Pathways to limit global-mean temperature rise to 1.5 °C: Multi-dimensional Implications

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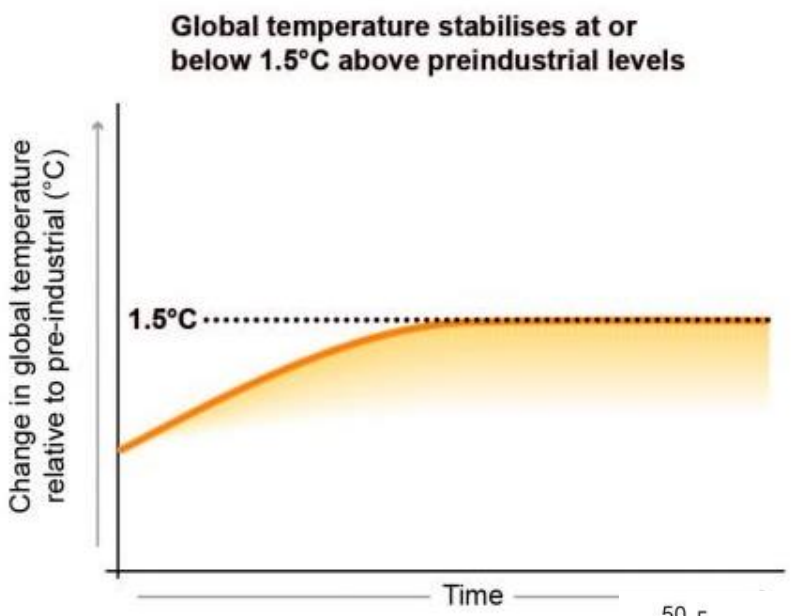
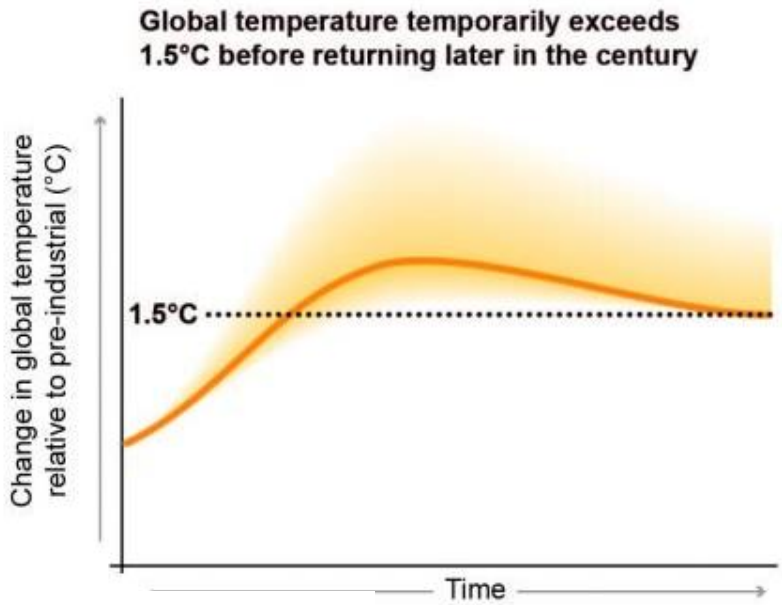
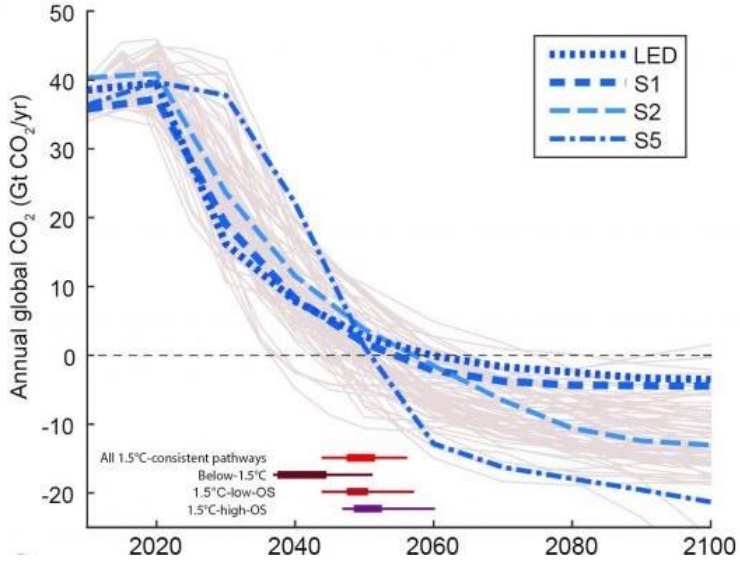
Possible pathways to attain 1.5 °C







