Scenarios compatible with the LTGG considered in the IPCC 2018-19 special reports

First meeting of the Structured Expert Dialogue of the second periodic review
Theme 1 - November 2020

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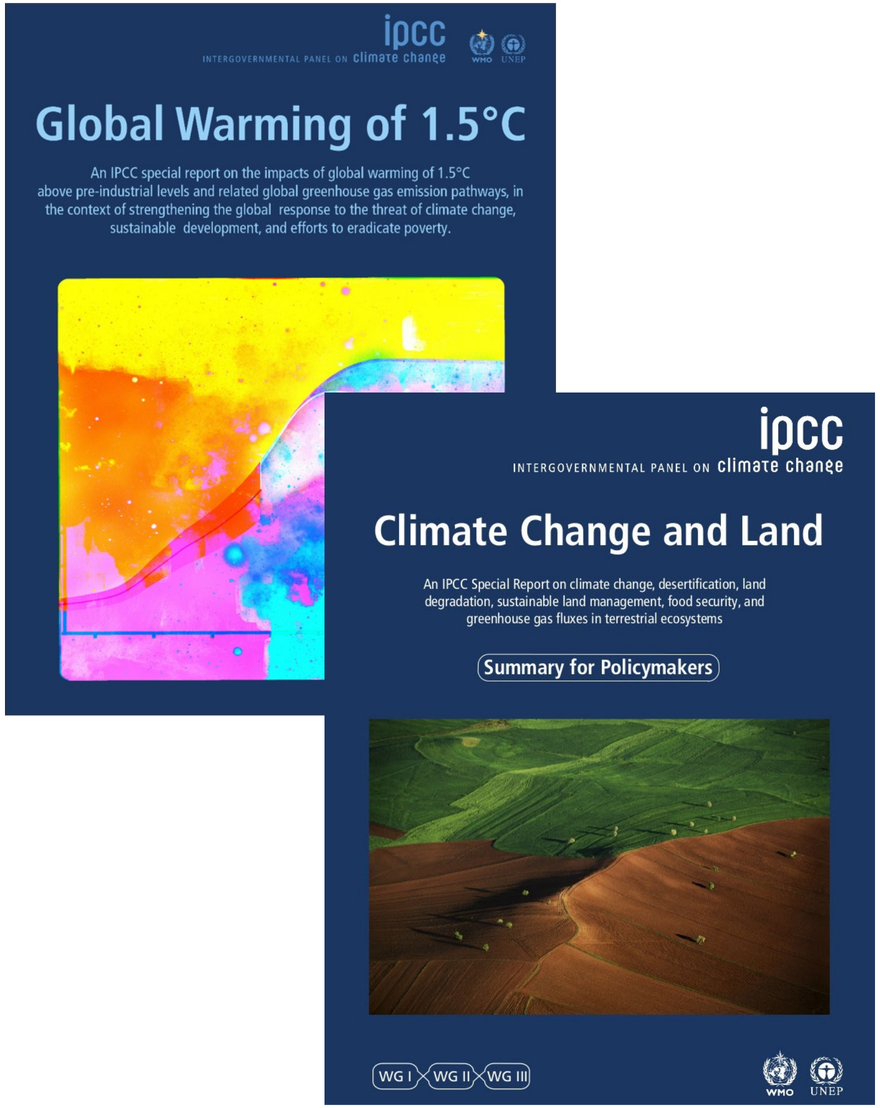
The talk covers:

