# The Inevitable Policy Response Forecast Policy Scenario 2023

## Detailed land use and nature results

September 2023

INEVITABLE POLICY RESPONSE

# Executive Summary

- **Population and income growth drives demand for food energy and materials, increasing demand for productive uses of land.** Global food demand increases by 21% by 2050, as income and population growth increase food demand in EMDEs. Increasing demand for housing drives to a 22% increase in demand for timber in construction, leading to the expansion of commercial forest plantations.
- **Climate and nature action drives demand for land conservation and restoration, restricting the potential for agricultural land and plantations expansion onto natural land**. Increasing nature action leads to the protection of an additional 980Mha of natural vegetation, stabilising of biodiversity intactness to 2020 levels by 2050. Carbon prices grow substantially, increasing both market-based and publicly-funded incentives for Nature-Based Solutions. By 2050, ~1.8 $GtCO_2$/yr. in emissions are avoided against baseline deforestation, while ~3.8 $GtCO_2$/yr in emissions are removed through NBS.
- **Increasing GHG costs in the agricultural sector, coupled with behavioral shifts and technological innovation, stabilizes agricultural methane and nitrous oxide emissions**. Behavioral shifts and innovation drive consumers away from conventional proteins consumption, leading to a peak in ruminant meat production by 2035. Innovative agricultural practices and inputs increase nitrogen fertilizer uptake efficiency, reducing nitrous oxide emissions form fertilizer use.
- **Technology and innovation facilitate the transition and create new sector growth opportunities.** The areas with the biggest impact are productivity-enhancing technologies (like precision agriculture), fertilizer efficiency, alternative proteins, methane reducing feed additives, waste reduction and management, and sustainable biomass crops and supporting infrastructure.

INEVITABLE POLICY RESPONSE

# IPR was commissioned by the PRI[1] and is supported by world class research partners and leading philanthropies, financial institutions, & NGOs

1. Principles for Responsible Investment
2. The conclusions of the report are solely those of Energy Transition Advisers and Theia Finance Labs

## Commissioned by PRI

In 2018, the Inevitable Policy Response was commissioned by PRI to advance the finance industry's knowledge of climate transition risk & support investor efforts to incorporate climate risk & opportunities in portfolio assessment

PRI Principles for Responsible Investment

## A Climate Research Consortium

This report was produced by Energy Transition Advisers and Theia Finance Labs[2] with support and analysis from Vivid Economics.

NGO partners include Carbon Tracker, Climate Bonds & Planet Tracker

Energy Transition Advisors ETA

THEIA FINANCE LABS

## Strategic Partners

In 2021, leading financial institutions joined the IPR as Strategic Partners to provide more in-depth industry input, and to further strengthen its relevance to the financial industry

FitchRatings · BNP PARIBAS ASSET MANAGEMENT · quinbrook infrastructure PARTNERS · TEMASEK

## Core philanthropic support

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 striving to innovate and accelerate climate solutions at scale

GORDON AND BETTY MOORE FOUNDATION · THE FINANCE HUB · climateworks FOUNDATION

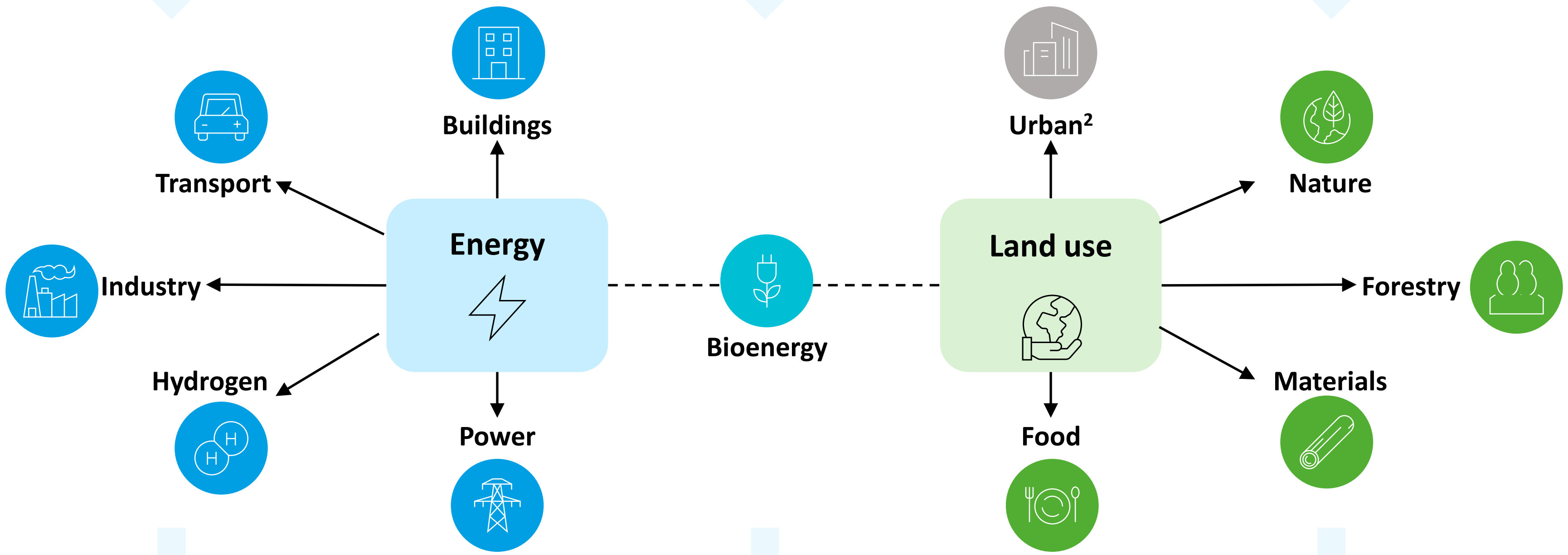
# IPR offers a range of applications to help financial institutions navigate the climate transition

**Policy forecast**

IPR produces **>300 high-conviction policy forecasts** covering 21 countries and 10 policy areas across energy and land use

Policy forecasts feed into a fully **integrated climate and nature scenario model** that elicits the impact of the forecasted policies on the energy, land use, and nature systems up to 2050, tracing detailed effects on all emitting sectors[1]

**Modeling**




**Value drivers**

IPR's integrated scenario model outputs detail value drivers across energy and land use. See Value Driver Visualizer

**Applications**

Fitch Ratings, Morning Star, Paris Agreement Capital Transition Assessment (PACTA), Planetrics, *tilt* (Climate data for SMEs)

1. IPR also develops a '1.5°C Required Policy Scenario'(1.5°C RPS) building on the IEA NZE by deepening analysis on policy, land use, emerging economies, NETs and value drivers. The RPS scenario is also run through the model and can be used by those looking to align to 1.5°C. 2. Urban areas are not modelled in detail in IPR

INEVITABLE POLICY RESPONSE

# IPR has developed global, policy-based forecasts of forceful policy responses to climate change and implications for energy, agriculture and land use

**Please see the IPR Home Page for further details**

| Scenario | Policy Forecast Details | Open Access Database |
|---|---|---|
| **IPR 2023 Forecast Policy Scenario (FPS)**<br>• Models impact of forecasted policies on the real economy | IPR FPS 2023 Summary Report<br>IPR 2023 Policy Forecast<br>IPR FPS 2023 Detailed Energy Results<br>IPR FPS 2023 Detailed Land Use and Nature Results<br>IPR 2023 Bioenergy Report | IPR FPS 2023 Value Drivers<br>IPR Scenario Explorer |
| **IPR 1.5°C Required Policy Scenario (RPS)**<br>• Required policies to align to a **1.5°C objective** building on the IEA's Net Zero scenario and deepening analysis on policy, land use, emerging economies and value drivers | IPR 1.5°C RPS Energy and Land Use System Results including Policy Details | IPR RPS 2021 Value Drivers |
| **IPR Forecast Policy Scenario + Nature (FPS + Nature)**<br>• First integrated climate and nature scenario for use by investors | IPR 2022 FPS + Nature detailed results | IPR FPS + Nature Value Drivers |

**IPR has published a set of publicly available outputs from the FPS and 1.5°C RPS that offer significant granularity at the sector/country level, allowing investors to assess their own climate risk across 4,000+ variables**

Disclaimer: This is not intended to constitute policy advice, financial advice or any specific advice.

# IPR 2023 forecasts higher climate policy ambition across 10 policy levers covering energy, land use, and nature

## Net zero

- Interim emissions target
- Net zero $CO_2$ long-term target

## Carbon pricing

- Carbon taxes
- Emission trading systems
- Carbon border adjustment mechanisms (CBAMs)

## Clean power

- Targets for a fully decarbonised electricity system
- Renewable capacity auctions
- Renewable subsidies
- Nuclear power targets and and strategies

## Low-carbon buildings

- Prohibiting regulations for fossil heating systems
- Purchase subsidies for low-carbon heating systems
- Thermal efficiency regulations for buildings
- Minimum energy performance standards for new appliances

## Low-carbon agriculture

- Subsidies for low-emissions practices and technologies
- Emissions regulation including via tax or cap-and-trade systems
- Farmer education and technical assistance programs

## Coal phase-out

- Regulations prohibiting coal build
- Emissions performance standards
- Electricity market reforms

## Zero emissions vehicles

- ZEV consumer subsidies Targets to fully decarbonise the new sales of road vehicles
- Manufacturer ZEV obligations

## Clean industry

- Emissions performance standards for industrial plants
- Subsidies for new or retrofit clean industrial processes

## Forestry

- Incentives for reforestation and afforestation
- Penalties for deforestation, supported by consumer pressure
- Mandates to ensure deforestation free supply chains

## Nature-based solutions

- Land protection and restoration policy
- Nature incentives for landowners to protect biodiversity hotspots and habitats
- Voluntary biodiversity credit markets

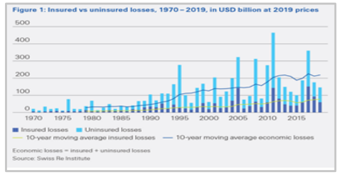
# The drivers of policy momentum make an inevitable and forceful policy response more likely…social tipping points are key

## Changes in physical & monetary costs

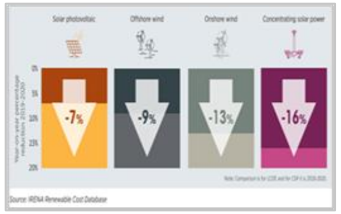
Extreme weather events

Increase in wet-bulb globe temperature

Uninsurable world




Cheaper renewable energy




## Increased pressure from society, markets & regulators

Financial markets pressure for net zero


Civil society advocating for 1.5C


Financial regulator interventions

Pressure for global institutions to support EDMEs transition

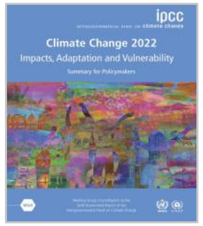
## Changes in geopolitics, energy security and research

US IRA impact on industrial policy


Impacts on security


Improved climate collaboration


New climate research



INEVITABLE POLICY RESPONSE

# Ratchet pressures increase the likelihood that governments will strengthen policy by 2025, and again to 2030 and beyond

**Paris Ratchet process triggers a cumulating policy response into 2025, 2030, and beyond**

**2021**
Countries communicate their updated or 2nd round of climate pledges

**2023**
Global Stocktake (GST) on climate, mitigation, and finance

**2025**
**2025 Ratchet**
Countries submit their 3rd round of climate pledges (NDCs)

**2028**
Second Global Stocktake (GST) on climate, mitigation, and finance

**2030**
**2030 Rachet**
Countries submit their 4th round of climate pledges (NDCs)

**Policy announcements are expected to continue in 2023 -2025, with continued acceleration in 2028-2030. Recognition of Overshoot grows from 2025**

COP28 UAE

# Content

INEVITABLE POLICY RESPONSE

# Four key macro trends shape the land sector over the next 30 years, under the FPS 2023

## Growing populations and incomes

- **Population and income growth drive food demand, particularly in emerging economies**
- Over the next 30 years, population grows by 1.3x[1]
- GDP is expected to grow 2x as fast[2] in non-OECD economies, particularly in Tropical Africa

## Climate and biodiversity policies

- **Climate and nature policy increases transition risks for "unsustainable" players in the agriculture and land use sector**
- Climate action incentivizes net-zero deforestation. Nature-based solutions (NBS) can help achieve climate goals by halting deforestation and pushing afforestation
- Biodiversity ambition increases restoration and conservation of natural ecosystems. Biodiversity credits could incentivize the uptake of biodiverse NBS, achieving both climate and biodiversity outcomes

## Evolving consumer preferences

- **Diets shift, driven by environmental and health concerns, and increasing innovation in alternative proteins**
- A shift to alternative proteins increases demand for plant-based products but reduces feed production
- Diet shifts away from animal proteins reduces pressure on the land use system

## Technology investment and uptake

- **GHG pricing, demand shocks and land scarcity drive increased investment in technological innovation in**:
  - Productivity-enhancing agricultural technologies, including both traditional methods (e.g. improved irrigation) and emerging methods (e.g. vertical farming)
  - Technologies that mitigate on-farm emissions, such as precision agriculture and improved livestock feed
- Increases in bioenergy demand in turn increase the demand for second generation bioenergy crops

1. United Nations
2. The World in 2050 Report

INEVITABLE POLICY RESPONSE

# IPR policy forecasts are informed by live tracking of major climate policy developments with land and nature implications

## Summary of key land use related climate policy announcements, Oct 2021 – Sep 2023

Legislated · Announced · IPR Policy Forecast release

**Oct 2021 – IPR 2021**
**2021 policy forecasts released**

**Nov 2021 – COP26** (Announced)
Many countries signed the 'Glasgow Leaders' Declaration on Forests and Land Use by 2030'

**Dec 2021 – UK's Environment Act 2021** (Legislated)
UK government introduces due diligence requirements for companies that use forest-risk commodities

**Nov 2021 – Vietnam's Climate Change Strategy** (Announced)
National climate change strategy to 2050 targets 70% emissions reductions from forestry and land use by 2030

**Aug 2022 – USA Inflation Reduction Act** (Legislated)
Government introduces market incentives to reduce emissions from crops and livestock

**Dec 2022 – COP15** (Announced)
Announcement of Global Biodiversity Framework Targets which emphasize the importance of land protection and restoration, and stimulation schemes

**Dec 2022 – EU deforestation free supply chains** (Legislated)
Policy announced to end deforestation in supply chains (legislated June 2023)

**Mar 2023 – Brazil deforestation** (Announced)
Pledge to end deforestation by 2030

**Jun 2023 – UK & France biodiversity market** (Announced)
International biodiversity market (ready 2024)

**Sep 2023 – IPR 2023**
**2023 policy forecasts released**

INEVITABLE POLICY RESPONSE

# The Policy Forecast remains largely consistent with 2021, though it shows some deceleration in ambition in the agricultural sector and includes three new forecast areas

Nature Action | Climate Action

Acceleration | Deceleration | No change

| Policy Area | Policy Type | Policy Lever | | Change in Forecast Relative to FPS 2021 |
|---|---|---|---|---|
| **Agriculture** | | **Emissions from agricultural production** | Policies that encourage farmers to significantly reduce emissions from agricultural production |  |
| **Land Use** | | **Afforestation and Reforestation** | Policies which encourage farmers to carry out significant afforestation and reforestation |  |
| | | **Deforestation- free supply chains** | Implementation of policies that require agricultural commodity inputs to be deforestation-free | New Forecast Area |
| **Nature** | | **Land protection** | Achievement of Dec 2022 COP15 Biodiversity target of protecting 30% of land and marine area | New Forecast Area |
| | | **Nature incentives** | Implementation of policies to deliver market incentives to improve biodiversity | New Forecast Area |

## Policy Implications

1. Deceleration in some countries is often due to a delay in announcement of the policy expected in FPS 2021. However, these are mostly technical and have a small impact on overall land use projections
2. In the case that a country's policy ambition decelerates, this occurs before 2030, resulting in a low impact on the sustainable transition of agriculture in the short term
3. Area protection policies limits agricultural land expansion which interact with other agriculture policies as land competition increases

INEVITABLE POLICY RESPONSE

# FPS 2023 land use modeling reflects the latest research and modeling improvements since the release of FPS 2021

| Lever | Update | Change between FPS 2021 and FPS 2023 |
| --- | --- | --- |
| **Diet shifts** | More detailed picture of the alternative protein market; assessment revised down to reflect latest developments in dietary shifts | Revised production and cost data by protein type and production method<br>Ruminant meat production falls less between 2020 and 2050, with a revision from peaking in 2030 to peaking in 2035 |
| **Timber demand** | Assessment revised down to reflect latest developments in low-carbon construction (10% of all new builds use wood as a construction material) | Assessment updated based on latest estimates of timber demand from low-carbon buildings[1]<br>Increase in industrial roundwood production from 2020 to 2050 revised down from 83% to 22%[2] |
| **Nature-based solutions** | Sequestration estimates revised down to account for marketability of NBS types. Avoided emissions estimates for NBS carbon credits revised down to account for a more realistic baseline, limitations in the demonstration of additionality, and challenges in demonstrating carbon sequestration for some types of interventions | FPS 2023 shows lower avoidance emissions relative to FPS 2021 but maintains sequestration values for removals values.<br>Land-based emission avoidance drops to ~1.8 $GtCO_2$/yr by 2050, but removals sequester ~3.8 $GtCO_2$/yr |
| **Food waste** | New assessment to account for policy ambition to reduce food waste | Additional food demand can be met by smaller production increases<br>Food waste[3] now assessed to fall globally from 26% of food being wasted in 2020 to 20% in 2050 |

1. Estimates based on Churkina et al. (2022) https://www.mdpi.com/2071-1050/14/7/4271
2. Industrial roundwood outlook aligned with FAOSAT IRW outlook (+25% by 2050) https://www.fao.org/documents/card/en/c/cc2265en
3. Food waste is calculated as a share of total food consumption and refers to all food wasted post-farm gate. In FPS 2023, the share of food wasted declines relative to 2020, while in FPS 2021 food waste as a share of food consumption remained constant

INEVITABLE POLICY RESPONSE

Add tracker

# Carbon sequestration drives emission reductions in the land use sector, while mitigation policies in the agriculture sector stabilize other GHG emissions

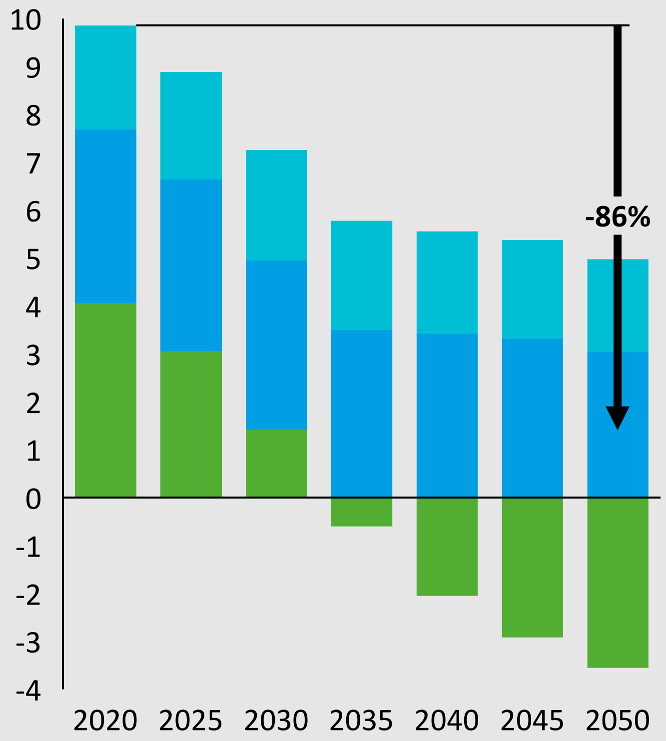
Historical values

IPCC C4 Max/Min

FPS 2023

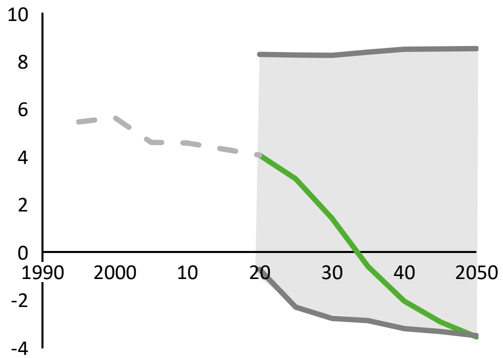
Nitrous Oxide | Methane | Carbon Dioxide

**FPS 2023: Global AFOLU Emissions,** Gt $CO_2$eq




**Global AFOLU Emissions by GHG,** Gt $CO_2$eq

**Net-$CO_2$ from Land[2]**



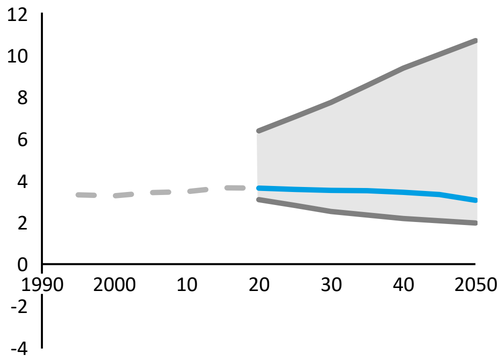

**Emissions Drivers:**

- Expansion of agricultural land onto natural land
- Sequestration from forest restoration, causing emissions to become negative

**Mitigation Levers:**

- These changes are driven by carbon pricing, A/R[1] policies, conservation and regulation against deforestation

**Methane**



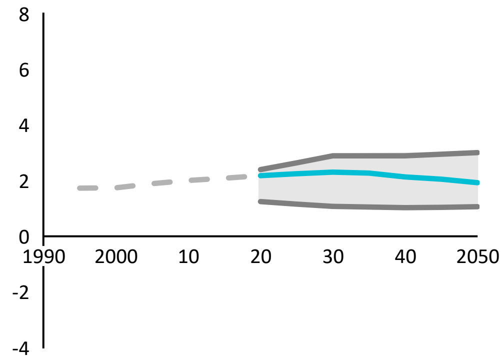

**Emissions Drivers:**

- Most methane emissions come from beef production (enteric fermentation)

**Mitigation Levers:**

- Growing emission costs incentivize producers to invest in technical mitigation (e.g., feed additives)
- Demand side shifts reduce production of emission intensive products

**Nitrous Oxide**




**Emissions Drivers:**

- Nitrogen-based inorganic fertilizers are the main source of nitrous oxide emissions

**Mitigation Levers:**

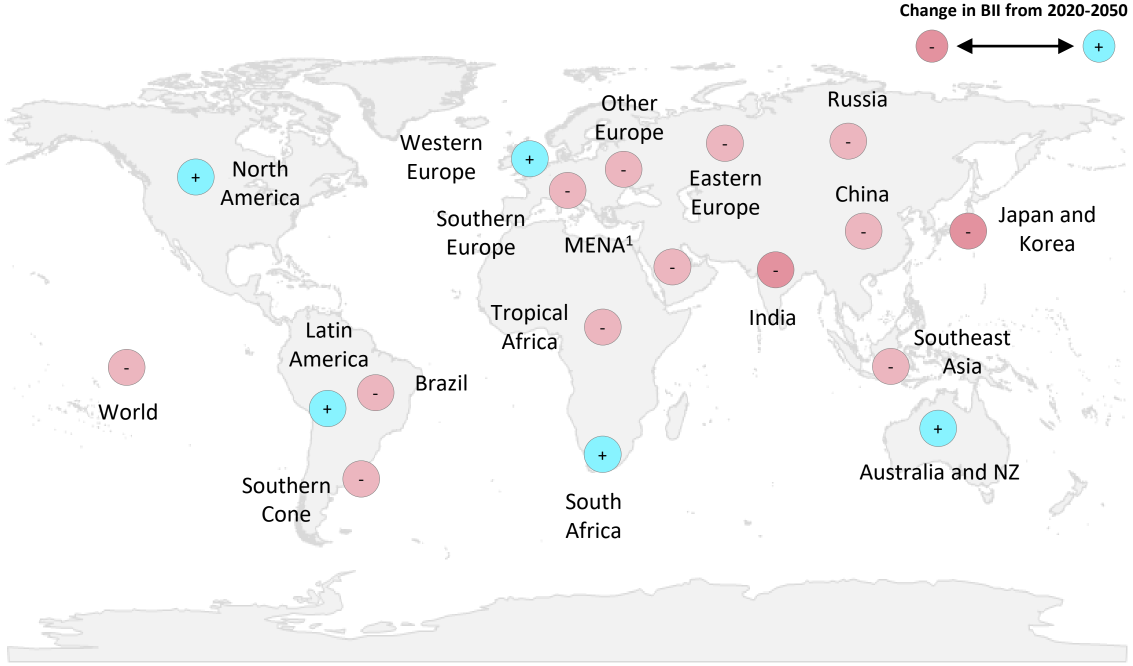
- A shift to sustainable agricultural practices decouple productivity growth and fertilizer use, reducing emissions

1. Afforestation and reforestation
2. This encapsulates both land use change and changes in carbon density on the same land use type (e.g., land may not change use, but may have negative emissions due to the growing of trees that sequester over time) as well as sequestration from nature-based solutions

