POTSDAM INSTITUTE FOR CLIMATE IMPACT RESEARCH

PIK

The 1.5^{o}C Transition: Challenges and Opportunities

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Leibniz Association

Peter Essick / Aurora Photos

Systems transitions in 1.5°C pathways

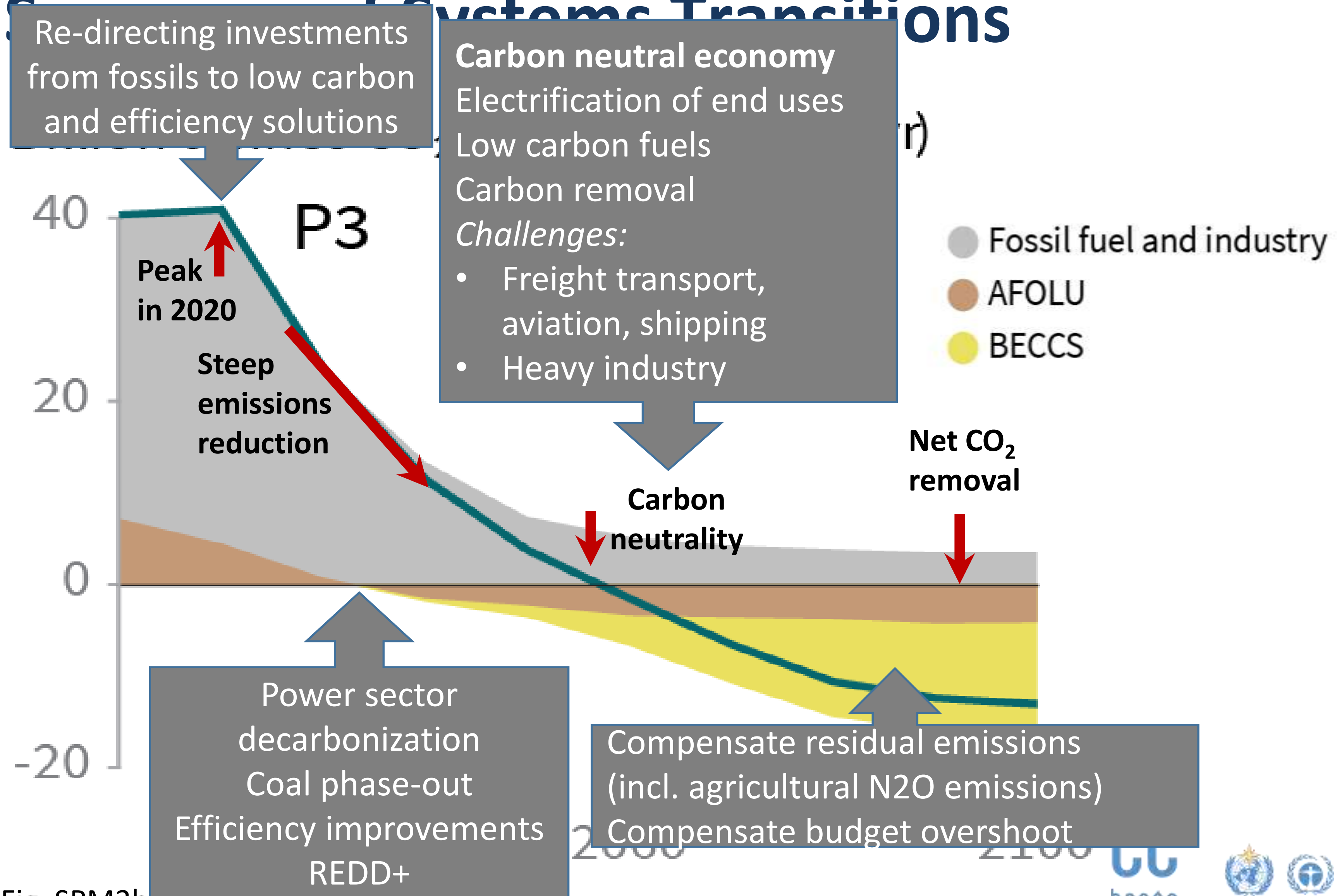
Limiting warming to 1.5°C would require rapid, far-reaching changes on an unprecedented scale:

- → Deep emissions cuts in all sectors and regions
- → A range of low carbon technologies
- → Behavioural changes
- → Sustainable land management
- → Carbon dioxide removal from the atmosphere
- → Investment into system transitions & low carbon options

with a systems perspective and global coordination.

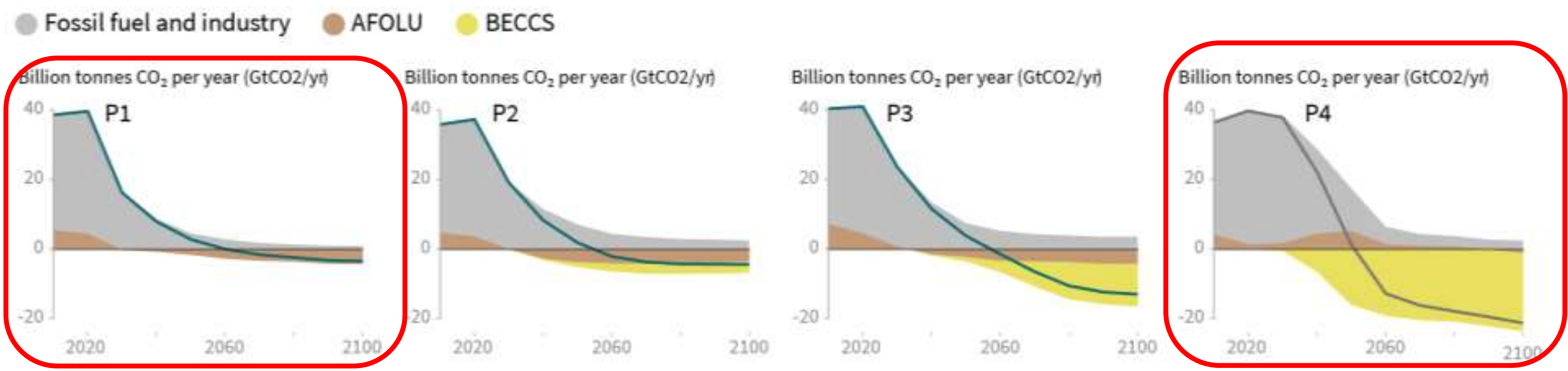
INTERGOVERNMENTAL PANEL ON climate change