Emissions aspects of scenarios compatible with LTGG

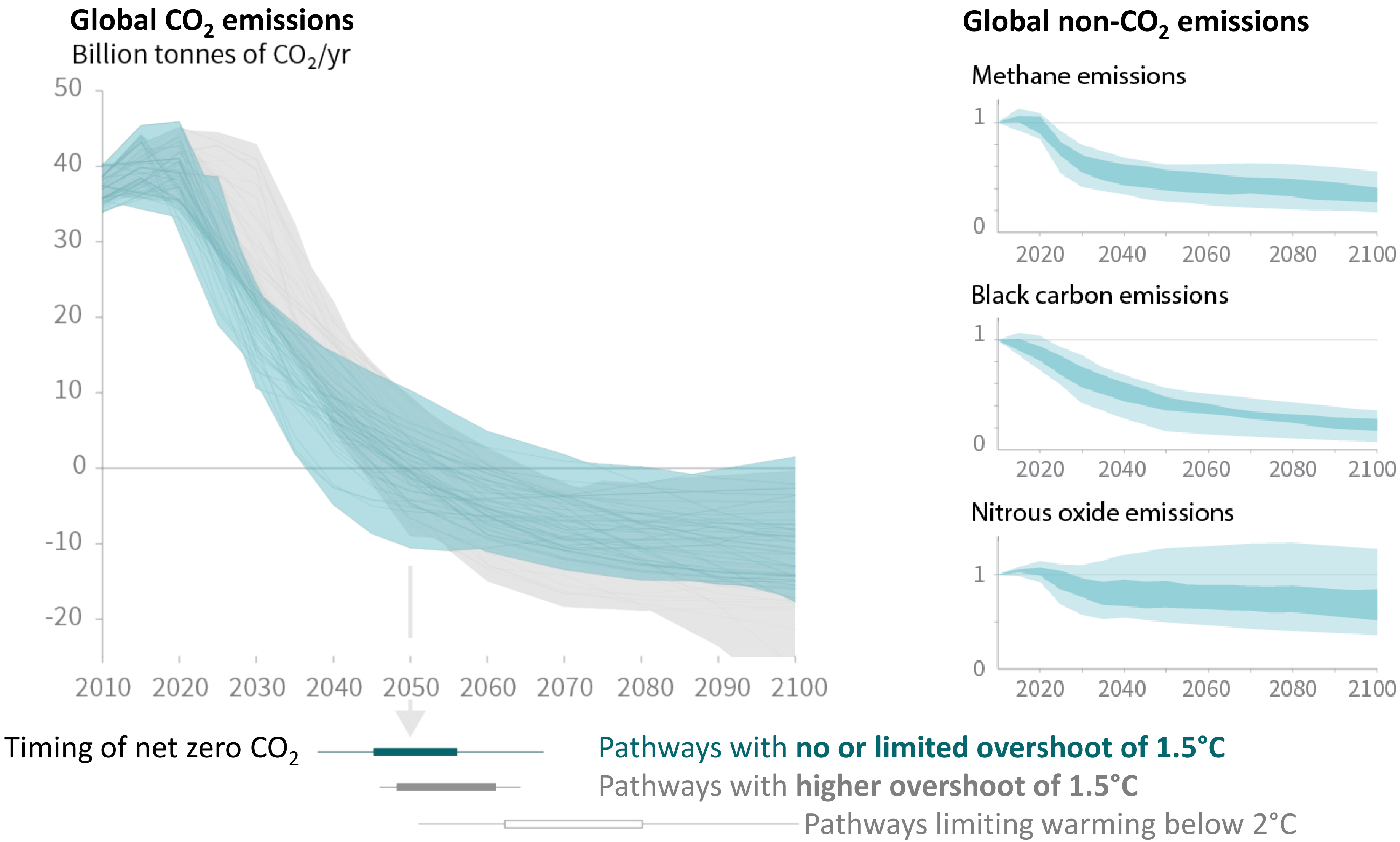
- Net zero CO_2 and net zero greenhouse gas emissions
- Comparability between scenarios and inventories

Carbon-dioxide removal aspects

- Trade-off between near term reductions and reliance on carbon-dioxide removal
- Integrated view on carbon-dioxide removal: options, limitations, and side-effects



Global CO_2 emissions are reduced to net zero and non-CO_2 emissions are strongly reduced as well for limiting global warming to 1.5°C



