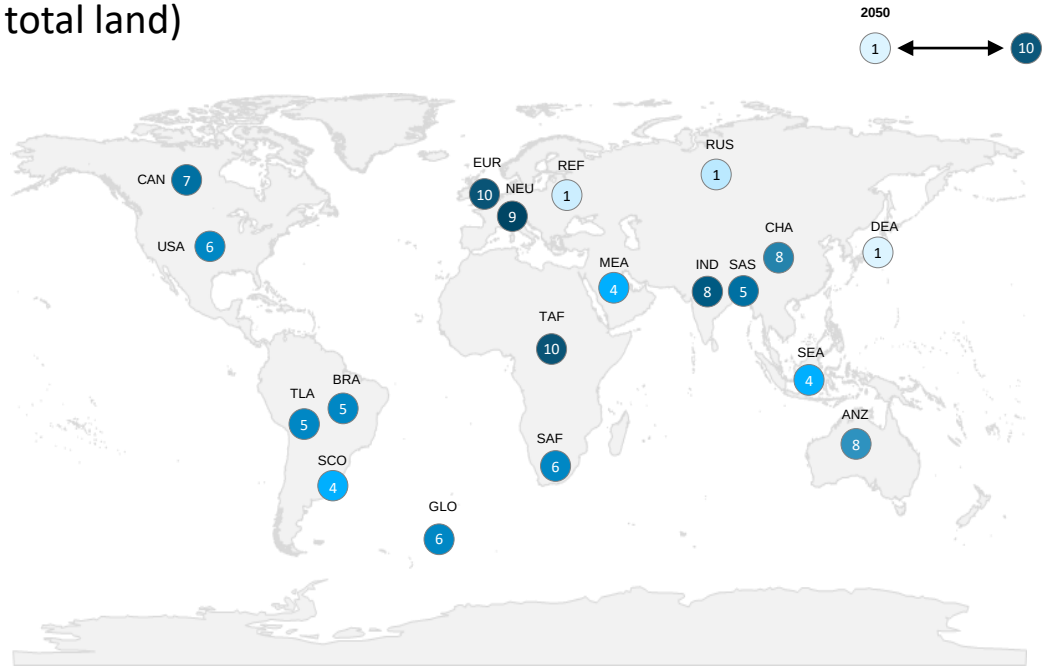
1. World Bank, covering IUCN categories I through VI, ranging from strict nature reserves (Ia) to protected areas with sustainable use of resources (VI) 2. Target proposed by the Convention on Biological Diversity (CBD) 3. CBD 4. European Commission 5. CBD
6. This includes IUCN categories I through VI. 7. For example, the EU has proposed strict protection for areas of very high biodiversity and climate value (European Commission)
Note: 2020 baseline values are aligned with World Bank data.

INEVITABLE POLICY RESPONSE

Land restoration: Governments are acting to restore degraded ecosystems, including forests and cropland, through public and private restoration activities

Policy trend: Governments across the world are beginning to introduce policies to restore degraded ecosystems through national programmes, supplemented by private sector action and funding

Additional land restored in 2050 compared to 2020 (% of total land)



Existing action

Up to 40% of global land is classed as degraded, primarily caused by unsustainable farming practices[1], with limited action historically to address land degradation

Global land restoration pledges total around 700 million hectares, over one-third of which are in Sub-Saharan Africa,[2] and include global initiatives such as the Bonn Challenge,[3] with frameworks like the UNCCD[4] and the CBD's COP 15 biodiversity framework[5] also focusing efforts[6]

National and private funds for restoration are emerging, alongside legislation strengthening the legal framework for restoration**,** such as the EU's proposed Nature Restoration Law[7]

Trajectory in FPS + Nature

By 2050, policy action targeted at degraded land could lead to an additional 6% of land being restored globally, with over 70% of this achieved by 2030

The largest share of global restoration could be seen in the EU and UK region as well as biodiversity-rich Tropical Africa, followed by China, with limited restoration in low commitment regions such as Russia and Developed East Asia

Increasing restoration could be driven by public sector restoration programmes, complemented by NGO action, particularly in high biodiversity areas, as well as private sector-led restoration, potentially financed through carbon or biodiversity credits[8]

1. UN 2. PBL 3. Bonn Challenge 4. UNCCD 5. CBD 6. Global initiatives like the UN Decade on Ecosystem Restoration also contribute to building awareness of the issue. 7. European Commission 8. For example, restoration in Europe has been implemented by governments, NGOs, research institutes, the private sector, and international bodies (UNEP-WCMC, FFI and ELP)
Note: Land restoration covers land restored as part of government pledges. 2020 baseline values are set at 0 to enable an analysis of *additional* restored land.

INEVITABLE POLICY RESPONSE

Implications for investors: Forecast Policy Scenario + Nature (FPS + Nature)

The following pages describe key outcomes from the exploratory FPS + Nature scenario and outline potential implications for investors. These fall into three categories, elaborated below:

1. Disruption to commodity production and supply chains

- **Deforestation-linked commodities** could experience market access, liability and reputational risks before policy action comes to halt commodity-driven deforestation
- **Some tropical commodities** may see costs and prices increase due to more land protection and action on deforestation
- **Ruminant meat production** could fall in developed regions and at the global level, despite increases in developing country demand due to increasing populations and incomes

2. The development and evolution of new products and technologies

- **Alternative protein production** could increase by 50x from 2020 to 2050, with market share potentially reaching 24% of the market for protein by 2050
- **Second-generation bioenergy production** could increase significantly to 2050, with opportunities distributed globally
- **New technologies to reduce nature and climate impacts** could present opportunities for investment, including sustainable crop production technology, food waste reduction technology, and technology for supply chain traceability

3. NBS-based carbon credits and emerging nature markets

- **The "quality" of NBS** could improve with more focus on nature increasing the potential to support positive biodiversity outcomes, compared to a scenario which focuses only on climate policy
- **Total revenue potential of NBS** could reach USD 204 billion in 2050, with cumulative investment of more than USD 1.1 trillion by 2050
- **Generation of biodiversity credits** could represent USD 18-43 billion in annual revenue in 2050, based on supply side analysis and preliminary assumptions

Note: Impacts are derived from the modelling of FPS + Nature.

INEVITABLE POLICY RESPONSE

1. Tropical commodity trade could face region-specific market access, liability and reputational risks before deforestation-free production is achieved

Companies producing and procuring commodities in regions with high deforestation rates could face risks related to market access, liability and reputation

	Market access risk could emerge as regulation develops at different speeds across regions, generating disparity in production and import standards	**Liability risk** could include criminal violations and fines for companies that drive deforestation, with increased costs passed down the supply chain	**Reputational risk** could emerge in the region of procurement where deforestation occurs, and it could flow through the supply chain
Description	Could occur for companies with supply chain deforestation, **when an importing country imposes regulation limiting imports** from jurisdictions that do not sufficiently regulate deforestation	Could occur for upstream companies, with 50% of policies regulating production imposing economic fines and the remaining 50% **imposing fines and criminal violations**[1]	Could occur when downstream companies purchase deforestation-linked commodities at market price, as current **prices do not internalize the costs of deforestation** in most countries
Impact	Could result in **limited access to procurement**, with mitigation options, such as upgrading operations or switching to new suppliers, potentially leading to increased costs	Could result in **higher costs**, and impacts could be passed down the value chain in the form of higher input prices for downstream companies sourcing from non-compliant suppliers	Could result in **decreased revenues** as consumers turn to deforestation-free products, with downstream company risk influenced by volume and region of commodity procurement[2]

1. Of 80+ deforestation-related policies analysed as part of the IPR's Supply Chain Analysis. 2. This risk remains for specific regions of procurement until all commodity production becomes free from deforestation.
Note: For additional information, please see the IPR's Supply Chain Analysis work.

INEVITABLE POLICY RESPONSE

1. Companies procuring commodities from regions with high levels of deforestation could face reputational risk, potentially impacting revenues

Estimated reputational risk from domestically produced and sourced beef[1]

Annual revenues at risk[2] 6-15% 3-6% 0-3%

Region	2020	2025	2030	2035	2040	2045	2050
Brazil	High	High	High	Low	Low	Low	Low
Southeast Asia	High	High	High	Low	Low	Low	Low
Tropical Latin America	High	High	Low	Low	Low	Low	Low
Tropical Africa	High	High	High	Low	Low	Low	Low
LatAm's Southern Cone	Medium	Medium	Low	Low	Low	Low	Low
United States	Medium	Low	Low	Low	Low	Low	Low
Southern Africa	Medium	Medium	Low	Low	Low	Low	Low
China	Low	Medium	Low	Low	Low	Low	Low
Australia and NZ	Low	Low	Low	Low	Low	Low	Low
South Asia	Low	Low	Low	Low	Low	Low	Low
India	Low	Low	Low	Low	Low	Low	Low
European Union	Low	Low	Low	Low	Low	Low	Low
Canada	Low	Low	Low	Low	Low	Low	Low
Middle East Asia	Low	Low	Low	Low	Low	Low	Low
Non-EU Western Europe	Low	Low	Low	Low	Low	Low	Low
Russia	Low	Low	Low	Low	Low	Low	Low
Developed East Asia	Low	Low	Low	Low	Low	Low	Low
Eastern Europe	Low	Low	Low	Low	Low	Low	Low

Key takeaways

Brazil, Southeast Asia and Tropical Africa could see the highest levels of reputational risk from deforestation driven by beef production to 2030

Changes in risk could be driven in part by decreasing consumer tolerance for deforestation in parallel with increasing ability to trace deforestation

All regions could see low levels of reputational risk by 2035, when tropical commodity-driven deforestation could be halted

Note: For additional information, see the IPR's Supply Chain Analysis work.

1. Reputational risk levels are estimated based on i) overall levels of deforestation related to commodity production, both in terms of absolute values of deforestation for a specific commodity, as well as non-specific to commodities. Risk is also dependent on relative levels of deforestation compared to other procurement regions and through time (there is risk associated with a relatively slow rate of reduction in deforestation). Additionally, consumer preferences as to (or consumer intolerance to) deforestation are factored in, as they are assumed to increase (decrease) over time, by defining increasingly lower thresholds after which certain levels of deforestation become less and les tolerated. Results for other commodities, and details on the methodology can be found in Annex III of IPR's Supply Chain Analysis. 2. Revenues at risk are estimated based on literature review and experts' opinions. The value is indicative, and its generalization limited due to limited research and empirical data available. See more details on the limitation of these estimates in the conclusions section of IPR's Supply Chain Analysis

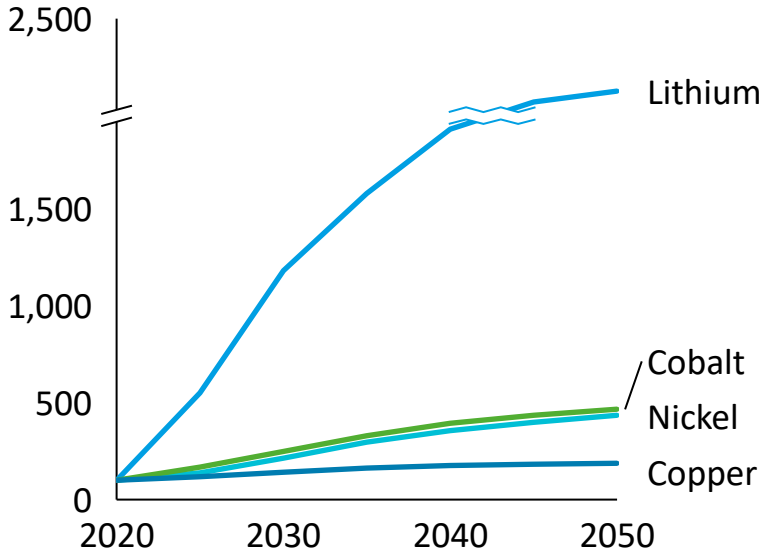
1. As demand for critical minerals grows, production in areas of priority for biodiversity protection could face transition risks that could increase costs or impact company reputations

INEVITABLE POLICY RESPONSE

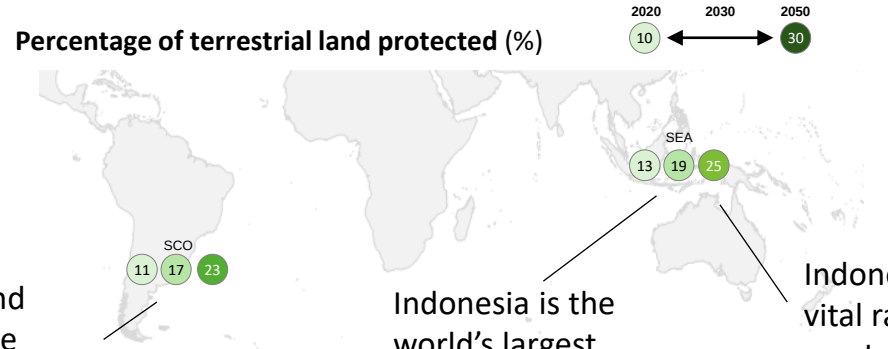
Demand for critical minerals could grow significantly in response to electrification, particularly in the transport and power sectors

Production of some minerals is **concentrated in regions that could see large increases in protected areas** in FPS + Nature. These regions could also introduce measures to restrict deforestation and mining waste, with potential for **reputational risk for companies with non-compliance** in their supply chains

Demand for select minerals in IPR FPS 2021, index (2020 = 100)



Percentage of terrestrial land protected (%)



Argentina, Bolivia and Chile hold 58% of the world's lithium deposits[1]

Indonesia is the world's largest producer of nickel[2]

Indonesia is home to vital rainforest and coral reef ecosystems

Both the Southern Cone of Latin America and Southeast Asia could see an approximate **doubling of protected areas** by 2050 in FPS + Nature. Extractives companies and downstream purchasers are also exposed to region-specific legislation or norms associated with the nature transition:

- In Chile, **additional taxation** on lithium producers was recommended by a National Lithium Commission,[3] with higher costs potentially passed down the value chain
- Indonesia, together with Papua New Guinea, accounts for 91% of the world's deep-sea waste mining disposal[2]