WMO UNEP



SR1.5 Fig. SPM3b

1.5°C pathways can put different emphasis on demand- vs. supply-side vs. CO2 removal



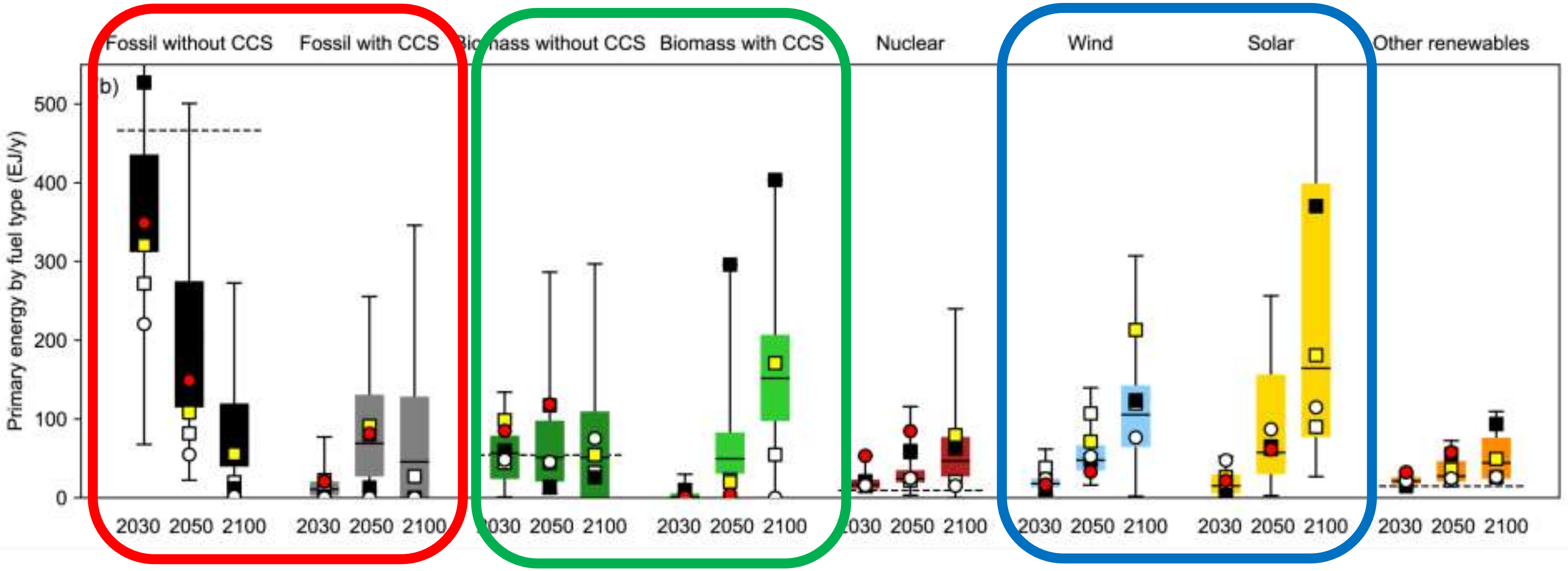
Global indicators	P1	P2	P3	P4	Interquartile range
Pathway classification	No or low overshoot	No or low overshoot	No or low overshoot	High overshoot	No or low overshoot
*Final energy demand** in 2030 (% rel to 2010)*	-15	-5	17	39	(-12, 7)
└ in 2050 (% rel to 2010)	-32	2	21	44	(-11, 22)
Primary energy from coal in 2030 (% rel to 2010)	-78	-61	-75	-59	(-78, -59)
└ in 2050 (% rel to 2010)	-97	-77	-73	-97	(-95, -74)
from biomass in 2030 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	(29,80)
└ in 2050 (% rel t[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	(123,261)
Cumulative CCS until 2[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	(550, 1017)
└ of which BECCS [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	(364, 662)

Demand-side measures (energy intensity, diets) and early emissions reduction reduce need for carbon dioxide removal

SR1.5 Fig. SPM3b

INTERGOVERNMENTAL PANEL ON climate change

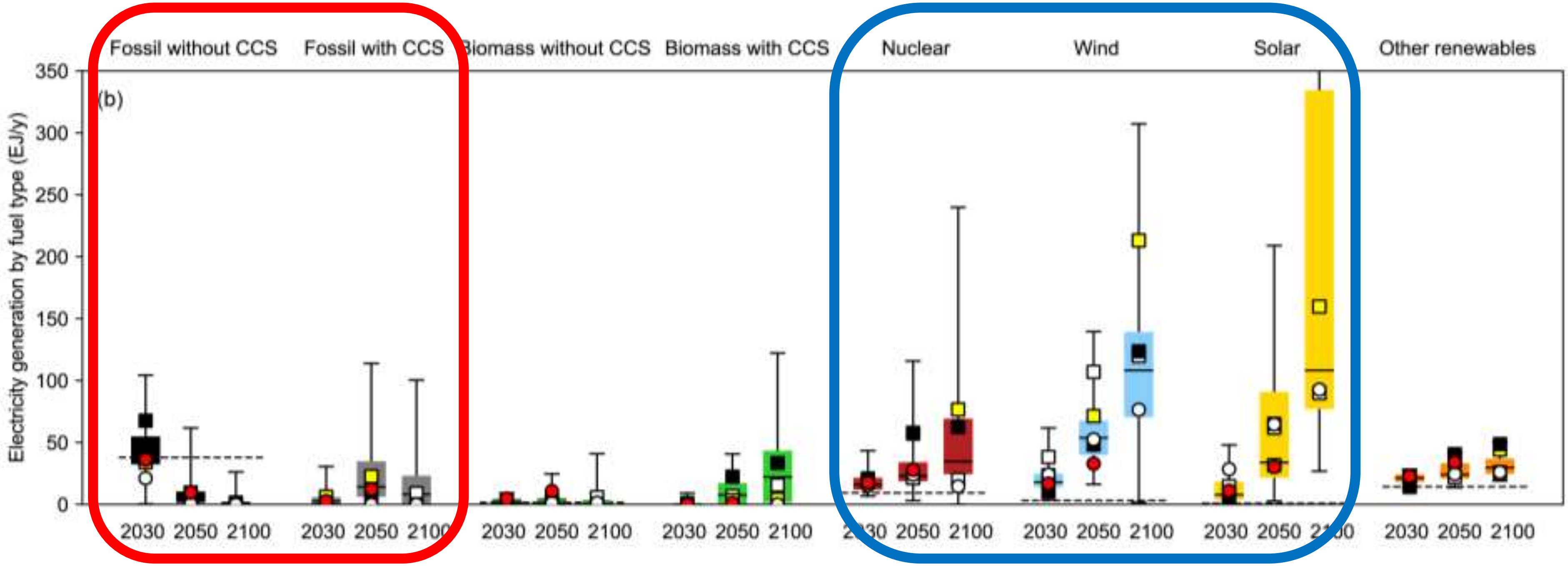
Energy system transitions
Global primary energy