Source: IPCC SR1.5 SPM Figure SPM.3A

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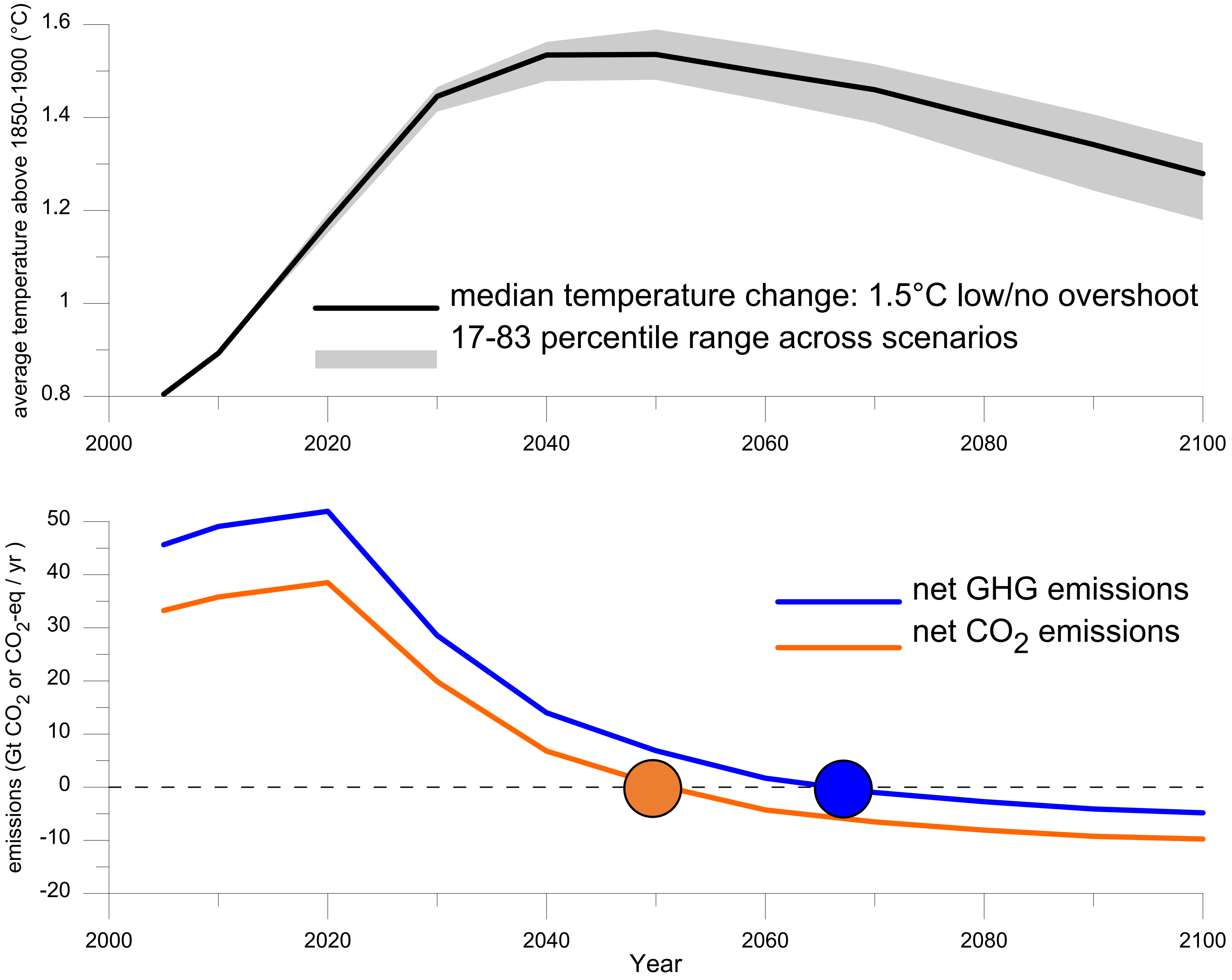
The timing and the temperature outcome is different for net zero CO_2 or net zero total greenhouse gas (GHG) emissions



Projected global warming for pathways with no or limited overshoot of 1.5°C

net-zero CO_2
around 2050 (2046–2055)

net-zero greenhouse gases (GHG)
around two decades later
2067 (2061, 2084)

Source: IPCC SR1.5 Chapter 2, Table 2.4, GHG aggregation with GWP-100

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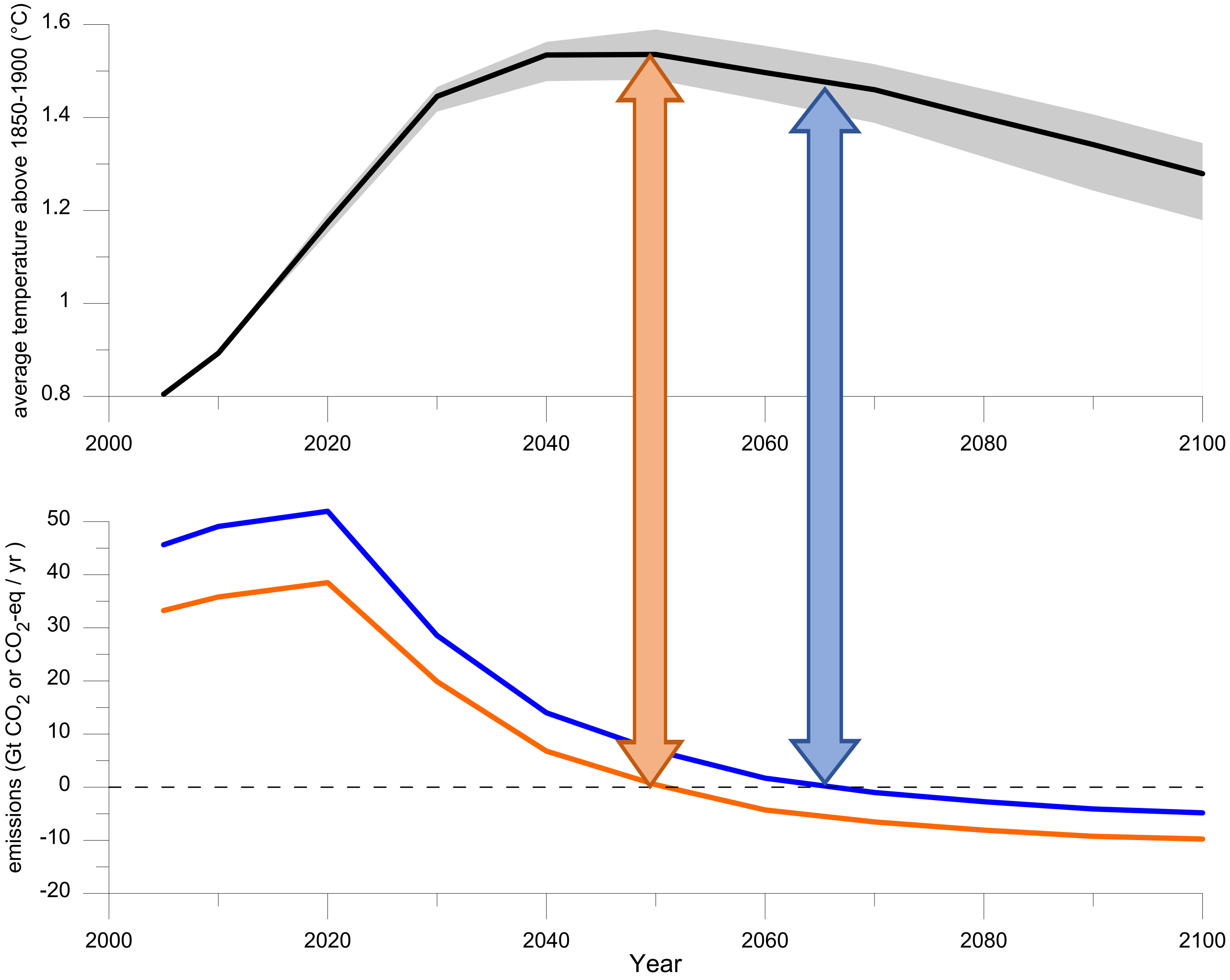