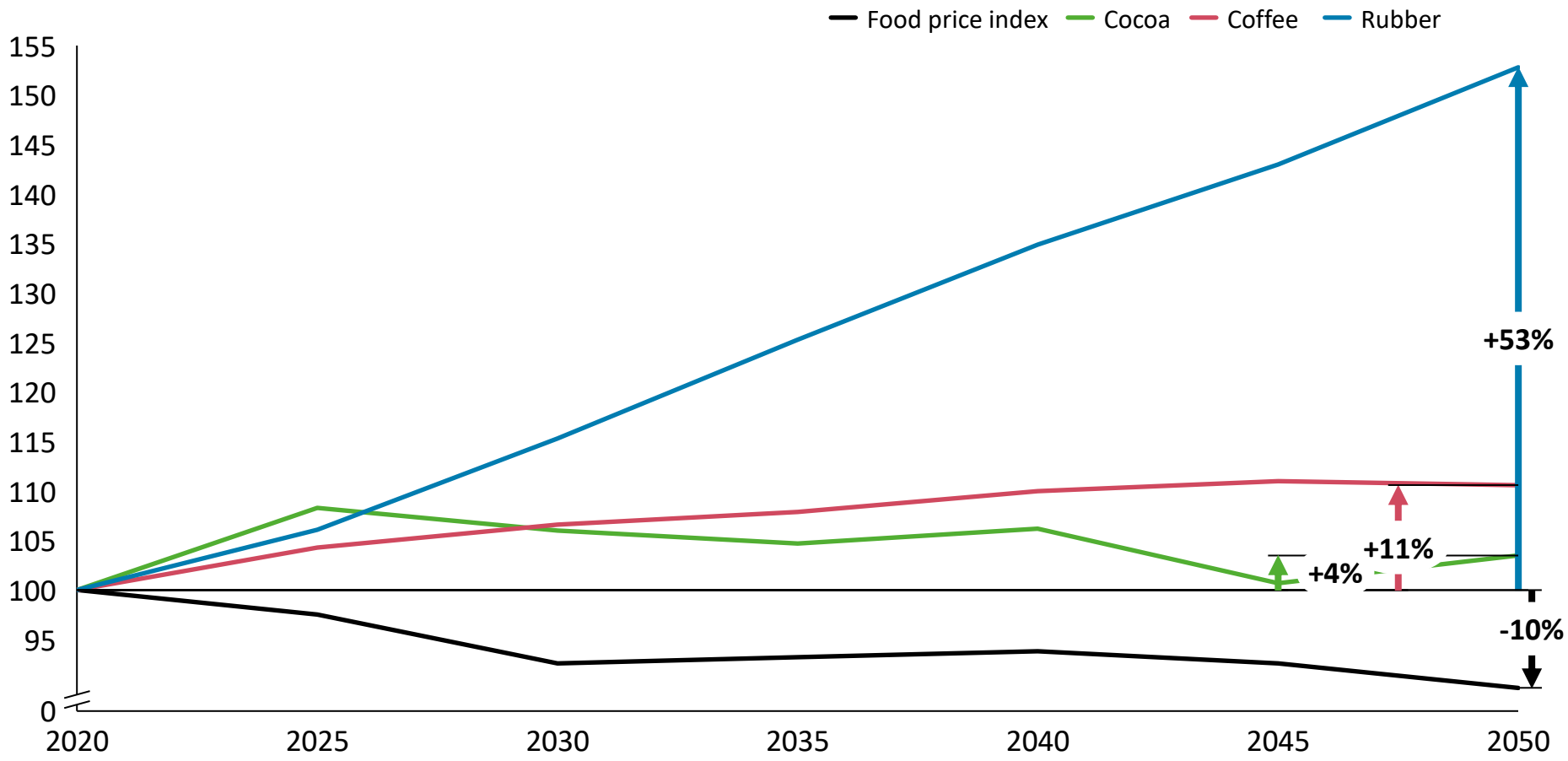
1. USGS 2021 2. Morse 2020 3. Gonzalez 2021

Note: Initiatives specifically focusing on mining and biodiversity include the Sustainable Critical Minerals Alliance, announced at the CBD's COP 15.

1. Land safeguarding efforts could contribute to higher costs and prices for deforestation-linked tropical commodities while staple commodity prices could remain stable

INEVITABLE POLICY RESPONSE

Price index in FPS + Nature (2020 = 100)



Tropical soft commodities could increase in price as measures to halt deforestation and protect land could drive up land prices, particularly in regions already experiencing high land competition (e.g., Southeast Asia, which is a key producer of rubber)

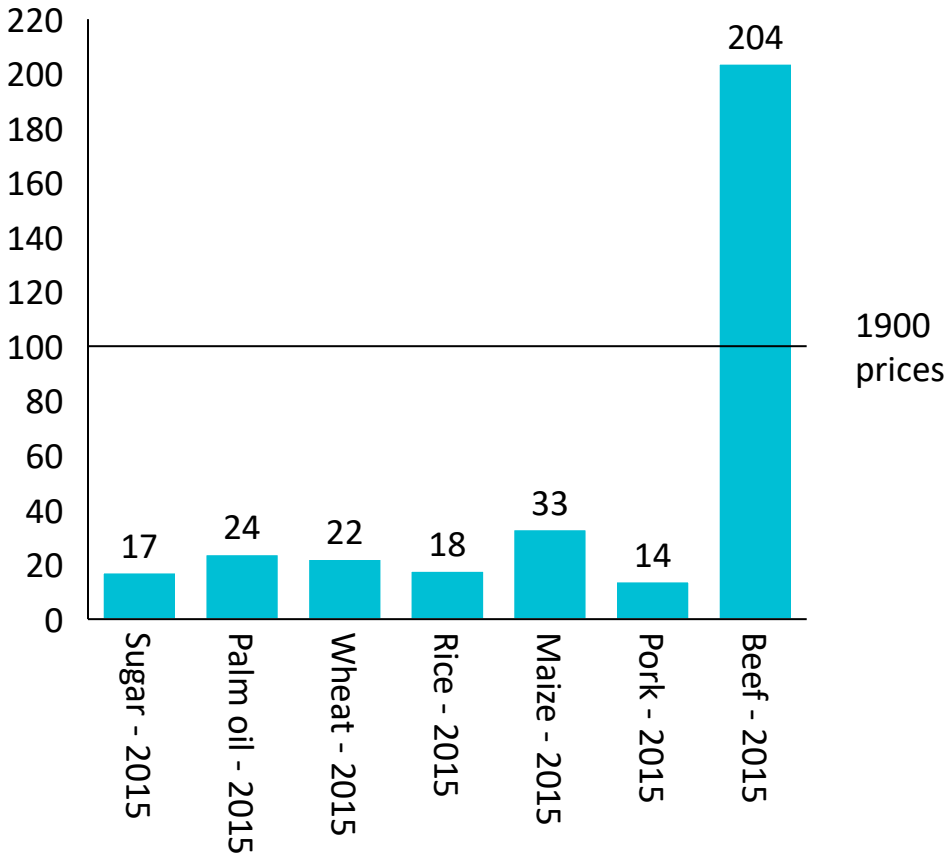
Policy action may not compromise historical trends of decreasing food prices[1] (see subsequent page for more information)

1. The food price index is comprised of all food types, weighted by their production. It does not account for changes in food prices resulting from changes to subsidies, nor does it account for acute physical risks related to climate change and nature loss. For more information on food prices, see the next slide.

INEVITABLE POLICY RESPONSE

1. Food prices have tended to fall over time due to yield growth, reinforcing the importance of continued yield growth to reduce upward pressure on prices

Commodity prices in 2015,[3] index (1900 = 100)



Historical commodity prices

Food commodity prices have fallen significantly over the past century, due to scale and technology-driven yield improvements (e.g., real wheat prices in 2015 were only 22% of their price in 1900)[3]

- **Beef is the exception** to this rule, increasing in price to 2015[3]

Continuation of historical trends

Continuation of the historical trend in food prices could be driven by:

- **Yield growth in some developing regions** that have historically seen lower-yielding production, such as Tropical Africa[1]
- **Diet shifts away from ruminant meat**, which could decrease land prices by freeing up land previously used to grow animal feed

Modelled food prices

Modelled food prices are long run, average farmgate prices, which means that they do not account for:

- **Supply chain volatility** or geopolitical shocks
- **Processing and transport** costs
- **Acute physical risks** (although climate-related chronic physical risks consistent with <2°C of warming are accounted for[2])

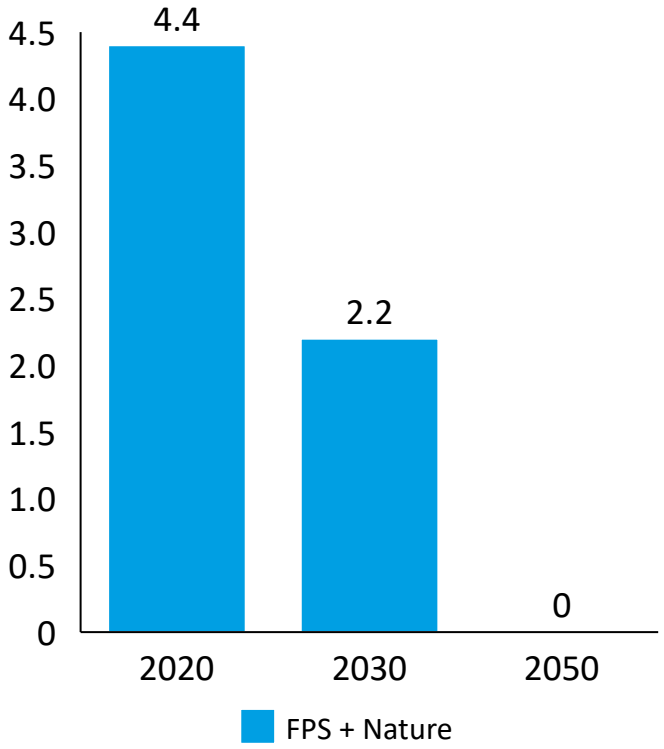
1. This effect could occur despite the impact of chronic climate-related physical risks, which are accounted for in FPS + Nature modelling. 2. These include changes in average temperature and average precipitation rates, both of which impact crop yields.
3. Our World in Data, based on Jacks (2019)

INEVITABLE POLICY RESPONSE

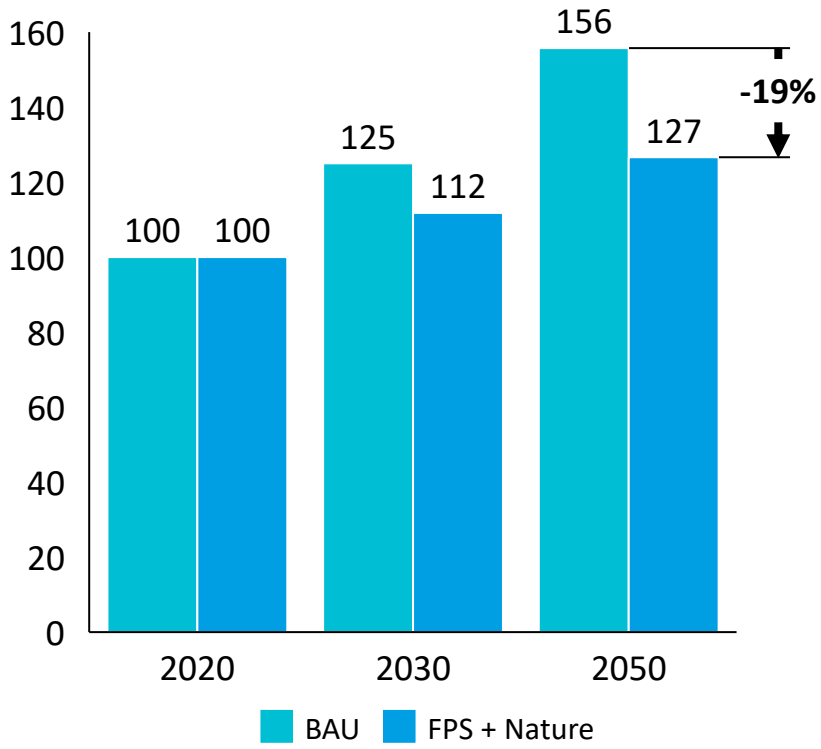
1. The phasing out of first-generation bioenergy is likely to reduce production of oil crop feedstocks in biodiverse regions, such as oil palm in Southeast Asia

First-generation bioenergy is derived from conventional food crops such as oil palm, which is grown almost exclusively in the biodiverse regions of Southeast Asia and Tropical Africa

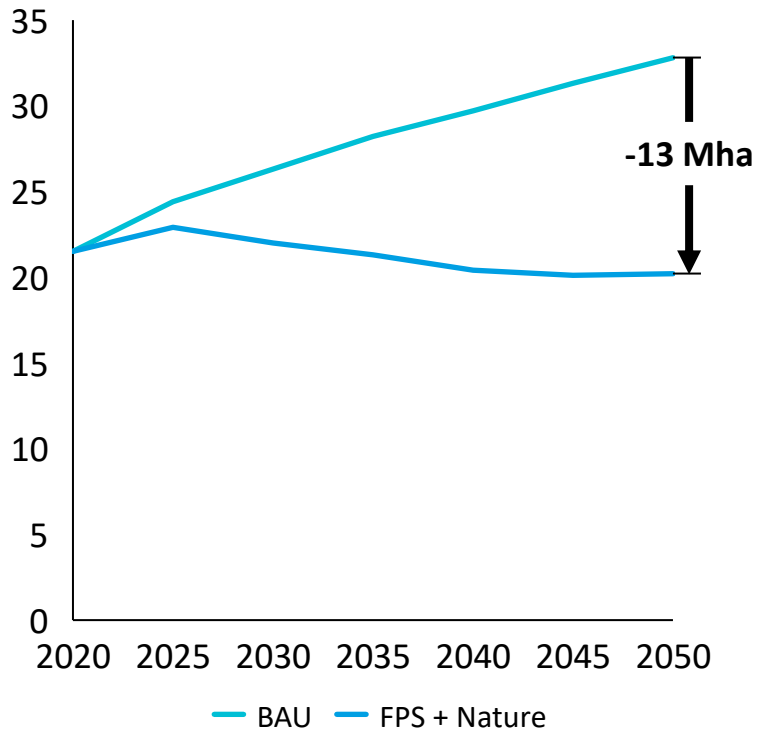
Global first-generation bioenergy production, EJ



Oil palm production in **Southeast Asia**, index (2020 = 100)