# Conservation and restoration policies reverse biodiversity loss to 2020 levels by 2050

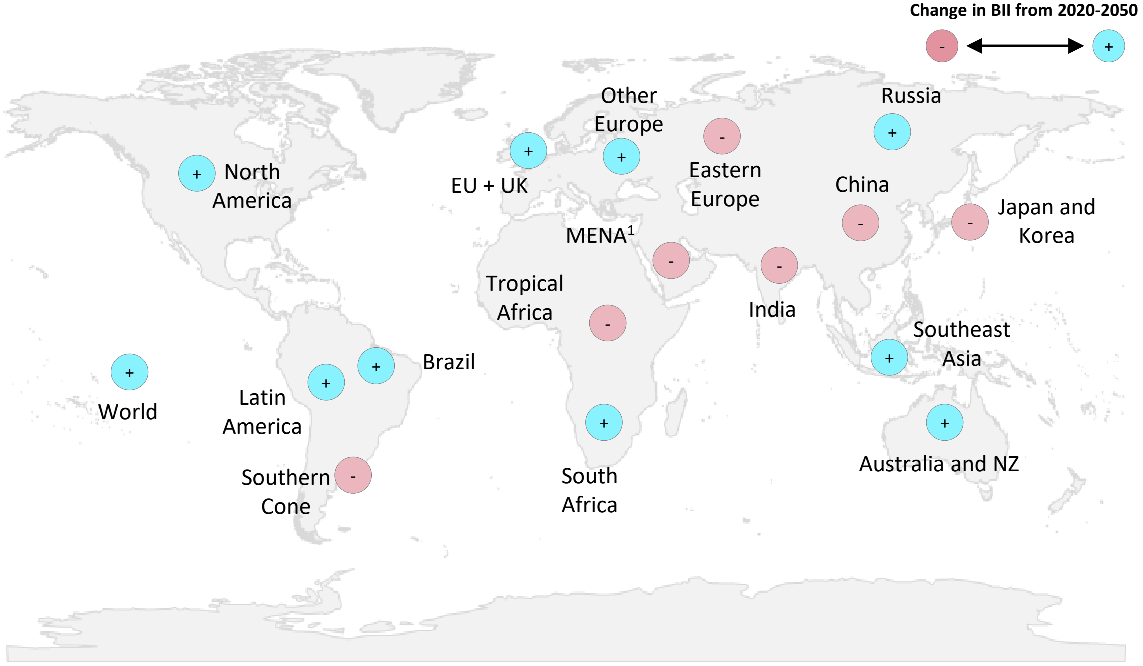
## **FPS 2021: Change in biodiversity 2020-2050**, BII

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




## **FPS 2023: Change in biodiversity 2020-2050**, BII

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




1. Middle East and Northern Africa

INEVITABLE POLICY RESPONSE

# Macro trends involve significant shifts for each of the major land use products - food, materials, energy, nature and urban space

Deep dive to follow

**Several products compete for land, including food, materials, energy and natural capital**

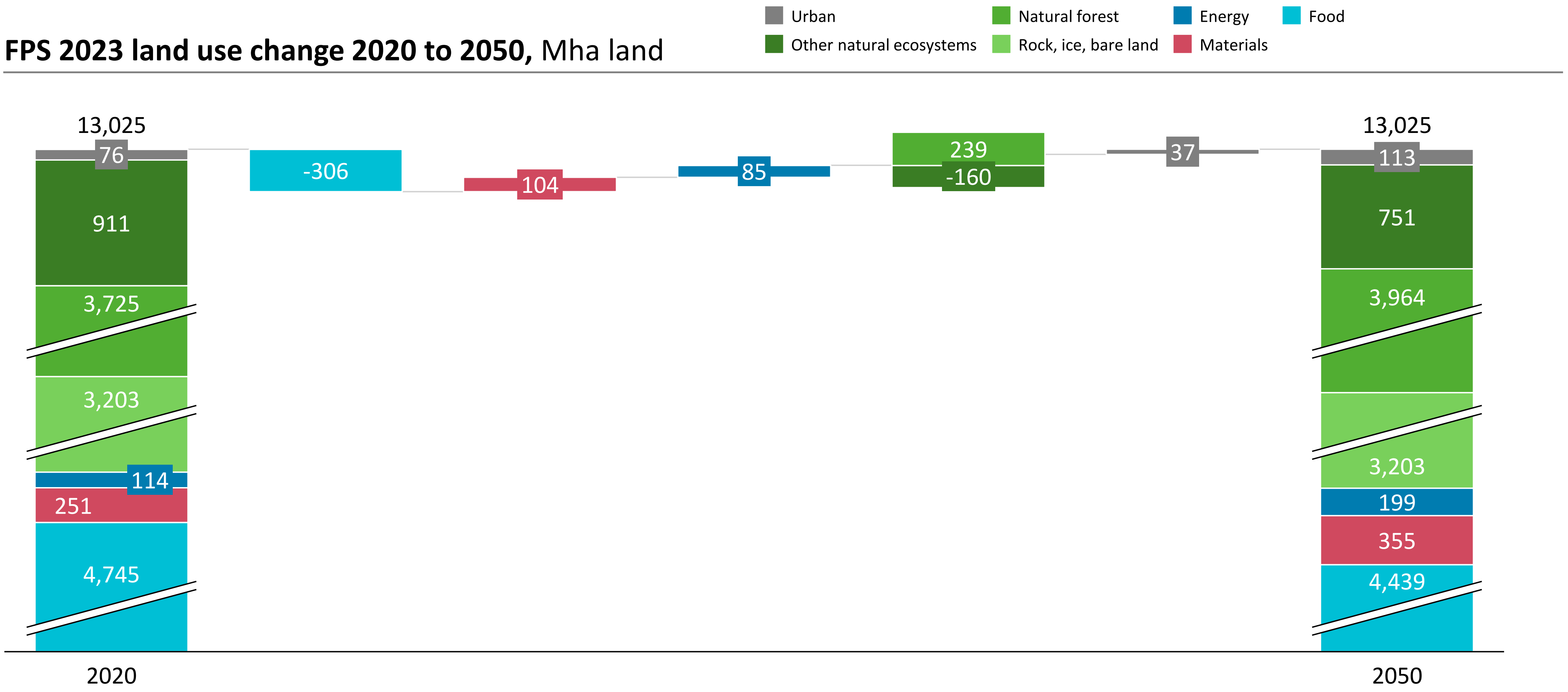
Climate and nature targets and affordability outcomes represent constraints on the products we consume from the land system

Improving yields, changing consumption habits, and reducing waste can all ease competition and improve tradeoffs

| Land system | Context |
| --- | --- |
| **Food** | Per capita food demand grows by 26% globally as countries become wealthier and increase their consumption. Waste reductions and a shift in per-capita consumption away from animal products eases land use competition and reshapes the food mix by increasing the reliance on alternative proteins. |
| **Materials** | Demand for sustainable alternatives to emissions-intensive materials like steel, cement and synthetic fibres increases. Increased demand for wood in construction leads to a +22% growth in timber production by 2050. Land availability and biomass supply are limited and become increasingly scarce as demands on land and sustainable materials grows. |
| **Energy** | Though use of traditional biomass has slowly declined, it has more than been offset by accelerating increases in consumption of modern biomass. Our in-depth analysis explores bioenergy's demands on land and their implications for land competition. |
| **Nature** | Nature is at the heart of the transition and regulators are increasingly aware of the need to protect it. A combination of nature and climate policies (e.g., area protection and carbon and biodiversity pricing) increase the value of natural capital. Conservation policies protect an additional 980Mha of natural land by 2050. As natural land is preserved and restored, land availability for productive uses is further constrained, increasing land use competition. |
| **Urban** | Urbanization has been a key driver of land use change, but it is concentrated around major cities. Its effect on global land competition is limited compared to the other categories of land use. |

# Under FPS 2023, shifts in policy, consumer preferences and technology combine with increasing demands on the land system to shift land use away from agricultural land toward nature and bio-based energy and materials

**FPS 2023 land use change 2020 to 2050,** Mha land



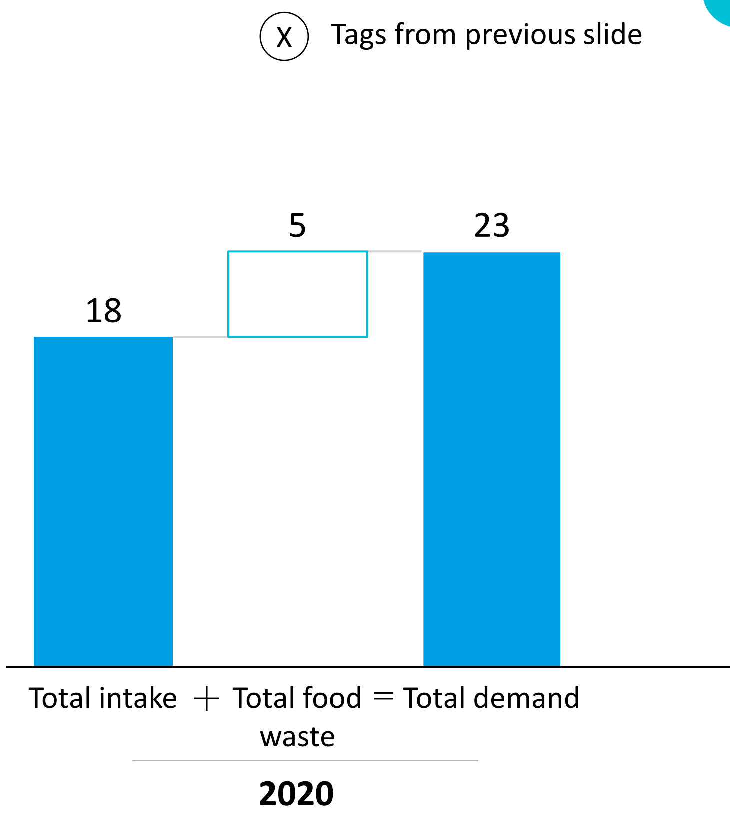

Source: FAO Forestry, FAO Land Use, FAO Land Cover, IPR team analysis

INEVITABLE POLICY RESPONSE

# Global food demand increases by 21%, as income and population growth increase food demand in EMDEs

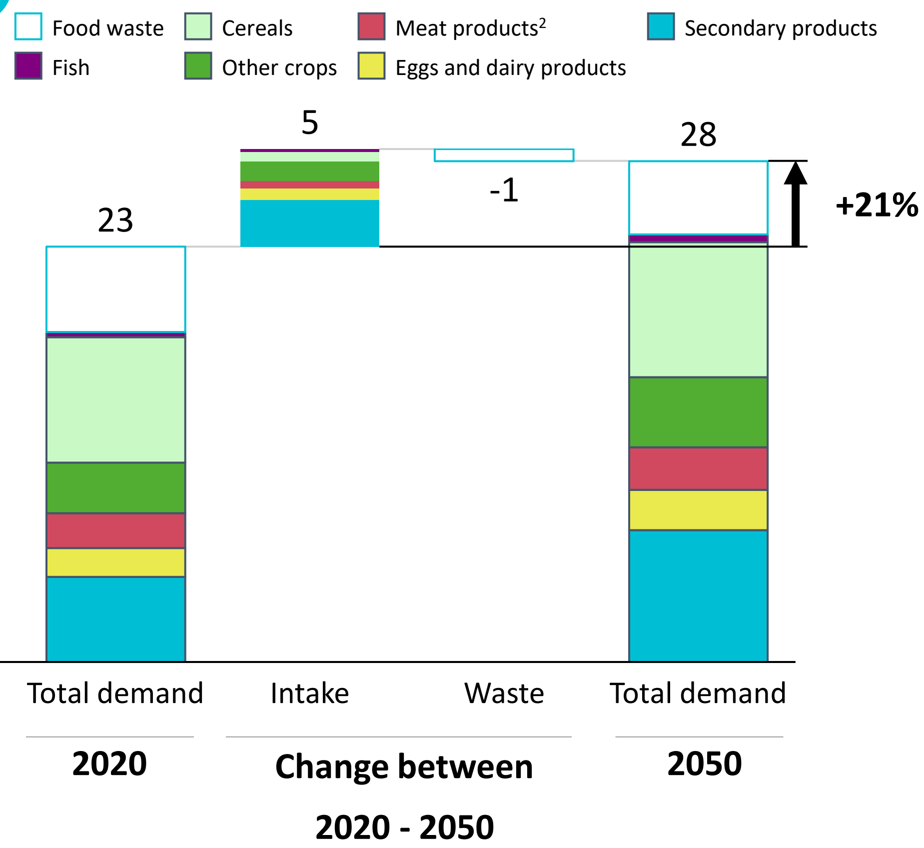
### Composition of global caloric demand in 2020

Tn Kcal/day




### Change in global caloric demand (2020 – 2050)

Tn Kcal/day




1. Even so, the US still remains above the global average per capita caloric demand
2. Conventional proteins

## Regional differences

**Per capita food demand declines in AEs, as slow GDP growth is offset by food waste reductions.**

Between 2020 and 2050, caloric intake in the **US** remains stable, but **food waste declines by 18%** reducing average per capita food demand by over 600 calories.[1]

**By 2050, EMDEs account for 86% of total caloric demand.**

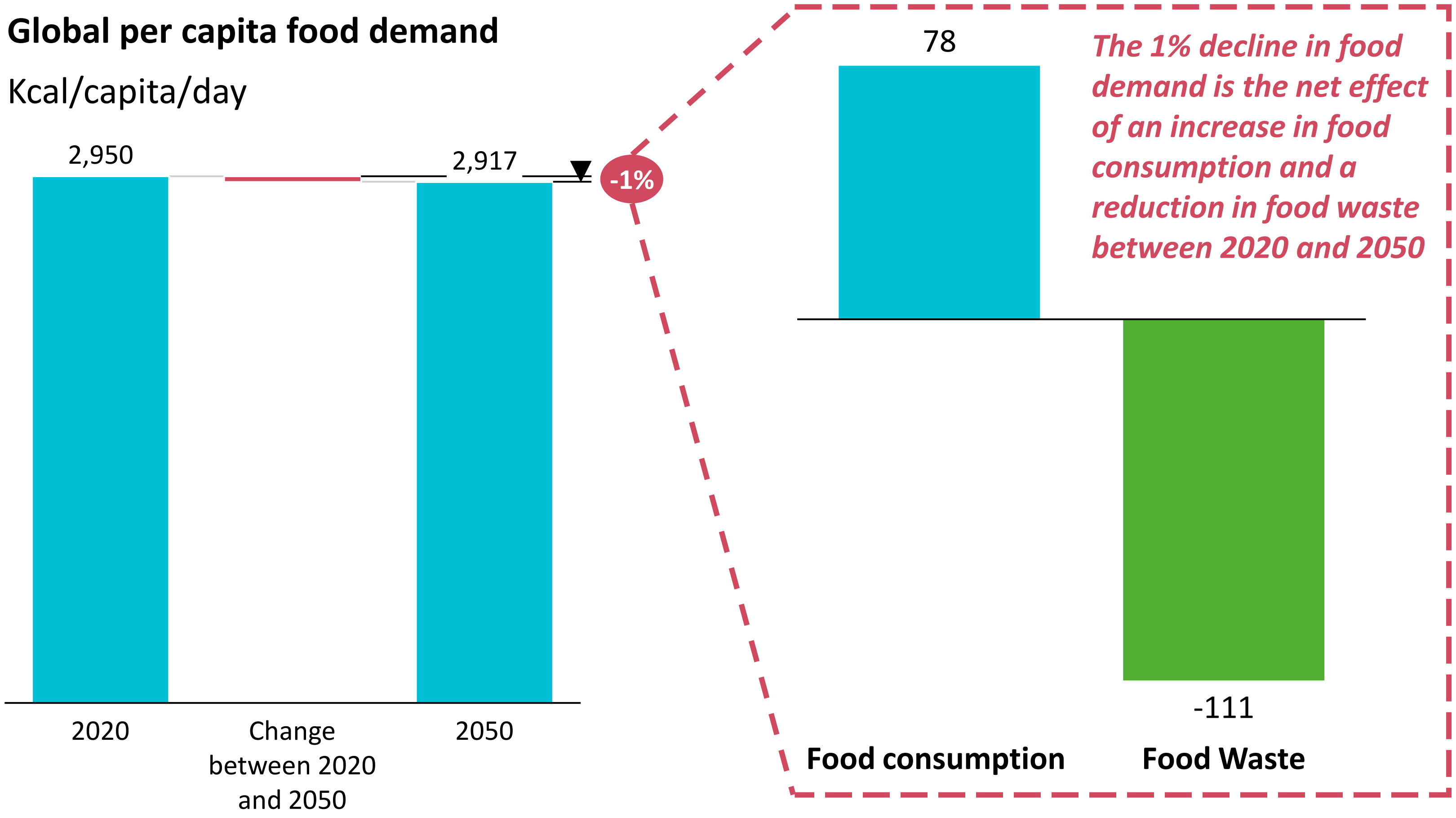
**Tropical African** countries witness the fastest growth in demand, as **their share of global food demand increases from 11% to 20%.**

INEVITABLE POLICY RESPONSE

# Overall, the food waste reductions offset the increase in consumption, leading to a 1% decline in global per capita food demand by 2050

**Global per capita food demand**

Kcal/capita/day




1. AI-based sales, harvest and food waste forecasting; new storage and preservation technologies
2. Education and labelling programs aimed at reducing food waste at the consumption stage; policy incentives for food donation such as tax exemptions; development of secondary markets to sell food surplus and non-standard food products

**Innovation[1] and increased[2] consumption of "surplus food" reduce global food waste globally**

For example, labelling campaigns have been effective in the UK, where improved labelling reduced food waste by 14% between 2007-2012. Examples of future innovation include AI-based sales, harvest and food waste forecasting; new storage and preservation technologies

**The decline in food waste is primarily driven in Advanced Economies.**

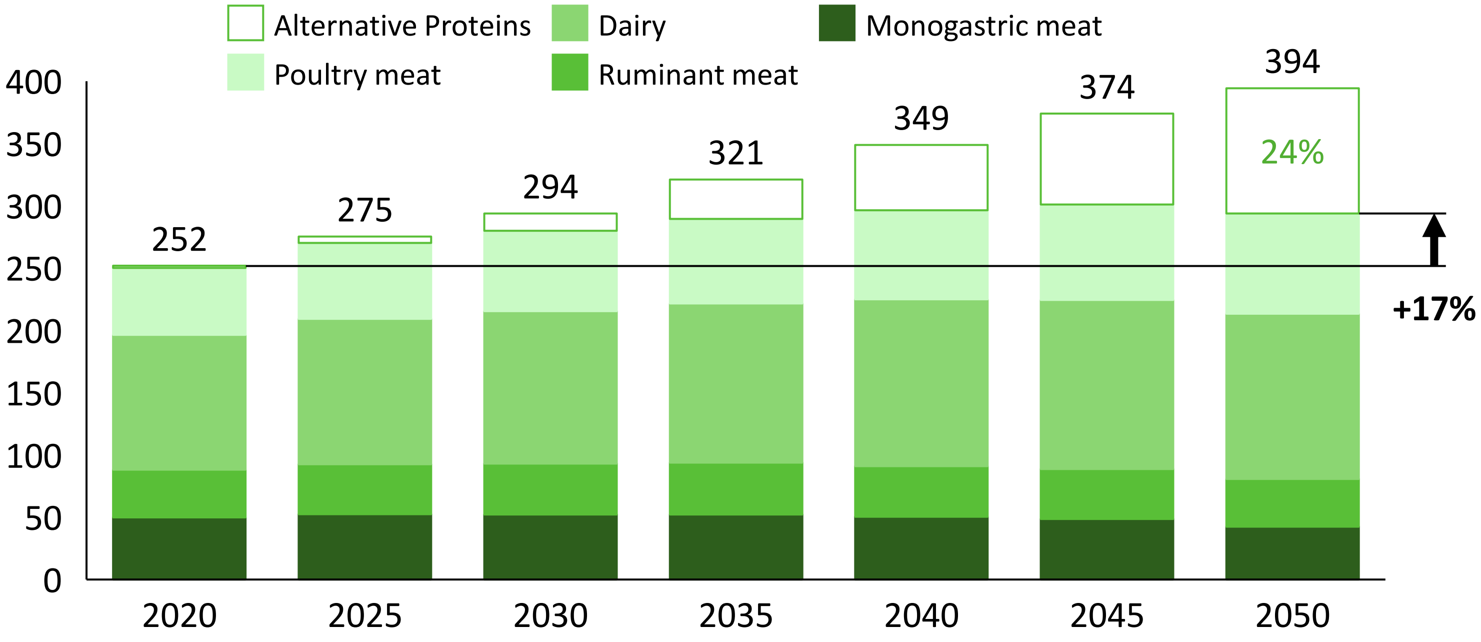
Though declining globally, per capita food waste increases in EMDEs as income growth pushes up waste, outweighing the impact of measures pushing down waste. In Tropical Africa, for instance, the share of food waste increases from 18% to 22% of demand

INEVITABLE POLICY RESPONSE

# Diet shifts transform the food mix, increasing use of alternative proteins

## **Global Protein Production,** Mt DM[1] per year

Though global livestock production increases **by ~17%** by 2050, a diet shift to alternative proteins reduces overall reliance on animal products. In 2050, alternative proteins represent close to a quarter of global proteins production.




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

1. Mega Tonnes of Dry Matter
2. Ruminants are herbivores with three- or four-chambered stomachs, such as cattle and sheep

## Defining Alternative Proteins

### Plant-based Alternative Proteins

Incorporates plant-based protein sources such as soy, pea, wheat etc.

### Fermented Alternative Proteins

Proteins manufactured through microorganism breaking down organic matter to produce proteins (e.g., tempeh)

### Cell-based Alternative Proteins

Proteins produced by growing animal cells in a laboratory setting without the need to raise or slaughter animals

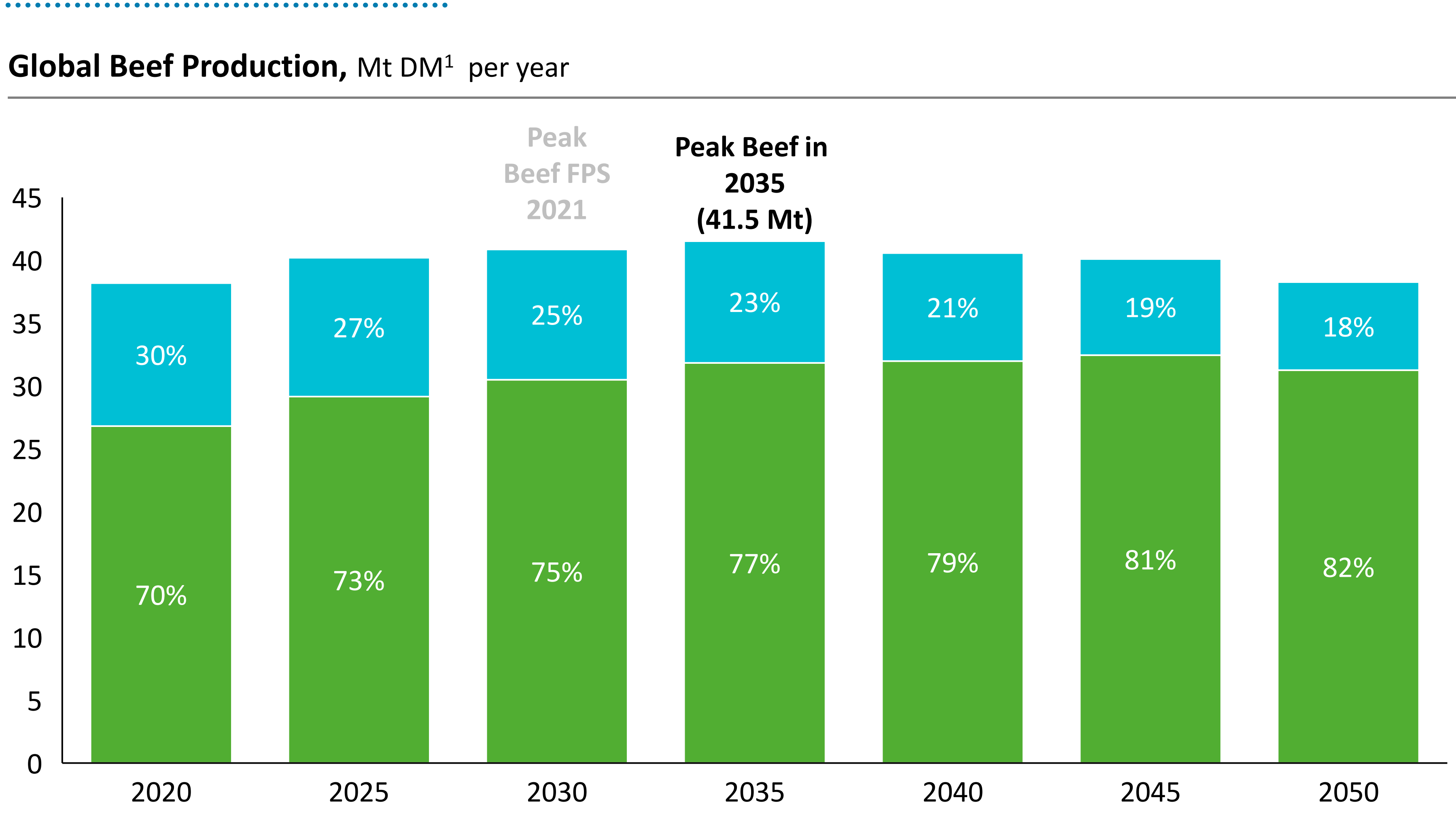
### Insects/New Animal Sources

Proteins from alternative animal sources that are often cheaper and less $CO_2$ intensive than conventional production