Projected global warming for pathways with no or limited overshoot of 1.5°C

net-zero CO_2
around 2050 (2046–2055)
≈ time of peak temperature

net-zero greenhouse gases (GHG)
around two decades later
2067 (2061, 2084)
≈ temperature has peaked and starts to decline gradually

Source: IPCC SR1.5 Chapter 2, Table 2.4, GHG aggregation with GWP-100

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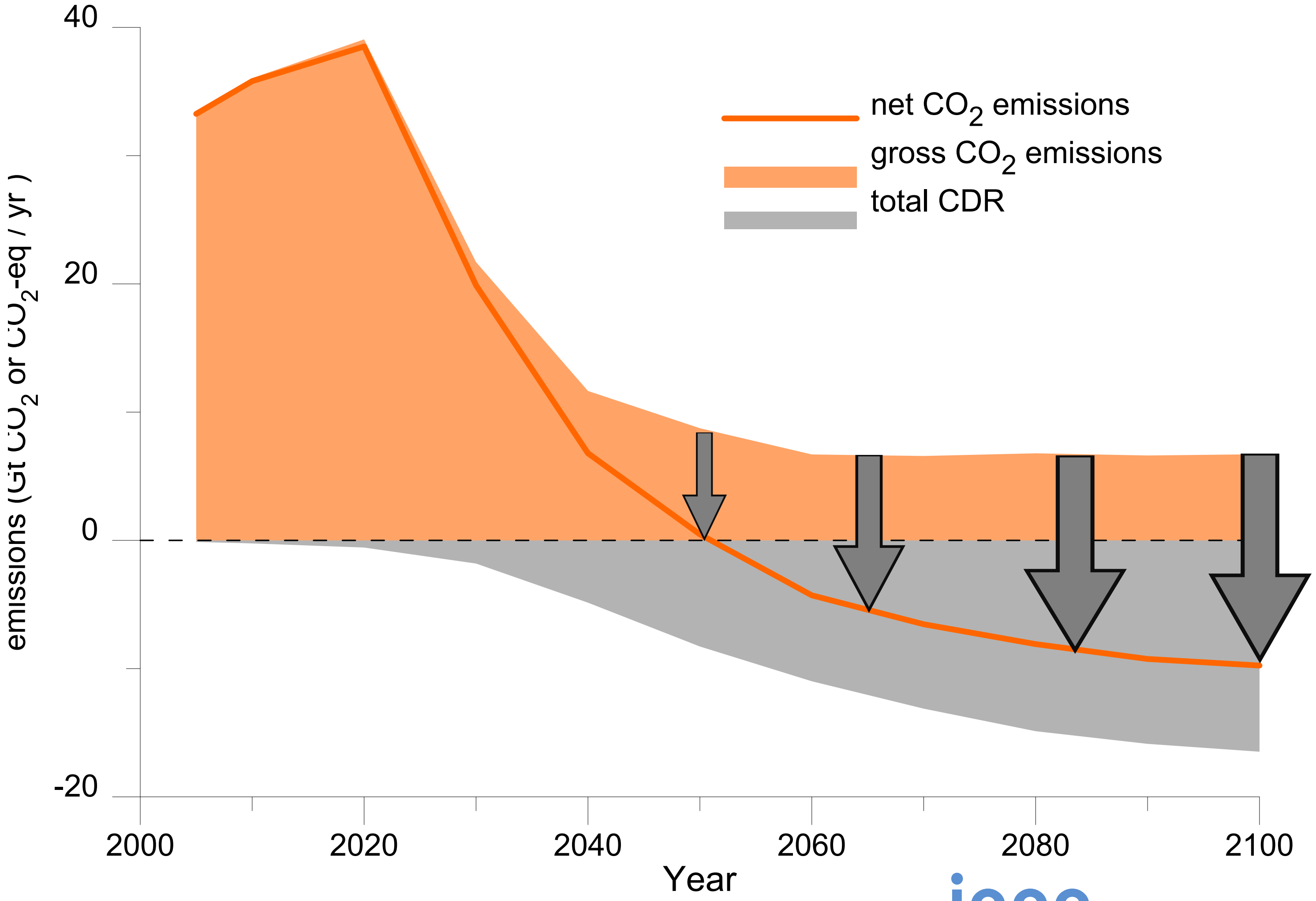
Carbon-dioxide removal (CDR) is necessary for net zero CO_2 emissions