Oil palm cultivation land area in **Southeast Asia**, Mha

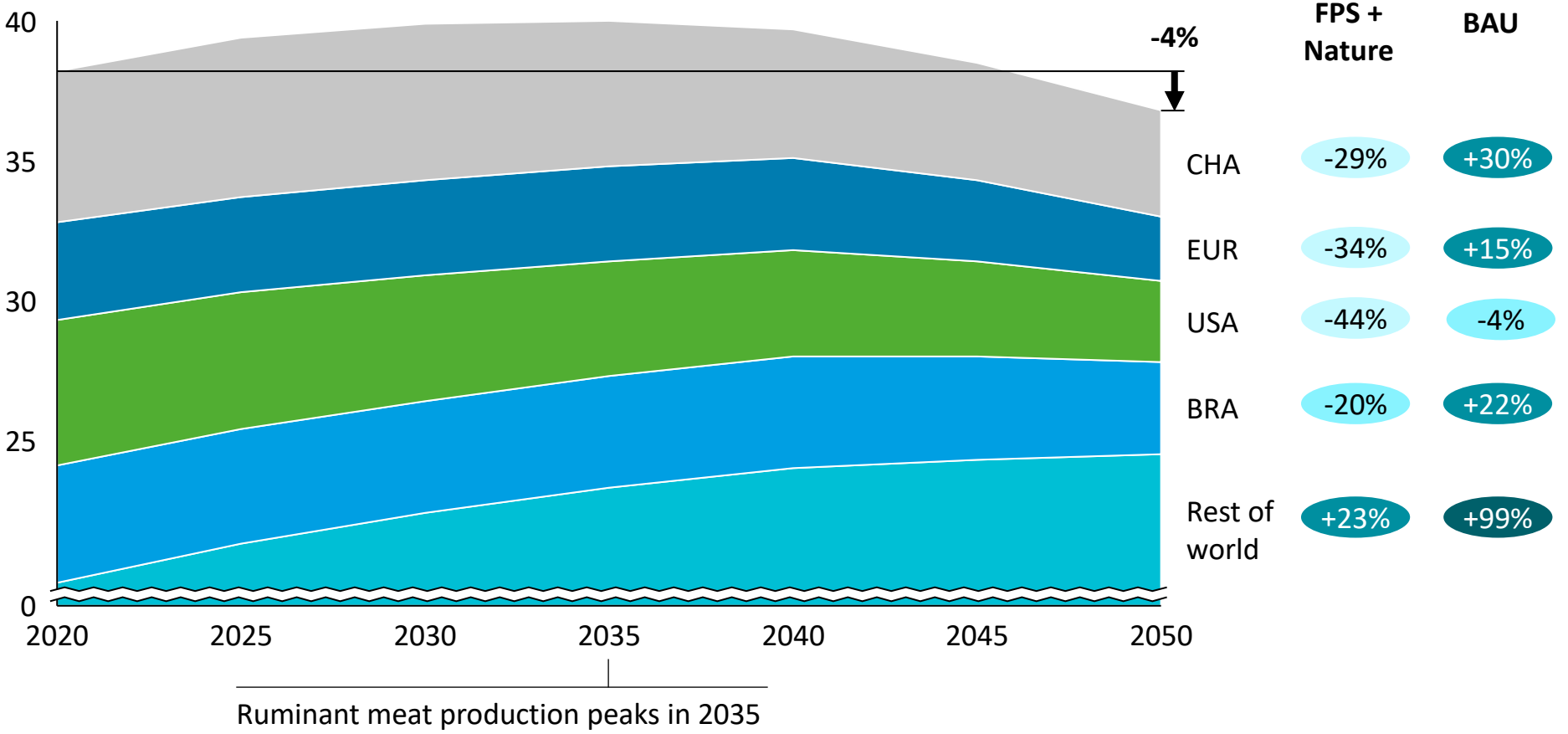


Note: First-generation bioenergy is produced from food crops. Second-generation bioenergy is produced from crop residues and dedicated bioenergy crops (Nanda et al. 2018). First-generation bioenergy production could decrease in line with policy incentives that aim to shift bioenergy production towards the use of second-generation feedstocks.

1. Emerging diet shifts away from meat consumption coupled with complementary climate and nature policy action could lead to decreased production

INEVITABLE POLICY RESPONSE

Global ruminant meat production in FPS + Nature, Mt DM



Change in production, 2020-2050

	FPS + Nature	BAU
CHA	-29%	+30%
EUR	-34%	+15%
USA	-44%	-4%
BRA	-20%	+22%
Rest of world	+23%	+99%

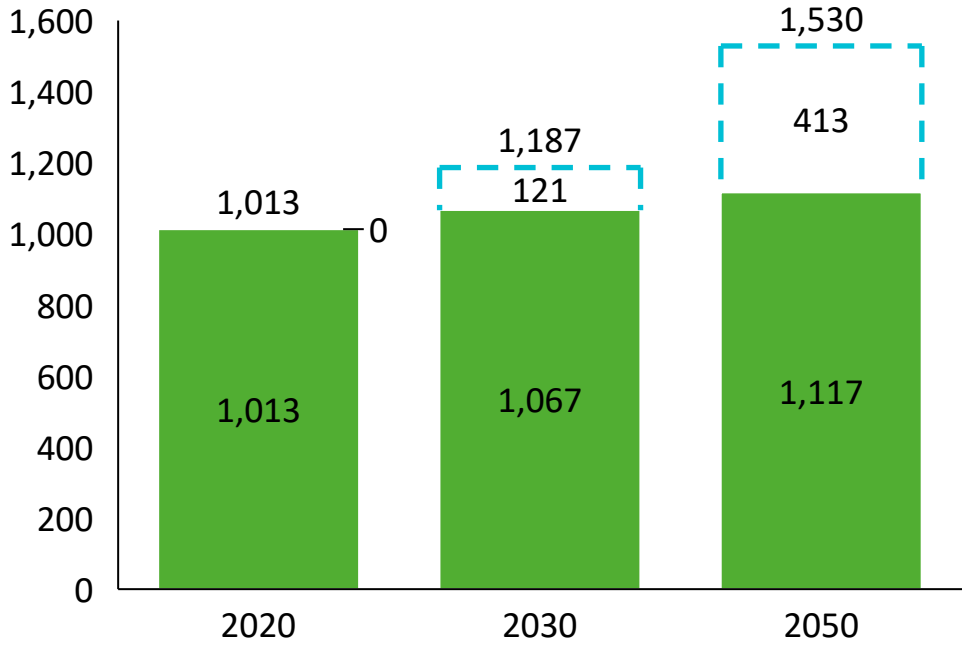
The largest declines in production could occur in regions where production volumes are currently the largest (high or middle-income countries), where policies such as R&D support for alternative proteins accelerate consumer shifts away from ruminant meat consumption

Increases in ruminant meat production could threaten biodiversity improvement in biodiversity rich areas with high expected rates of population and income growth, such as Tropical Africa and South Asia

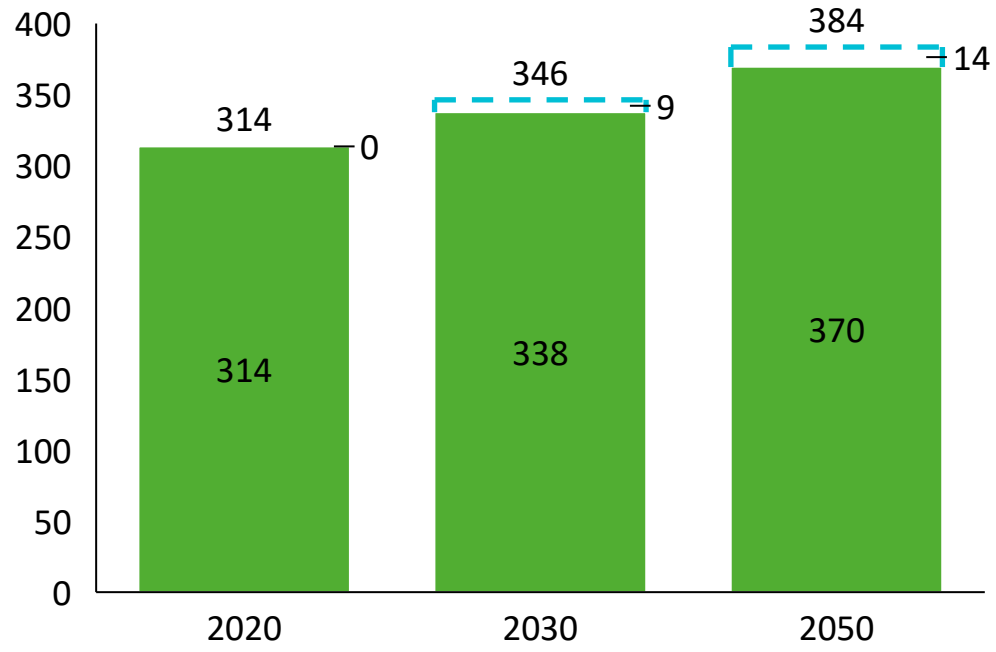
1. Trends are also influenced by improvements in the taste and texture of alternative proteins, which are a potential substitute for conventional animal meat products.
Note: Decreases in production could be smaller than per capita decreases in consumption in part due to population growth. Shorter-term variation may obscure longer-term trajectories.

1. Decreases in ruminant meat production could have the knock-on effect of depressing commodities used in animal feed

Maize production, Mt DM/yr



Soy production, Mt DM/yr



Declines in maize production compared to a BAU scenario are consistent with regional declines in ruminant meat production, with the US and China seeing significantly lower production of both commodities compared to BAU. **This is also influenced by decreasing production of first-generation bioenergy**
Soy is produced at similar levels compared to a BAU scenario because although demand for soy used in animal feed decreases, this is counterbalanced by increases in demand for soy used in alternative protein production and consumed in place of animal meat

INEVITABLE POLICY RESPONSE

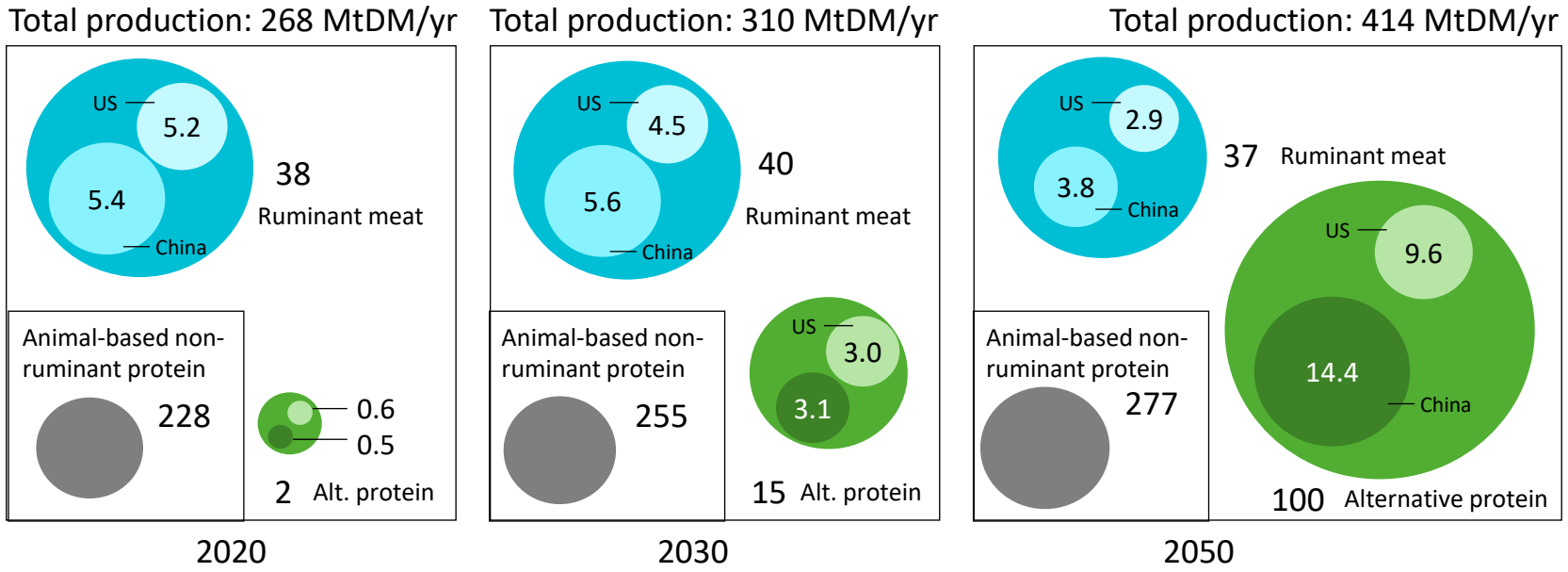
2. Alternative protein production could grow as ruminant meat production declines, in line with shifting consumer diets and technology

Production of protein in FPS + Nature, Mt DM/yr

Ruminant meat — **<1x (decline)**

Animal-based non-ruminant protein[1] — **>1x (growth)**

Alternative protein[2] — **~50x (growth)**



Two main types of policy may contribute to growth in the market for alternative proteins: (1) R&D support for alternative proteins enables improvements in taste and texture as well as price decreases; (2) Regulatory approvals for cell-based meat facilitate production