INEVITABLE POLICY RESPONSE

# Global beef production peaks in 2035 and begins to decline slowly, driven by declining demand from OECD countries

**Global Beef Production,** Mt DM[1] per year




**Advanced Economies**

Demand for beef reduces in AEs driven by **diet shifts.** Consequently, beef production reduces by **38%** between 2020 and 2050

**Emerging Markets and Developing Economies**

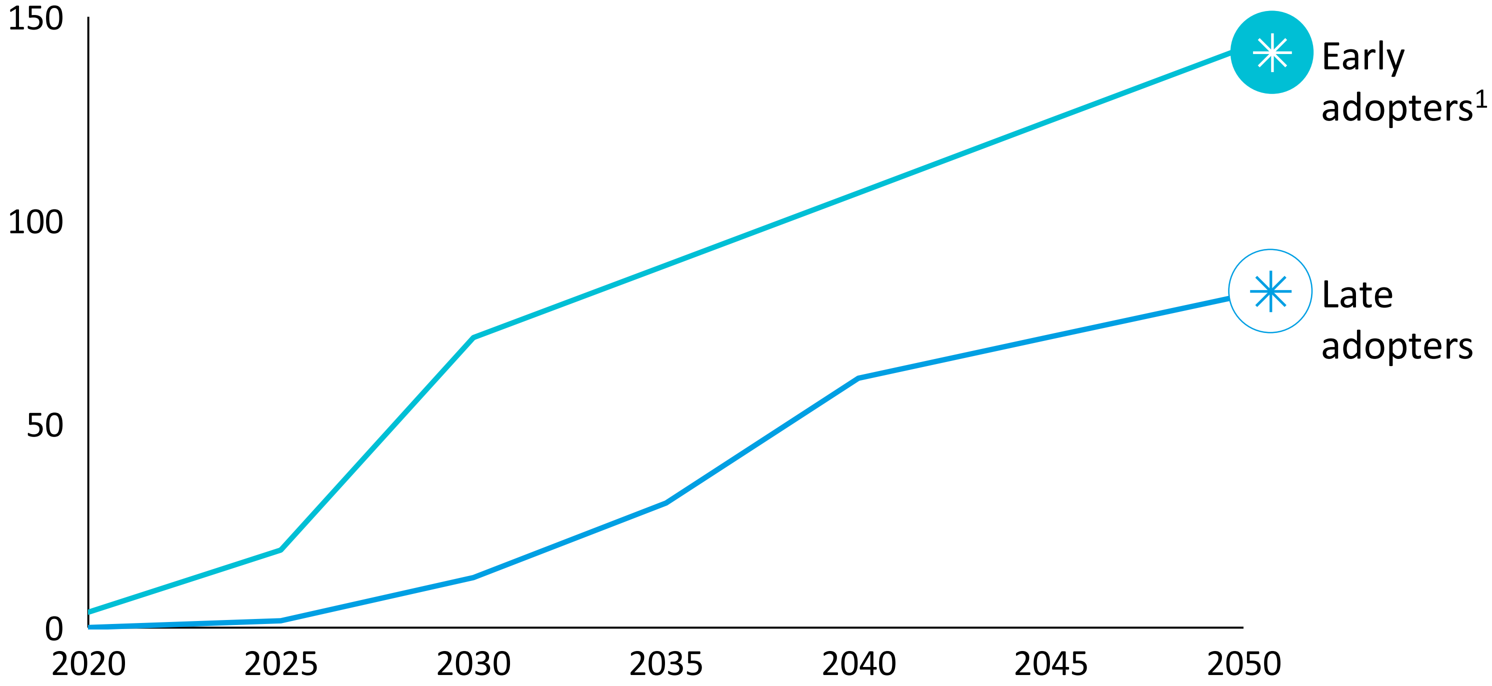
Growing **GDP** and **population** drives the demand for beef in EMDEs. This results in a **16%** increase in beef production between 2020 and 2050

1. Mega tonnes of Dry Matter

# Carbon prices grow substantially, increasing market-based incentives for Nature-Based Solutions

**FPS 2023 Carbon Prices** (2020 US$/$tCO_2eq$)

Carbon prices representing the gradual incorporation of carbon incentives in land use practices, which varies depending on regional ambition.



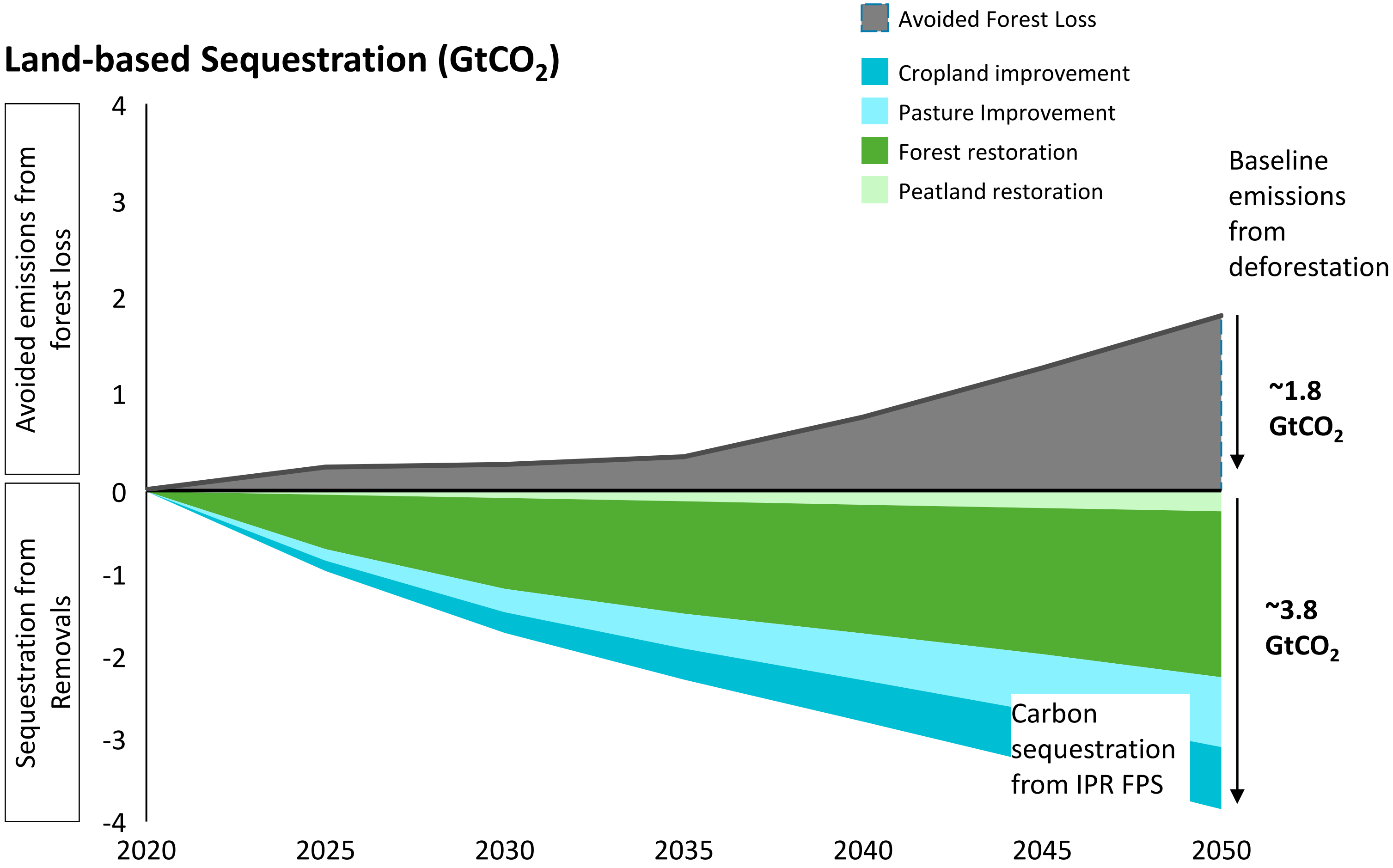

1. Early adopters include Australia and New Zealand, most of EU + UK, Canada, China, Scandinavian countries, South Africa, Japan.

- There is a price differential between energy and land use until compliance markets start covering land use. Under the FPS 2023, land use is increasingly covered by compliance markets after 2025 for early adopters
- Land use carbon prices gradually rise, moving closer to carbon prices in energy and industry. Changes in carbon prices affect NBS uptake: demand is highest if NBS prices are lower than other offset projects, supply only increases if carbon revenues are high enough to outcompete potential agricultural profits
- Other non-$CO_2$ GHGs are priced differently. $N_2O$ and $CH_4$ emissions from agriculture are often harder to abate, and policymakers are expected to protect these emissions somewhat to avoid impacts on food prices

INEVITABLE POLICY RESPONSE

# By 2050, action to halt deforestation reduces emissions by 1.8 $GtCO_2$/yr, while other policy and market incentives helps capture an additional ~3.8 $GtCO_2$/yr

## Land-based Sequestration ($GtCO_2$)




1. The reference scenario projects the land use change we would expect to see without NBS policies that conserve forest land, improve practices to optimize sequestration, and create new ecosystems. These values represent the difference in removals and reduction between the FPS 2023 scenario and this reference scenario, as a baseline.
2. Ecosystems described here refer to major land-based and carbon-rich ecosystems (e.g. forests, peatland, mangroves, pastureland)

Under FPS, forest-based removals are key for the climate transition as they're responsible for two thirds of the total shift in land-based emissions against a reference scenario[1].

Land-based emissions avoidance and removals **can be broken into three categories:**

### Avoided Forest Loss

- Practices that prevent the loss of existing ecosystems (e.g. avoided deforestation)
- NDCs to protect land for biodiversity contribute to the avoidance of ~111 Mha of forest loss
- Reduces emissions by **1.8 $GtCO_2$** relative to a reference scenario[1] by 2050

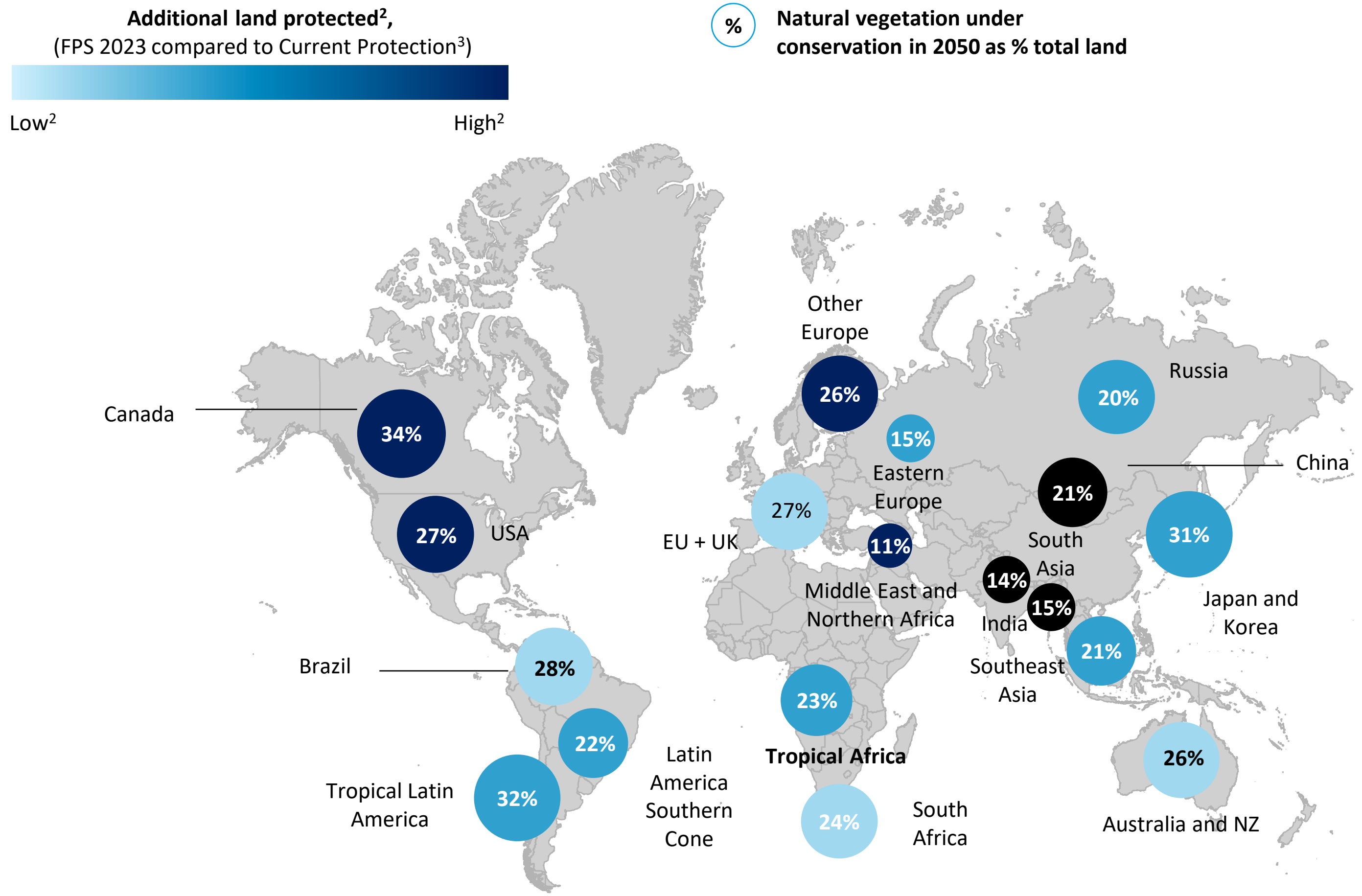
### Agricultural Improvement

- Practices that improve carbon retention in agricultural lands (e.g. soil or production improvements)
- Removes **1.6 $GtCO_2$** a year by 2050, equivalent to ~938 Mha

### Ecosystem Restoration

- Practices that creates new ecosystems[2] (e.g. restoration of natural forests and other ecosystems)
- Removes **2.2 $GtCO_2$** a year by 2050, equivalent to ~302 Mha

# Under FPS 2023 biodiversity and nature policies protect an additional 980 million hectares of natural vegetation[1] from 2020-2050….




1. Natural vegetation includes primary and secondary forestland
2. Low ~ 50%; High ~1100%
3. 'Current Protection' refers to a counterfactual scenario where protected areas are kept at current levels

# …shifting production away from biodiversity hotspots

INEVITABLE POLICY RESPONSE

## Regional Implications

Land protection is already ambitious in Brazil, so the increase in conservation of natural vegetation between 2020-2050 is low. Coupled with ambitious policies and market incentives to end deforestation, strict area protection helps restore natural vegetation and increase forest area.

China faces a substantial increase in protection of natural vegetation, though the share of natural vegetation protected remains below that of European, African and American regions.

Russia already protects a large share of its natural vegetation as low population density and high amounts of unproductive land create less barriers to protecting land from agricultural production.

India protects ~13% of natural vegetation by 2050. Although this a relatively low share, it represents a significant increase from 2020-2050, driven by a push in policies which protect natural land.

INEVITABLE POLICY RESPONSE

# Content

INEVITABLE POLICY RESPONSE

# 1. FOOD – Implications of FPS23 for food production

Deep-dive

## Land system

**Food**

Materials

Energy

Nature

Urban

**Several products compete for land, including food, materials, energy and natural capital.**

Climate and nature targets and affordability outcomes represent constraints on the products we consume from the land system.

Improving yields, changing consumption habits, and reducing waste can all ease competition and improve tradeoffs.

| Drivers | Description | Key Implications for the land use Sector |
|---|---|---|
| **1. GDP and population growth** | Population growth increases food demand, particularly in regions such as Tropical Africa and India | Per capita food demand grows by 26% globally as countries become wealthier and increase their consumption |
| **2. Food waste** | Food waste is particularly high in high-income countries, leading to inefficiencies in the food system | Waste reductions reduce the effect of GDP growth on food demand |
| **3. Diet shifts and alternative proteins** | Diets shift away from animal products, particularly ruminant meat (beef, sheep and goat meat) which peaks in 2035 | A slowdown in per-capita consumption of animal products eases land use competition and reshapes the food mix by increasing the reliance on alternative proteins |
| **Productivity** | Increasing food demand in Emerging Markets and Developing Economies(EMDEs) is partially met by catch-up yield growth | Crop yields in EMDEs grow to accommodate some of the additional food production |

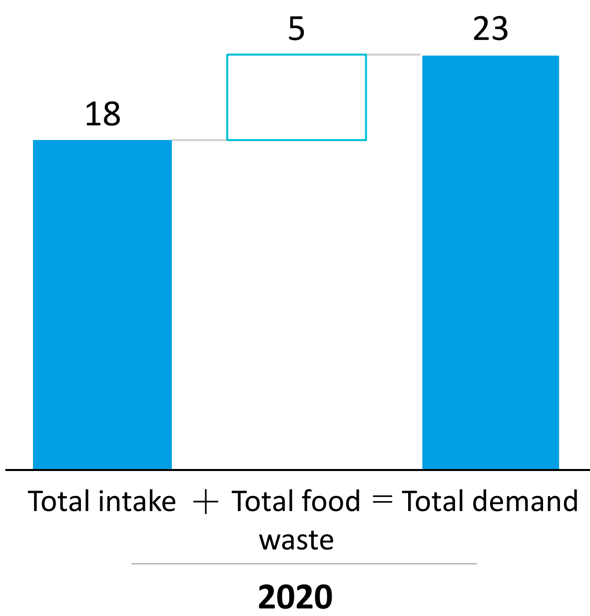
INEVITABLE POLICY RESPONSE

# Global food demand increases by 21%, as income and population growth increase food demand in EMDEs

### Composition of global caloric demand in 2020

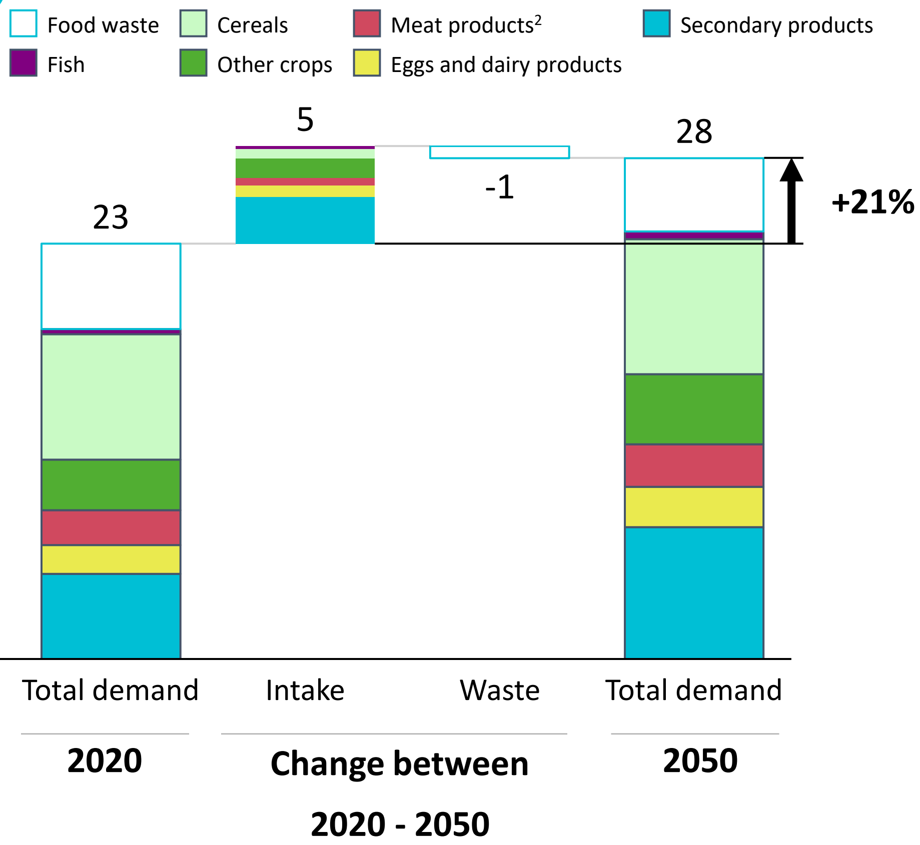
Tn Kcal/day

X Tags from previous slide




### Change in global caloric demand (2020 – 2050)

Tn Kcal/day




1. Even so, the US still remains above the global average per capita caloric demand
2. Conventional proteins

## Regional differences

**Per capita food demand declines in AEs, as slow GDP growth is offset by food waste reductions.**

Between 2020 and 2050, caloric intake in the **US** remains stable, but **food waste declines by 18%** reducing average per capita food demand by over 600 calories.[1]

**By 2050, EMDEs account for 86% of total caloric demand.**

**Tropical African** countries witness the fastest growth in demand, as **their share of global food demand increases from 11% to 20%.**

INEVITABLE POLICY RESPONSE

# 1. Tropical Africa represents a third of global food consumption by 2050, as food demand more than doubles

## 108%

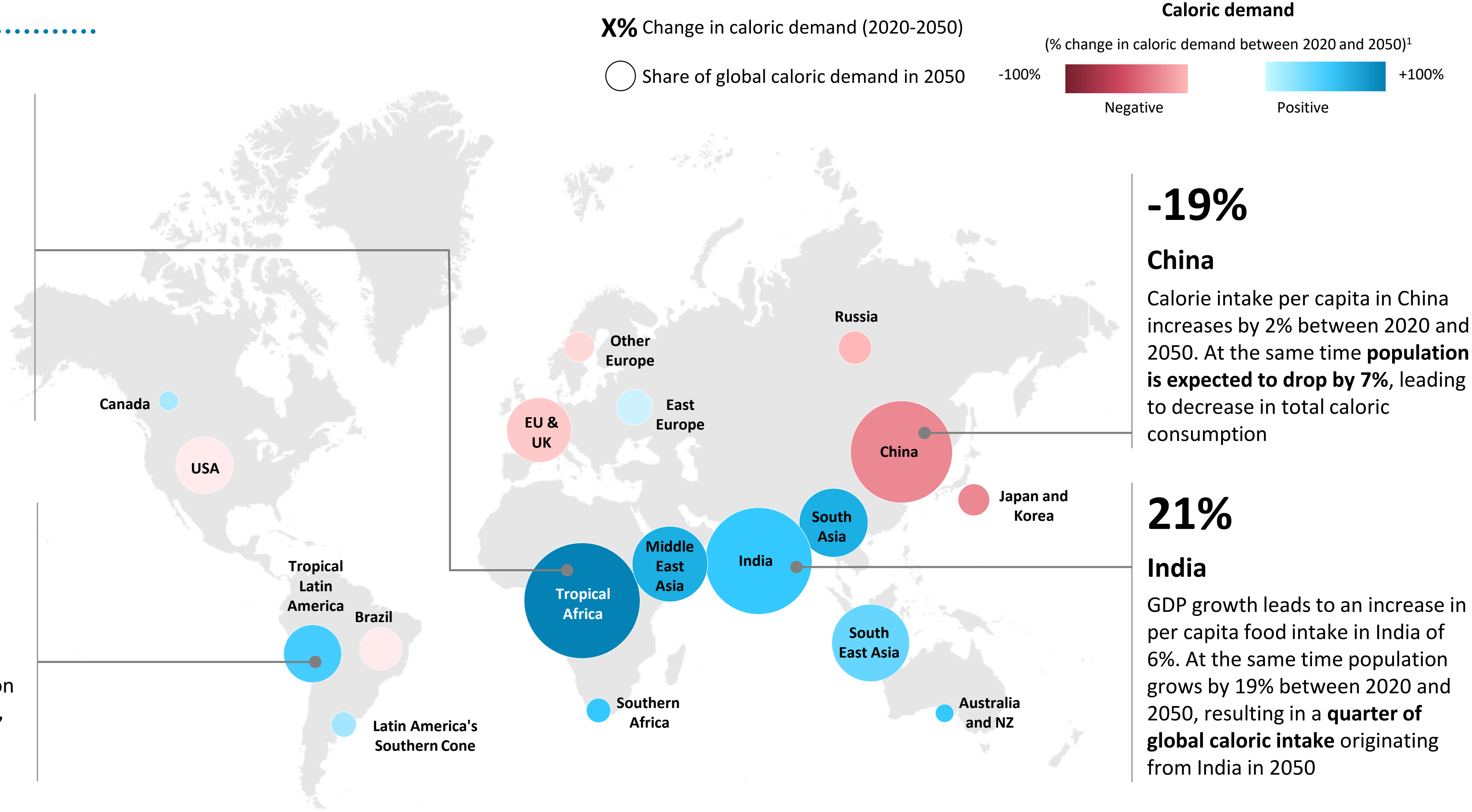
### Tropical Africa

Increase in GDP drives per capita caloric intake in the African continent. At the same time population growth is the highest across regions (24-80%). This results in a **third caloric intake** in 2050 originating from Tropical Africa. Food waste levels are low in the region so the share of global demand remains low

## 18%

### South America

Intake per capita growth remains relatively low in South America. However, large growth in population especially in Tropical Latin America, **leads to a 23% increase in caloric intake**




## -19%

### China

Calorie intake per capita in China increases by 2% between 2020 and 2050. At the same time **population is expected to drop by 7%**, leading to decrease in total caloric consumption