Mitigation pathways rely on CDR

- to achieve net-zero CO_2 *(compensate for residual CO_2 and stabilize warming)*
- to achieve net-negative CO_2 emissions afterwards *(achieve temperature decline)*



Source: IPCC SR1.5 Chapter 2, Table 2.4, GHG aggregation with GWP-100

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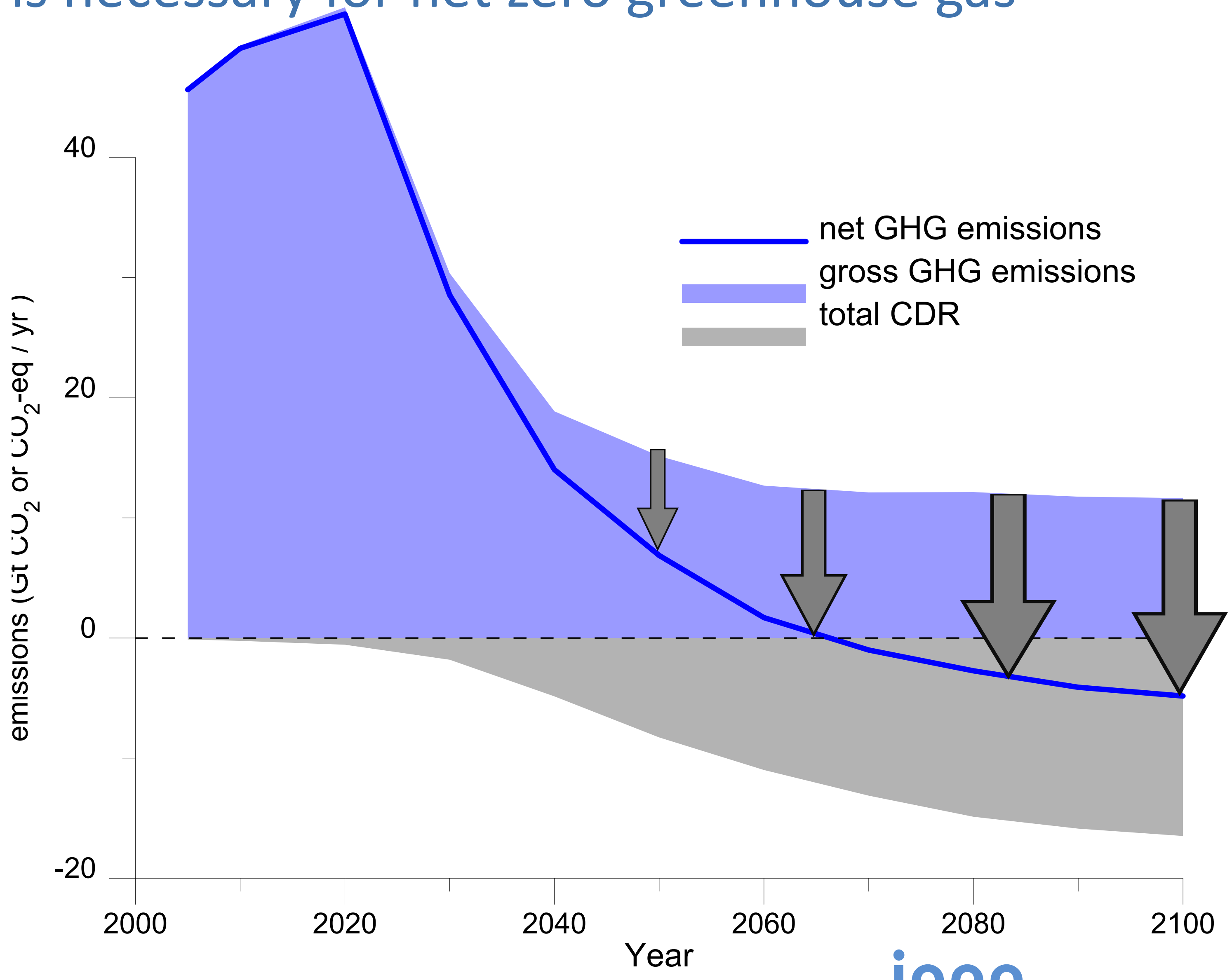
Carbon-dioxide removal (CDR) is necessary for net zero greenhouse gas (GHG) emissions