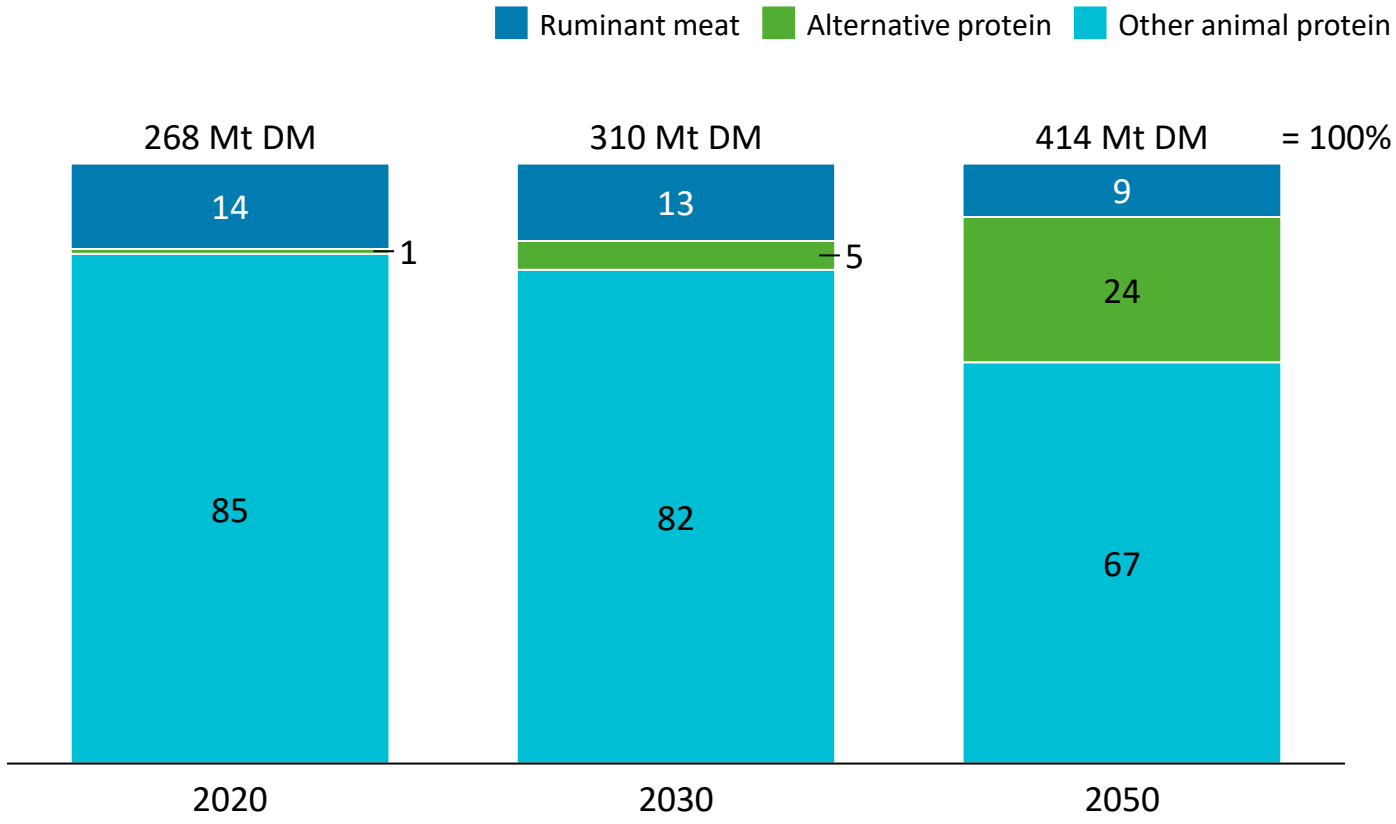
Reduced ruminant meat production geographically aligns with increased alternative protein production: Regions with strong declines in ruminant meat production and consumption could see particularly pronounced growth in alternative protein production, including the US and China

1. Animal-based non-ruminant protein includes pork, poultry and dairy. 2. Alternative proteins represent a substitute for conventional animal meat. Alternative proteins include plant-based meat (both structured and unstructured), plant-based dairy and cell-based meat.
Note: Shorter-term variation may obscure longer-term trajectories.

INEVITABLE POLICY RESPONSE

2. Alternative proteins could comprise nearly 25% of global protein market share in 2050

Share of global protein market[1] in FPS + Nature, %



Ruminant meat production decreases

- Market share could decline from 14% in 2020 to 9% by 2050
- **A sharp decline in the share of ruminant meat may occur after 2030**, as technology improvements lead to both a decline in the cost and improvement in the taste of alternative ruminant meat, leading to greater substitution options for consumers
- **Declines could be seen in Australia and New Zealand**, a major beef-consuming region, aligned with emerging trends away from ruminant meat consumption[2], with ruminant's share of the regional protein market falling 15 percentage points from 29% to 14% by 2050

Alternative protein production increases

- Market share could grow by over 20 percentage points to 24% by 2050
- **The largest market shares in 2050 could be seen in high-income countries**, driven by substitution away from ruminant meat production

1. Share of global production 2. Whitton et al. (2021)
Note: Other animal protein includes pork, poultry and dairy. Shorter-term variation may obscure longer-term trajectories.

INEVITABLE POLICY RESPONSE

2. The growth of alternative protein production is largely driven by plant-based alternatives reaching or approaching cost parity

Alternative protein source[3]	Year of global cost parity[1] with comparable animal protein source[2]
Plant-based ruminant meat	2030
Cell-based ruminant meat	After 2050
Plant-based poultry	After 2050
Cell-based poultry	After 2050
Plant-based monogastric meat	After 2050
Cell-based monogastric meat	After 2050
Plant-based dairy	2035

Production costs influence date of cost parity

- **The higher cost of producing ruminant meat** drives achievement of cost parity with plant-based ruminant meat by 2030, compared to plant-based poultry and monogastric alternatives, which only approach cost parity by 2050[4]
- **The high production cost of cell-based meat** hinders achievement of cost parity across all animal meat categories, although the cost of production for cell-based ruminant meat, poultry and monogastric meat could be approximately 100 times lower in 2050 than in 2020, driven by increased investment in R&D

Developed regions tend to achieve cost parity first

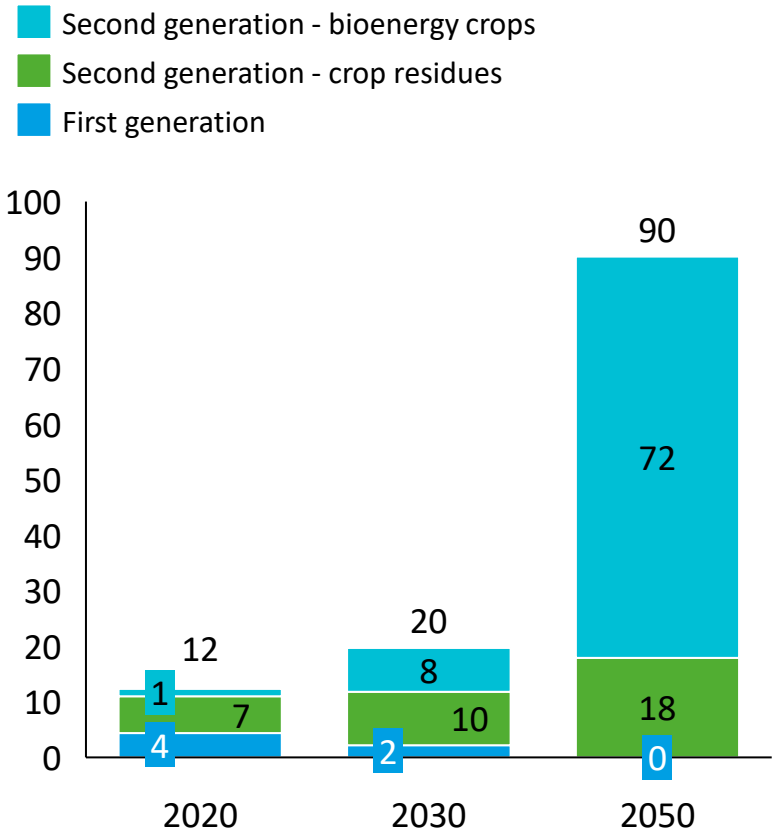
- **Plant-based dairy** could reach cost parity in some developed regions already in 2030, with cost parity in developing regions usually lagging by five to ten years
- **Plant-based poultry and monogastric substitutes** could reach cost parity before 2050 in many developed regions, driven by relatively higher conventional animal meat prices
- **Cell-based ruminant meat** could reach cost parity with unprocessed ruminant meat by 2050 in developed regions, driven by relatively greater technological readiness

1. Cost parity is based on global average farmgate prices; therefore, timing of parity for consumer prices may differ, as consumer prices are affected by factors such as profit margins and taxes. 2. As an example, the price of both plant-based and cell-based ruminant meat sources are compared to the price of ruminant meat. 3. Cell-based alternatives are likely to represent a better substitute for unprocessed conventional animal proteins (e.g., pork chops) than plant-based alternatives, which may more easily substitute for products like minced meat. 4. Conventional poultry and monogastric meat cost less to produce than conventional ruminant meat, thus remain cheaper than plant-based alternatives for longer, despite the decrease in production costs of these alternatives.
Note: Conventional meat prices are an average of processed and unprocessed meat cuts. Processed cuts are typically more inexpensive and are likely to be substituted for plant-based alternative meats. Shorter-term variation may obscure longer-term trajectories.

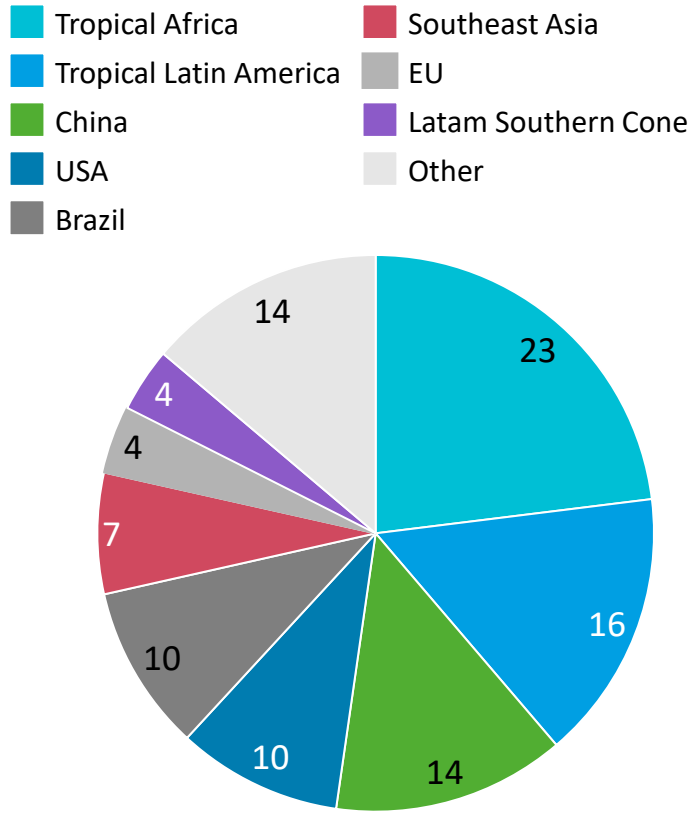
INEVITABLE POLICY RESPONSE

2. Increasing bioenergy demands could be met by second-generation sources, with nearly 40% of production in Tropical Africa and Tropical Latin America

Bioenergy production in FPS + Nature, by feedstock[1] (EJ)



Second-generation bioenergy crops production share in 2050 in FPS + Nature, %



Key takeaways

- Increasing demand for second-generation bioenergy could be met with **230 Mha of land by 2050** used for bioenergy crops, although some demand is met through crop residue feedstocks that do not put pressure on land
- Second-generation bioenergy production could be relatively **geographically dispersed**, although significant production volumes could be seen in Tropical Africa and Tropical Latin America

1. First-generation bioenergy is produced from food crops. Second-generation bioenergy is produced from non-food residues and energy crops (Nanda et al., 2018). Second-generation bioenergy production could increase in line with policy incentives that aim to shift bioenergy production towards the use of second-generation feedstocks.

INEVITABLE POLICY RESPONSE

2. Technologies that improve sustainability in agriculture, decrease food waste, and track deforestation are likely to grow in response to the climate and nature transition

Several technologies across the value chain could reduce pressure on land and see growth in light of the climate and nature transition. Some examples of innovations at different levels of maturity along with third party estimates of market size are:

Sustainable agriculture

Precision agriculture: Can improve nitrogen uptake efficiency to reduce fertiliser needs

- Market for digital agriculture: **USD 10.5 billion by 2027** (CAGR: 11% from 2020)[1]

Vertical agriculture: Can reduce the land footprint of crop production

- Market for vertical agriculture: **USD 24 billion by 2030** (CAGR: 23% from 2020)[2]

Gene technologies: Can emphasise favourable and yield-enhancing traits or improve nitrogen-fixing characteristics (e.g., via CRISPR)

- Market for gene editing technologies: **USD 44 billion by 2031**[3]

Regenerative agriculture: Can include techniques such as no-till methods, crop rotation or polyculture to improve sustainability

Food waste reduction

Inventory and value chain management: Can be improved, including through use of AI-based sales forecasting

- Market for sales forecasting software: **USD 143 billion by 2030** (CAGR: 11% from 2023)[4]

Secondary markets: Can capitalise on value of surplus food, imperfect products, or products nearing expiration

- Market for near-expired food in China: **USD 4.6 billion in 2020**[7]

Processing and packaging: Can be used to increase the shelf life of products

Applications to prevent waste: Can include apps that suggest recipes given available ingredients or connect businesses with charity organisations for food donations

Supply chain traceability

Internet of Things (IoT): Can be used to collect data and feed into supply chain optimisation

- Market for IoT in logistics: **USD 100 billion by 2030** (CAGR: 13% from 2020)[5]

Cybersecurity: Can reduce the risks of using technology to monitor supply chains

- Market for supply chain security: **USD 1 billion by 2027** (CAGR: 7% from 2021)

Deforestation monitoring: Can be conducted via satellites and remote sensing or machine learning, and can include real-time identification of deforestation hot spots

Blockchain and AI: Can be used to support quality assurance and tropical commodity sourcing

1. Brandessence Market Research 2. Allied Market Research 3. IDTechEx 4. Verified Market Research 5. Business Wire 6. KBV Research 7. Beijing Review
Note: Examples are illustrative and not exhaustive.