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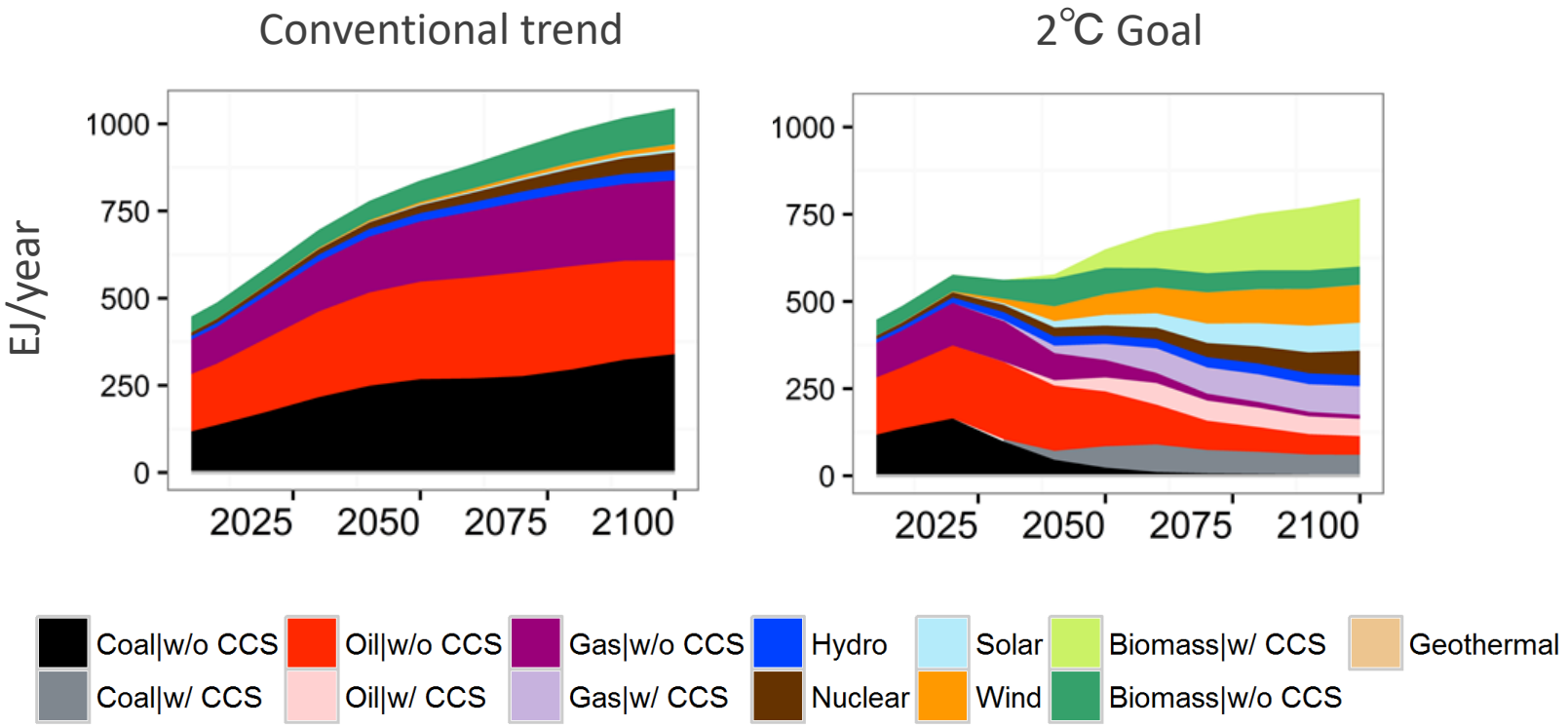
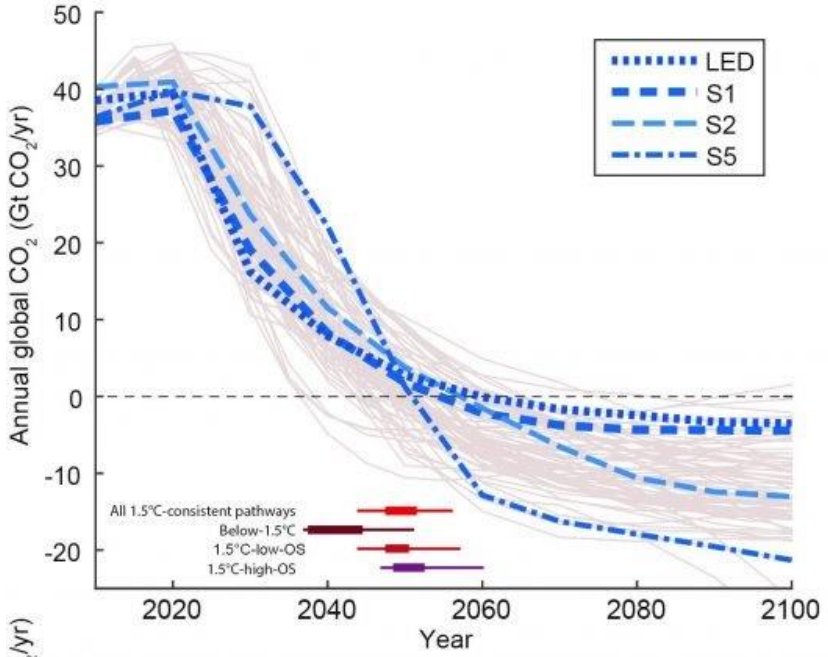
Energy system change example