Mitigation pathways rely on CDR

- to achieve net-zero GHG *(compensate for residual CO_2 and hard-to-abate residual non-CO_2 emissions)*



Source: IPCC SR1.5 Chapter 2, Table 2.4, GHG aggregation with GWP-100

National GHG inventories and global pathways define the anthropogenic land flux differently thus requiring special attention when setting targets

b) Conceptual differences in defining the anthropogenic land CO_2 flux

IPCC AR5 and Global Carbon Budget:

Bookkeeping models:

"Land Use Change"

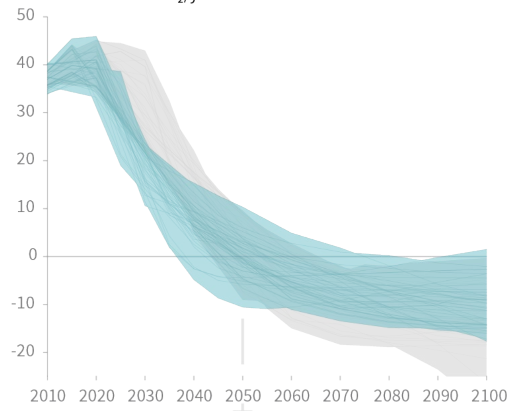
	Managed land	Unmanaged land
Direct human induced effects	✓	
Indirect human induced effects		
Natural effects		

Country GHG inventories:

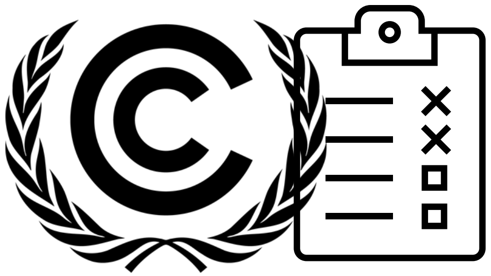
"AFOLU (LULUCF)"

	Managed land	Unmanaged land
Direct human induced effects	✓	
Indirect human induced effects	✓	
Natural effects	✓	

Global pathways

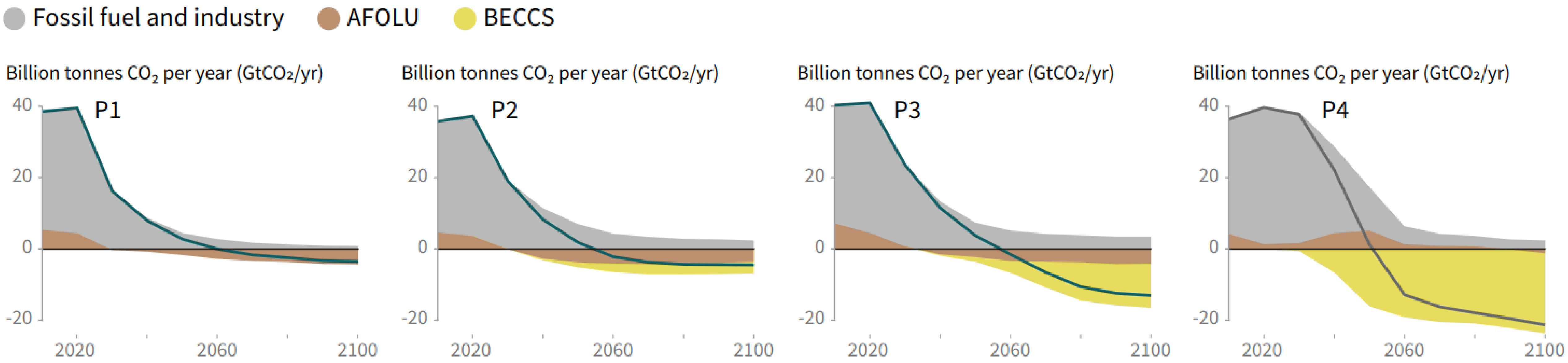


National GHG inventories



Source: IPCC SRCCL Chapter 2

Carbon-dioxide removal (CDR) plays a role in achieving both net zero CO_2 and net zero greenhouse gas emissions



but timing and scale depends:

- on stringency of gross emissions reduction over near term
- on mitigation portfolio and strategy, including desired mix of CDR technologies (AFOLU, BECCS, DAC, other …)
- on desired rate of temperature decline after the peak (net negative emissions)