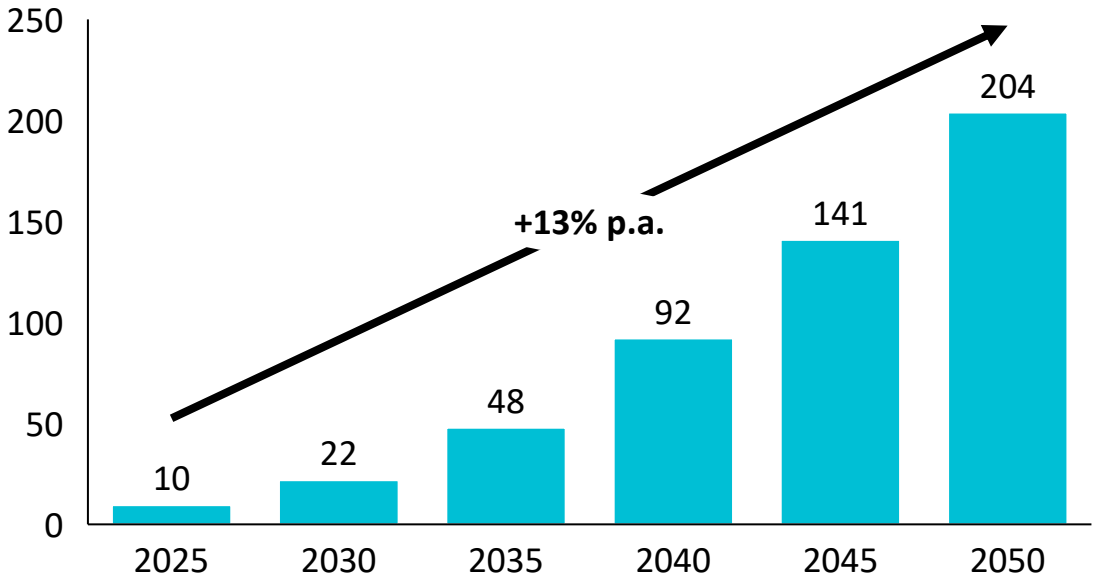
INEVITABLE POLICY RESPONSE

3. In 2030, NBS could directly restore, improve or avoid the conversion of 275 million hectares of land, generating USD 22 billion in annual revenues

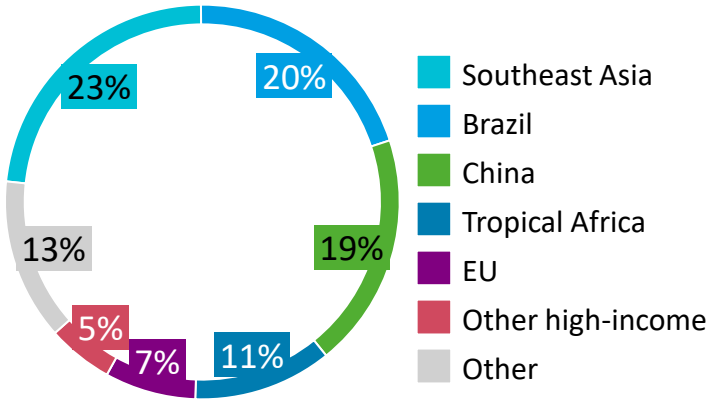
NBS could grow to reach USD 22 billion in annual revenue in 2030, and USD 204 billion in annual revenue in 2050, as corporates and governments pursue cost-effective carbon mitigation options that also produce nature co-benefits

NBS revenues could be concentrated in middle-income regions, with Brazil, China and Southeast Asia together accounting for over half of revenues in 2030. High income regions are likely to generate only 13% of revenues due to higher investment costs reducing the quantity supplied[1]

Annual NBS revenue in FPS + Nature (billion USD)



Share of total NBS revenues in 2030



Regions with low-cost NBS options dominate NBS revenues – NBS could represent a valuable source of climate finance to developing countries

Higher carbon prices help incentivise NBS in regions with higher investment costs

Revenues are calculated as the quantity of emissions sequestered multiplied by the prevailing voluntary carbon price in that year.[2] This does not differentiate between direct government investment, compliance markets, and voluntary markets. This estimate therefore does not represent an estimate of voluntary or compliance market revenues.

1. 13% is composed of the EU (7.5%) + other high-income regions (5.4%): Australia and New Zealand, Canada, Developed East Asia, and USA. 2. Analysis assumes a voluntary carbon market price for NBS-based credits that rises to USD 45/tCO_2 in 2050.
Note: All NBS depicted is additional to levels of NBS in 2020. Annual revenue only accounts for NBS options whose cost is less than the prevailing voluntary carbon price in that year.

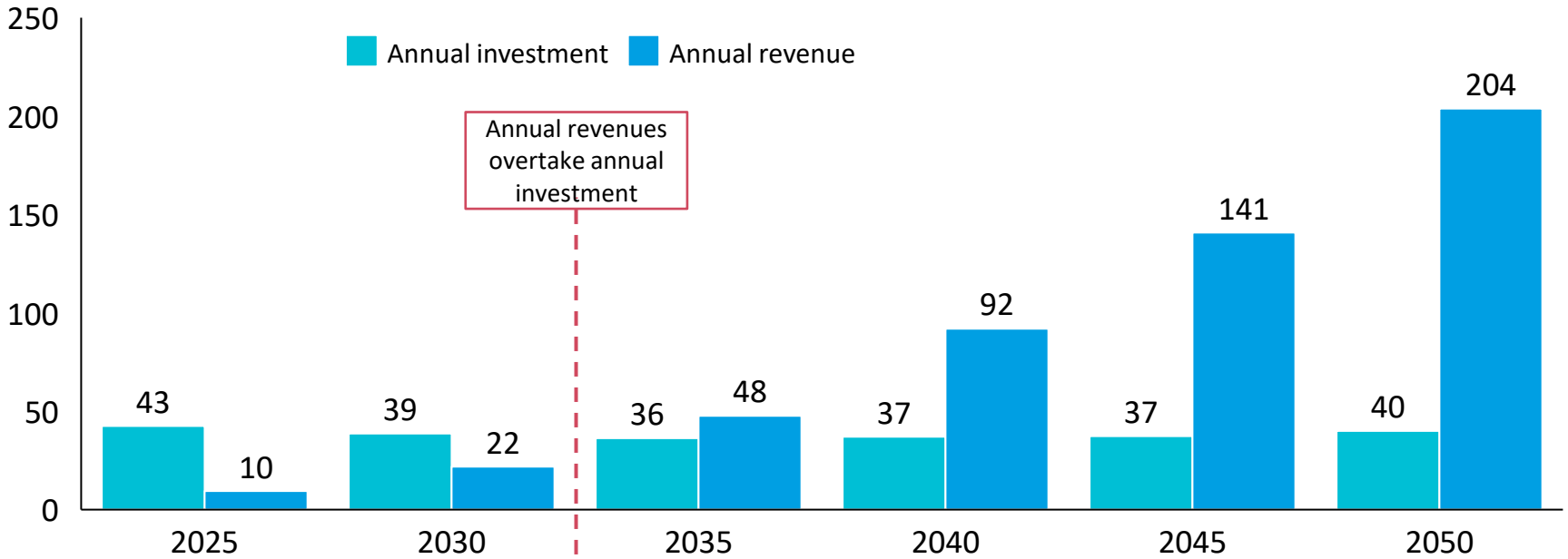
3. NDC-driven afforestation could drive annual investment in NBS to 2030, after which forestry plantations and pasture improvements could make up most investment

INEVITABLE POLICY RESPONSE

Investment: In 2030, **USD 39 billion could be invested annually** in NBS, the majority of which could be into low- and middle-income regions, where costs could be lower and expected baseline losses of natural ecosystems could be relatively high

Revenues: NBS **annual revenues could overtake annual investment by 2035** as the capital stock grows and investment falls once NDC afforestation targets are achieved in 2030

Annual global NBS investment and revenue in FPS + Nature, billion USD



Afforestation to meet NDC commitments may drive spikes in investment in 2025 and 2030

Forestry plantations and pasture improvement are more expensive solutions, so may attract greater investment towards 2050 when carbon prices could be higher

Note: Revenues are calculated as the quantity of emissions sequestered multiplied by the prevailing voluntary carbon price in that year. NDC-driven afforestation is included in investment but not in revenue figures, as it will require investment but may not generate revenues. These data do not represent estimates for voluntary market investment or revenues; these will likely be split between direct government investment, compliance, or voluntary markets. Analysis assumes a voluntary market price for NBS-based credits that rises to USD 45/tCO_2 in 2050.

Note: All NBS depicted is additional to levels of NBS in 2020. Annual revenue only accounts for NBS options whose cost is less than the prevailing voluntary carbon price in that year. Annual investment is calculated as the present-value of the lifetime costs of all NBS area newly established in a given year, including CAPEX and discounted annual OPEX for the project lifetime, not accounting for opportunity cost.

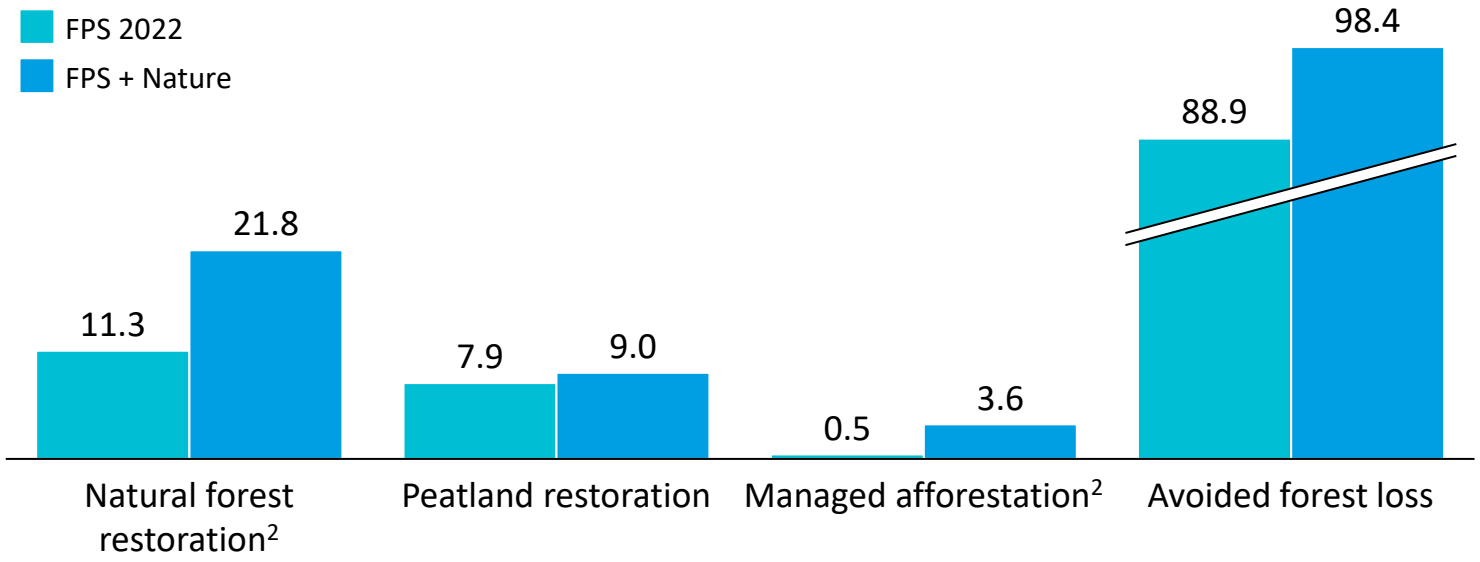
INEVITABLE POLICY RESPONSE

3. Greater quantity and quality of NBS could be supplied if corporates and suppliers place greater emphasis on achieving positive nature outcomes

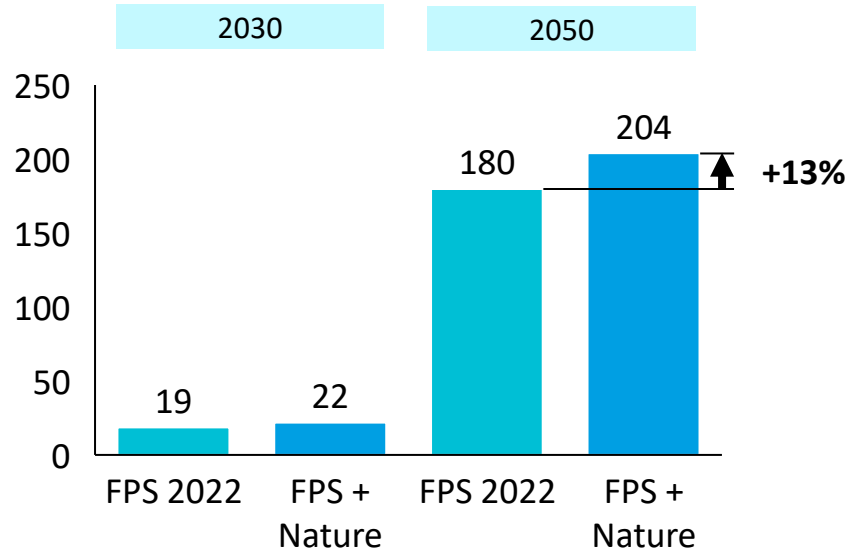
1 **Revenue from higher quality NBS options could increase** (compared with policies only focused on climate) due to greater demand for NBS that produce positive nature outcomes and co-benefits.[1] This includes natural forest and peatland restoration, which could improve habitats to support biodiversity, or avoided loss of biodiversity-rich forests

2 Increases in higher quality NBS lead to a **moderate increase in total annual NBS revenues** (compared to a scenario of climate policies alone), in line with carbon sequestration potential

Annual NBS revenue, by NBS type in 2050 (billion USD)



Annual NBS revenue, by scenario (billion USD)



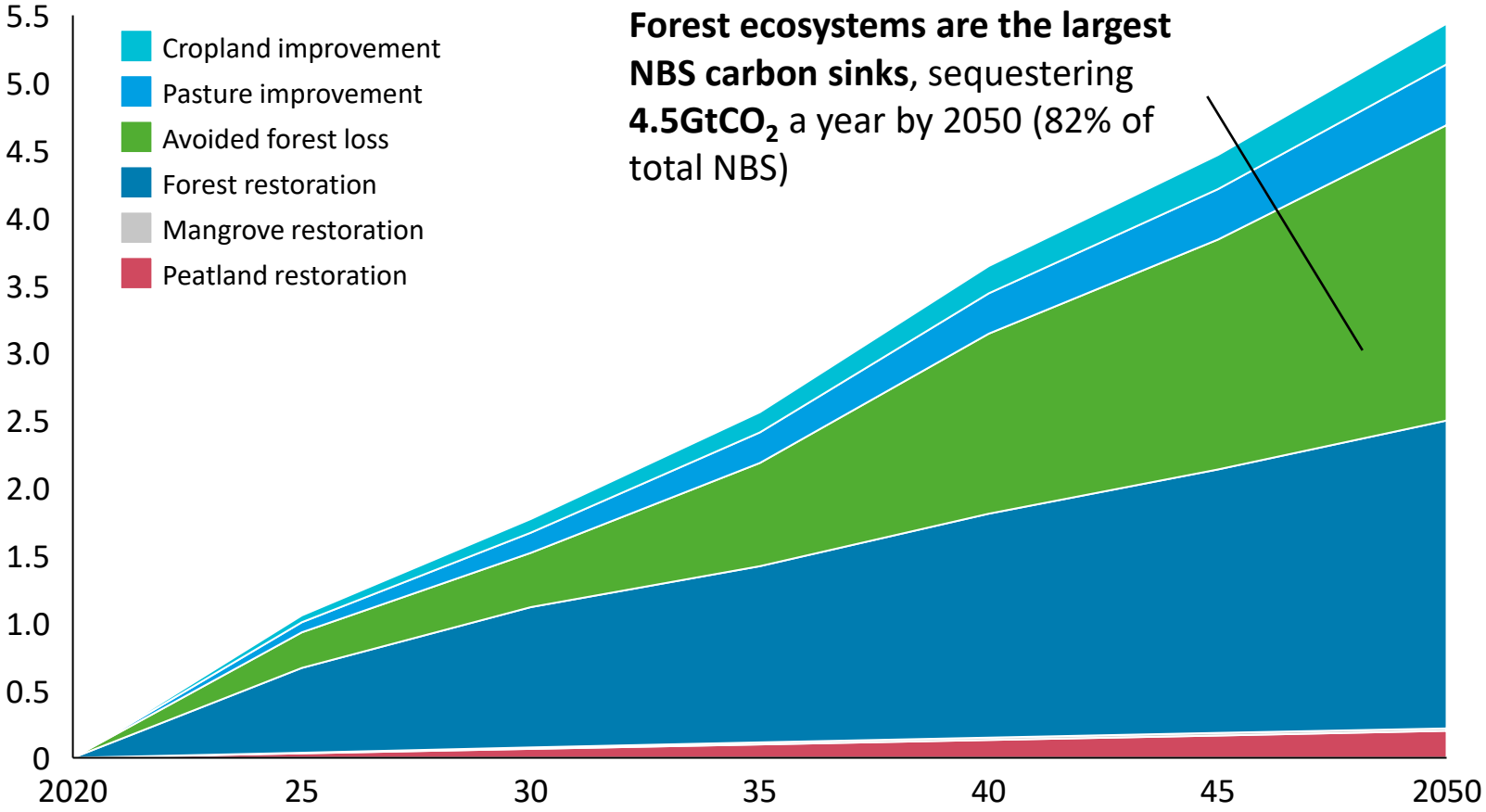
1. High quality NBS projects implemented appropriately can support relatively higher levels of biodiversity, compared to other types of NBS. For example, afforestation using a natural mix of trees rather than monoculture could produce more positive nature outcomes (Hua et al. (2016)). 2. Natural forest restoration and managed afforestation are subsets of the forest restoration NBS category in the value drivers.
Note: Revenues are calculated as the quantity of emissions sequestered multiplied by the prevailing carbon price in that year. This does not differentiate between direct government investment, compliance, or voluntary markets. This estimate therefore does not represent voluntary or compliance market revenues.