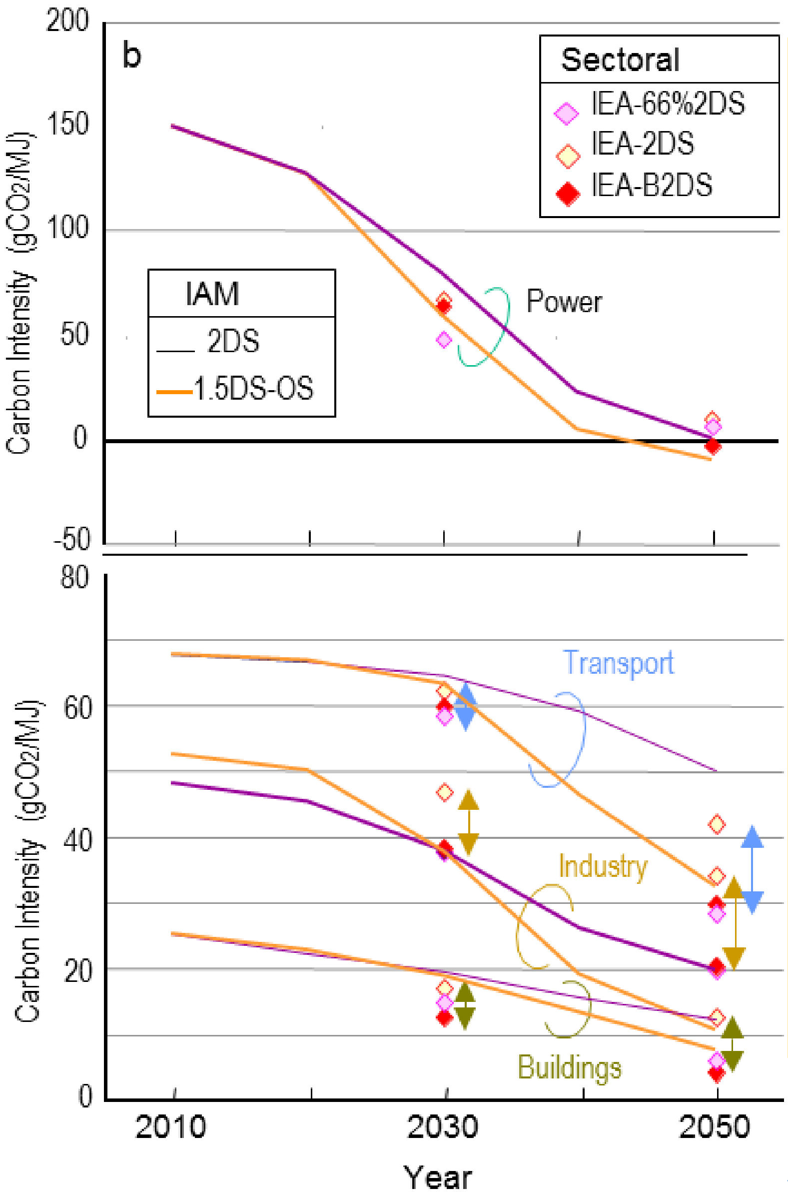
- Fossil fuel eductions vary with fuel type: coal the most, gas the least
- Limited amount of fossil CCS (predominantly gas)
- Solar, wind, bionenergy with CCS gain the most

SR1.5 Chap. 2 Fig. 2.15

Electricity system transitions
Full decarbonisation by mid-century



- Gas supplies 3-11% of electricity (depend. CCS)
- Coal is phased out as source for electricity (0-2%)
- Renewables supply 70-85% of electricity



Systems transitions: Energy use in industry, transport, buildings

CO_2 emissions from industry in 2050:

- 75-90% reduced from 2010 levels

  ⟶ Compared to 50-80% for 2°C

Share of low-emission final energy in transport:

- 35-65% in 2050

  ⟶ Compared to 25-45% for 2°C

Electricity share of final energy in buildings:

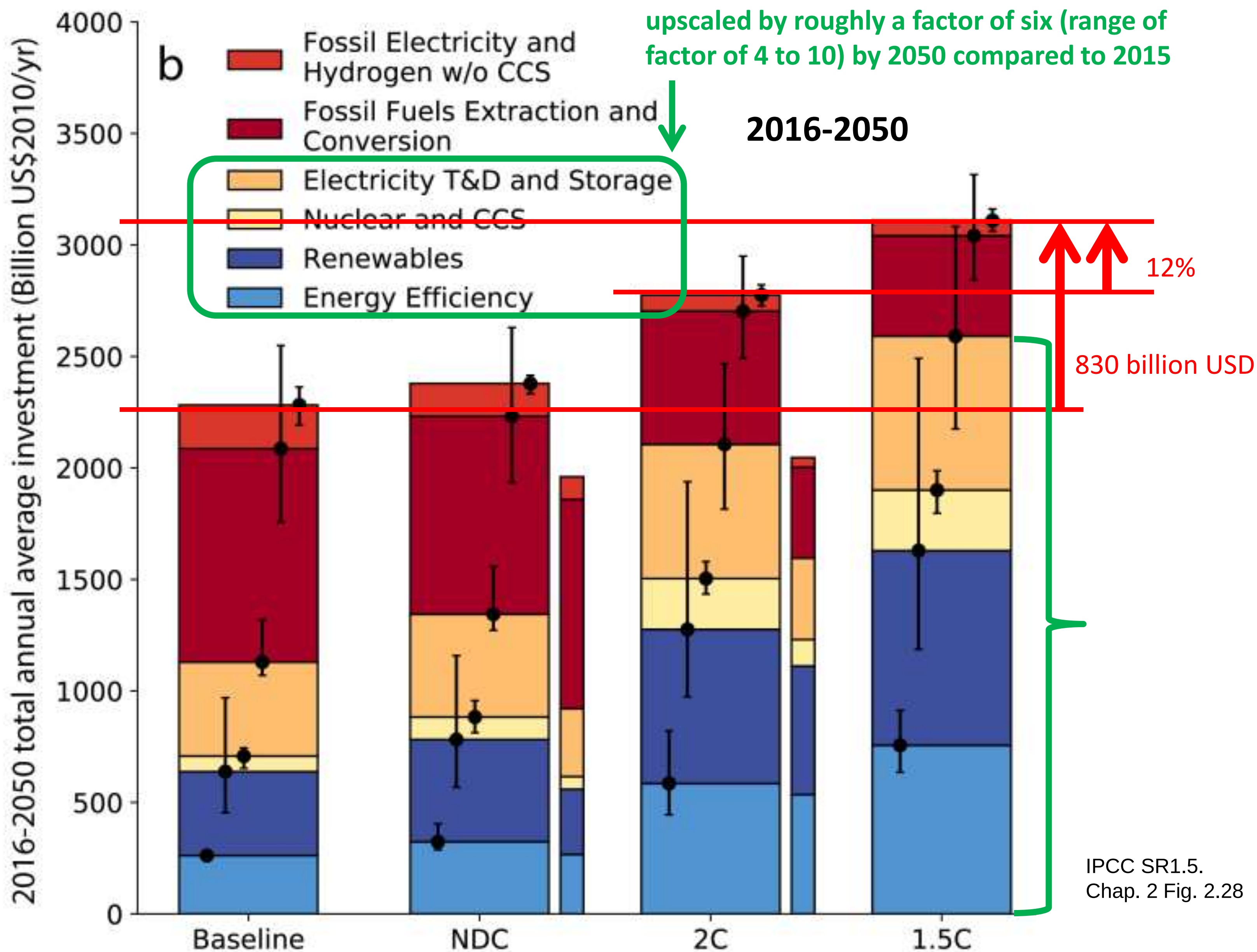
- 55-75% in 2050

  ⟶ Compared to 50-70% for 2°C

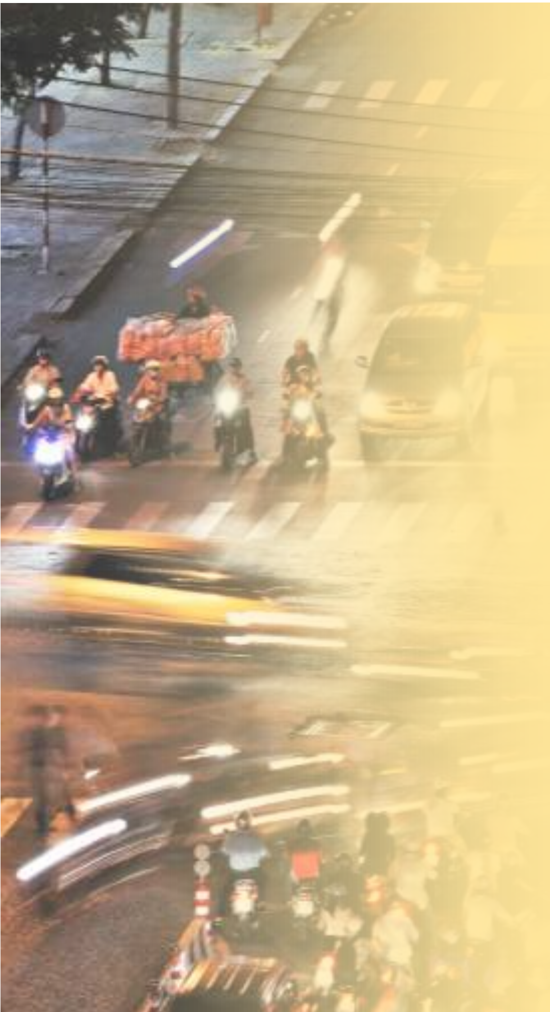
SR1.5 Chap. 2 Fig. 2.20

INTERGOVERNMENTAL PANEL ON climate change

Energy investments needed in 1.5-2^{o}C pathways



IPCC SR1.5.
Chap. 2 Fig. 2.28



Gerhard Zwerger-Schoner / Aurora Photos

Systems transitions
Carbon Dioxide Removal (CDR)

All 1.5°C pathways use CDR in the range of 100-1000 $GtCO_2$ over the 21st century, to

- Compensate residual emissions of CO_2
- Achieve net negative CO_2 emissions for overshoot

BECCS and AFOLU CDR are predominant options in 1.5°C pathways

- **BECCS:** 0-1 $GtCO_2$/yr in 2030, 0-8 $GtCO_2$/yr in 2050
  Assessed max. 2050 potential: 5 $GtCO_2$/yr
- **AFOLU:** 0-5 $GtCO_2$/yr in 2030, 1-11 $GtCO_2$/yr in 2050
  Assessed max. 2050 potential: 3.6 $GtCO_2$/yr

Range of CDR measures

Portfolio of CDR measures would limit individual deployment and therefore sustainability issues for each single measure

- *Soil carbon enhancement, biochar and land restoration*
- **Afforestation**
- **BECCS using energy crops**
- *BECCS using algae*
- *Direct Air Capture + Geological storage (DACCS)*
- *Enhanced Weathering*
- *Artificial ocean alkalinization*
- *Carbon capture and usage (e.g. carbon fiber / wood)*