Source: IPCC SR1.5 SPM.3B, SRCCL Chapter 6

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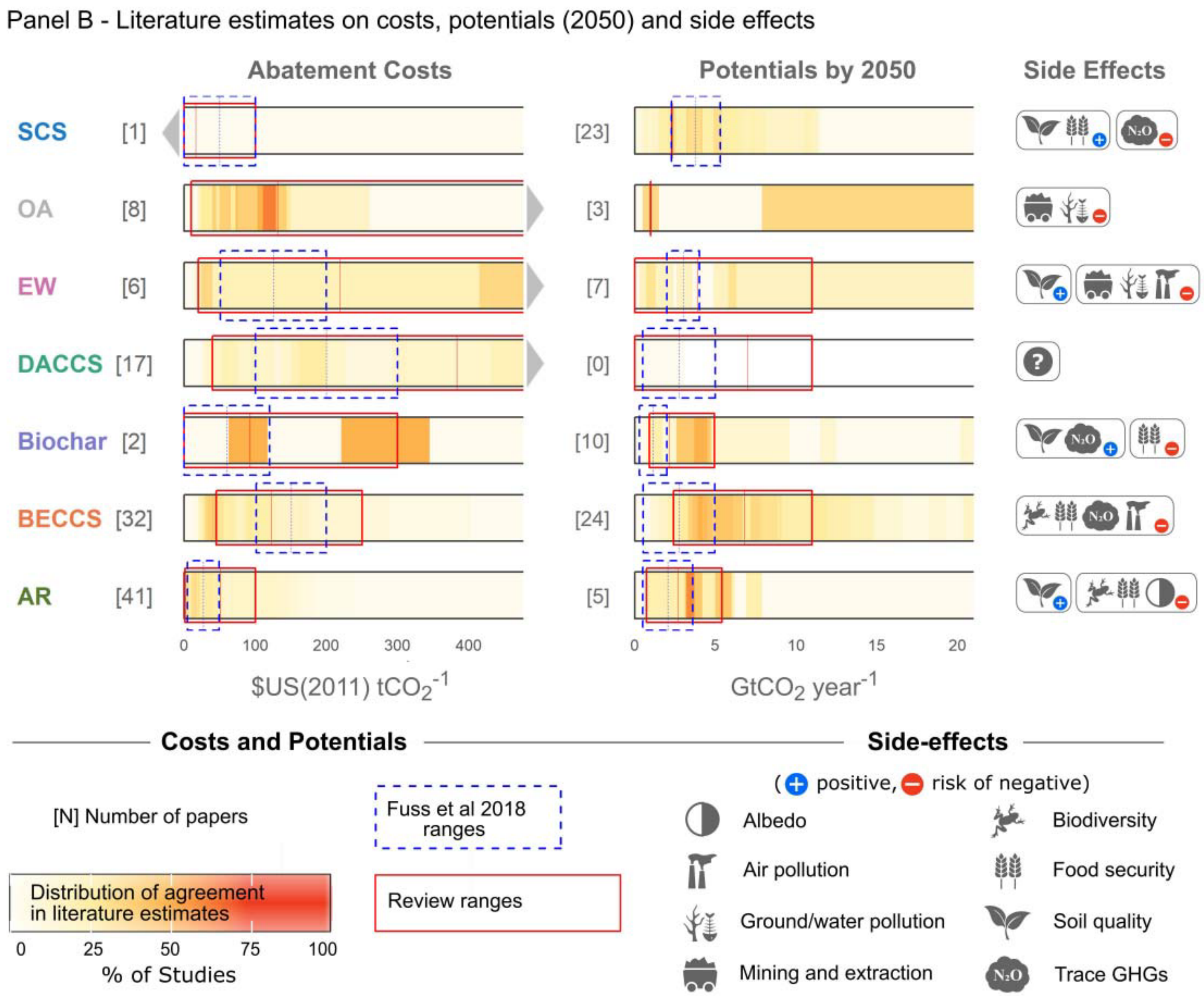
An integrated view on carbon-dioxide removal (CDR): various options



CDR options vary in:

- cost
- potential
- side-effects

Risks of "overshooting":

- higher temperature resulting in increased climate risks (talk 3)
- risk of failure to reverse warming after overshoot because:
  - exceeding global warming limits can weaken or reverse land-based carbon storage
  - limits to the sustainable CDR potential

Source: IPCC SR1.5 Figure 4.2, SRCCL Chapter 6

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Bioenergy and BECCS

Mitigation	Adaptation	Desertification	Land degradation	Food security	Cost
H	L			L	

High level: Impacts on adaptation, desertification, land degradation and food security are maximum potential impacts, assuming carbon dioxide removal by BECCS at a scale of 11.3 $GtCO_2\ yr^{-1}$ in 2050, and noting that bioenergy without CCS can also achieve emissions reductions of up to several $GtCO_2\ yr^{-1}$ when it is a low carbon energy source {2.6.1; 6.3.1}. Studies linking bioenergy to food security estimate an increase in the population at risk of hunger to up to 150 million people at this level of implementation {6.3.5}. The red hatched cells for desertification and land degradation indicate that while up to 15 million km_2 of additional land is required in 2100 in 2°C scenarios which will increase pressure for desertification and land degradation, the actual area affected by this additional pressure is not easily quantified {6.3.3; 6.3.4}.