## 21%

### India

GDP growth leads to an increase in per capita food intake in India of 6%. At the same time population grows by 19% between 2020 and 2050, resulting in a **quarter of global caloric intake** originating from India in 2050

Source: IPR team analysis

INEVITABLE POLICY RESPONSE

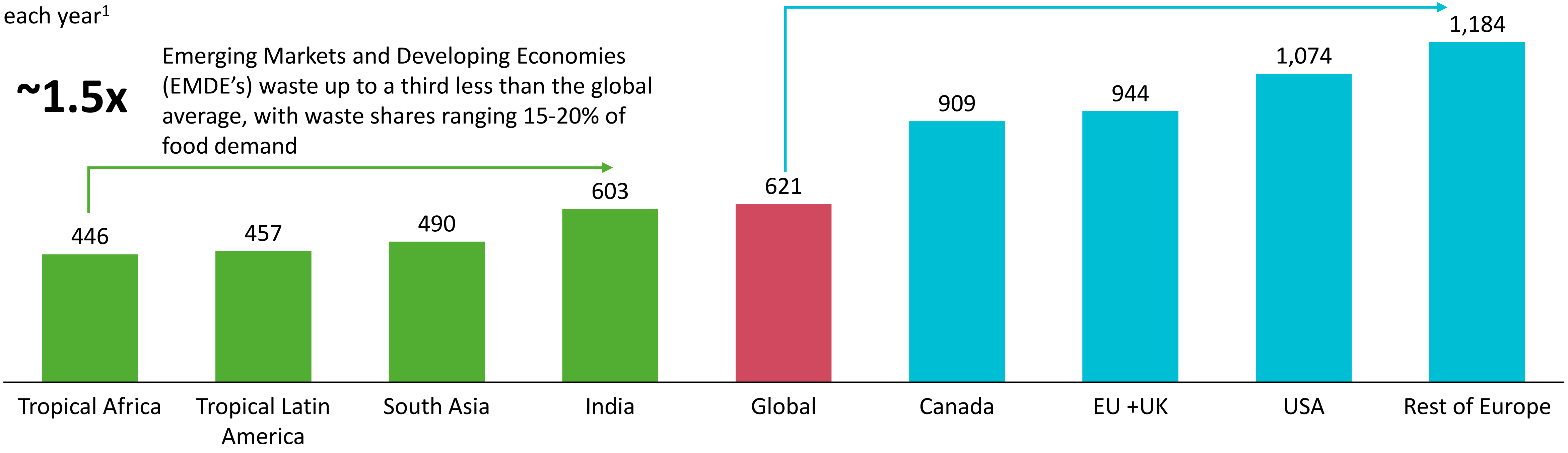
# 2. Consumers in developed economies responsible for ~2x the global average

## Food Waste[2] (post-farmgate) in 2020,
Kcal/capita/day

**Over a fifth of food is currently wasted, leading to an inefficiently high use of agricultural land.** According to WRI, an area larger than China is used to produce food that is not eaten each year[1]

**~2x** Advanced Economies have a particularly high share of food waste (>26%), with countries such as the US wasting almost twice as much the global average

**~1.5x** Emerging Markets and Developing Economies (EMDE's) waste up to a third less than the global average, with waste shares ranging 15-20% of food demand




1. WRI
2. Food waste refers to the post farmgate generated through the distribution, processing and consumption of agricultural products

Source: IPR team analysis

# 2. Global per capita food waste declines by 18% by 2050, driven by technological innovation and behavioral shifts in consumption patterns

## Innovation and increased consumption of "surplus food" reduce food waste globally

Under IPR FPS 2023, global per capita food waste decreases driven by:

### Technological Innovation

- AI-based sales, harvest and food waste forecasting
- New storage and preservation technologies

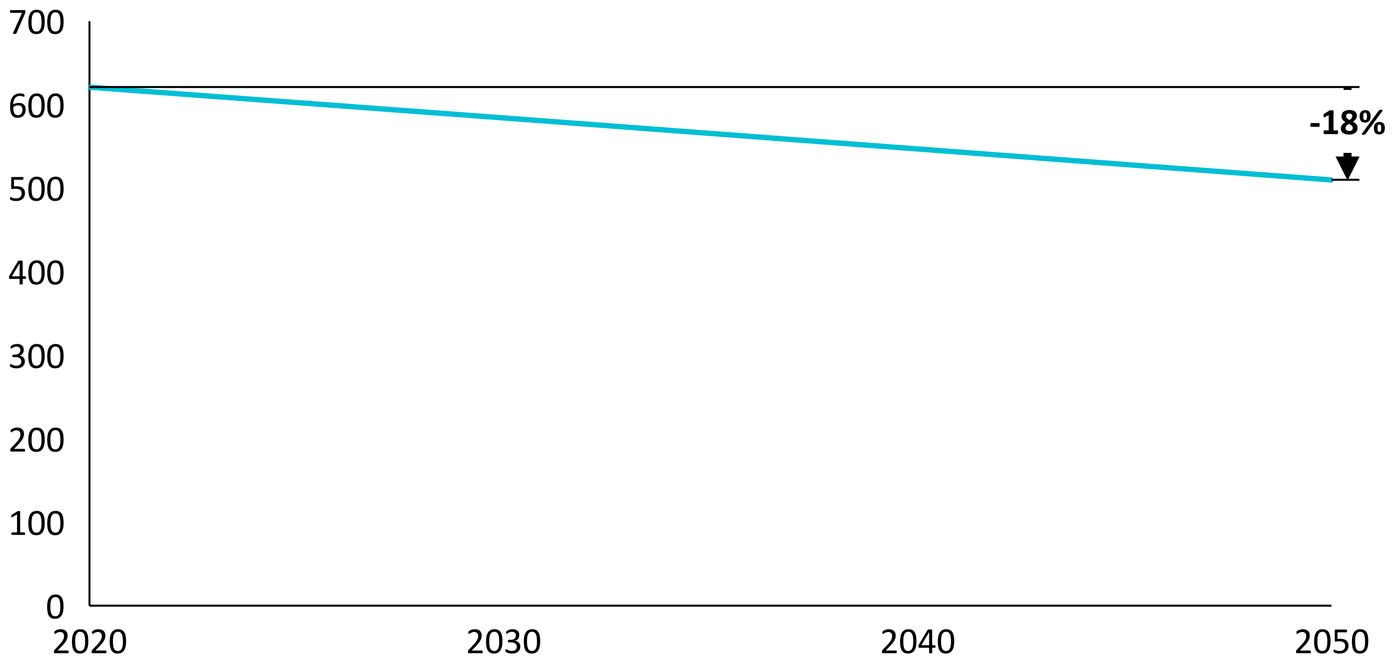
### Behavioral/policy interventions

- Education and labelling programs aimed at reducing food waste at the consumption stage
- Policy incentives for food donation such as tax exemptions
- Development of secondary markets to sell food surplus and non-standard food products

## Per capita food waste declines by 18% by 2050, stabilizing global total food waste at 2020 levels

**Global per capita food waste**

Kcal/capita/day




Source: World Resource Institute (2019), Lipinski et al (2013), Ellen Macarthur Foundation (2019), Richards & Hamilton (2018)

INEVITABLE POLICY RESPONSE

# 2. Technology and behavioral shifts reduce food waste in middle- and high-income economies, and slow growth in food waste in low-income countries

## Food Waste Trajectories in High-income vs. Developing economies

### Advanced Economies (AEs)

Implementation of **policy targets** aimed at **food waste reduction.** The USA set a 50% household waste reduction between 2015-2030 and the EU a 10-30% food waste reduction by 2030.[1]

- **Case studies** show that high income economies can drastically reduce food waste by **targeting consumer behavior.** For instance, the **UK reduced food waste by 14% between 2007-2012 through improved labelling campaigns**

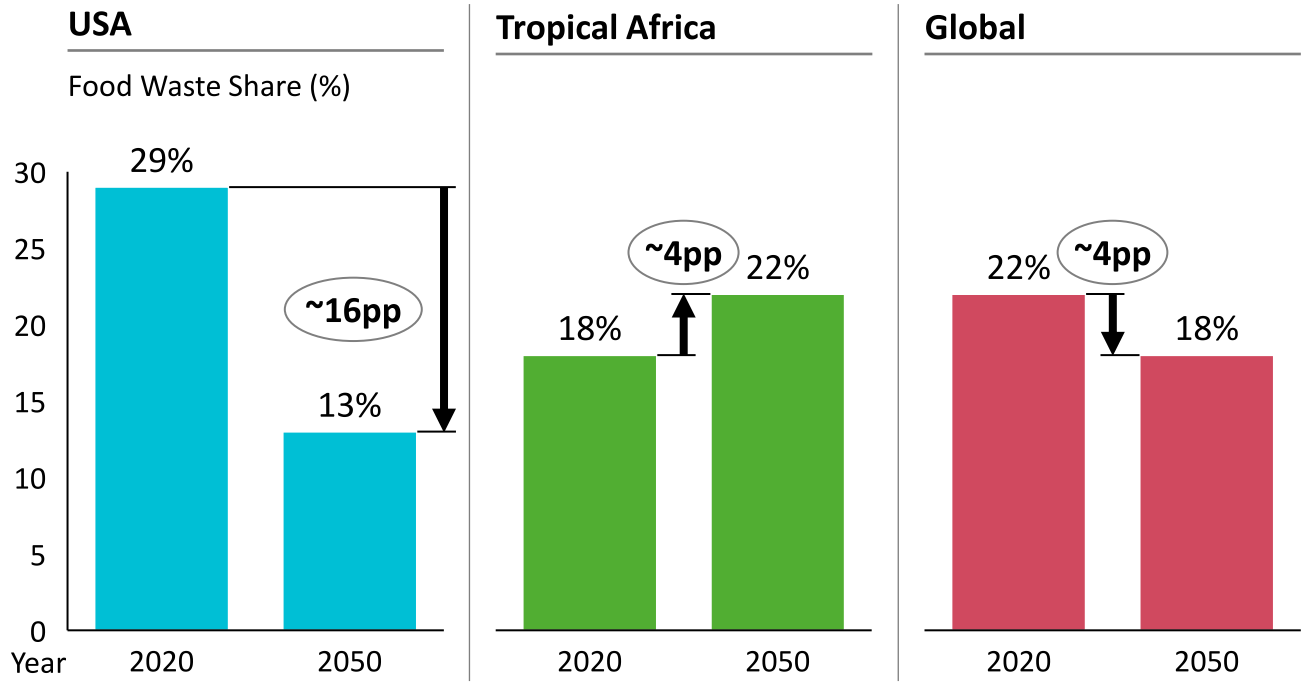
### Emerging Economies (EMDEs)

- Historically, food waste increases as countries transition from low to middle-income countries[2] (e.g., per capita food waste in China increases by 75% between 1995 and 2020). We expect a similar **growth-induced increase in food waste** in developing economies albeit tempered by emerging food waste reduction policies

## Share of food waste in terms of food demand in 2020 vs. 2050

%

FPS expects the **share of waste in global food demand to decline by 4pp until 2050.** This is primarily driven by food waste reductions in **Advanced Economies.**




1. 10% food reduction in processing and manufacturing and 30% reduction (per capita) in retail and consumption
2. For example, Xue et. al (2017) show a concave upwards relationship between GDP and household food waste

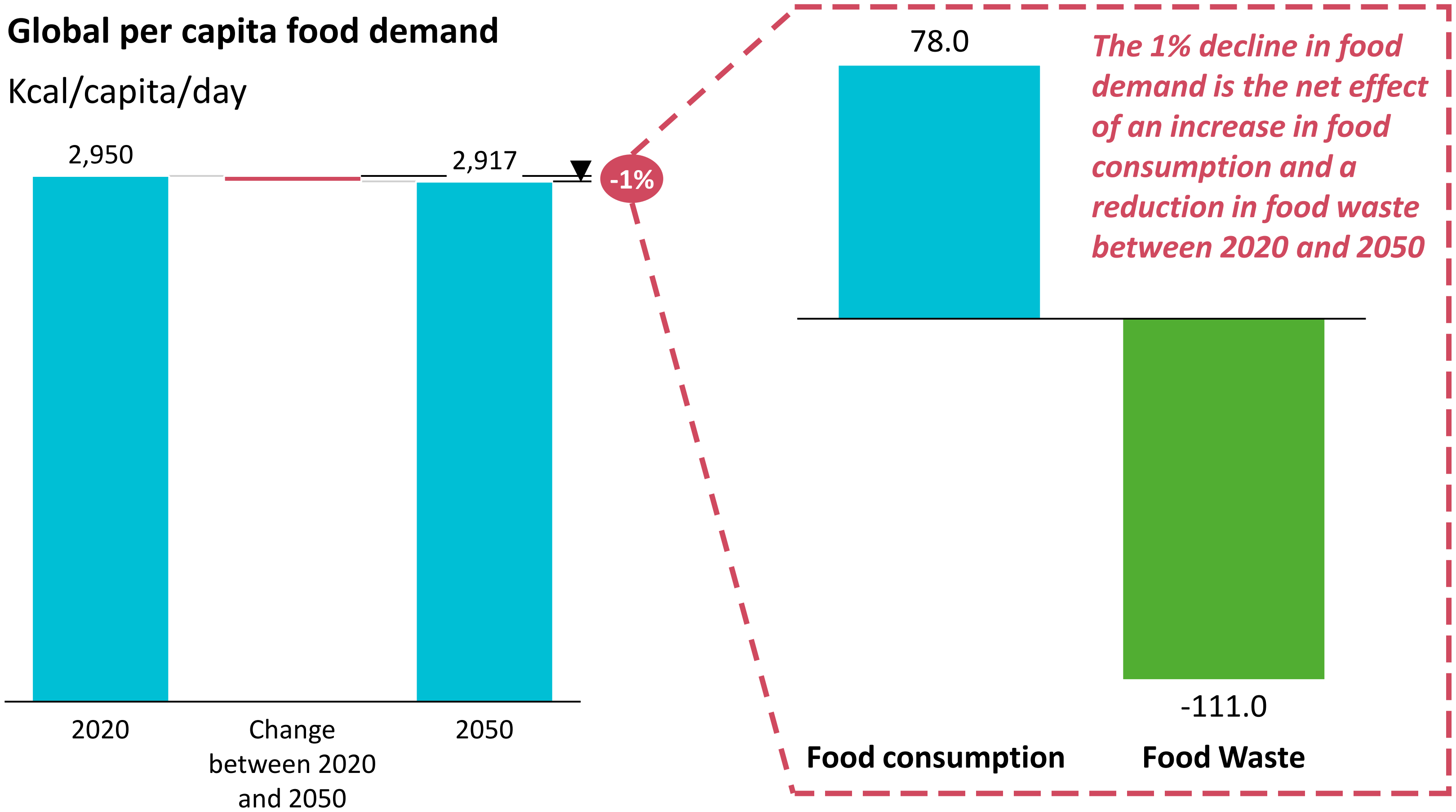
Source: World Resource Institute (2019), EPA, EU Commission

INEVITABLE POLICY RESPONSE

# 2. Overall, the food waste reductions offset the increase in consumption, leading to a 1% decline in global per capita food demand by 1% by 2050

**Global per capita food demand**

Kcal/capita/day




1. AI-based sales, harvest and food waste forecasting; new storage and preservation technologies
2. Education and labelling programs aimed at reducing food waste at the consumption stage; policy incentives for food donation such as tax exemptions; development of secondary markets to sell food surplus and non-standard food products

**Innovation[1] and increased[2] consumption of "surplus food" reduce global food waste globally**

For example, labelling campaigns have been effective in the UK, where improved labelling reduced food waste by 14% between 2007-2012. Examples of future innovation include AI-based sales, harvest and food waste forecasting; new storage and preservation technologies

**The decline in food waste is primarily driven in Advanced Economies.**

Though declining globally, per capita food waste increases in EMDEs as income growth pushes up waste, outweighing the impact of measures pushing down waste. In Tropical Africa, for instance, the share of food waste increases from 18% to 22% of demand

INEVITABLE POLICY RESPONSE

# 3. Innovation, environmental awareness and health concerns shift demand away from animal proteins

## Historically, diets have transitioned quickly …

USDA research has found that US **diets have changed significantly over the past 50 years. Relative to 1970, Americans consume:**

**2x**
more chicken

**-30%**
less beef

**-50%**
less milk

## … and innovation, increased environmental awareness and health concerns are pushing consumers to shift to alternative proteins

### Environmental concerns

**15%**

consumers in selected AE's want to become **vegan or vegetarian** in 2023 **because of environmental concerns[1].** This sentiment is especially prevalent among the younger generation

### Health concerns

**60%**

of flexitarians name **health concerns** as the primary reason for wanting to reduce their meat consumption

### Innovation

**6x**

**1-year growth in investment in cultivated meat** in 2020[2]. Investment in R&D makes alternatives proteins **cheaper** and align their **taste** profiles to that of conventional proteins

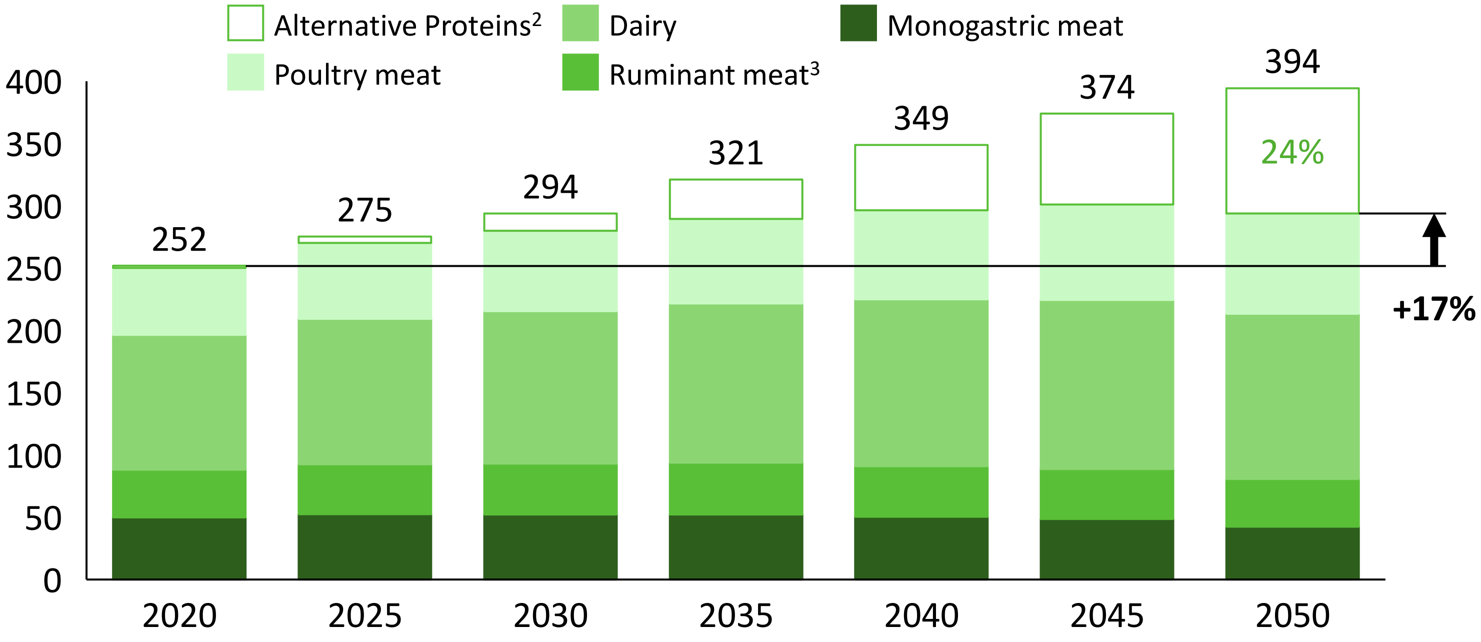
1. McKinsey Global Protein Survey 2022. Figures represent averages across Germany, The Netherlands, UK, and US
2. Good Food Institute (GFI) 2021. The figure refers to private-sector investment

INEVITABLE POLICY RESPONSE

# 3. Diet shifts transform the food mix, increasing use of alternative proteins

## **Global Protein Production,** Mt DM[1] per year

Though global livestock production increases **by ~17%** by 2050, a diet shift to alternative proteins reduces overall reliance on animal products. In 2050, alternative proteins represent close to a quarter of global proteins production.




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

1. Mega Tonnes of Dry Matter
2. There is a minor difference between the published ppt and the value drivers as the former accounts for all alternative proteins (including eggs and fish), while the latter only includes meats and dairy alternatives
3. Ruminants are herbivores with three- or four-chambered stomachs, such as cattle and sheep

## Defining Alternative Proteins

### Plant-based Alternative Proteins

Incorporates plant-based protein sources such as soy, pea, wheat etc.

### Fermented Alternative Proteins

Proteins manufactured through microorganism breaking down organic matter to produce proteins (e.g., tempeh)

### Cell-based Alternative Proteins

Proteins produced by growing animal cells in a laboratory setting without the need to raise or slaughter animals

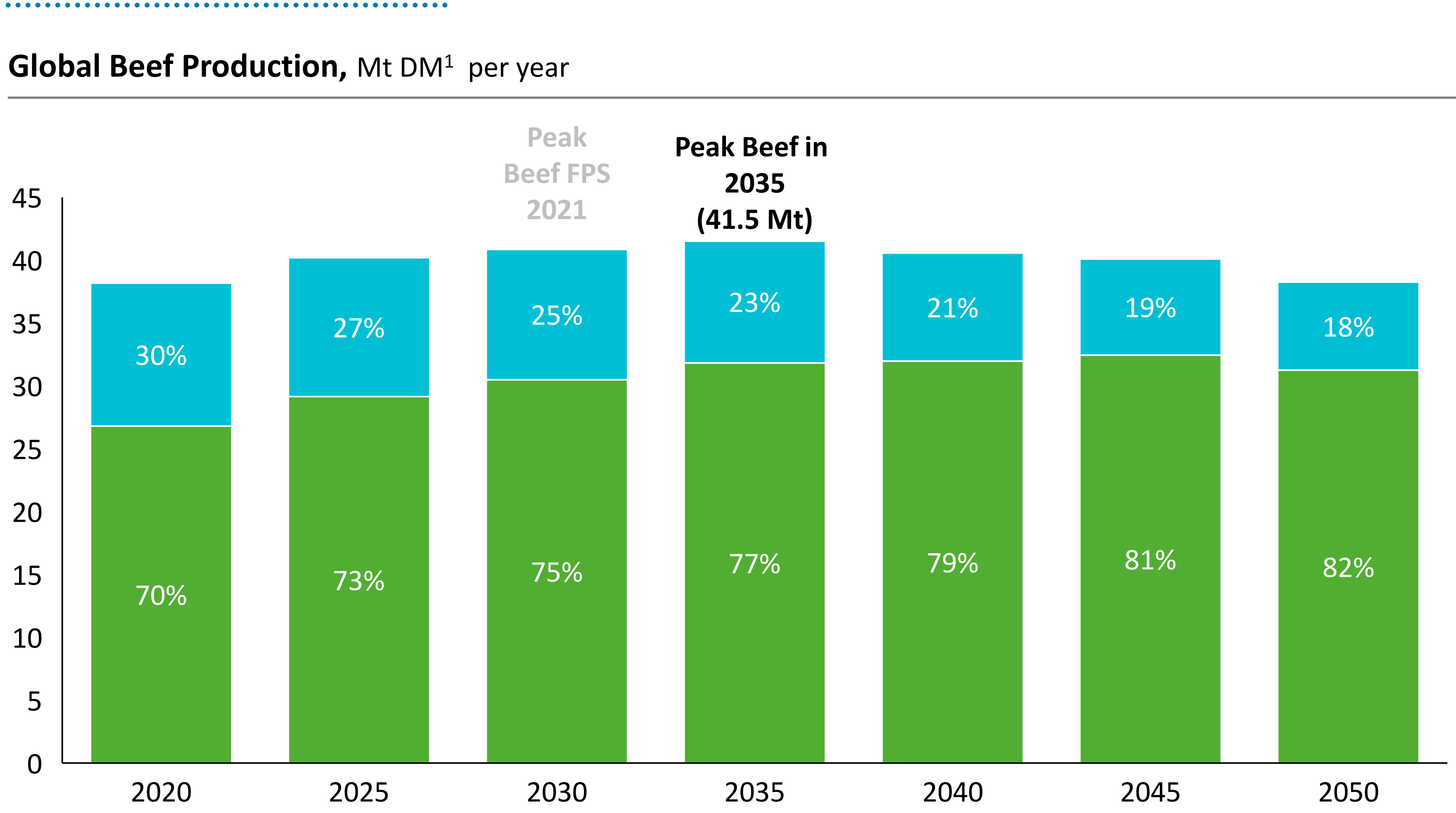
### Insects/New Animal Sources

Proteins from alternative animal sources that are often cheaper and less $CO_2$ intensive than conventional production

INEVITABLE POLICY RESPONSE

# 3. Global beef production peaks in 2035 and begins to decline slowly, driven by declining demand from OECD countries

**Global Beef Production,** Mt DM[1] per year




**Advanced Economies**

Demand for beef reduces in AEs driven by **diet shifts.** Consequently, beef production reduces by **38%** between 2020 and 2050

**Emerging Markets and Developing Economies**

Growing **GDP** and **population** drives the demand for beef in EMDEs. This results in a **16%** increase in beef production between 2020 and 2050