Terrestrial storage
Early deployment

Geological storage
Medium-Long term

Mineralisation
Medium-Long term

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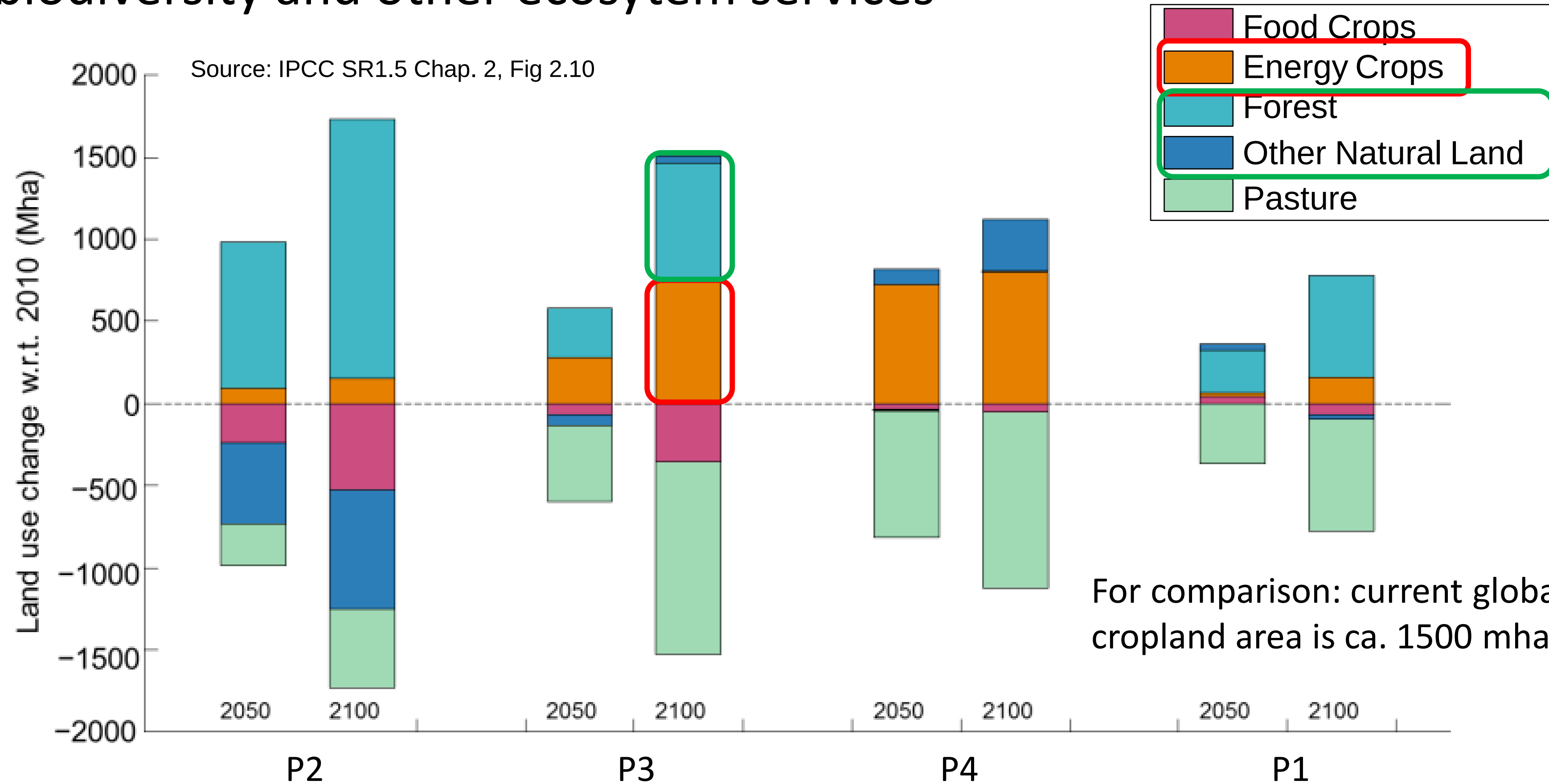
System transitions: Land-use changes

to provide food, feed, fibre, bioenergy, carbon storage, biodiversity and other ecosytem services