Note: All NBS depicted is additional to levels of NBS in 2020.

INEVITABLE POLICY RESPONSE

3. Nature-based solutions could avoid and sequester nearly 5.5 $GtCO_2$ emissions per year by 2050, with forest ecosystems accounting for 82% of the total

$GtCO_2$ emissions avoided and sequestered per year by NBS type



Forest ecosystems are the largest NBS carbon sinks, sequestering **4.5$GtCO_2$** a year by 2050 (82% of total NBS)

The NBS fall into three categories, according to how they sequester carbon:

- **Restoration**: NBS that creates new ecosystems – sequesters **2.5 $GtCO_2$** a year by 2050
- **Avoidance**: NBS that prevents the loss of existing ecosystems – sequesters **2.2 $GtCO_2$** a year by 2050
- **Improvement**: NBS that improves practices and carbon retention in agricultural lands – sequesters **0.75 $GtCO_2$** a year by 2050

Note: The reference amount of ecosystem loss used to calculate carbon sequestration and revenues for avoided loss NBS options is calculated by taking the difference between FPS + Nature and the modelled reference business as usual (BAU) scenario. All NBS depicted is additional to levels of NBS in 2020.

Forest, mangrove and peatland restoration NBS overlap to some extent with government restoration targets outlined in the policies and trends sections of this report. Restoration targets are defined as public sector led with land managed for biodiversity benefit; they could encompass a wide range of habitat types. In contrast, restoration NBS can be derived from a mix of public and private sources; it encompasses a narrower range of habitat types and is principally focused on carbon sequestration.

INEVITABLE POLICY RESPONSE

3. Land used to generate biodiversity credits may overlap with land used to generate carbon credits, offering the possibility of an additional source of revenue for landowners

Emerging standards and best-practice guidance on credit creation may permit generation of carbon credits and biodiversity credits on the same land via land conservation and improvement projects. Land could produce three combinations of credits:

	NBS-based carbon credits	Carbon credits and biodiversity credits	Biodiversity credits
Description	Carbon credits derived from NBS projects involve safeguarding and improvement of land to **avoid and sequester carbon emissions**	There is approximately 40% overlap between high-biodiversity areas and areas with high potential for carbon storage,[1] suggesting that conservation could deliver **positive outcomes for both climate and nature**, e.g., as in the case of REDD+ projects	Land safeguarding and improvement projects that can demonstrate **desirable biodiversity outcomes** could be used to generate biodiversity credits
Process	Generation of carbon credits via NBS could be **incentivised by carbon pricing** and supported by government initiatives to conserve land, which may crowd in private sector funding	Total NBS funded by the private sector could shift towards higher quality NBS that facilitates desirable biodiversity outcomes; this is encouraged by increased nature-related target setting and **emerging carbon credit best-practice guidance that includes biodiversity safeguarding as a minimum requirement[2]**	Not all biodiversity-relevant areas have high carbon sequestration potential, thus a biodiversity credit market could incentivize conservation of **land additional to what is used for generation of NBS-based carbon credits**

Overlap: Generation of biodiversity credits on land that is also used to generate carbon credits may be possible to facilitate market scale up and increase funding for desirable nature outcomes. Rules and standards to govern this interaction and elaborate on additionality requirements are still being developed.

1. Soto-Navarro (2020) 2. WRI

Note: Biodiversity credits would be bought and sold voluntarily as an investment in the recovery of natural capital. They are distinct from biodiversity offsets, which are generally intended to compensate for damage.

3. Although highly uncertain and based on preliminary assumptions, supply side analysis implies annual revenue of USD 18-43 billion from biodiversity credits in 2050

INEVITABLE POLICY RESPONSE

Estimated biodiversity credit market annual revenue[2] in FPS + Nature based on supply side analysis, USD billion

Note: Analysis makes no assumptions on volume of demand

Mha — Land used for biodiversity credit generation

Overlapping: Annual revenue from land overlapping with carbon-credit generating land

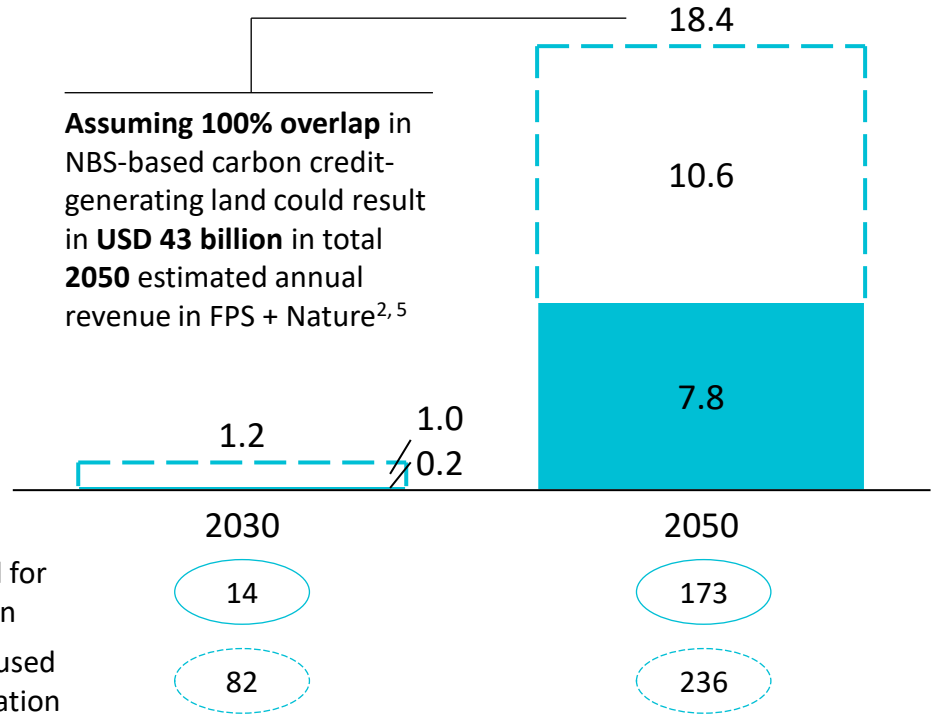
Additional: Annual revenue from land additional to land used for carbon credit generation

Assumptions used to estimate supply of biodiversity credit-generating land and associated revenue in FPS + Nature:

- **Biodiversity credit price:** Biodiversity credit prices are assumed to range from basic conservation costs (USD 12/ha/yr)[4] to observed willingness to pay for biodiversity co-benefits in the NBS-based carbon credit market (USD 45/ha/yr).[3] Analysis assumes prices increase linearly as one possible scenario
- **Overlap with carbon credit-generating land:** Analysis assumes that 30% of FPS + Nature modelled NBS land could be used to generate biodiversity credits in 2030 and 2050, aligned with the proportion of NBS-based Verra carbon credits issued over the past 10 years with biodiversity-related certification[1]
- **Compliance with guidance on additionality:** Analysis assumes that biodiversity credit generation is consistent with additionality guidance related to NBS-based carbon credit generation

This figure assumes a linear increase in biodiversity credit price over time

Assuming 100% overlap in NBS-based carbon credit-generating land could result in **USD 43 billion** in total **2050** estimated annual revenue in FPS + Nature[2, 5]

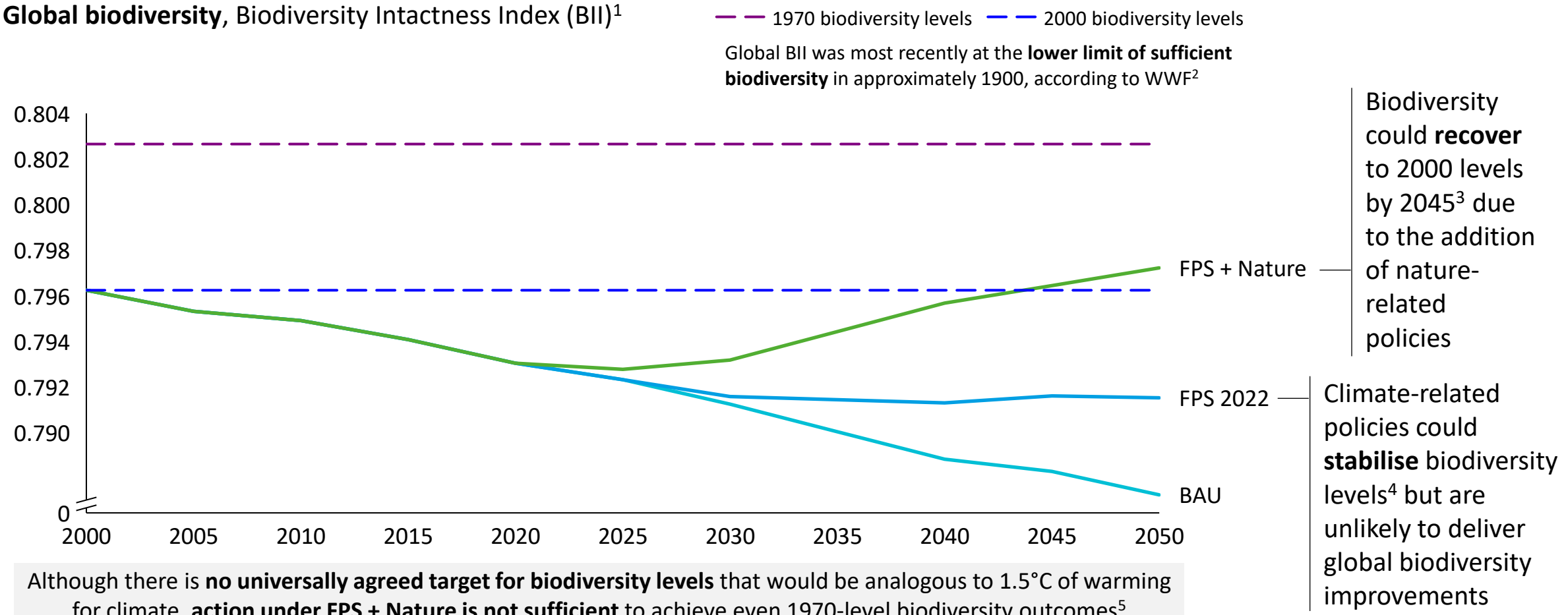


	2030	2050
Additional to land used for carbon credit generation	14	173
Overlapping with land used for carbon credit generation	82	236

1. For purposes of this analysis, it is assumed that all land implicated in FPS + Nature modelled NBS could be used to generate carbon credits. Analysis assumes a 30% overlap because this proportion aligns with the number of CCB-certified NBS-related Verra carbon credits issued over the past 10 years, relative to total NBS-related Verra carbon credits issued (as per the Verra online registry database). The CCB is Verra's Climate, Community and Biodiversity standard. 2. Annual revenue is estimated on the basis of the full estimated biodiversity credit price (see Appendix for full methodology), including for credits generated on land assumed to be used to also generate NBS-based carbon credits. 3. Willingness to pay is based on an observed price premium of USD 5/tCO_2 in the voluntary carbon credit market in May 2022 for carbon credits certified under Verra's Climate, Community and Biodiversity (CCB) standard. Note that Verra is the most significant independent carbon credit standard, based on volume of voluntary market credits issued. (Source: Vivid Economics analysis) See Appendix for full methodology. 4. Lindsey et al. (2018). See Appendix for full methodology. 5. This sensitivity was chosen because all carbon credit-generating NBS projects following best-practice guidelines about biodiversity safeguarding (e.g., see WRI) may be able to value those biodiversity outcomes in the biodiversity credit market; by 2050, all carbon credit-generating NBS projects could be following these guidelines, as an upper bound.
Note: Numbers should not be construed as a forecast. In line with FPS + Nature's focus on land, total estimated revenue does not account for marine biodiversity credits.