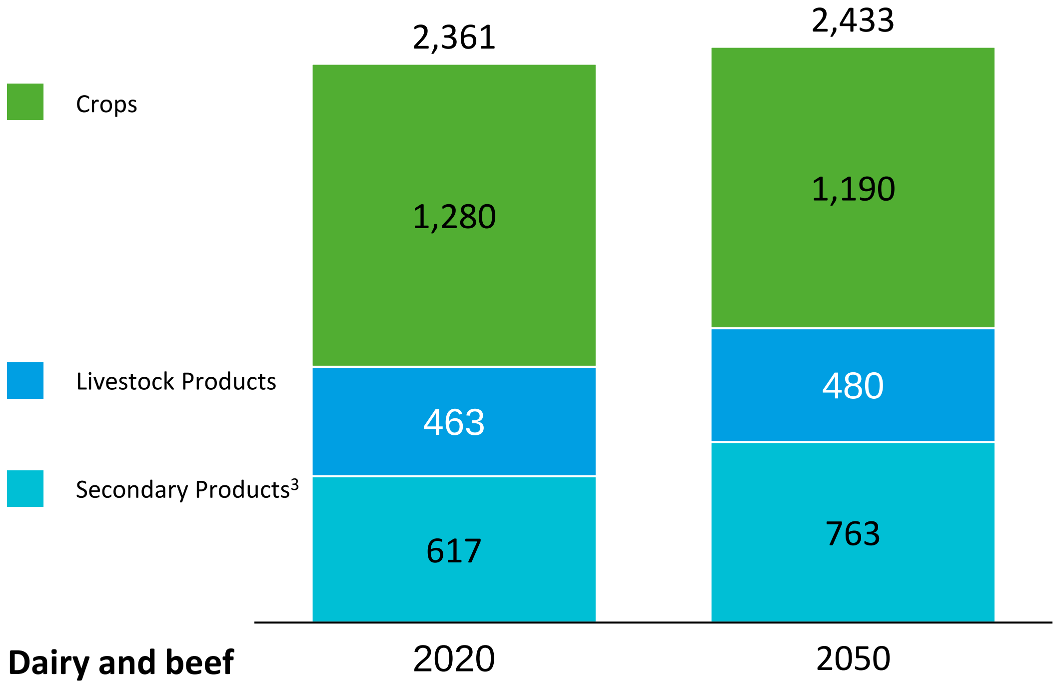
1. Mega tonnes of Dry Matter

INEVITABLE POLICY RESPONSE

# 3. Cattle and sheep represents a small percentage of global average per capita caloric intake, but they could be responsible for ~20% of global emissions by 2050

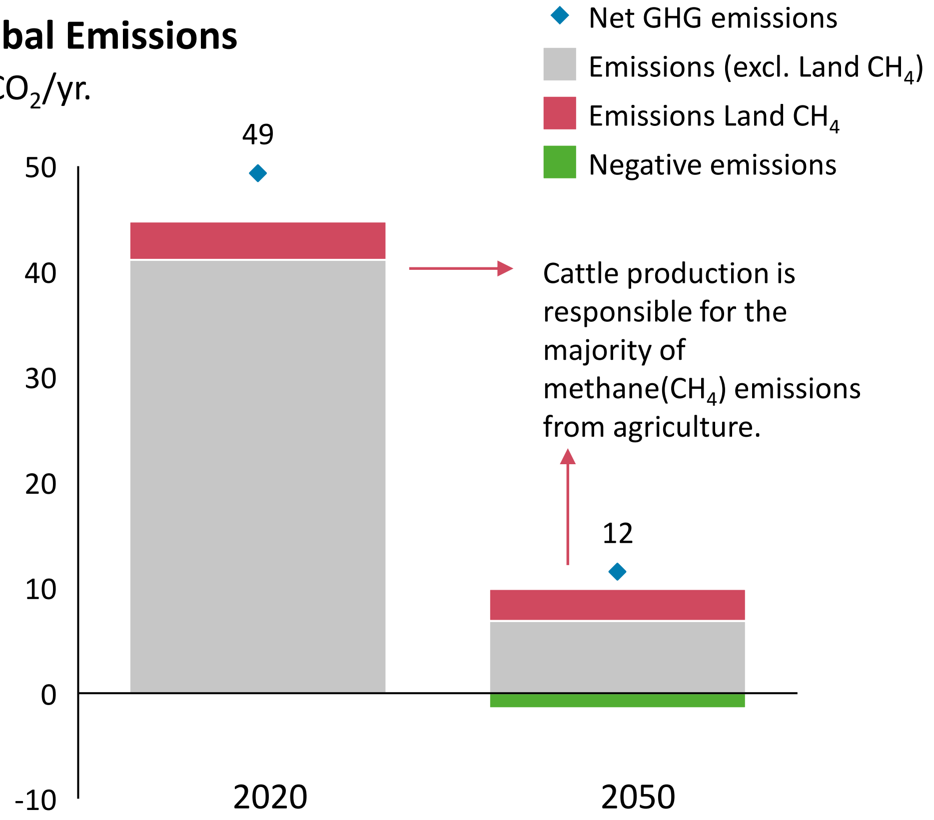
**Global Caloric Intake[4]**

Kcal/capita/day




**Global Emissions**

Gt $CO_2$/yr.




| | 2020 | 2050 |
|---|---|---|
| **Dairy and beef consumption, %** | **~12%** | **~10%** |
| **Dairy and beef as share of total global emissions[2], %** | **~5%** | **~20%** |

1. Using GWP 100 emissions values
2. We use enteric fermentation as a proxy for methane emissions form ruminants, which account for 70%-80% of total methane emissions from agriculture. This excludes a portion of emissions from animal waste management. Total emissions from animal waste management (covering all livestock products, not just ruminants) account for only 5-15% of overall methane emissions from land.
3. Including sugars, alcohol, brans and other secondary products
4. Caloric intake is caloric demand net of food waste

Source: Springmann M, Wiebe K, Mason-D'Croz D, Sulser T, Rayner M, Scarborough P. Health and nutritional aspects of sustainable diet strategies and their association with environmental impacts: a global modelling analysis with country-level detail

INEVITABLE POLICY RESPONSE

# Content

INEVITABLE POLICY RESPONSE

# 2. MATERIALS – Impact of FPS 2023 on sustainable materials

## Land system

1. Food
2. **Materials**
3. Energy
4. Nature
5. Urban

**Several products compete for land, including food, materials, energy and natural capital.**

Climate and nature targets and affordability outcomes represent constraints on the products we consume from the land system.

Improving yields, changing consumption habits, and reducing waste can all ease competition and improve tradeoffs

| Drivers | Description | Implications for the land use Sector |
|---|---|---|
| **Demand for sustainable materials** | Higher incomes and population growth drive demand for materials, particularly timber and fibres<br><br>Additionally, policies incentives to shift away from carbon-intensive products accelerate demand for sustainable materials (e.g., timber in construction, organic cotton for fibres, and bioplastics) | Land use and biomass supply are limited and become increasingly scarce as demands on land use products grow |

INEVITABLE POLICY RESPONSE

# Demand for three types of sustainable material could grow, contributing to land competition

Focus of following sections

## Timber production already occupies a substantial share of productive land, and demand growth could have substantial implications for the land system

| Sustainable materials | Share of land | Description |
| --- | --- | --- |
| Timber | **12.0%**<br>Timber plantations as a share of cropland | Timber demand in construction grows with urbanization and an increasing demand for sustainable substitutes to cement and other emission-intensive construction materials. Under the FPS 2023, the additional demand for lumber contributes to a doubling in global timber plantation with important implications for the land use sector. |
| Fibers | **2.4%**<br>Seed cotton as a share of cropland | Per capita consumption of non-cotton fibres overtook cotton in the 1990s, with cotton consumption peaking in 2007 and decreasing thereafter as polyester gained competitiveness.<br>Net zero targets and consumer preferences could make cotton a preferred substitute for synthetic virgin fibres, particularly sustainably grown cotton as its demand has been increasing steadily since 2010 (25% of total production in 2018). |
| Bioplastics | **0.1%**<br>Crops used for bioplastics production | The bioplastics market could grow by 8% p.a. to 2026, driven by regulatory change, companies' net-zero targets (e.g., CPGs like Coke) and the emergence of more sophisticated products and applications.<br>Though an important niche, the market share for bioplastics remains small [1]as other sustainable options, e.g., recycled plastics, offer a cheaper sustainable substitute to virgin plastics. |

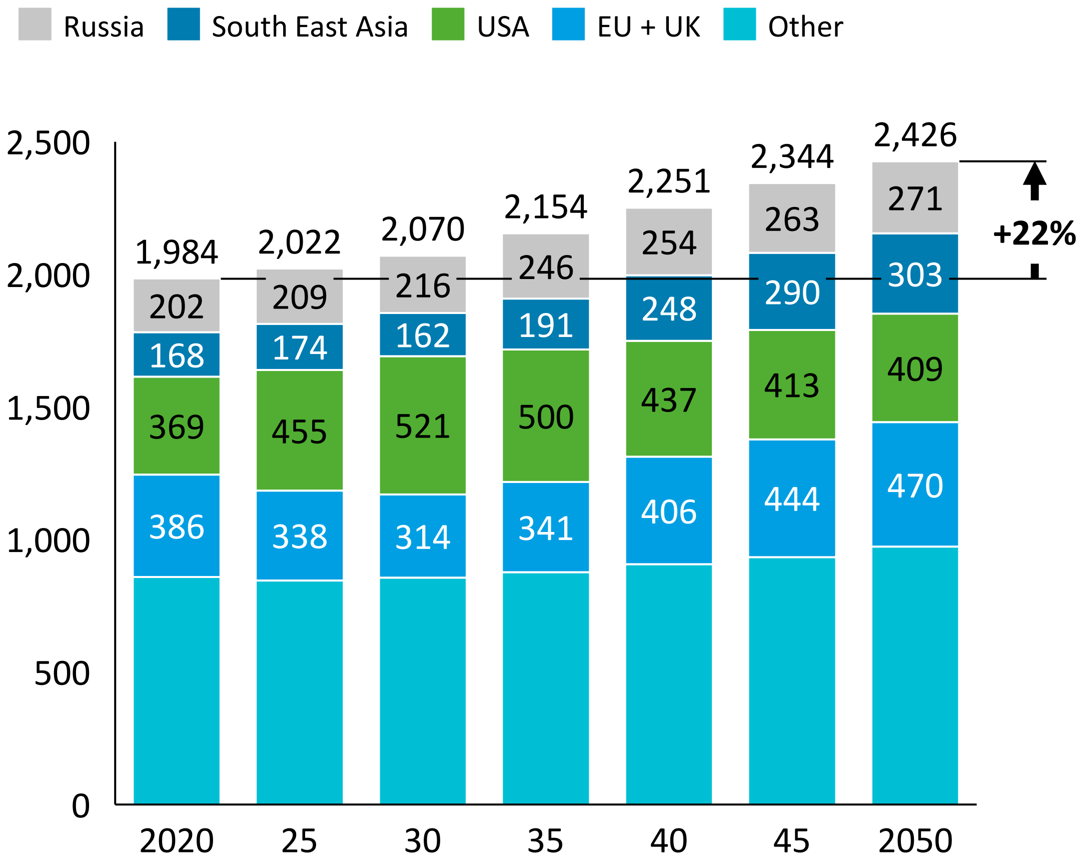
1. Planned investments could push the market share from 1% to >2%

Source: IPR team analysis, OECD-FAO Agricultural Outlook 2022-2031 https://www.oecd-ilibrary.org/sites/eaea8c33-en/index.html?itemId=/content/component/eaea8c33-en, https://www.statista.com/statistics/678929/agricultural-land use-for-bioplastics-production/#:~:text=In%202022%2C%20the%20total%20agricultural,percent%20of%20global%20agricultural%20area

INEVITABLE POLICY RESPONSE

# Demand for forestry products grows through 2050…

**Industrial roundwood,** Mm$^3$/year




# … as population and GDP grow, and lumber becomes a key alternative to carbon-intensive construction materials

## Population, income growth and urbanization

**Population and income growth** drives existing **demand for all forest products**.

**Urbanization**, particularly in emerging economies, are key in driving timber **demand in construction.**[1]

GDP and population account for ~ 2/3rds of the expected growth in timber demand[2].

## Sustainable materials

Lumber could become an interim substitute for unsustainable construction materials (cement and steel). **Under FPS, 10% of all new buildings use wood as a construction material.**

Increased use of lumber for sustainable construction materials accounts for ~1/3rd of the growth in timber demand, leading to **an overall increase 22% increase in industrial roundwood production.**

1. According to the Shared Socioeconomic Pathway 2 scenario, the global share of population living in urban areas could rise to 80% by 2100.
2. IPR team modelling based on Churkina et al. (2020)

INEVITABLE POLICY RESPONSE

# Depending on the location, timber producers face transition risks related to conservation policies or carbon pricing

| | |
|---|---|
| **Europe** | Demand for sustainable materials drives production in the EU. The **EU Forest Strategy** already recognizes the importance of woody biomass to store carbon, particularly through materials and products with long lifecycles, and aims to increase the supply of sustainably produced timber. |
| **USA** | The US is the second largest global producer of industrial roundwood, accounting for **~19% of global production**.<br>Though the US maintains status as a leading producer, timber production peaks around 2030 as land competition reduces US exports' competitive advantage relative to neighboring countries. |
| **South-East Asia** | Southern East Asia accounts for less than 10% of global industrial roundwood supply today, but **production has been growing by >60% over the past 30 years**.<br>Increasing global demand (both domestic and foreign) drives production growth in the region leading to a **90% increase in industrial roundwood production between 2020 and 2050**. |

Expanding protected areas in the **Northern Hemisphere** puts pressure on the land use system, limiting land availability and increasing costs for forestry products companies

**Tropical rainforests** become extremely valuable from a climate perspective, as they have the highest carbon sequestration rates

Source: Global forest sector outlook 2050 (FAO, 2022) https://www.fao.org/3/cc2265en/cc2265en.pdf, https://unece.org/sites/default/files/2021-11/2114516E_Inside_Final_web.pdf

INEVITABLE POLICY RESPONSE

# Content

INEVITABLE POLICY RESPONSE

# 3. ENERGY – Impact of the sustainable transition on energy demand

## Land system

1. Food
2. Materials
3. **Energy**
4. Nature
5. Urban

**Several products compete for land, including food, materials, energy and natural capital.**

Climate and nature targets and affordability outcomes represent constraints on the products we consume from the land system.

Improving yields, changing consumption habits, and reducing waste can all ease competition and improve tradeoffs

| Drivers | Description | Key Implications for the land use Sector |
|---|---|---|
| **Bioenergy demand** | Climate policies incentivize the use of bioenergy as an alternative energy source as<br>1. It is a lower carbon **energy** compared to fossil sources<br>2. **Negative emissions** when combined with carbon capture and storage (CCS) | Increasing demand for bioenergy further constraints the land use system |

# Land scarcity and energy alternatives require closely examining the bioenergy outlook

- **Bioenergy plays a pivotal role** in any climate scenario :
  - It sits **between energy and land systems** and **influences nearly every outcome**, from forest land restoration to decarbonization pathways in hard-to-abate sectors like aviation and cement
  - Modern biomass use is recent and only occupies ~83 Mha (~5% of global cropland), but climate scenarios universally project **significant future growth**. Median IPCC 2$^{o}$C scenarios call for as much as ~380-700 Mha (~25-50% of current global cropland) by 2100
- Because modern biomass use for energy is still new, it **remains poorly understood** and therefore **highly uncertain:**
  - Most recent scenarios account for the **economic and direct carbon costs of biomass**, but typically assume the land system supplies whatever biomass the energy system demands
  - To account for indirect impacts such as the **land opportunity costs** of growing biomass, more fully integrated approach is required

Source:: Harper, A.B., et al. 2018; Field and Mach 2017

**This special report is part of the 2023 update to the IPR Forecast Policy Scenario.**

It uses new modelling to examine the tradeoffs associated with biomass to more clearly define its role in the net-zero, nature-positive transition.

The full bioenergy report can be found here.

INEVITABLE POLICY RESPONSE

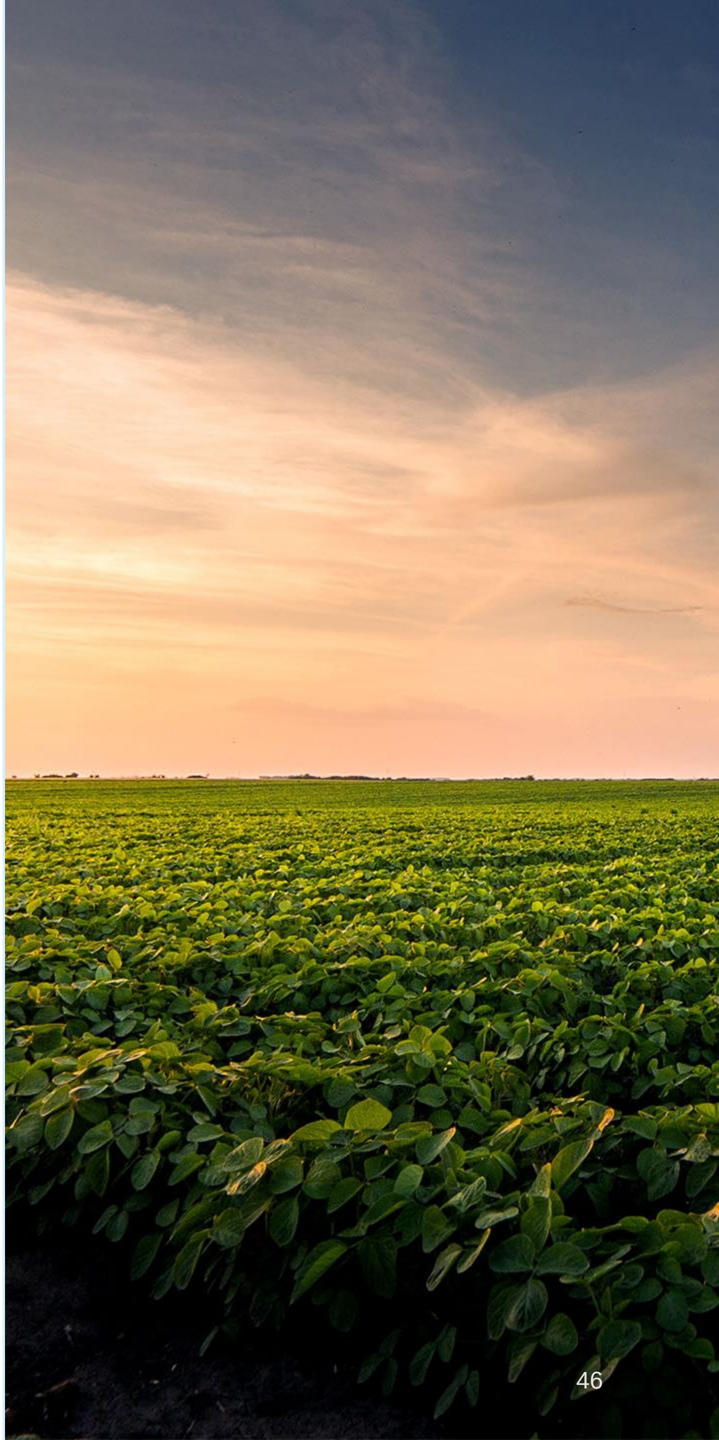
# Bioenergy Key findings

1. Bioenergy competes for scarce land in a system increasingly asked to provide more food, materials, urban space, and natural ecosystems
   - Bioenergy is costly for the land system to produce, but can facilitate decarbonization by delivering both low carbon energy and negative emissions when used with carbon capture and storage (CCS)
   - There are many competing demands for a fixed amount of land, and bioenergy might displace other uses that currently store carbon. This opportunity cost can be represented as the time required for bioenergy to capture and store the carbon it displaces (the "carbon payback period")
   - To be useful in the energy system, biomass must be either lower cost or more sustainable than other decarbonization technologies
2. Sustainable sourcing policy makes feedstock a critical determinant of bioenergy's competitiveness
3. Policymakers are expected to increasingly introduce sustainability guardrails for sourcing biomass, including avoiding nature displacement, deforestation, food competition, and irrigation
   - There are ~30 EJ of potential supply of waste and residue feedstocks that minimally compete for land and are currently underutilized. Bioenergy demand beyond that must be met with land dedicated to growing biomass
   - By 2050, IPR FPS uses 91Mha of land with a low carbon payback period, most of which is in arid or cold biomes, and none is in tropical biomes where re/afforestation could be a more efficient store of carbon
   - Current bioenergy capital stock does not match locations of sustainable dedicated supply, implying the industry needs to transition away from 1G crops toward waste and residues and build out new infrastructure
4. Bioenergy without CCS is likely to be outcompeted by lower carbon alternatives in most energy system applications
   - Aviation, shipping and the pulp & paper industry are exceptions - a lack of cleaner alternatives and very inexpensive self-supply of waste and residues make unabated bioenergy cost competitive through 2050
5. Bioenergy with carbon capture and storage (BECCS) in industry and power is costly but offers negative emissions. ~1 $GtCO_2e$ of BECCS removals may outcompete direct air capture (DACCS) depending on achievable biomass yields
   - Power and cement applications together represent ~13 EJ of BECCs by 2050. This contrasts with other prominent transition outlooks, many of which expect a larger role for bioenergy
   - As with bioenergy in transport, BECCs applications are also expected to transition away from the unsustainable 1G crops currently used, toward agricultural residues and some dedicated 2G lignocellulosic biomass

# Bioenergy: Implications for investors

**Takeaways from IPR FPS 2023**

1. Land scarcity implies sustainable sourcing policy is expected to constrain bioenergy
2. Unabated biomass plays a long-term role in the aviation, shipping and pulp & paper sectors, but is otherwise outcompeted by cleaner, cheaper alternatives
3. Waste and residues are expected to make up a growing share of feedstock as a more sustainable alternative to the 1G crops currently common. Some 2G dedicated biomass crops will likely be required to meet demand, but is limited to ~91Mha
4. High land opportunity costs constrain BECCS to ~1GT of removals in power and cement industries
5. There is a mismatch between current bioenergy infrastructure and what is needed in the long term. Location and feedstock mismatches create both investment opportunities and stranding risks



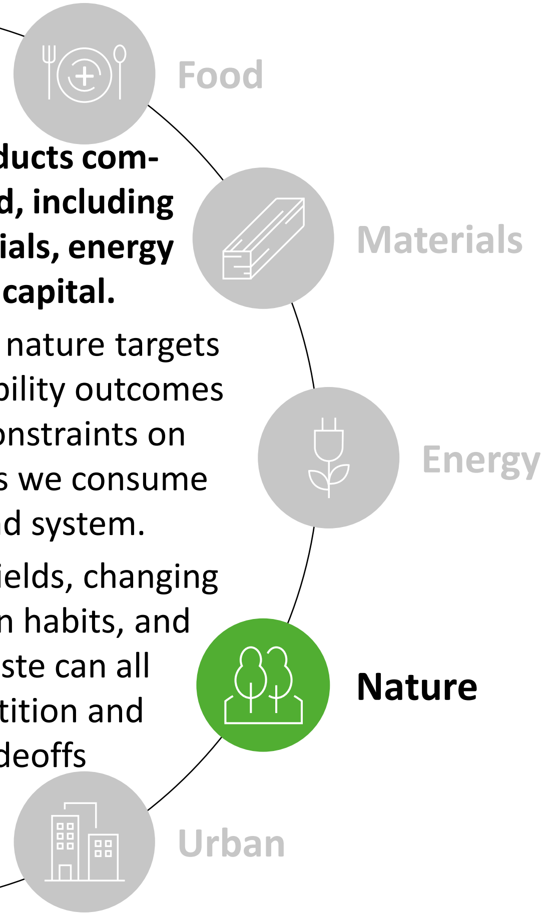
INEVITABLE POLICY RESPONSE

# Content

# 2. NATURE - Conservation policies, Nature-Based Solutions (NBS), and deforestation free supply chains are be central levers to preserve and restore natural capital

INEVITABLE POLICY RESPONSE

## Land system




**Several products compete for land, including food, materials, energy and natural capital.**

Climate and nature targets and affordability outcomes represent constraints on the products we consume from the land system.