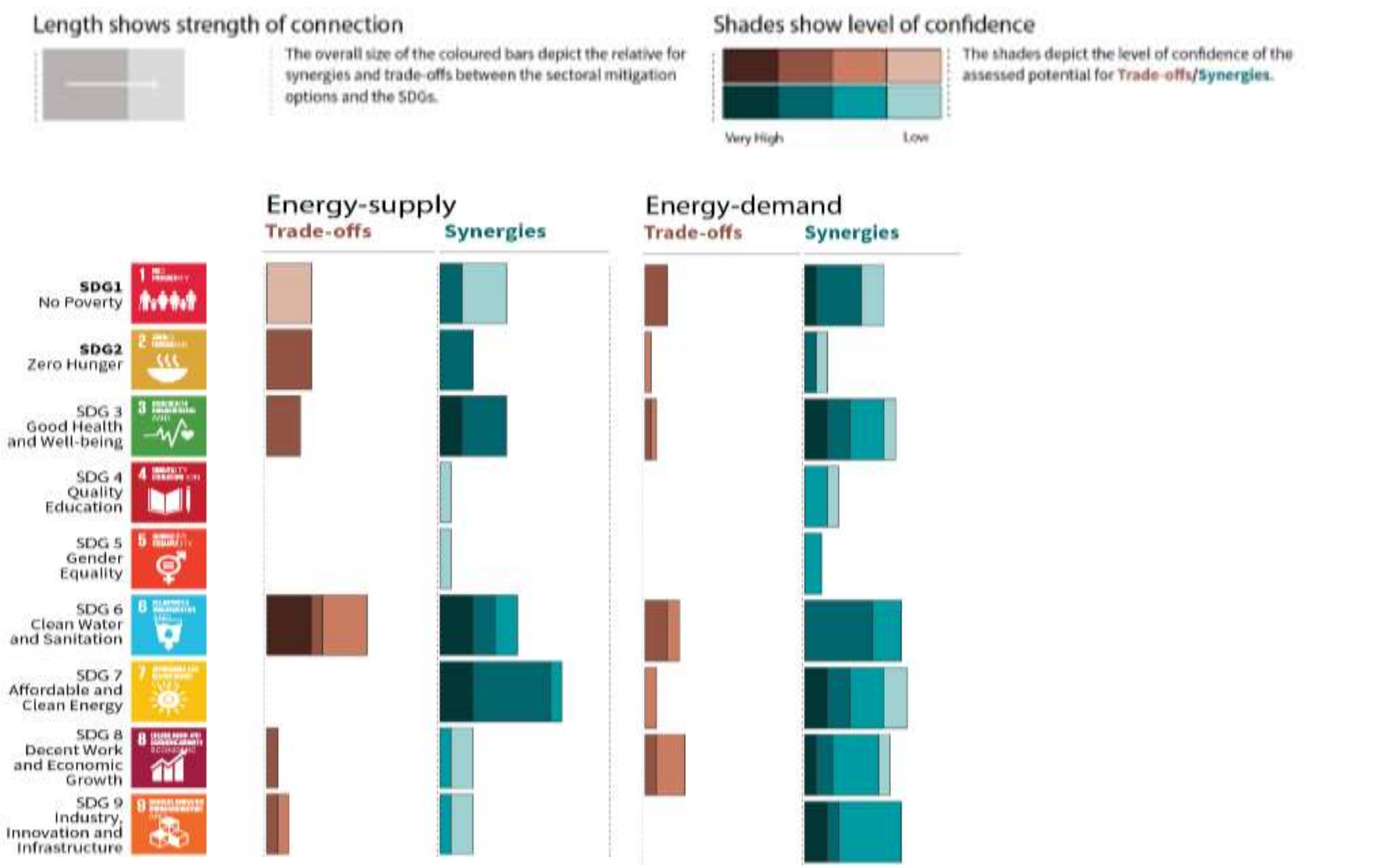


For comparison: current global cropland area is ca. 1500 mha

Need for sustainable land management in 1.5°C pathways

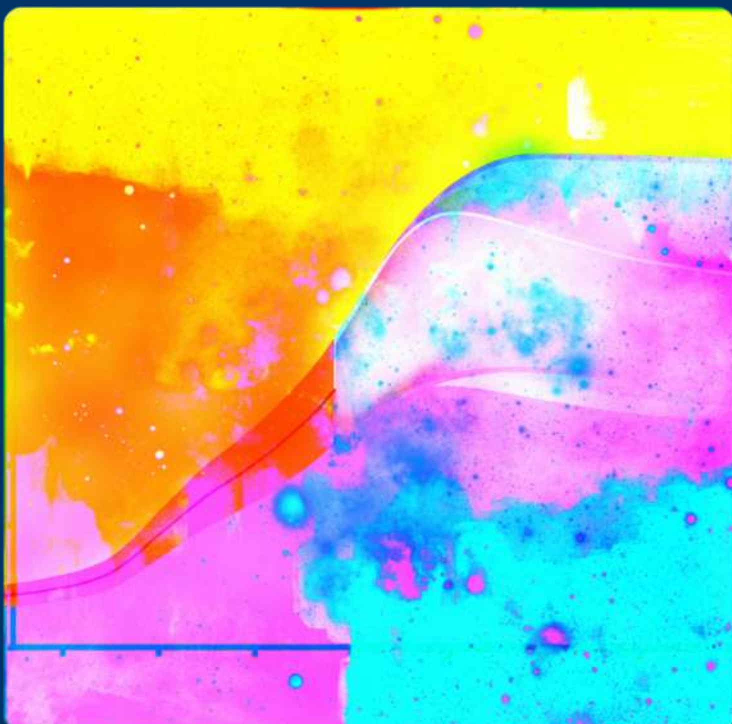
Linkages between 1.5°C pathways and sustainable development

(the linkages do not show costs and benefits of mitigation)



SR1.5 Fig. SPM4

INTERGOVERNMENTAL PANEL ON climate change



https://data.ene.iiasa.ac.at
/iamc-1.5c-explorer

Peter Essick / Aurora Photos

System transitions - general trends

I. Improve energy efficiency
Limiting final energy demand in 2050
to +20 to -10% rel. to 2010 levels

II. Decarbonize the power sector
(carbon-intensity of electricity about 0 or negative in 2050)

III. Electrify energy end use
(mobility, buildings, industry)

IV. Subs. residual fossil fuels with low-carbon options
(e.g. gas for heating, petrol for driving with bio-based fuels)

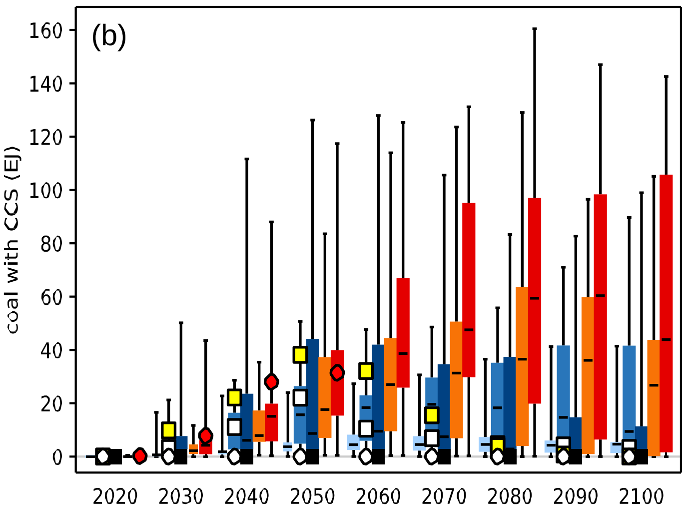
- Different roles for different type of fuels

INTERGOVERNMENTAL PANEL ON climate change

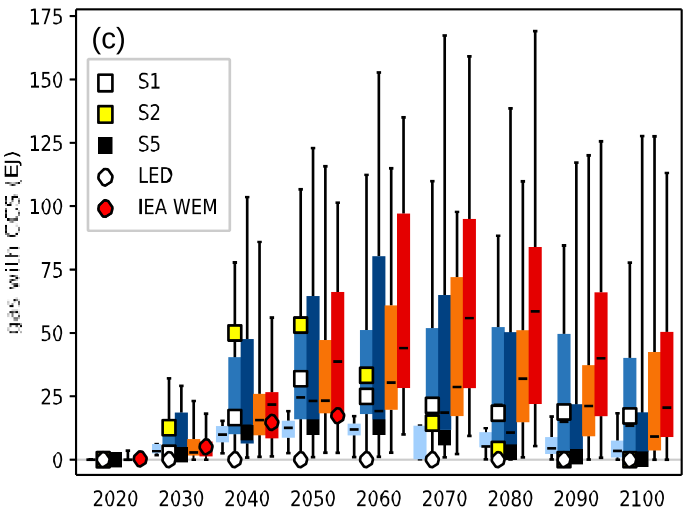
Wide range of CCS that is deployed across 1.5-2°C pathways: Fossil CCS