Mitigation	Adaptation	Desertification	Land degradation	Food security

Best practice: The sign and magnitude of the effects of bioenergy and BECCS depends on the scale of deployment, the type of bioenergy feedstock, which other response options are included, and where bioenergy is grown (including prior land use and indirect land use change emissions). For example, limiting bioenergy production to marginal lands or abandoned cropland would have negligible effects on biodiversity, food security, and potentially co-benefits for land degradation; however, the benefits for mitigation could also be smaller. {Table 6.58}

Reforestation and forest restoration

Mitigation	Adaptation	Desertification	Land degradation	Food security	Cost
M	M	M	M	M	

High level: Impacts on adaptation, desertification, land degradation and food security are maximum potential impacts assuming implementation of reforestation and forest restoration (partly overlapping with afforestation) at a scale of 10.1 $GtCO_2\ yr^{-1}$ removal {6.3.1}. Large-scale afforestation could cause increases in food prices of 80% by 2050, and more general mitigation measures in the AFOLU sector can translate into a rise in undernourishment of 80–300 million people; the impact of reforestation is lower {6.3.5}.

Mitigation	Adaptation	Desertification	Land degradation	Food security

Best practice: There are co-benefits of reforestation and forest restoration in previously forested areas, assuming small scale deployment using native species and involving local stakeholders to provide a safety net for food security. Examples of sustainable implementation include, but are not limited to, reducing illegal logging and halting illegal forest loss in protected areas, reforesting and restoring forests in degraded and desertified lands {Box6.1C; Table 6.6}.

Afforestation

Mitigation	Adaptation	Desertification	Land degradation	Food security	Cost
M	M	M	L	M	

High level: Impacts on adaptation, desertification, land degradation and food security are maximum potential impacts assuming implementation of afforestation (partly overlapping with reforestation and forest restoration) at a scale of 8.9 $GtCO_2\ yr^{-1}$ removal {6.3.1}. Large-scale afforestation could cause increases in food prices of 80% by 2050, and more general mitigation measures in the AFOLU sector can translate into a rise in undernourishment of 80–300 million people {6.3.5}.

Mitigation	Adaptation	Desertification	Land degradation	Food security

Best practice: Afforestation is used to prevent desertification and to tackle land degradation. Forested land also offers benefits in terms of food supply, especially when forest is established on degraded land, mangroves, and other land that cannot be used for agriculture. For example, food from forests represents a safety-net during times of food and income insecurity {6.3.5}.

Biochar addition to soil

Mitigation	Adaptation	Desertification	Land degradation	Food security	Cost
M			L	L	

High level: Impacts on adaptation, desertification, land degradation and food security are maximum potential impacts assuming implementation of biochar at a scale of 6.6 $GtCO_2\ yr^{-1}$ removal {6.3.1}. Dedicated biomass crops required for feedstock production could occupy 0.4–2.6 Mkm^2 of land, equivalent to around 20% of the global cropland area, which could potentially have a large effect on food security for up to 100 million people {6.3.5}.

Mitigation	Adaptation	Desertification	Land degradation	Food security

Best practice: When applied to land, biochar could provide moderate benefits for food security by improving yields by 25% in the tropics, but with more limited impacts in temperate regions, or through improved water holding capacity and nutrient use efficiency. Abandoned cropland could be used to supply biomass for biochar, thus avoiding competition with food production; 5-9 Mkm^2 of land is estimated to be available for biomass production without compromising food security and biodiversity, considering marginal and degraded land and land released by pasture intensification {6.3.5}.

Source: IPCC SRCCL SPM.3B

Response options and their contribution to mitigation, adaptation, and combating desertification, land degradation, and enhancing food security

Side-effects and synergies:
land requirements, food, water, and sustainable development impacts depend on scale of deployment & socioeconomic context

Suitable & sustainable national level of bioenergy depends on local aspects

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Conclusions

- Various scenarios compatible with the LTGG do exist
- These different scenarios have implications for the timing of net zero CO_2 and net zero greenhouse gases, with the latter coming later, and for the resulting temperature outcomes
- National GHG inventories and global pathways define the anthropogenic land flux differently, thus requiring special attention when setting targets
- Carbon-dioxide removal (CDR) plays a role in achieving both net zero CO_2 and net zero greenhouse gas emissions
- But there are trade-offs between near term reductions and CDR reliance
- Land requirements, food, water, and sustainable development impacts of land-based CDR depend on the scale of deployment & socioeconomic context