Improving yields, changing consumption habits, and reducing waste can all ease competition and improve tradeoffs

| Drivers | Description | Key Implications for the land use Sector |
|---|---|---|
| **1. Conservation policies** | Command-and-control enforcement of government-protected areas to **improve biodiversity through nature conservation** | Increased area protection **pushes production away** from highly biodiverse areas. This **increases biodiversity** and natural capital, while increasing incentives for productivity increases on agricultural land |
| **2. Deforestation-free supply chains** | Implementation of policies that **require agricultural commodity inputs** to be **deforestation-free** | Incentives for deforestation-free supply chains **shifts crop production** for tropical soft commodities away from biodiversity hotspots |
| **3. Market-based credits** | **Carbon or biodiversity credits** bought by a public or private actor seeking to compensate for negative activities or to contribute to reaching global goal | Incentives for carbon credits encourages the improvement and restoration of land to **increase carbon sequestration** |

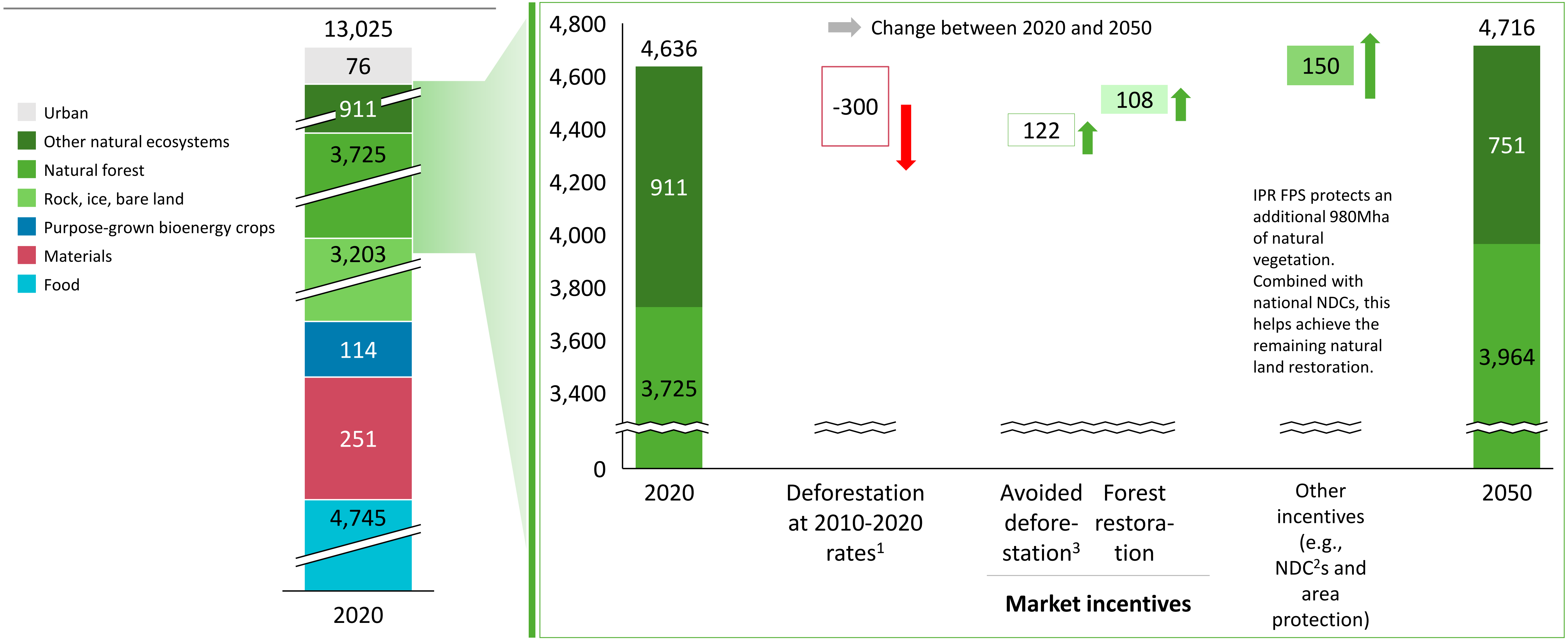
**These mechanisms are not mutually exclusive.** For example, a country might seek carbon or biodiversity credits to pay for its conservation programs. Both carbon credits or enforcement of conservation areas could be used to eliminate deforestation from supply chains.

# Natural ecosystems occupy ~1/3 of land globally…

# … and nature and climate policies and incentives help preserve and restore natural ecosystems

INEVITABLE POLICY RESPONSE

**Land use and land use change,** Mha



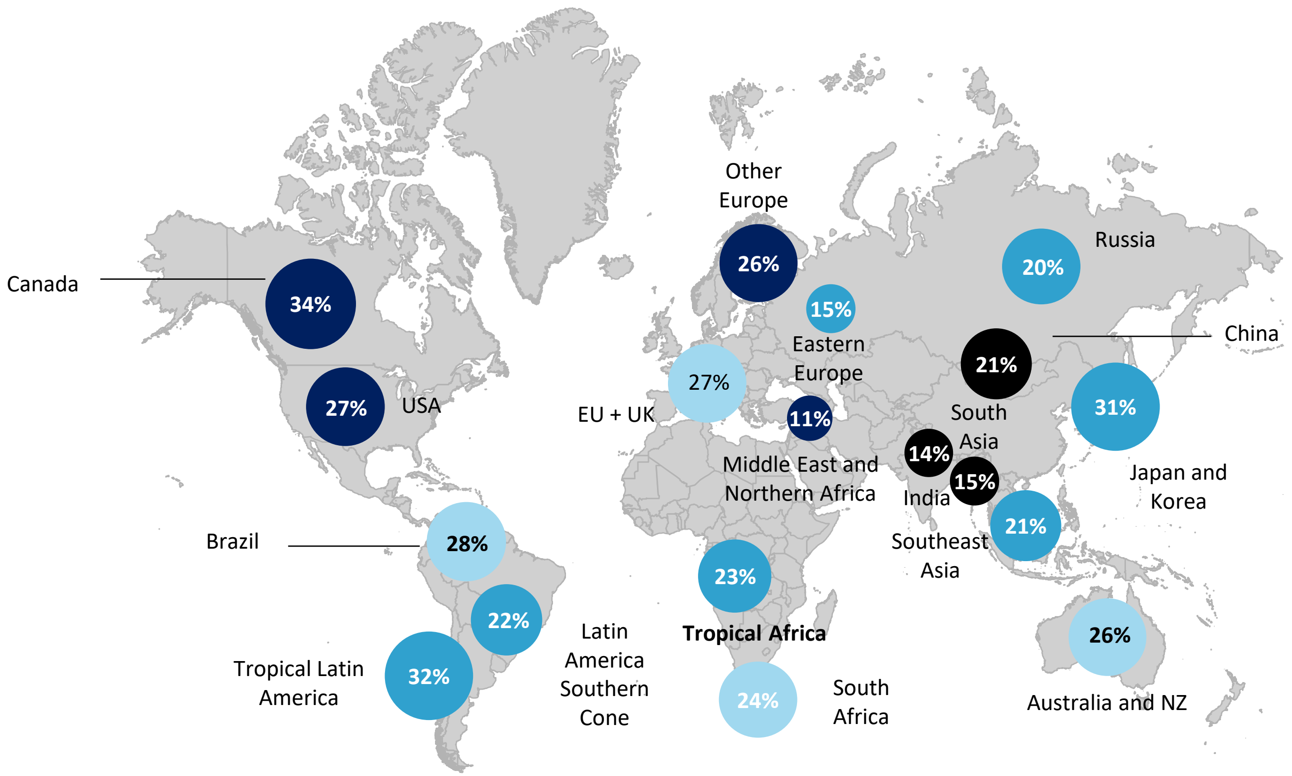

1. Based on FAO FRA 2020, which estimated average annual deforestation in 2015-2020 at 10Mha/year. https://fra-data.fao.org/assessments/fra/2020/
2. Nationally Determined Contributions
3. Calculated against a baseline

# 1. Under FPS 2023 biodiversity and nature policies protect an additional 980 million hectares of natural vegetation[1] from 2020-2050….

**Additional land protected[2],**
(FPS 2023 compared to Current Protection[3])

Low[2] High[2]

**% Natural vegetation under conservation in 2050 as % total land**




1. Natural vegetation includes primary and secondary forestland
2. Low ~ 50%; High ~1100%
3. 'Current Protection' refers to a counterfactual scenario where protected areas are kept at current levels

# …shifting production away from biodiversity hotspots

INEVITABLE POLICY RESPONSE

## Regional Implications

Land protection is already ambitious in Brazil, so the increase in conservation of natural vegetation between 2020-2050 is low. Coupled with ambitious policies and market incentives to end deforestation, strict area protection helps restore natural vegetation and increase forest area.

China faces a substantial increase in protection of natural vegetation, though the share of natural vegetation protected remains below that of European, African and American regions.

Russia already protects a large share of its natural vegetation as low population density and high amounts of unproductive land create less barriers to protecting land from agricultural production.

India protects ~13% of natural vegetation by 2050. Although this a relatively low share, it represents a significant increase from 2020-2050, driven by a push in policies which protect natural land.

# 2. FPS 2023 provides an update to the IPR Supply Chain Analysis on the risks associated with operating downstream of tropical commodity supply chains

## Why downstream companies and their investors have a responsibility to understand transition risk in supply chains

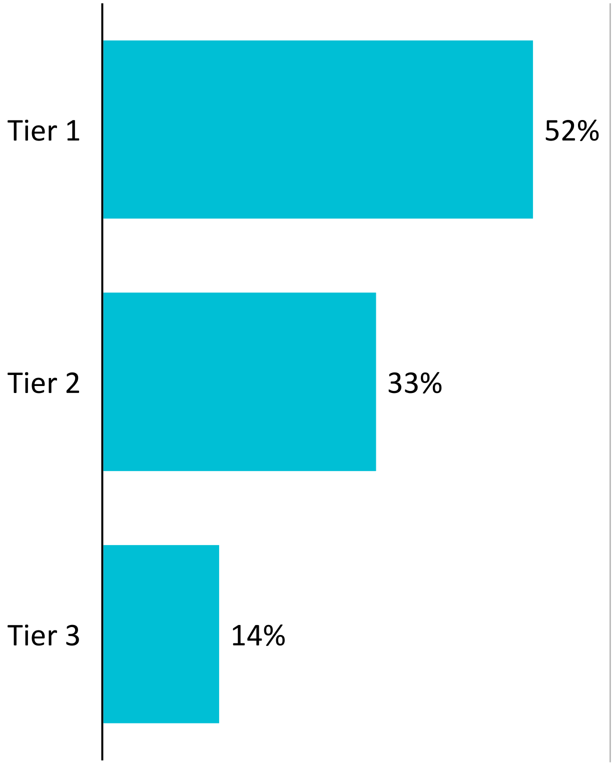
- Tropical soft commodities (beef, soybean, palm oil, timber, coffee, rubber, cocoa) drive a disproportionate share of deforestation, driving significant scope 3 emissions and negative nature impacts, and creating financial risks for downstream companies
- Supply chains of tropical soft commodities are reliant on international trade, meaning that upstream deforestation in a few jurisdictions can drive direct and indirect risks to investors in downstream companies globally
- There is increased financier and regulatory pressure for companies to disclose the environmental impacts of their supply chains and stress test their strategies for transition risk using scenario analysis
- An ‘inevitable policy response’ scenario includes significant policy action to tackle deforestation in most jurisdictions – both exporting and importing – exacerbating risks for companies and investors
- Scenarios and value drivers applicable to companies operating downstream in the land use sector are now available from the IPR initiative, and conducting this analysis in now technically feasible

Source: IPR Supply Chain Analysis https://www.unpri.org/inevitable-policy-response/ipr-supply-chain-analysis-for-tropical-soft-commodities/10678.article

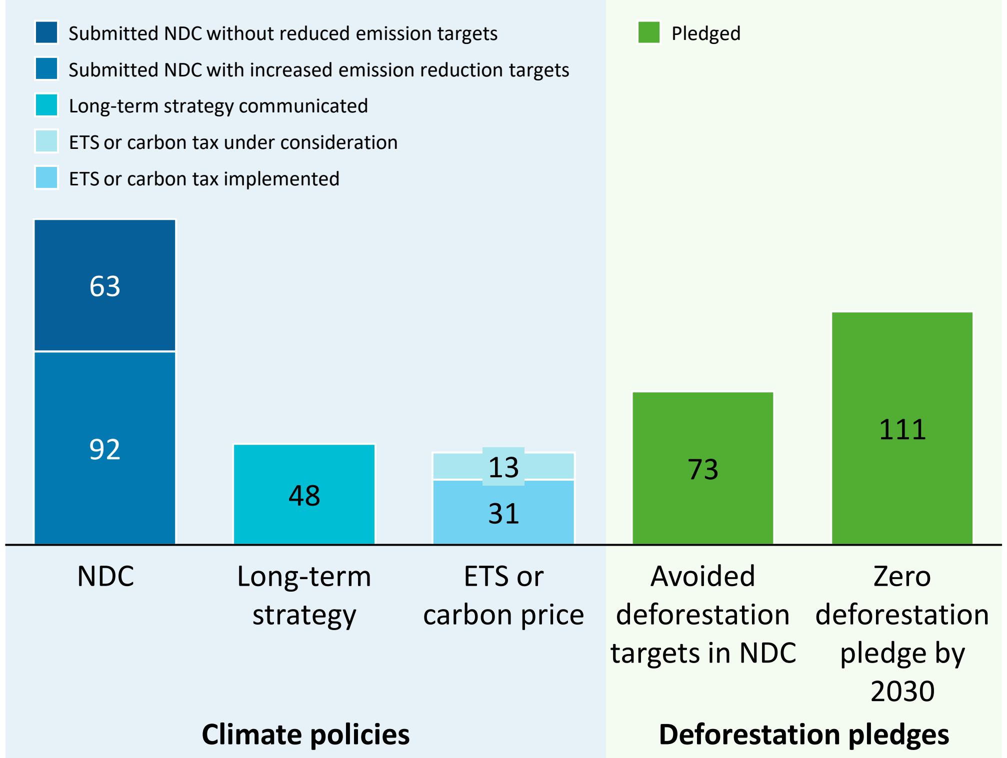
# 2. As producing and importing countries commit to stopping deforestation, policies regulating deforestation are likely to become more stringent

INEVITABLE POLICY RESPONSE

### % of countries in each tier of policy for deforestation[1,2]




### Number of countries with different climate and forestry commitment types



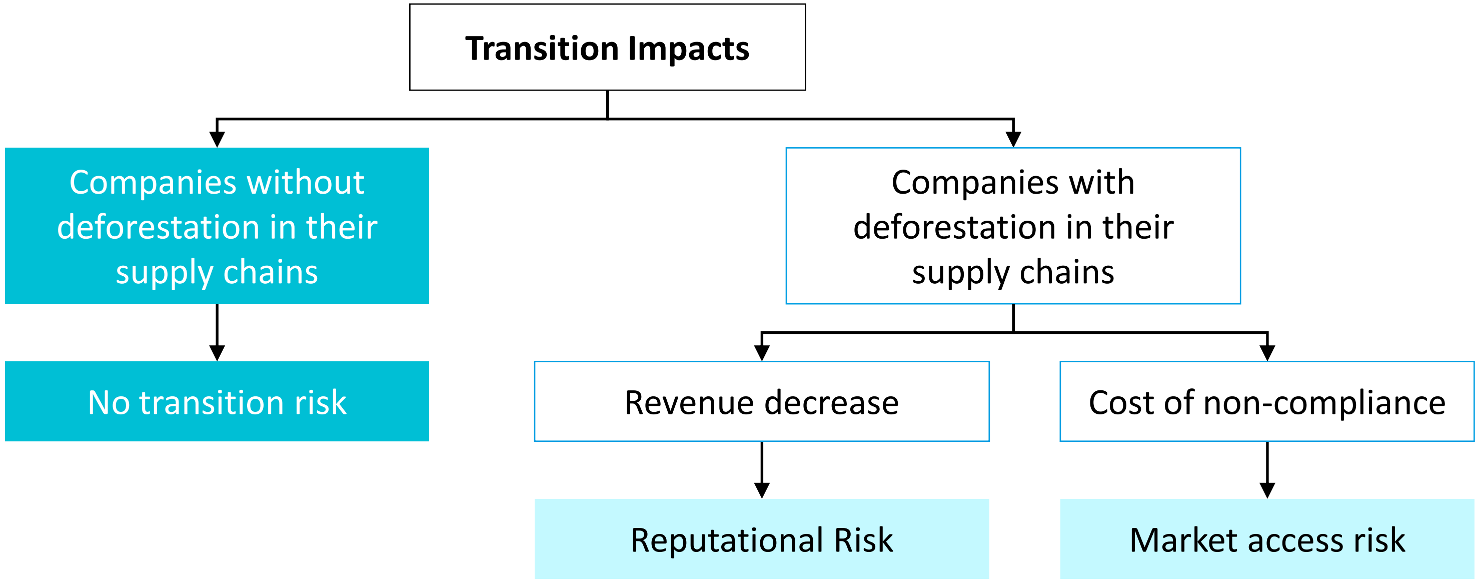

1. Tiers 1-3 represent categories of deforestation policy in increasing ambition level. Tier 1 is the most ambitious, usually with goals for net deforestation by 2025. Tier 2 countries seek to achieve net zero deforestation by 2030, and Tier 3 corresponds to ending deforestation by 2035 and beyond.
2. 21 countries were surveyed as a part of the policy forecast exercise

Source: Based on IPR team analysis, drawing on data from UNFCCC and ClimateWatch

- **In FPS 2023, future policy stringency in exporting countries is expected to increase** as they increasingly commit to long-term strategies for GHG emission reduction or pledge to halt deforestation
- **88% of countries have made commitments either in climate or forestry, and 67% have committed to reduce or eliminate deforestation.** Most countries have made relatively few environmental pledges, with a climate and forestry commitment score of ≤2
- **Leading importing regions,** such as EU, UK, US and Canada, China, Japan and South Korea, Australia and New Zealand **have implemented or committed to climate- or deforestation-related policies.** This creates another source of risk, and puts further pressure on policy in exporting countries

# 2. Policy that encourages deforestation-free supply chains has significant risk implications for downstream companies in tropical commodities….

We evaluate the risk of these policies by mapping them together with production and price value drivers, which are then distilled into two risk categories




**Reputational Risk**

**Description:** Risk of losing revenues due to an ESG event

**Indicator:** Low/medium/high by commodity and region of procurement, and averages given sector and company region

**Market access risk**

**Description:** Risk of losing access to procurement channels

**Indicator:** Low/medium/high by region, 2020-2050

INEVITABLE POLICY RESPONSE

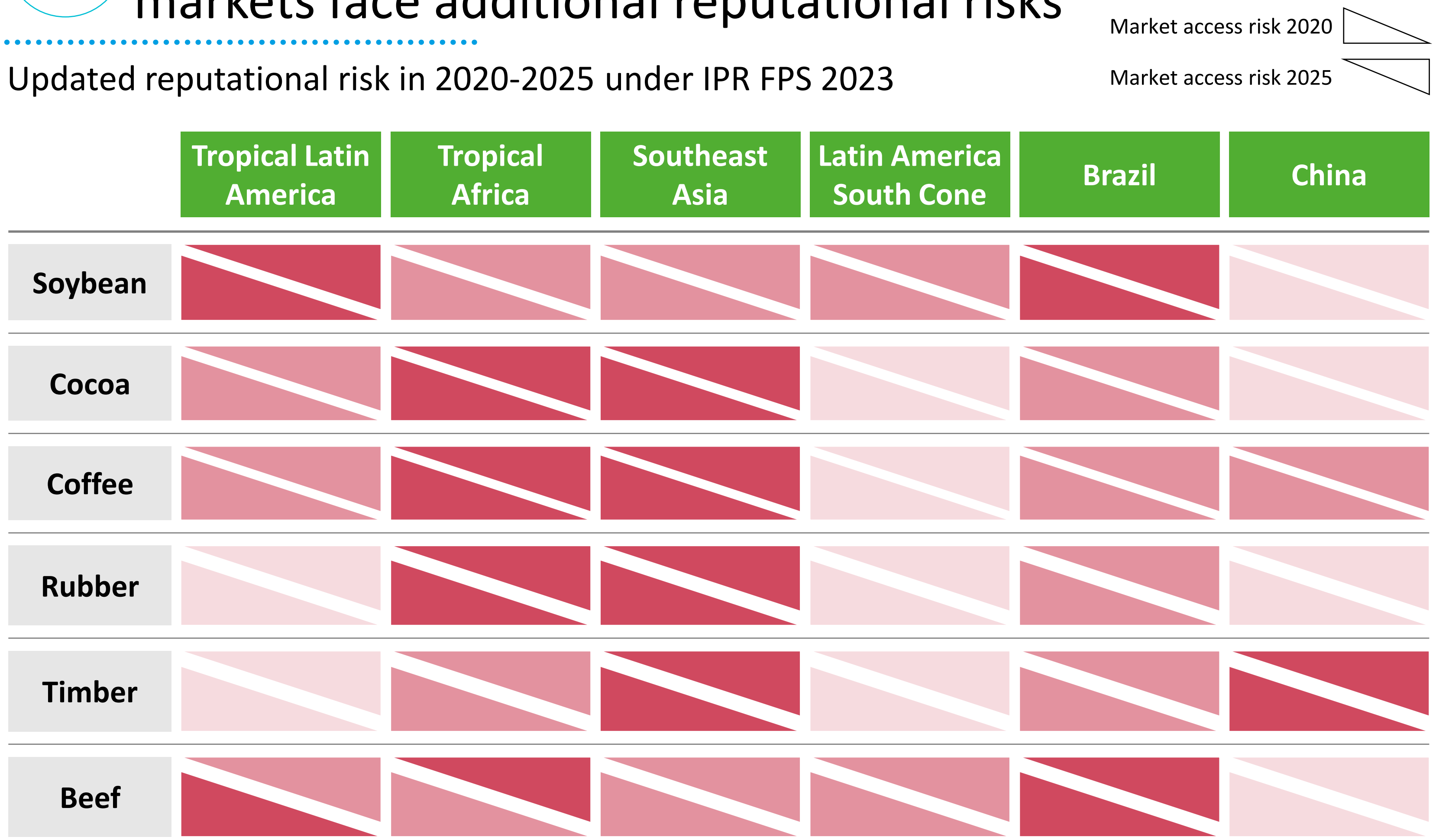
## …resulting in market access and reputational risks

- Market access and reputational risk decrease as policies for deforestation-free supply chains become integrated around the world, as non-compliance becomes less common
- These risks are evaluated for tropical soft commodities: soybean, rubber, cocoa, coffee, palm oil, timber and beef as these may have deforestation in their supply chain
- Companies can manage this risk by upgrading operations or paying a global price premium for deforestation-free commodities

INEVITABLE POLICY RESPONSE

# 2. Downstream companies sourcing from unregulated markets face additional reputational risks

## Updated reputational risk in 2020-2025 under IPR FPS 2023




**Reputational risk decreases over time as policies are implemented which incentivize and require deforestation-free supply chains**

Revenues at risk[1]

6-15% | 3-6% | 0-3%

Reputational risk emerges when **downstream companies purchase commodities linked with deforestation at market price** as the current market price does not internalize deforestation in most countries

Downstream companies suffer from reputational risk **based on the levels of commodity-driven deforestation** at the region of procurement

Reputational risk **flows through the supply chain as companies import** commodities. Increasing disclosure requirements are likely to exacerbate risks for downstream companies

1. Revenues at risk are estimated based on the reputational risk downstream companies may face when purchasing commodities linked to deforestation. Based on IPR Team Analysis, drawing on Chain Reaction Research estimates for revenue at risk estimations.

INEVITABLE POLICY RESPONSE

# 2. High market access risks decrease as regulations on deforestation-free supply chains tighten

Market risk of procuring commodities from Tropical Africa in 2020-2025

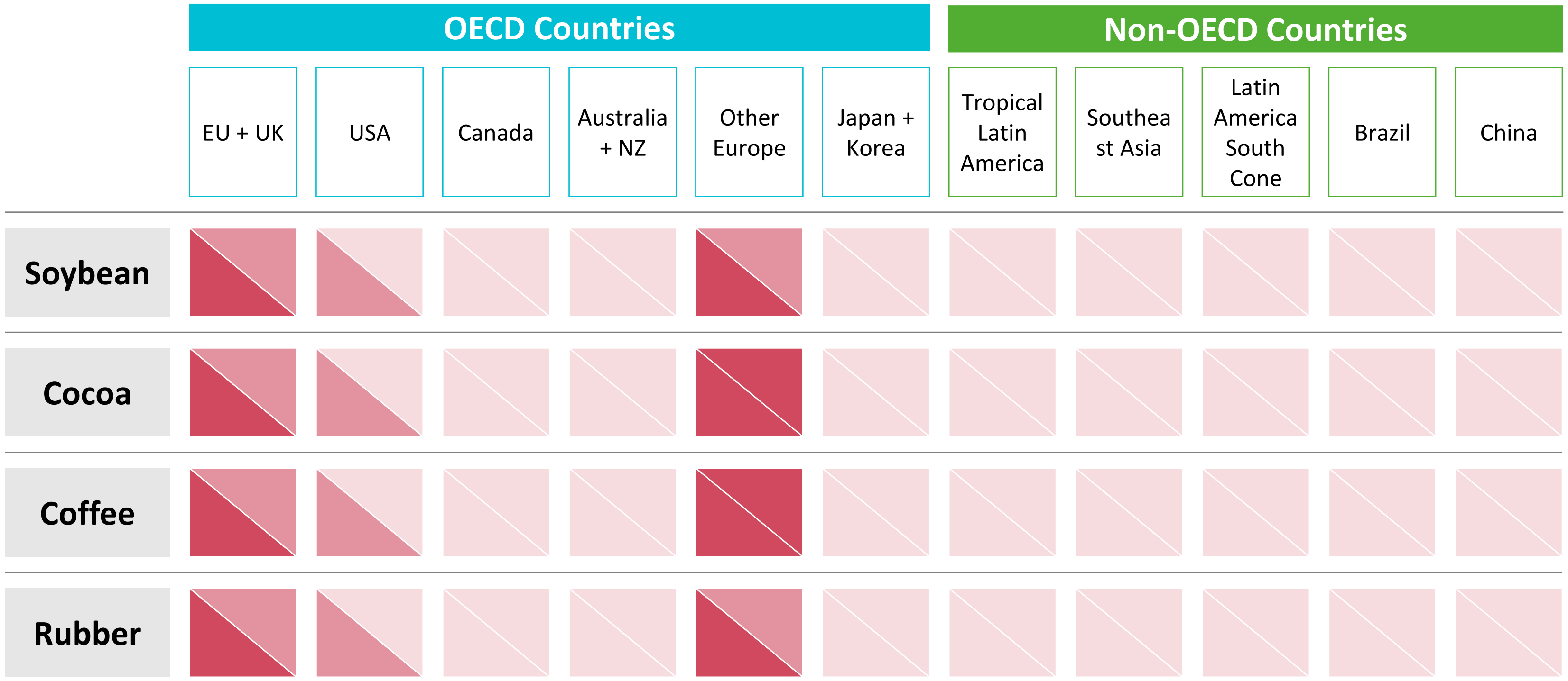
**Tropical Africa Case Study**

Market access risk 2020

Market access risk 2025

Revenues at risk[1]

6-15% | 3-6% | 0-3%




**Europe's integrated deforestation-free supply chain policies experience more risk when procuring from areas without such policies (such as Tropical Africa). This decreases over time as more regions integrate such policies**

**Market access risk is dependent on the region of procurement and the commodity**

**Market-based penalties and market access risk can in some cases increase until 2035**

- **The likelihood of losing revenues increases,** as both regulation becomes more stringent and consumers less tolerant towards deforestation
- **Market-based penalties as well as market access risk increase** as regulation tightens

1. Revenues at risk are estimated based on the reputational risk downstream companies may face when purchasing commodities linked to deforestation. Based on IPR Team Analysis, drawing on Chain Reaction Research estimates for revenue at risk estimations.