- **Smaller use of fossil CCS in energy supply systems** in 1.5°C pathways compared to 2°C pathways
- Illustrative pathways:
  No coal, < 25 EJ gas
- Smaller use of fossil CCS in low overshoot pathways
- Declining use of CCS over time

Coal with CCS (EJ)

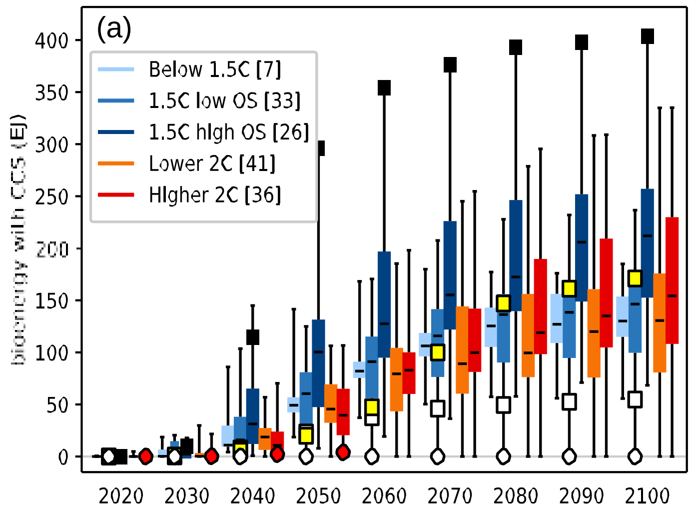


Gas with CCS (EJ)

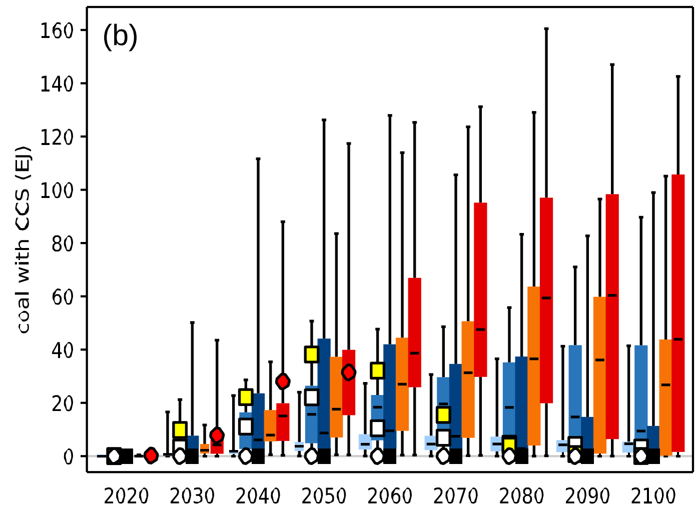


Wide range of CCS that is deployed across 1.5-2ºC pathways: BECCS

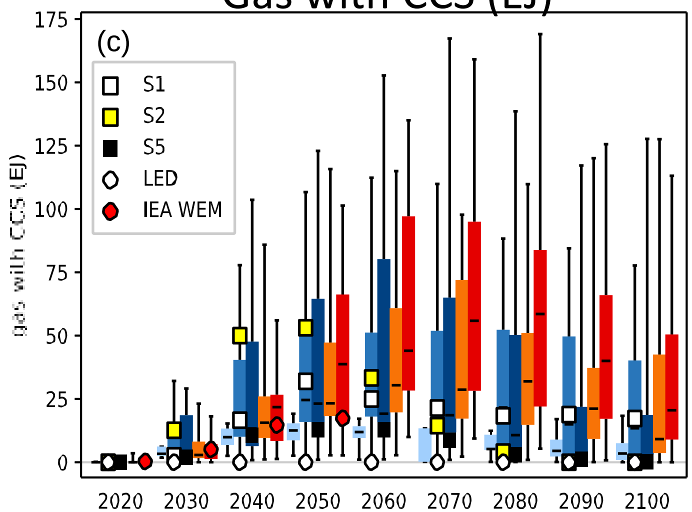
Bioenergy with CCS (EJ)



Coal with CCS (EJ)