Nature-related policy action could halt and reverse global biodiversity loss; climate-related policies alone are unlikely to achieve this outcome

Global biodiversity, Biodiversity Intactness Index (BII)[1]



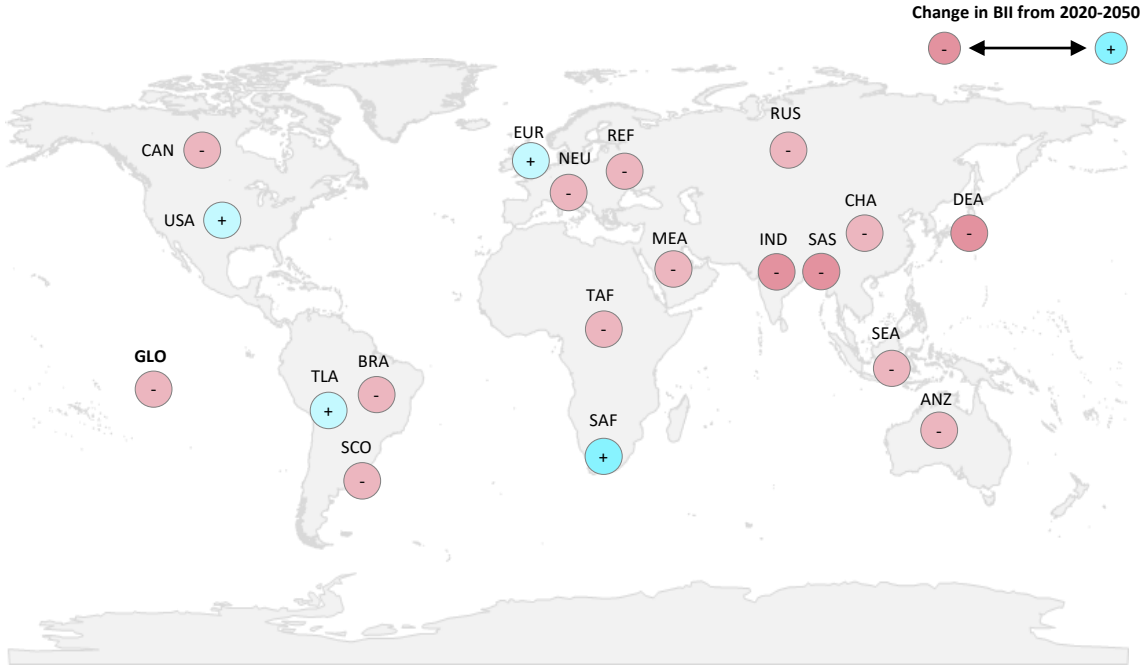
Although there is **no universally agreed target for biodiversity levels** that would be analogous to 1.5°C of warming for climate, **action under FPS + Nature is not sufficient** to achieve even 1970-level biodiversity outcomes[5]

1. BII estimates how much of an area's natural biodiversity remains by assessing the average abundance of native terrestrial species in comparison to their abundance in the absence of pronounced human impacts (Natural History Museum; De Palma et al. (2021)). It proxies for global change in ecosystem services or nature outcomes. BII level is extrapolated backwards to 1970, based on the rate of change modelled in BAU here. 2. WWF (2020), p. 29 3. Halting and reversing biodiversity loss is central to the CBD's 2050 vision. 4. Stabilisation could be driven by policies that contribute to reduced ruminant meat consumption, which alleviates land pressure; the end of net deforestation could also play a role. 5. Note also that 'extinction debt' could cause an accelerated rate of extinctions in all scenarios, regardless of BII outcomes.

A climate-only policy future may achieve biodiversity improvement in one quarter of regions; nature-related policy could result in improvement in three quarters of regions

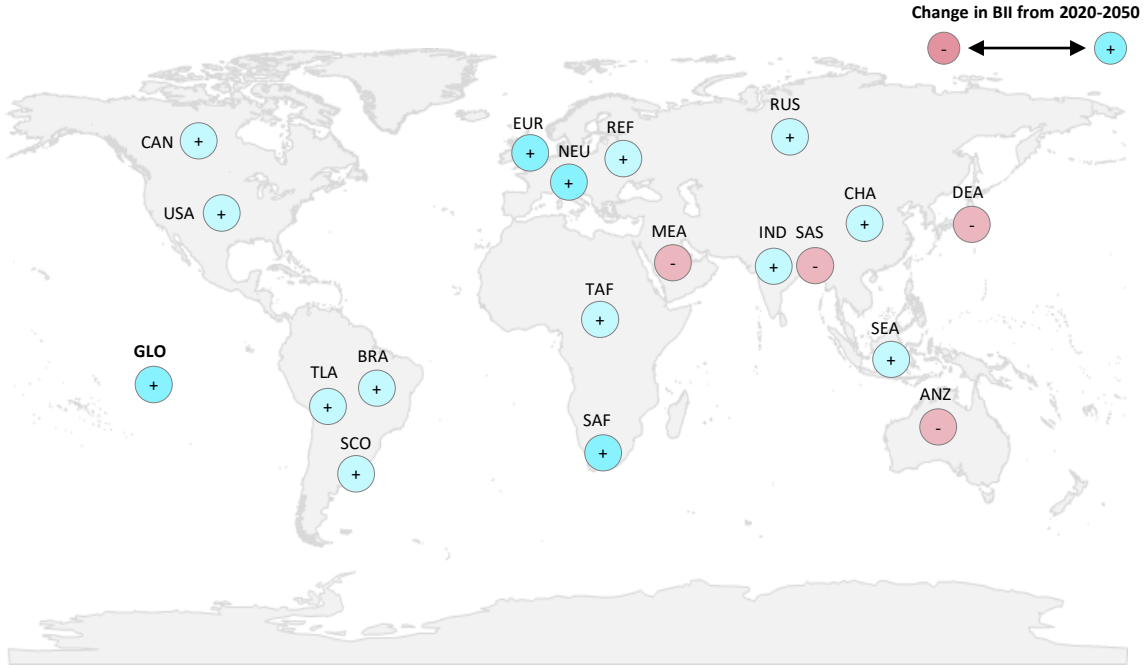
FPS 2022: Change in biodiversity 2020-2050, BII

Pursuit of climate-only policies could result in continued biodiversity decline globally and in critical regions such as Tropical Africa, Southeast Asia and Brazil



FPS + Nature: Change in biodiversity 2020-2050, BII

Nature policies related to protected areas, restoration and biodiversity valuation could drive biodiversity recovery globally and in critical biodiversity-rich regions

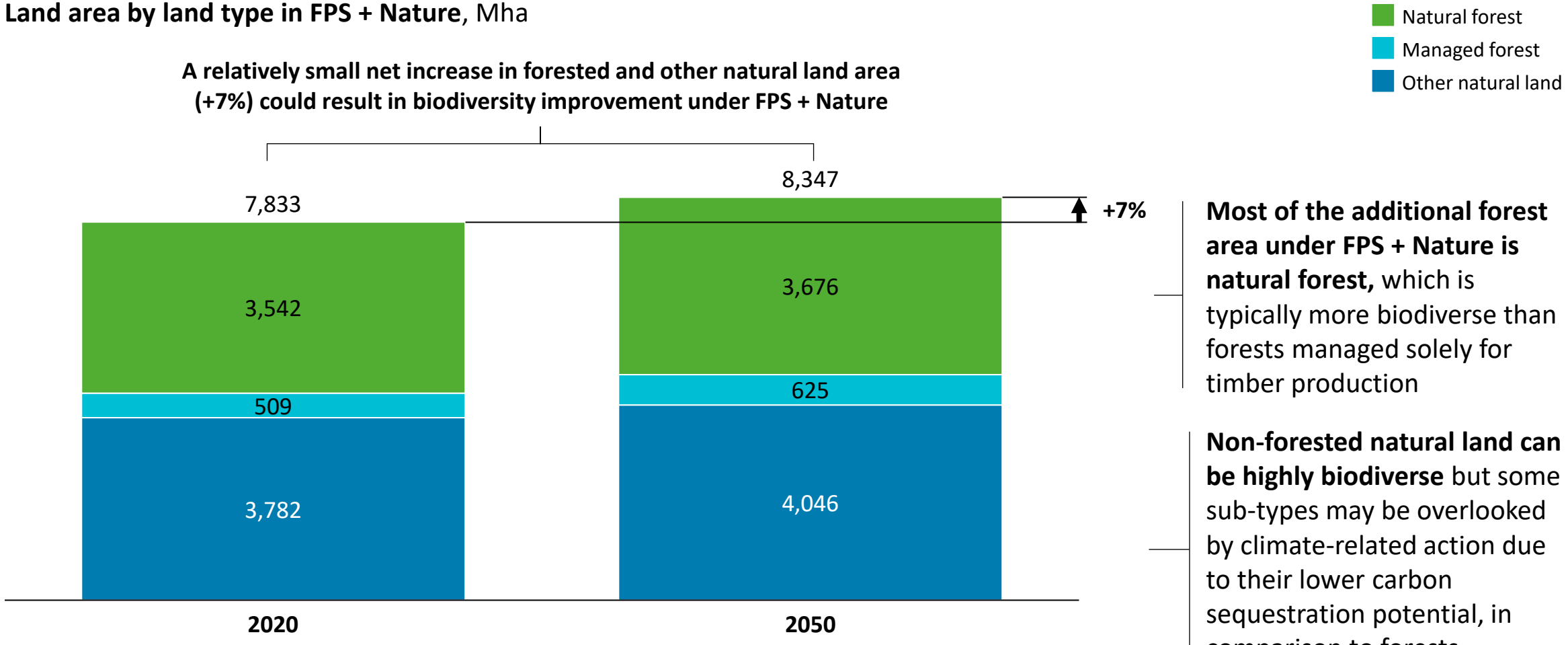


Note: Australia & New Zealand could see no significant improvement in BII from FPS 2022 to FPS + Nature despite ambitious nature policies. This could be caused by changes in production patterns, as additional protected area restrictions enacted in FPS + Nature in China and Middle East & North Africa reduce temperate cereal production in those regions, some of which is then produced in Australia & New Zealand, negatively impacting land use and biodiversity outcomes.

INEVITABLE POLICY RESPONSE

Biodiversity improvement could be driven by protection and restoration of highly biodiverse areas, contributing to increases in natural forest and other natural land

Land area by land type in FPS + Nature, Mha



Most of the additional forest area under FPS + Nature is natural forest, which is typically more biodiverse than forests managed solely for timber production

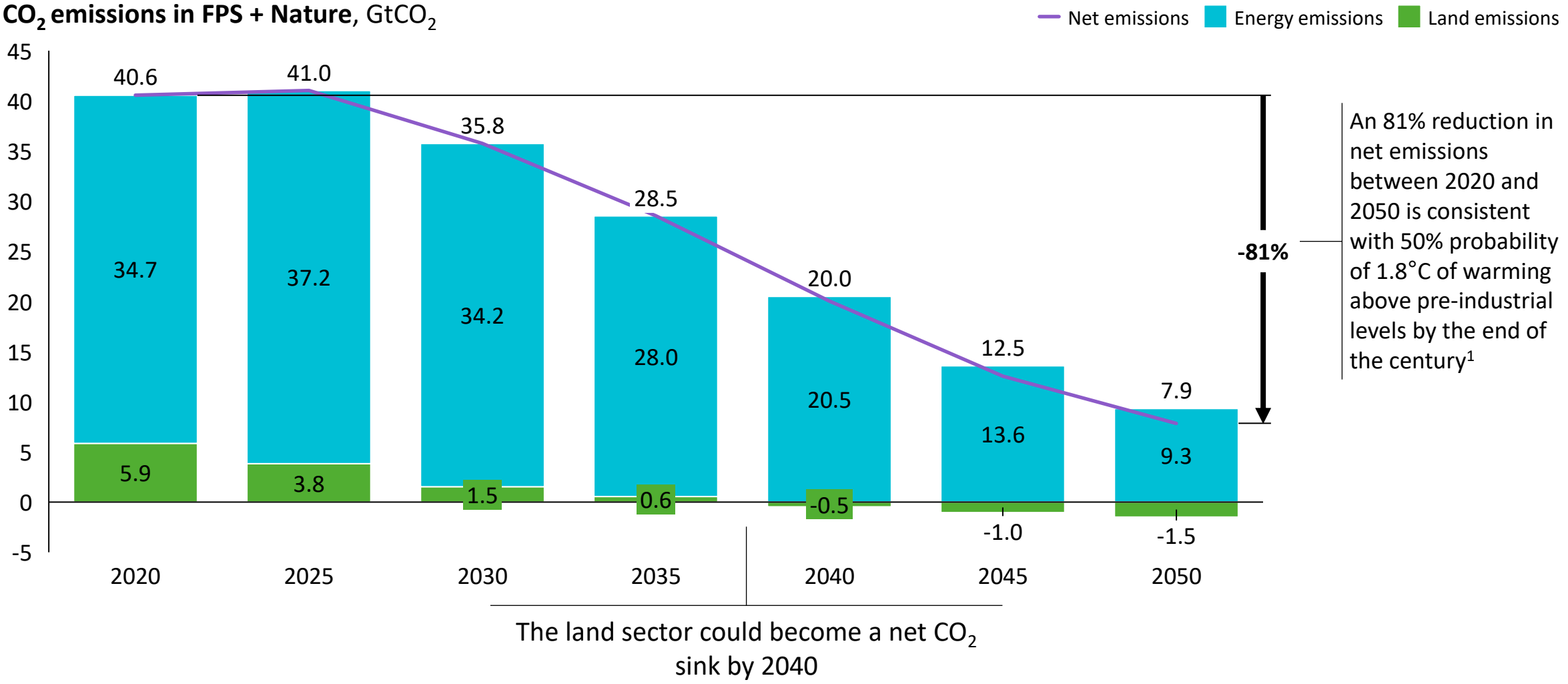
Non-forested natural land can be highly biodiverse but some sub-types may be overlooked by climate-related action due to their lower carbon sequestration potential, in comparison to forests

Note: Other natural land includes all non-forested natural land, such as scrubland, wetlands, and peatlands.