INEVITABLE POLICY RESPONSE

# 3. Market-based incentives include both carbon and biodiversity credits, though their impacts are often overlapping

**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 produces three combinations of credits:**

| | 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 **incentivized 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.

INEVITABLE POLICY RESPONSE

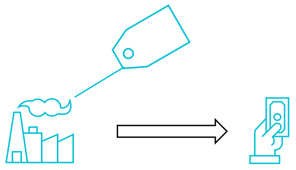
Carbon credits

# 3. Compliance and voluntary carbon markets create market-incentives for land-based emissions reductions

## Compliance carbon market

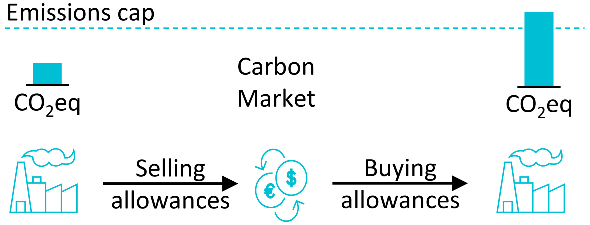
- **Set a mandatory price on emissions for firms covered by policy/regulation**
- **These are the best-established carbon markets, a few of which already includes land-based emissions reductions (e.g., New Zealand)**

### Carbon tax



- The regulator sets a **fixed unit price** per ton of $CO_2$eq emitted (overall or for specific sectors)
- Regulated polluters then **simply pay for each ton emitted**
- In some countries (e.g., Colombia, South Africa), **companies can meet (part of) their carbon tax obligation in-kind by retiring eligible carbon credits**

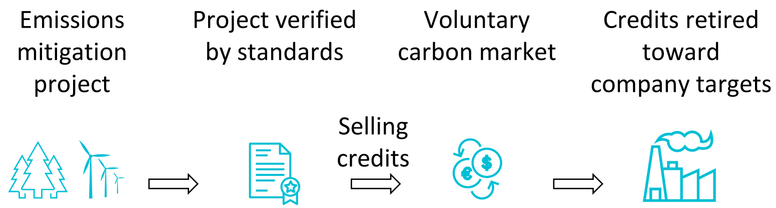
### Emissions trading system




- The regulator **sets a fixed limit on emissions ('cap')** and **auctions allowances** (typically one allowance grants the right to emit one ton of $CO_2$eq)
- Regulated firms can **choose to reduce emissions or buy allowances** from other firms on a secondary market
- In some systems, **eligible carbon credits can be used in lieu of allowances** (often up to a certain threshold / maximum)

## Voluntary carbon market (VCM)

- **Create opt-in positive incentive for offsetting emissions**
- **VCMs land-based emissions reductions are well-established and already used by companies to achieve their net-zero targets**




- A **developer voluntarily sets up a project** that avoids certain emissions (e.g., methane capture from a landfill) or removes carbon from the atmosphere (e.g., reforestation)
- Projects are **registered under a standard** (e.g., VCS, Gold Standard); validation and verification by an independent body
- **Carbon credits** equivalent to the mitigation achieved are **issued to the project** subject to verification
- The developer then **sells the carbon credits to companies, governments, or individuals** seeking to compensate and/or neutralize their emissions

Source: World Bank (2021) State and Trends of Carbon Pricing 2021

# 3. Biodiversity credit markets are growing as both the private and public sector recognize and formalize the need for nature-related targets



Biodiversity credits

| | Public sector action | Private sector action |
|---|---|---|
| **Similar past interventions** | **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**

## Awareness of nature is increasing

**196**

Countries adopted the global biodiversity framework in 2022

**51%**

of Fortune 500 companies acknowledge biodiversity loss[3]

**$6bn**

US dollars of private finance currently flowing to biodiversity offsets[10]

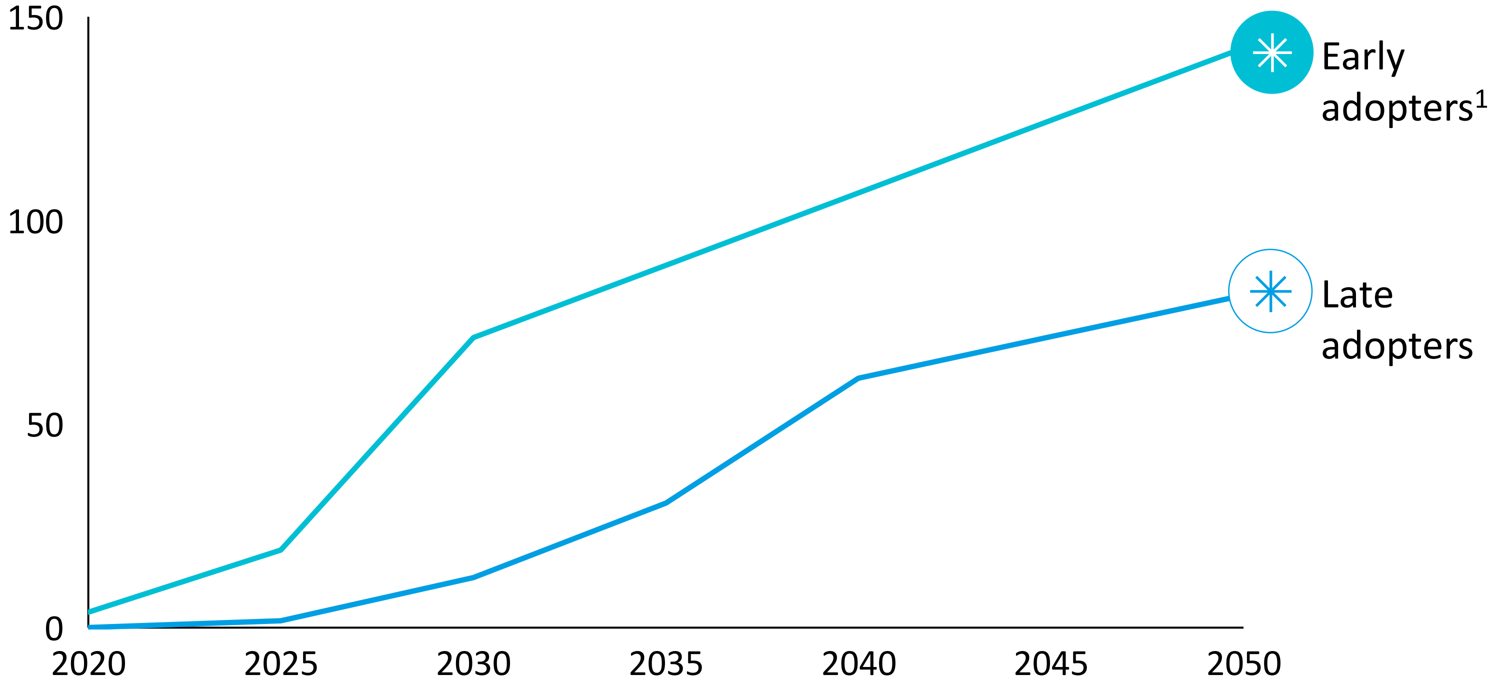
1. This is similar to the way that targets on climate helped catalyze carbon markets. 2. Convention on Biological Diversity 3. McKinsey 4. For example, Australia's Threatened Species Action Plan explicitly states a goal to "support innovative market mechanisms for increasing biodiversity and conservation 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) 10. State of Finance for Nature (2022)
Note: Nature markets could be additional to carbon markets that involve sale of NBS-based carbon credits

INEVITABLE POLICY RESPONSE

# Carbon prices grow substantially, increasing market-based incentives for Nature-Based Solutions

## **FPS 2023 Carbon Prices** (2020 US$/t$CO_2$eq)

Carbon prices representing the gradual incorporation of carbon incentives in land use practices, which varies depending on regional ambition.




1. Early adopters include Australia and New Zealand, most of EU + UK, Canada, China, Scandinavian countries, South Africa, Japan.

- There is a price differential between energy and land use until compliance markets start covering land use. Under the FPS 2023, land use is increasingly covered by compliance markets after 2025 for early adopters
- Land use carbon prices gradually rise, moving closer to carbon prices in energy and industry. Changes in carbon prices affect NBS uptake: demand is highest if NBS prices are lower than other offset projects, supply only increases if carbon revenues are high enough to outcompete potential agricultural profits
- Other non-$CO_2$ GHGs are priced differently. $N_2O$ and $CH_4$ emissions from agriculture are often harder to abate, and policymakers are expected to protect these emissions somewhat to avoid impacts on food prices

INEVITABLE POLICY RESPONSE

Carbon and biodiversity credits

# 3. Climate policy and incentives increase the uptake of NBS, encouraging both biodiversity restoration and carbon sequestration

## Through Nature-Based Solutions, carbon pricing helps deliver the nature agenda

**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

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

Source: UNEA via Nature-based Solutions Initiative

INEVITABLE POLICY RESPONSE

# Nature-based solutions vary widely by ecosystem and intervention, and can improve biodiversity

**Although NBS can lead to increased biodiversity, not all NBS directly support it. It is important to distinguish between solutions with climate-only vs climate and biodiversity co-benefits to accurately apply financial incentives**

NON-EXHAUSTIVE

Climate | Biodiversity | Partial benefit

| NBS Examples | Description | Benefits |
|---|---|---|
| **Forest, mangrove and peatland conservation** | Protection of biodiverse habitats as well as plants and trees which sequester carbon | Climate, Biodiversity |
| **Reforestation** | Reforestation can improve biodiversity, but this is highly dependent on local conditions. Without proper safeguards, restoration can harm biodiversity. It does improve carbon sequestration through planting of trees | Climate, Biodiversity (partial) |
| **Agroforestry** | Planting trees on farmland can result in increased habitats for wildlife, improving biodiversity and carbon sequestration, though this is highly location dependent | Climate |
| **Cover-cropping** | Crop restoration through cover-cropping may have slightly positive biodiversity impacts, particularly for insects and from reduced pollution of freshwater habitats. It can also lead to enhanced soil sequestration | Climate, Biodiversity (partial) |
| **Monoculture afforestation** | Fast growing monocultures sequester carbon rapidly but may not maximize storage in the long term, and do not improve biodiversity due to the quick growth-rotation cycle and monoculture plantation | Climate (partial) |

Source: IPR Team Analysis

INEVITABLE POLICY RESPONSE

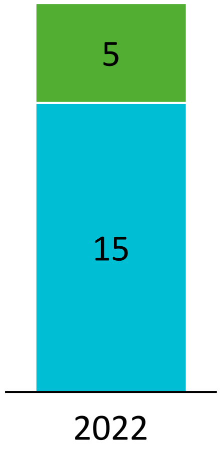
Carbon and biodiversity credits

# 3. Desirable biodiversity outcomes can also be achieved on land used to generate NBS-based carbon credits

## Biodiversity premia in carbon credit markets

Afforestation & reforestation carbon credit prices ($USD/tCO_2$)

Biodiversity premium
Carbon credit price




**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 emphasizes 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

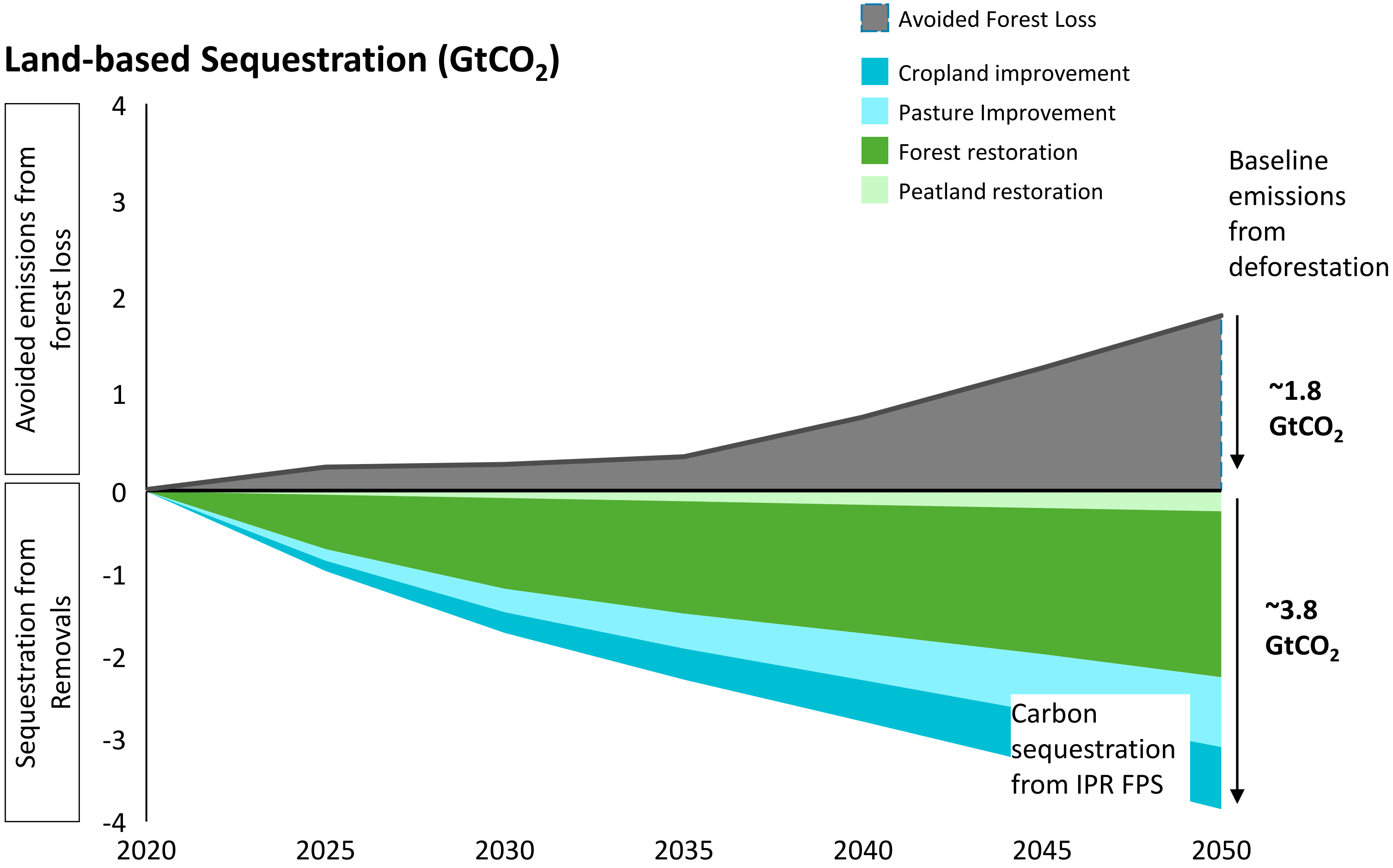
## Relationship between markets

Land used to generate NBS-based carbon credits could also be used to generate biodiversity credits, **contingent on best-practice standards** that 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: IPR Team 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

# By 2050, action to halt deforestation reduces emissions by 1.8 $GtCO_2$/yr, while other policy and market incentives helps capture an additional ~3.8 $GtCO_2$/yr




1. The reference scenario projects the land use change we would expect to see without NBS policies that conserve forest land, improve practices to optimize sequestration, and create new ecosystems. These values represent the difference in removals and reduction between the FPS 2023 scenario and this reference scenario, as a baseline.
2. Ecosystems described here refer to major land-based and carbon-rich ecosystems (e.g. forests, peatland, mangroves, pastureland)

INEVITABLE POLICY RESPONSE

Under FPS, forest-based removals are key for the climate transition as they're responsible for two thirds of the total shift in land-based emissions against a reference scenario[1].

Land-based emissions avoidance and removals **can be broken into three categories:**

### Avoided Forest Loss

- Practices that prevent the loss of existing ecosystems (e.g. avoided deforestation)
- NDCs to protect land for biodiversity contribute to the avoidance of ~111 Mha of forest loss
- Reduces emissions by **1.8 $GtCO_2$** relative to a reference scenario[1] by 2050

### Agricultural Improvement

- Practices that improve carbon retention in agricultural lands (e.g. soil or production improvements)
- Removes **1.6 $GtCO_2$** a year by 2050, equivalent to ~938 Mha

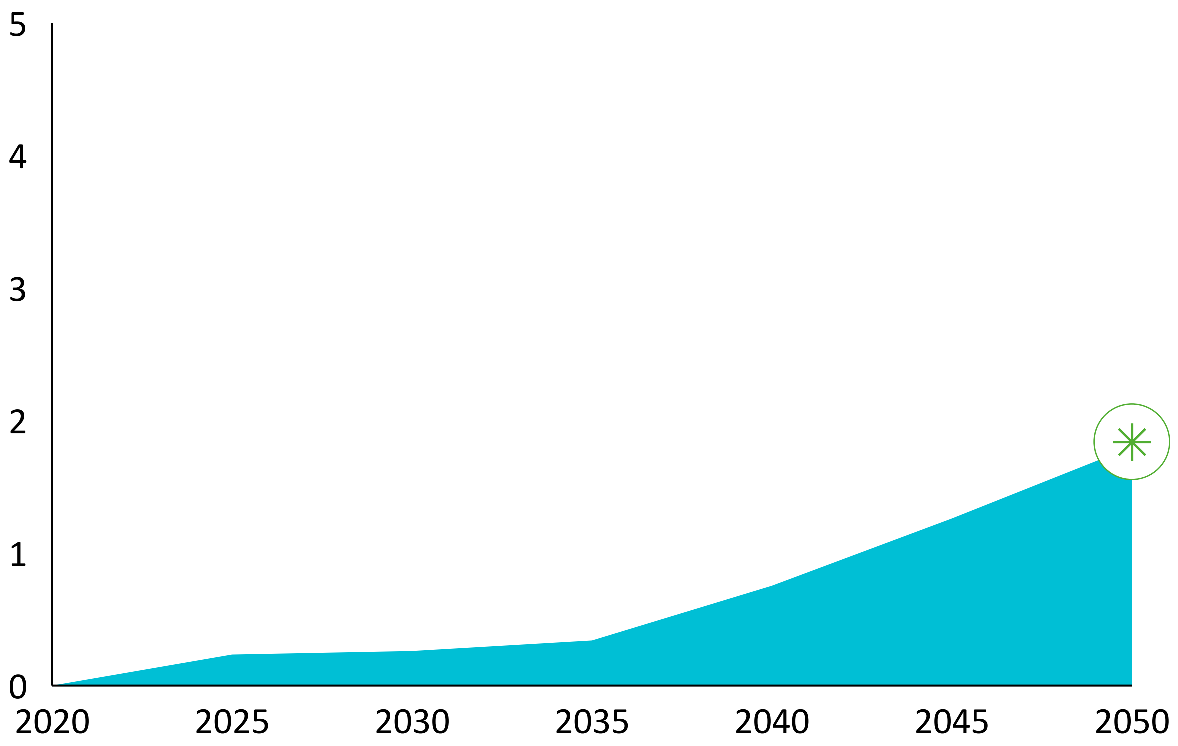
### Ecosystem Restoration

- Practices that creates new ecosystems[2] (e.g. restoration of natural forests and other ecosystems)
- Removes **2.2 $GtCO_2$** a year by 2050, equivalent to ~302 Mha

# Net-zero deforestation incentives in Tropical Africa drives growth in avoidance NBS after 2035

## Annual emissions avoidance under FPS

$GtCO_2$ of avoided emissions




1. Baseline scenarios establish how much avoided emissions have accrued by determining what would have happened on the land if no financial incentive was in place. In this way the opportunity cost (in terms of emissions) can be calculated, and the carbon credit correctly allocated.
2. Robust standards for avoided deforestation carbon credits can include REDD+/J-REDD frameworks

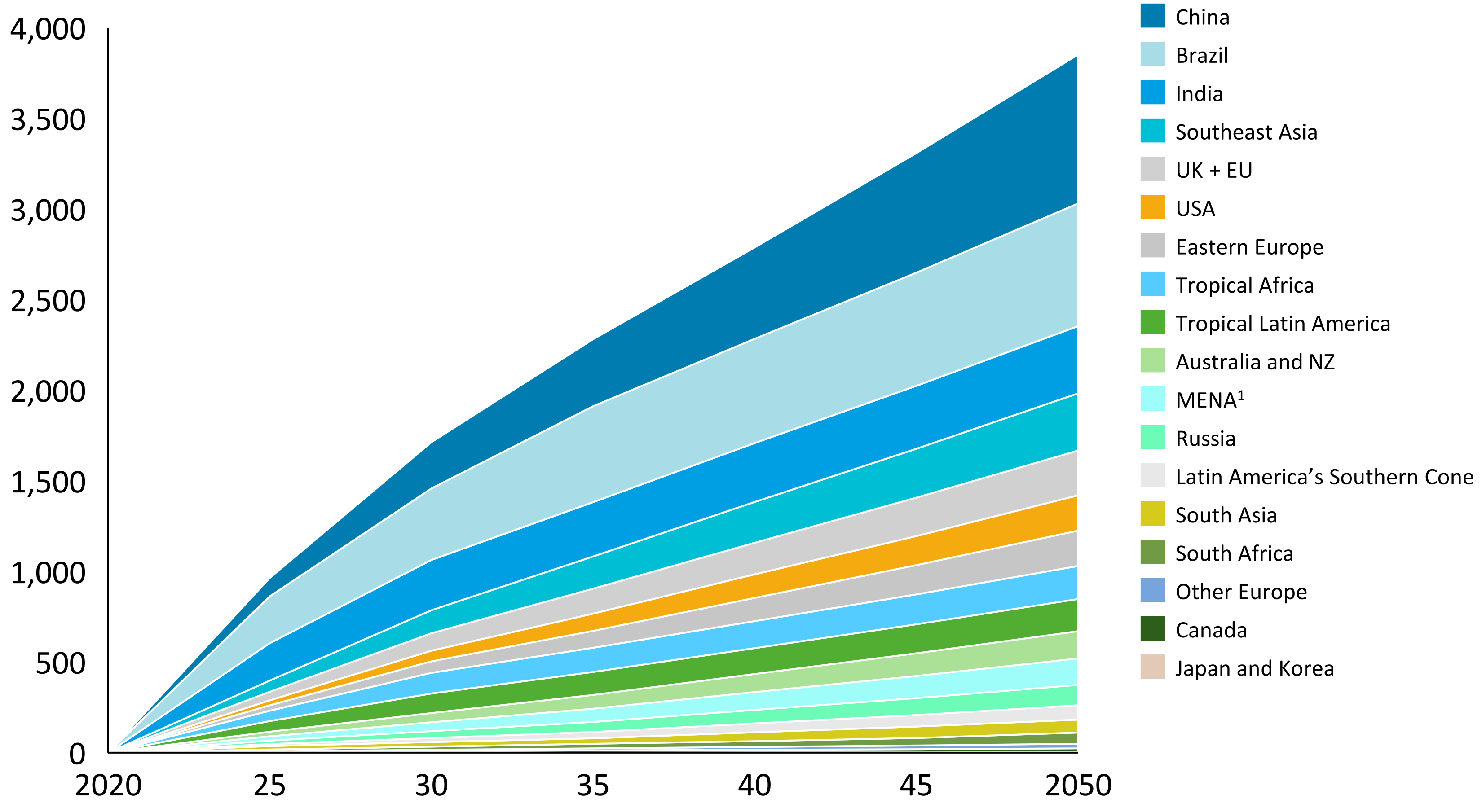
INEVITABLE POLICY RESPONSE

## Avoidance credits

- Avoidance NBS credits are **financial incentives for agricultural producers and land-owners** to preserve nature and land. Producers **forgo the profits from cultivation in exchange for the carbon credit** associated with the additional sequestration from the vegetation
- **Reference scenarios[1] and robust standards[2] are a key component** of implementing avoidance credits