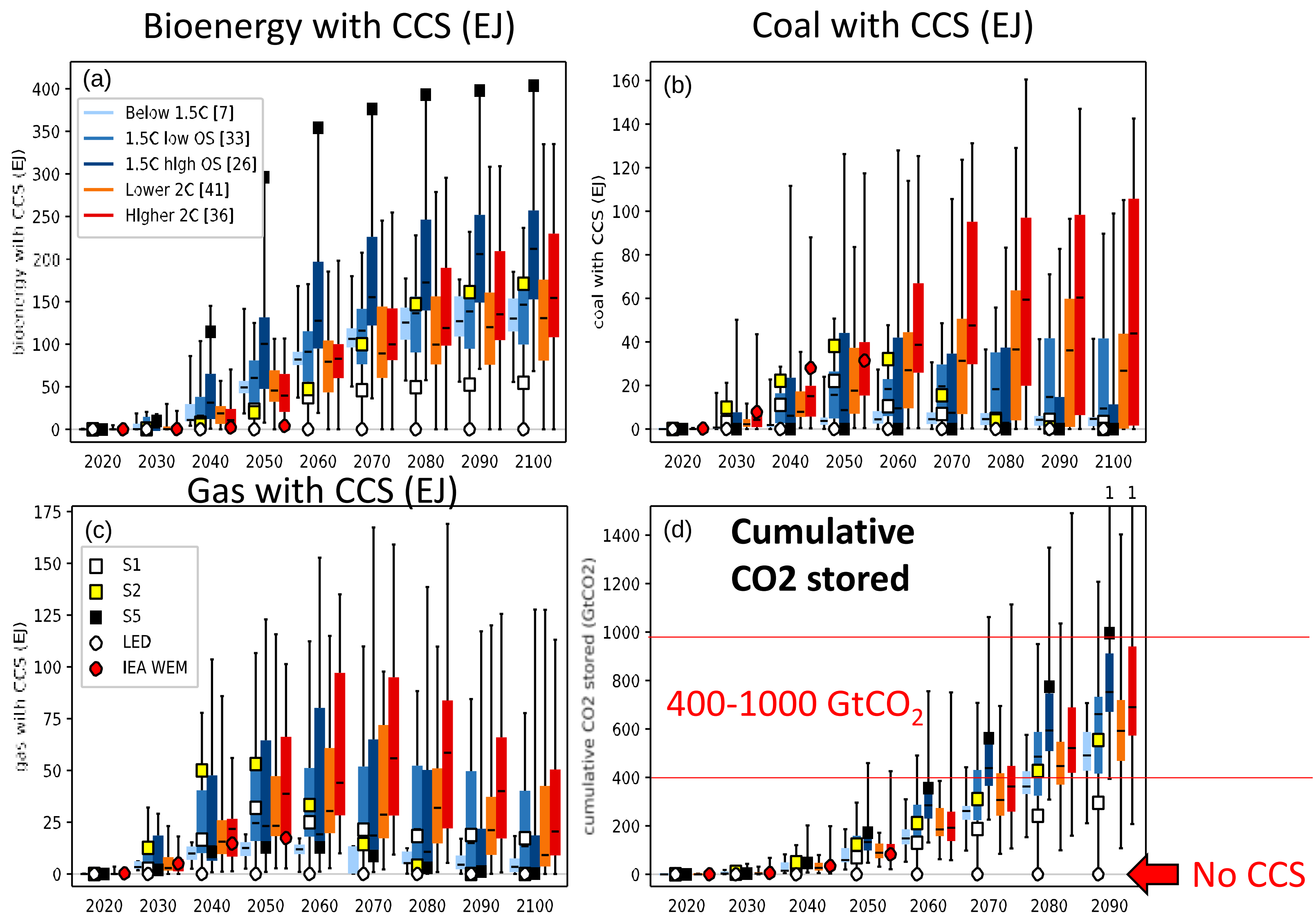


Gas with CCS (EJ)

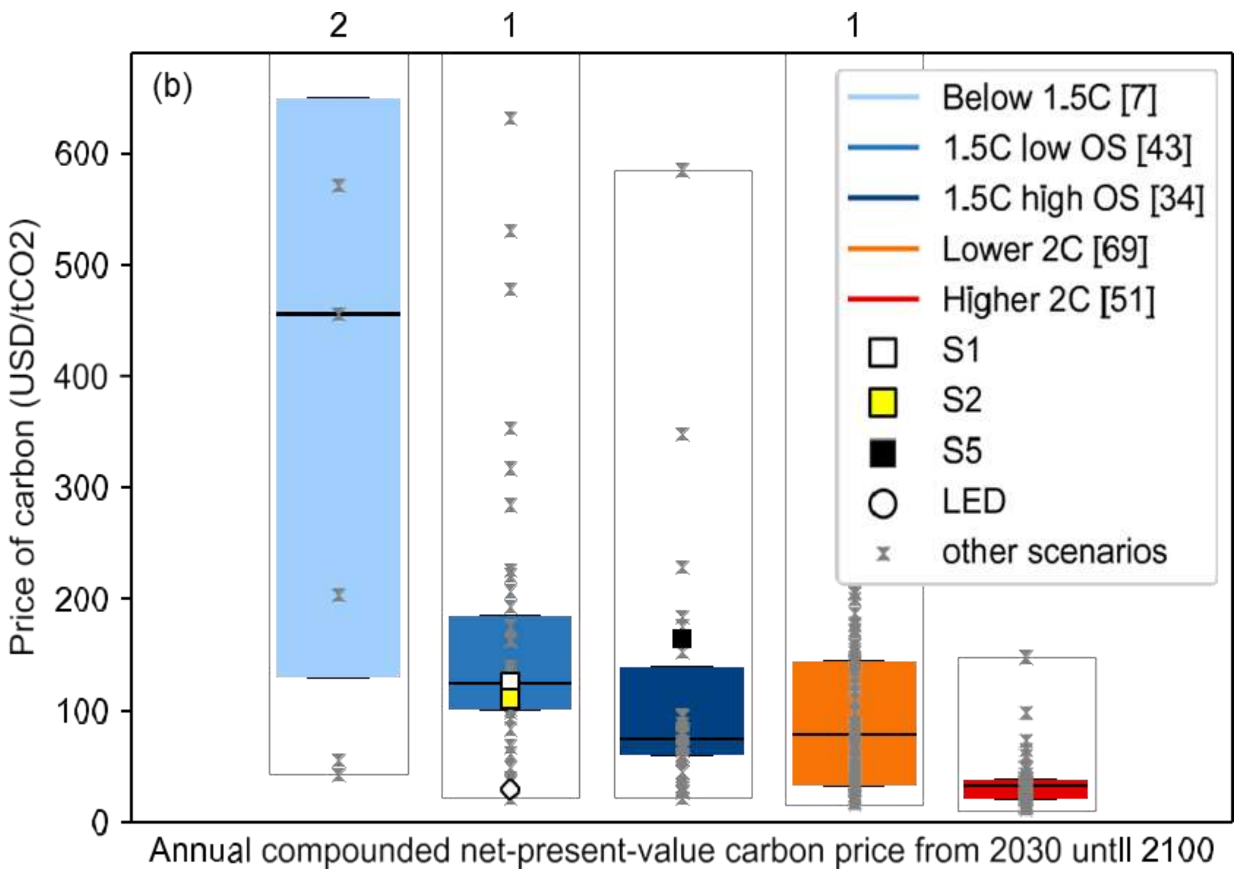


- **Dominant source of CCS in 1.5°C pathways**
- Larger use of BECCS in overshoot pathways
- Similar use of BECCS in low overshoot 1.5°C and lower 2°C pathways

Wide range of CCS that is deployed across 1.5-2°C pathways: Total CO_2 stored



Marginal abatement cost in 1.5°C pathways



Cost discounted at 5%/yr to 2020.