INEVITABLE POLICY RESPONSE

Integrated policy action is consistent with 1.8°C of warming; nature-related policy could contribute to the land use sector becoming a net carbon sink by 2040

CO_2 emissions in FPS + Nature, $GtCO_2$



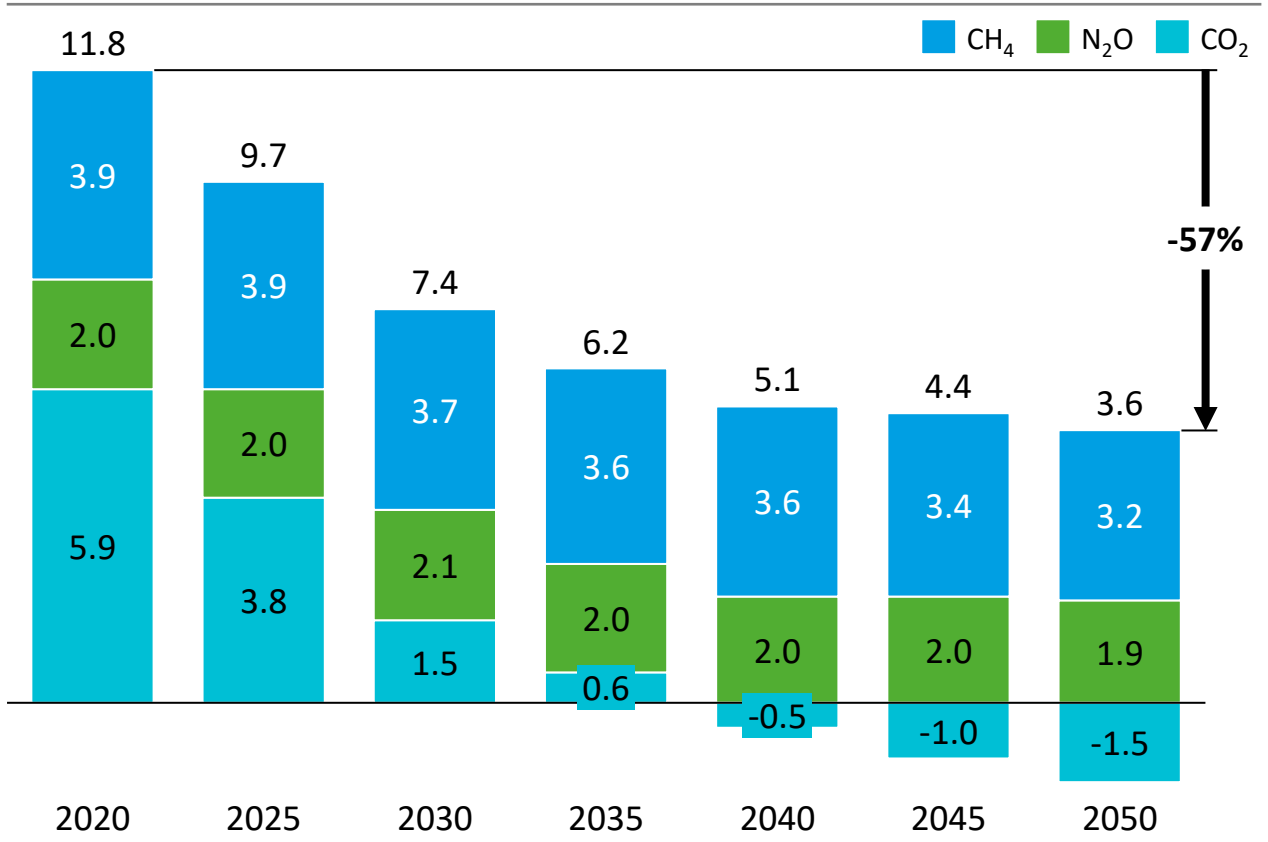
1. IPCC

Note: Energy emissions are unchanged from FPS 2021. Land use emissions in 2020 are aligned to Global Carbon Project, and sequestration from avoided emissions is excluded in order to avoid double counting.

INEVITABLE POLICY RESPONSE

Additional protection of natural land could contribute to lower land use emissions, as crucial carbon sinks could be protected

Global land use emissions in FPS + Nature ($GtCO_2e$)



Carbon dioxide: FPS + Nature sequesters more CO_2 than a climate policy only scenario, as the **expansion of protected areas could secure key carbon sinks**, leading to 0.7 Gt CO_2e less emissions in 2050, aligning with a 1.8˚C potential warming outcome

Methane: CH_4 land use emissions **are largely driven by livestock production**, which implies similar emissions across FPS 2022 and FPS + Nature, primarily influenced by consumer shifts away from ruminant meat consumption

Nitrous oxide: N_2O emissions are **largely driven by application of nitrogen fertilisers**, with similar emissions across FPS 2022 and FPS + Nature as necessary yield increases could be accomplished sustainably, with limited increases in fertiliser use

Note: Land use emissions in 2020 are aligned to Global Carbon Project, and sequestration from avoided emissions and land improvement is excluded in order to avoid double counting. N_2O and CH_4 emissions are aligned to FAO agriculture emissions, from FAO.

FPS + Nature is a ‘beta version’ scenario that represents an exploratory, plausible pathway for the future, subject to uncertainty

Scenarios

A scenario is a **hypothetical but plausible pathway** for the future

It is a tool that can be used to **enhance strategic thinking**, challenge standard assumptions about the future, and conduct risk and opportunity analyses

FPS + Nature

Assumptions shape the scenario: Modelling inputs are derived from nature- and climate-related policies, shaping the narrative of the pathway

Value drivers describe the scenario: Modelling outputs are indicative, investor-relevant value drivers that describe the exploratory outcomes of the pathway shaped by the input assumptions

Caveats

As with all modelling exercises, scenarios are necessarily a **simplification**

As with all assessments of the future, scenarios are **subject to uncertainty**

Disclaimer

The contents of this presentation do not constitute investment advice, policy advice, or any other type of advice for investors

FPS + Nature extends the IPR scenario framework to incorporate accelerating policy action to safeguard and restore the natural world

IPR has previously focused on policy responses to climate change

2019

First release of Forecast Policy Scenario (FPS) – traces the impact of forecast climate policies

2020

Data collection for the **Policy Forecast** (launched in 2021 and supplemented with **Quarterly Forecast Trackers** to track policy progress against FPS throughout 2022)

2021

Updated release of FPS – includes additional variables and deeper granularity driven by an updated assessment of climate policies

First release of 1.5°C Required Policy Scenario (1.5°C RPS) – highlights key actions necessary to reach a 1.5°C climate outcome

2022

Release of IPR Supply Chain Analysis – focuses on in-depth analysis of transition risk in tropical soft commodity supply chains

Updated release of FPS – incorporates updated assessment of climate policies[1]

2023

First release of FPS + Nature – incorporates the effect of policies to address nature loss in addition to updated climate policies to produce an exploratory 'beta version' scenario

1. Note that FPS 2022 is also included as one of the WBCSD's recently-released climate reference scenarios for the land use sector (i.e., the WBCSD's <2°C Forecast Policy Scenario (IPR)). See here for more information.

INEVITABLE POLICY RESPONSE

The Biodiversity Intactness Index (BII) is used to estimate biodiversity outcomes in FPS + Nature

Biodiversity Intactness Index

Biodiversity refers to the differences within species, between species, and of ecosystems[1]

BII is a measure of biodiversity that estimates how much of an area's natural biodiversity remains by assessing the **average abundance of native terrestrial species** in comparison to their abundance in the absence of pronounced human impacts[2, 3]

BII considers only the **diversity of species** to proxy for biodiversity outcomes, although changes in genetic and ecosystem diversity are likely to be keeping with changes in species diversity

It is used as one of the indicators in the **Planetary Boundaries framework**[4]

Comparison of selected measures of biodiversity

Name	Description	Metric
Biodiversity Intactness Index	Assesses how much of an area's natural biodiversity remains intact	BII is rated from 0 to 100% with 100% representing an undisturbed or pristine natural environment
Global Human Footprint Index	Measures how much a biome has been altered by human activity	Rates human impact on biomes on a scale of 0 to 100 based on satellite imagery
Living Planet Index	Measures global biodiversity based on population trends of vertebrate species	Measures population trends in the 20,811 monitored populations of 4,392 vertebrate species
Red List Index	Tracks the extinction of groups of species over time	Assessment of 134,425 species and evaluation of their extinction risk
Species Habitat Index	Measures the proportion of suitable habitats that remain intact for a country's species	Ranks countries with a score from 0 to 100 based on the availability of intact habitats
Swiss Re Biodiversity and Ecosystem Services (BES) Index	Classifies and ranks worldwide ecosystems based on resource availability and habitat intactness	Aggregates data on nature-regulating services and resource availability at a resolution of 1 km^2 across the globe

Modified from Sitra. Source: Vivid Economics, based on Scholes and Biggs (2005), WCS (2005), IUCN (2020), EPI (2020), WWF (2020), Swiss Re Institute (2020)

1. IPBES 2. Natural History Museum; De Palma et al. (2021) 3. Mean Species Abundance (MSA) is another measure of biodiversity closely related to BII. MSA calculates the mean abundance of species in disturbed habitat relative to their abundance in undisturbed habitat. It considers some different anthropogenic drivers of biodiversity loss, compared to BII (Dasgupta Review). 4. Steffen et al. (2015)

FPS + Nature includes a detailed analysis of six different types of NBS

	Forestry	Peatland	Mangroves	Cropland	Pastureland
New deployments	Forest restoration, which includes: natural afforestation, managed afforestation (NDC and non-NDC); new timber plantations	Peatland restoration	Mangrove restoration		
Avoided impacts	Avoided deforestation of primary and secondary forests				
Improved practices				Cropland improvement	Pasture improvement

NBS are actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems, which address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services and resilience and biodiversity benefits

1. UNEA via Nature-based Solutions Initiative

Potential biodiversity credit price is assumed to range from basic conservation costs to observed willingness to pay for biodiversity outcomes in the voluntary carbon credit market

Uncertainty

Potential revenue in the emerging biodiversity credit market is difficult to assess and **depends significantly on the potential price** of biodiversity credits

Credit prices are likely to be **driven by market supply and demand**

Methodology for supply side analysis

FPS + Nature assumes a linear increase in biodiversity credit prices over time, as one possible scenario

- Biodiversity credit **prices are assumed to range** from basic conservation costs to observed willingness to pay for biodiversity outcomes in the voluntary carbon credit market
- In FPS + Nature, estimated **prices initially could reflect basic per hectare costs of land conservation**[3] as markets for biodiversity emerge by 2030
- By 2050, as markets mature, **prices could reflect observed willingness to pay** for biodiversity outcomes in the voluntary carbon credit market
  - There is an **observed price premium** of USD 5/tCO_2 in the voluntary carbon credit market for biodiversity- and community-related co-benefits[1]
  - This is **converted to a value of USD 45/ha/yr**[2]

Nature markets could incentivise land safeguarding and improvement by imposing an opportunity cost on land conversion in the form of foregone biodiversity credit revenue. Higher credit prices may incentivise additional conservation and increase the quantity of land being used to produce biodiversity credits, also potentially increasing total revenue

1. This is a price premium observed in the voluntary carbon credit market in May 2022, for carbon credits certified under Verra's Climate, Community and Biodiversity (CCB) standard. Note that Verra is the most significant independent carbon credit standard, based on volume of voluntary market credits issued. (Source: Vivid Economics analysis) 2. The conversion uses the quantity of carbon sequestered by natural forest. 3. Lindsey et al. (2018)
Note: Numbers should not be construed as a forecast.

INEVITABLE POLICY RESPONSE

Specification of market and policy trends and scenario modelling is performed for 18 regions and countries covering the whole of the globe

ANZ	Australia and New Zealand
BRA	Brazil
CAN	Canada
CHA	Greater China
DEA	Developed East Asia (Japan and Korea)
EUR	European Union and United Kingdom
IND	India
MEA	Middle East Asia and North Africa
NEU	Non-EU Europe (excl. United Kingdom)
REF	Eastern Europe and Central Asia (excl. Russia)
RUS	Russia
SAF	Southern Africa
SAS	South Asia
SCO	Latin America's Southern Cone
SEA	Southeast Asia
TAF	Tropical Africa
TLA	Tropical Latin America
USA	United States of America

INEVITABLE POLICY RESPONSE

FPS 2022 land use modelling has been updated to reflect the latest policy developments and modelling improvements since the release of FPS 2021

Lever	Update	Details	Effect
Diet shifts	More detailed picture of alternative protein market; assessment revised down to reflect latest developments in dietary shifts	Production and cost data by protein type and production method are revised	In '21, ruminant meat falls 14.2% from 2020-2050, peaking in 2030; now it falls 3.4%, peaking in 2035
Timber demand	Assessment revised down to reflect latest developments in low-carbon construction	Assessment updated based on latest estimates of timber demand from low-carbon buildings	Timber production increase from 2020 to 2050 revised from 83% to 23%
Nature-based solutions	Sequestration estimates revised down to account for marketability of NBS types and ensure consistency	See following slide for more details on NBS modelling changes from FPS 2021	See following slide for more details on NBS modelling changes from FPS 2021
Sustainable agriculture	New assessment on changes in nitrogen uptake efficiency to reflect policy ambition to reduce excess nitrogen and eutrophication	Soil nitrogen uptake efficiency (SNUpE) increases to a global average of 65% in 2050	Yield improvements can be achieved with lower additional inputs of nitrogen
Food waste	New assessment to account for policy ambition to reduce food waste	Food waste falls globally by 23%, from 26% of food being wasted in 2020 to 20% in 2050	Additional food demand can be met by smaller production increases

Note: FPS 2022 energy system modelling remains the same as in FPS 2021. Energy system modelling is underpinned by Quarterly Forecast Trackers that confirm policy momentum towards FPS. Energy-related value drivers released as part of FPS 2022 and FPS + Nature remain the same as in IPR FPS 2021. Note also that the BAU scenario used as a counterfactual has been updated to reflect latest market developments and modelling capabilities.

INEVITABLE POLICY RESPONSE

NBS outputs have been updated since FPS 2021 to improve investor relevance and consistency, and to reflect latest available data

A subset of the full suite of modelled NBS types is included in FPS + Nature 2022. In FPS 2021, a full suite of possible NBS types were included in the results summary document, from which 8.7 $GtCO_2$ of NBS sequestration was derived. However, after having accounted for marketability and which NBS types could be expected to be realized at scale, only a subset of these NBS types were included in the final value drivers. In order to establish consistency between the results summary document and the value drivers, only the subset of NBS types is included in the summary document for FPS 2022 and FPS + Nature. In comparison to FPS 2021, this results in lower sequestration presented in the summary document.

The carbon value metric has been replaced with annual revenue. Revenue is calculated by multiplying the sequestration of each NBS type by the prevailing voluntary carbon market price for NBS-based credits, which is assumed to potentially reach USD 45/tCO_2 in 2050. NDC-driven afforestation, a subset of forest restoration, is not counted when calculating annual revenue, as it is not expected to generate revenue. Annual revenue is indicative and does not represent an estimate of voluntary carbon market revenues as NBS is unlikely to be funded exclusively through voluntary markets; instead, NBS may be split between NBS funded through direct government investment, compliance markets, and voluntary markets, with revenues accruing accordingly.

The cumulative investment metric has been updated. This previously just incorporated the CAPEX costs of NBS, but now accounts for both the CAPEX and the discounted lifetime OPEX of each NBS at its initiation. This assumes that OPEX financing is in place at project initiation and more accurately accounts for the investment needs of NBS. This change explains why investment numbers are greater than in FPS 2021.

CO_2 sequestration per hectare for different NBS solutions has been revised. This is in line with latest data, with some sequestration numbers increasing and others decreasing. This results in a net downward revision of sequestration per hectare.