# China, Brazil and India are key countries for removals NBS

**Sequestration by region,** $GtCO_2$




1. Middle East and North Africa

INEVITABLE POLICY RESPONSE

Covered in following slide

## Implications of Removals Nature-Based Solutions

- Removals NBS include restoration and improvement of a variety of ecosystems to accelerate sequestration
- To scale the potential for NBS, solutions must collaborate across stakeholders and be commercially viable
- Brazil, India and China are key countries for removals nature-based solutions because of their size and presence of tropical forests on their territories which sequester carbon faster

INEVITABLE POLICY RESPONSE

# Content

INEVITABLE POLICY RESPONSE

# Since 2020, IPR has published annual updates to the impacts of FPS on the AFOLU sectors, expanding the outputs to include nature and supply chains

FPS + Nature

## IPR 2021

Policy research for new FPS (2021)

Additional high-ambition scenario (RPS 2021)

Energy and Land Use alignment

First full set of value drivers published

## Research update

2021 Policy Research, with additional research on selected assumptions

Re-run new version of MAgPIE with updated assumptions around diets and timber production

Published value drivers (FPS and FPS + Nature)

## New scenario

**Nature included** in the analysis with more information on nature-based solutions, area protection and biodiversity intactness

Published value drivers (FPS and FPS + Nature)

## Supply Chains

Deforestation risks for downstream companies

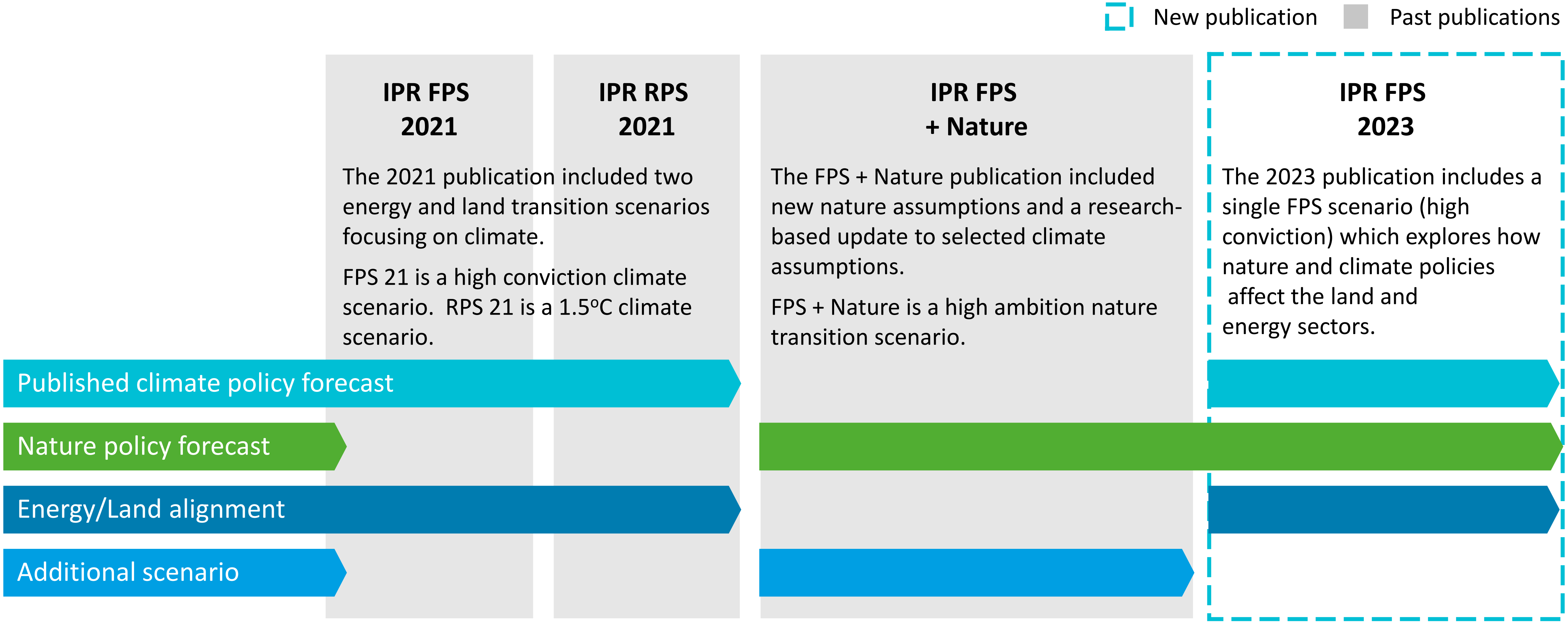
Includes additional information on **market access and reputational risks**, **additional costs** to make supply chains sustainable and **price premia** to source deforestation-free commodities

Published value drivers

INEVITABLE POLICY RESPONSE

# The Inevitable Policy Response has produced three distinct scenarios

## IPR FPS 2023 updates FPS 2021 with a new policy forecast and the research from FPS + Nature



INEVITABLE POLICY RESPONSE

# Methodology

- The Model of Agricultural Production and its Impact on the Environment (MAgPIE) is the main source of insight for the calculations in this chart pack (unless indicated otherwise).
- More information on the model can be found here: https://www.pik-potsdam.de/en/institute/departments/activities/land use-modelling/magpie

INEVITABLE POLICY RESPONSE

# Detailed methodology and data sources for baseline food demand[1]

| Overview | Methodology | Data sources | Literature |
|---|---|---|---|
| The MAgPIE model is the main source of our insights. Our model shows total food/caloric demand estimates for different regions and a breakdown of caloric/food demand into categories of commodities (e.g., ruminant meat, corn) | Food demand is calculated by multiplying population and caloric consumption per capita<br><br>Caloric consumption per capita is a function of subsistence food intake and additional income-based food consumption<br><br>Subsistence food intake is estimated by splitting population groups based on location/region, BMI, height, age, pregnancy status and physical activity levels. Then using literature estimates and historical data caloric requirements for each of these groups are calculated<br><br>Income related food consumption uses food prices and total income to determine the food consumption beyond the subsistence requirements | Metabolic rate is estimated based on the Schofield equation which allows to calculate calories needed based on a few simple variables: gender, age and weight<br><br>Demographic information is based on Shared Socioeconomic Pathways (SSP) (https://www.sciencedirect.com/science/article/abs/pii/S0959378015000060?via%3Dihub)<br><br>Caloric and protein content of different products are based on FAOSTAT | Key paper introducing the model: https://www.nature.com/articles/s41598-020-75213-3<br><br>Model overview: https://www.pik-potsdam.de/en/institute/departments/activities/land use-modelling/food-demand-model/visualization-and-determination-of-demand-scenarios<br><br>Dashboard with visualizations of potential outputs: http://www.pik-potsdam.de/~bodirsky/demand_scenarios/#page1<br><br>Detailed description of the food demand calculations: https://rse.pik-potsdam.de/doc/magpie/4.5.0/15_food.htm |

1. Baseline food demand excludes diet shift of food waste reduciton assumptions

INEVITABLE POLICY RESPONSE

# Deep Dive: Food Demand Modelling[1]

## Modelling Underlying Food Demand

**Total food demand** is the product of per capita food demand and population. Per capita food demand consists of both **food intake** and **food waste**

- **Food intake** is a function of **subsistence and income related consumption**. Subsistence intake is a function of **demographic characteristics** (e.g., height, age, BMI) Income-related consumption is a function of **food prices** and **per capita income**[2]
- **Food waste** is modelled as an overconsumption of food which is primarily determined by **income**
- The composition of food demand changes with intake needs, income, shifts towards healthy diets and to alternative proteins[3]

## Input Assumptions/Sources

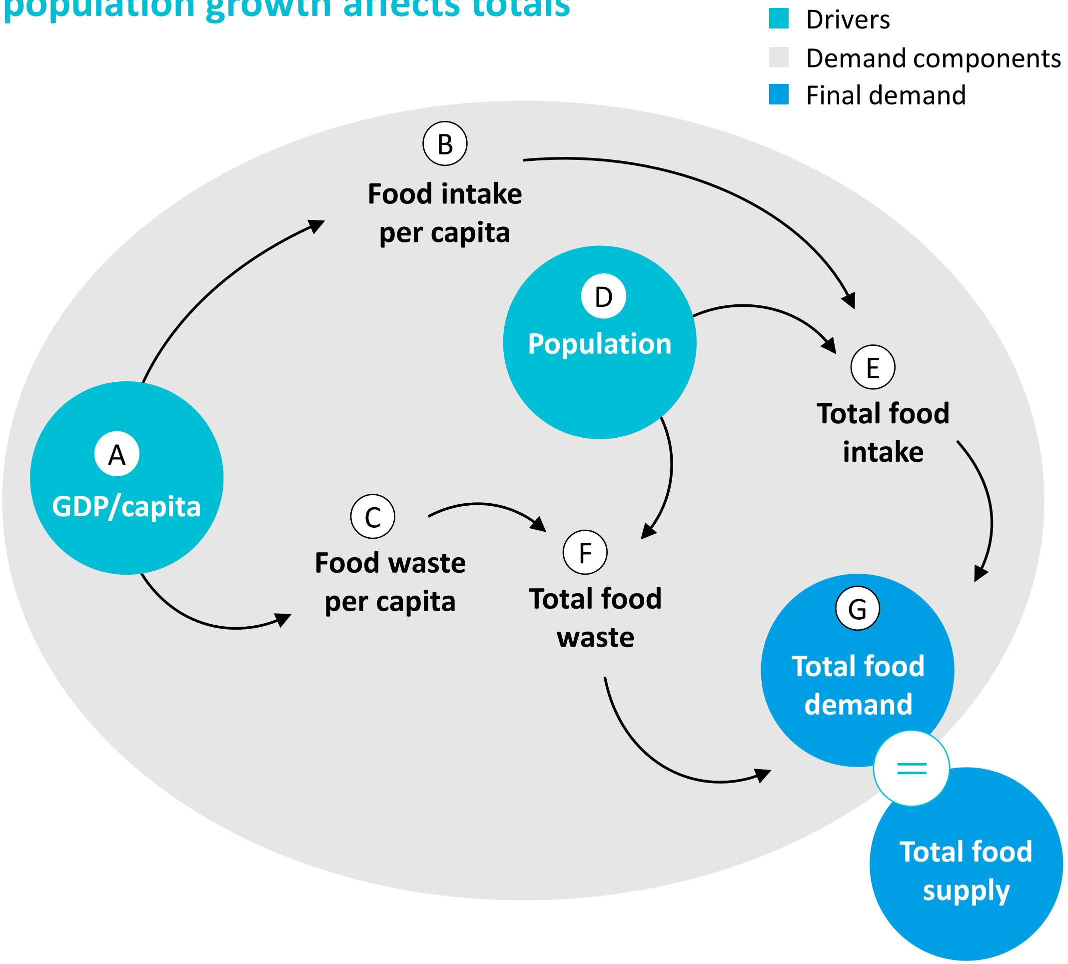
| | Input Assumptions | Sources |
|---|---|---|
| **Demographic Variables and GDP** | GDP, Age, Population etc. are based on the SSP2 scenario of the Shared Socioeconomic Pathways | Shared Socioeconomic Pathways (SSP) |
| **Historical data** | FAOSTAT to calibrate our historical values for food demand, protein content of food and regional processing differences | FAOSTAT |

1. Caloric modelling is based on the methodology presented in Bodirsky et. al (2020):
2. Literature shows a strong link between per capita demand and income growth.
3. Bodirsky, Benjamin Leon, Jan Philipp Dietrich, Eleonora Martinelli, Antonia Stenstad, Prajal Pradhan, Sabine Gabrysch, Abhijeet Mishra, et al. 2020. "The Ongoing Nutrition Transition Thwarts Long-Term Targets for Food Security, Public Health and Environmental Protection." Scientific Reports 10 (1): 19778.

# GDP and population affect food waste and intake, driving food demand

INEVITABLE POLICY RESPONSE

## GDP growth affects per capita intake and waste, while population growth affects totals




A. **GDP growth affects both per capita food waste and food intake**. Historically, income growth has led to an increase in both per capita waste and intake, particularly in emerging economies where GDP/capita is low

B. Per capita **food intake represents the actual consumption of each individual**. As people get richer, their caloric intake increases and diets include more expensive food products (e.g., beef)

C. **Per capita food waste represents the calories that are demanded by each individual, but not consumed** (i.e., post farm-gate). Richer countries waste substantially more than emerging economies, GDP growth drives larger increases in food waste the starting income is lower

D. **Population is a multiplication factor for both per capita food waste and intake.** Population growth is **concentrated in emerging economies**, enhancing the effect of food patterns in those regions on global food waste and intake

E.

F. **Both total food waste and intake grows substantially faster in emerging economies.** Population growth is going to enhance the effect of the increase in per capita waste and GDP in these regions

G. **Total food demand is the sum of food waste and food intake**

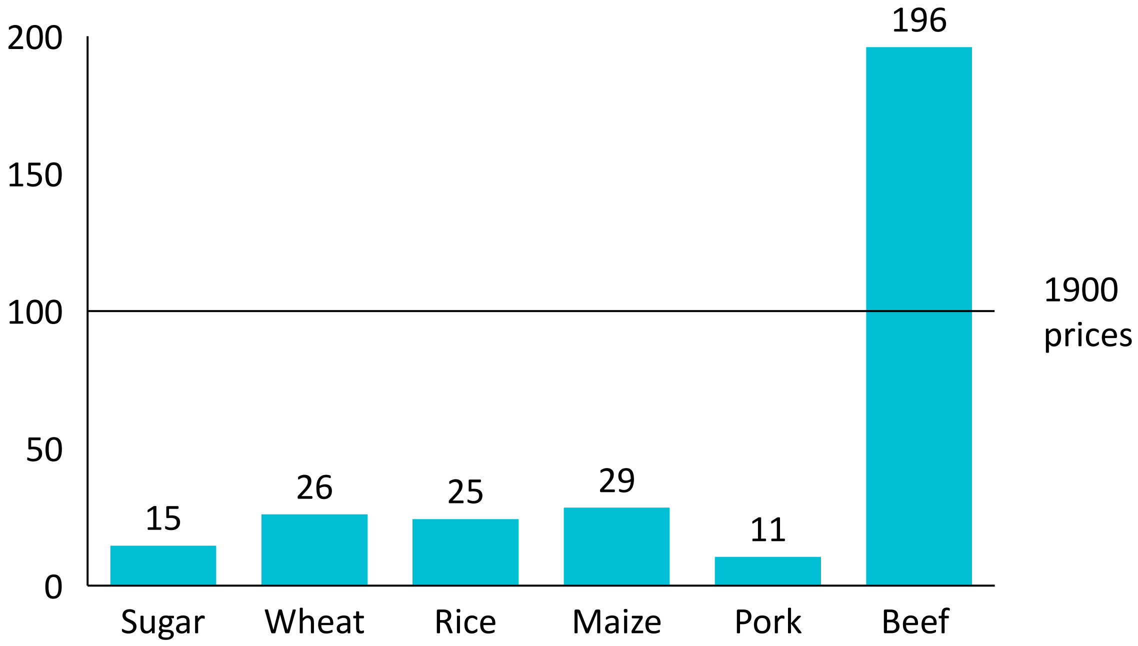
INEVITABLE POLICY RESPONSE

# Food prices for key commodities have historically declined, except beef

## Historical trajectory of commodity prices

Key commodity prices have **declined substantially over the last 100 years**, with the exception of beef

**Commodity prices in 2020** (Index: 1900 = 100)[2]

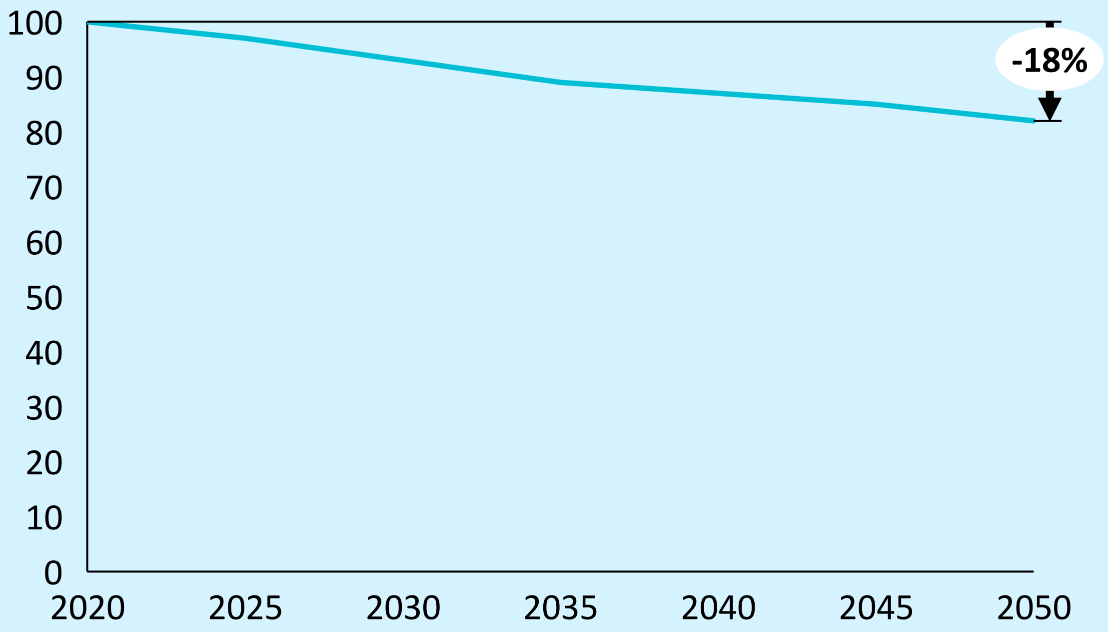



# Under IPR FPS, food prices further decline by 18% between 2020 and 2050

## **Food Price Index** (global, all commodities)

Food prices further decline by **18%** between 2020 and 2050 driven primarily by innovation leading to diet shifts, productivity growth, input efficiency and food waste reductions

**Food Price Index** (Index: 2020 = 100)[1]



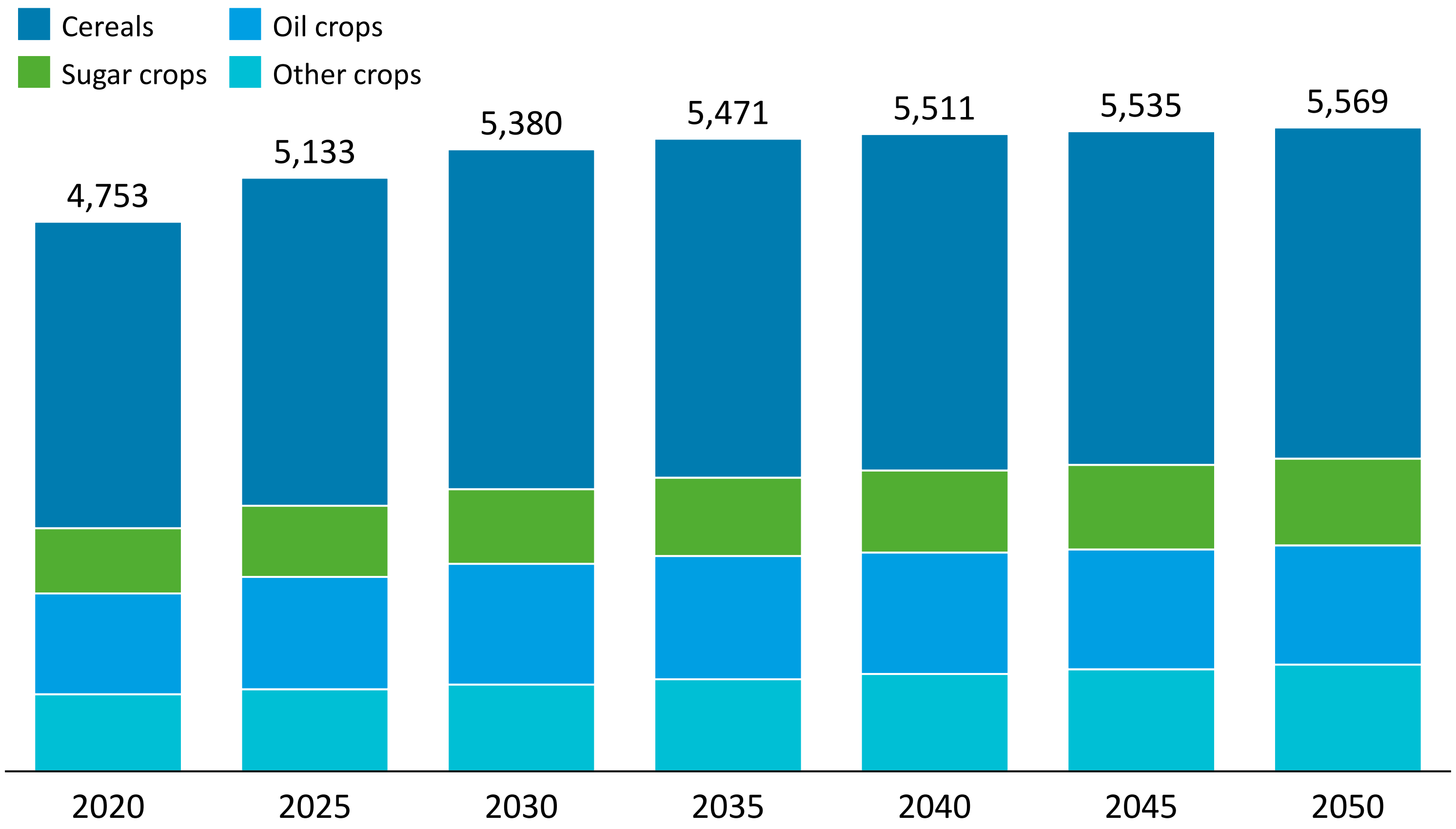

1. The food price index incorporates the price trajectories of all major agricultural commodities. Start year: 2020 = 100
2. Our World in Data, based on Jacks (2019)

INEVITABLE POLICY RESPONSE

# Global crop production increases by 17% between 2020 and 2050

**Global Production across major crop categories[1]**

Mt DM/year[1]




1. Mega tonnes of Dry Matter

## Drivers

- Food, feed an energy demand are the three key drivers of crop production.
- Though global population grows, food waste reductions stabilize global average per capita caloric intake, and demand for food crops by 2050.
- Diet shifts increase demand for food crops as alternative protein sources. However, the slow down in growth of livestock production, reduces demand for feed corps.
- Energy demand shifts away from first generation, reducing demand for first generation bioenergy crops (e.g., oil crops and corn for ethanol).

# Disclaimer

This report has been created by Energy Transition Advisers and Theia Finance Labs (The Inevitable Policy Response Consortium). This report represents the Inevitable Policy Response's own selection of applicable data. The Inevitable Policy Response is solely responsible for, and this report represents, such scenario selection, all assumptions underlying such selection, and all resulting findings, and conclusions and decisions.

The information contained in this report is meant for the purposes of information only and is not intended to be investment, legal, tax or other advice, nor is it intended to be relied upon in making an investment or other decision. This report is provided with the understanding that the authors and publishers are not providing advice on legal, economic, investment or other professional issues and services. Unless expressly stated otherwise, the opinions, recommendations, findings, interpretations and conclusions expressed in this report are those of the various contributors to the report and do not necessarily represent the views of PRI Association or the signatories to the Principles for Responsible Investment. The inclusion of company examples does not in any way constitute an endorsement of these organisations by PRI Association or the signatories to the Principles for Responsible Investment. While we have endeavoured to ensure that the information contained in this report has been obtained from reliable and up-to-date sources, the changing nature of statistics, laws, rules and regulations may result in delays, omissions or inaccuracies in information contained in this report. PRI Association is not responsible for any errors or omissions, or for any decision made or action taken based on information contained in this report or for any loss or damage arising from or caused by such decision or action. All information in this report is provided "as-is", with no guarantee of completeness, accuracy, timeliness or of the results obtained from the use of this information, and without warranty of any kind, expressed or implied. The IPR consortium are not investment advisers and makes no representation regarding the advisability of investing in any particular company, investment fund or other vehicle.

The information contained in this research report does not constitute an offer to sell securities or the solicitation of an offer to buy, or recommendation for investment in, any securities within the United States or any other jurisdiction. This research report provides general information only. The information is not intended as financial advice, and decisions to invest should not be made in reliance on any of the statements set forth in this document. The IPR consortium shall not be liable for any claims or losses of any nature in connection with information contained in this document, including but not limited to, lost profits or punitive or consequential damages. The information and opinions in this report constitute a judgement as at the date indicated and are subject to change without notice. The information may therefore not be accurate or current. The information and opinions contained in this report have been compiled or arrived at from sources believed to be reliable in good faith, but no representation or warranty, express or implied, is made by the IPR consortium as to their accuracy, completeness or correctness and the IPR consortium do also not warrant that the information is up to date.

INEVITABLE POLICY RESPONSE

# IPR Contacts:

**Investor Enquiries:**
Julian Poulter, Head of Investor Relations
julian.poulter@et-advisers.com

**Media Enquiries:**
Andrew Whiley, Communications Manager
Andrew.Whiley@inevitablepolicyresponse.org

**Social Media: Follow us at:**

IPR X (Twitter) @InevitablePol_R search #iprforecasts

IPR LinkedIn Inevitable Policy Response search #iprforecasts

INEVITABLE
POLICY
RESPONSE