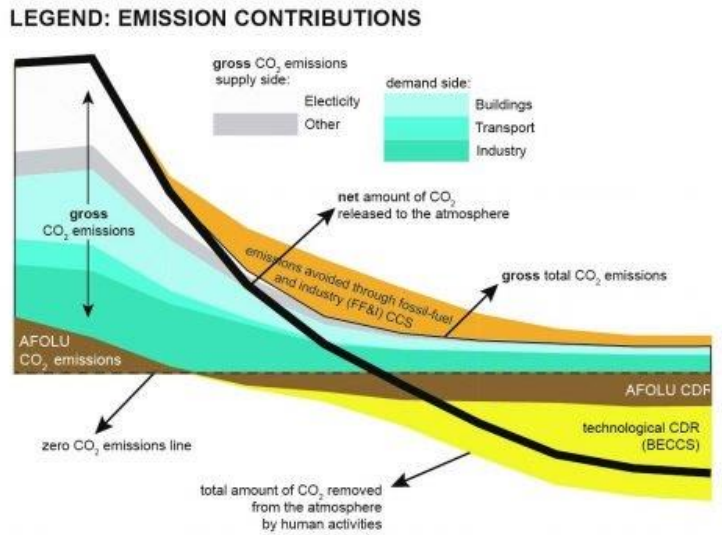


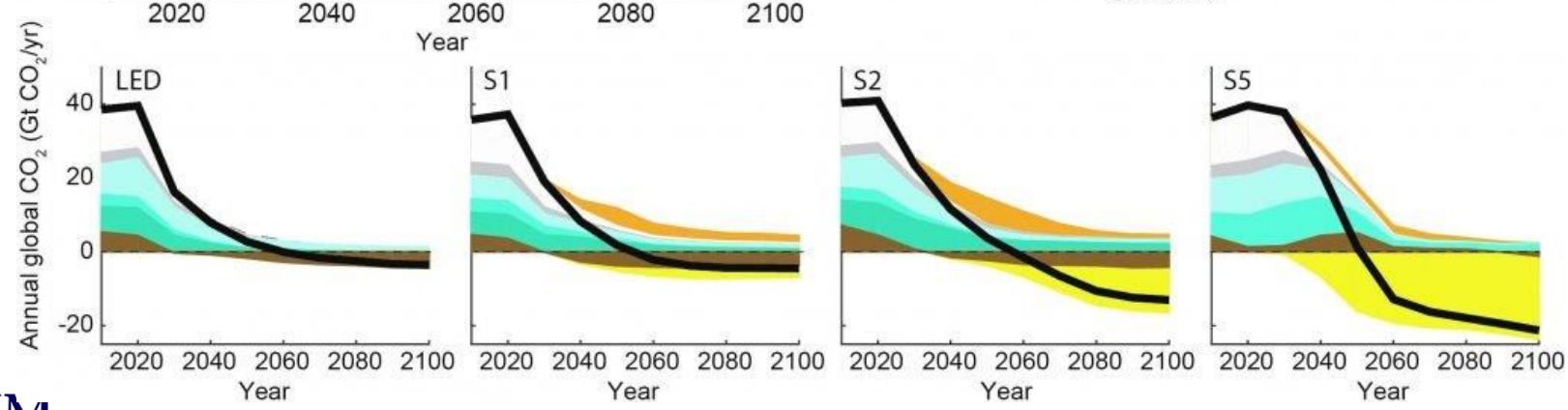
- Heavy usage of fossil fuel in the current system
- Mitigation scenario relies on renewables and CCS

Fujimori et al. (2016)

1.5 °C scenarios







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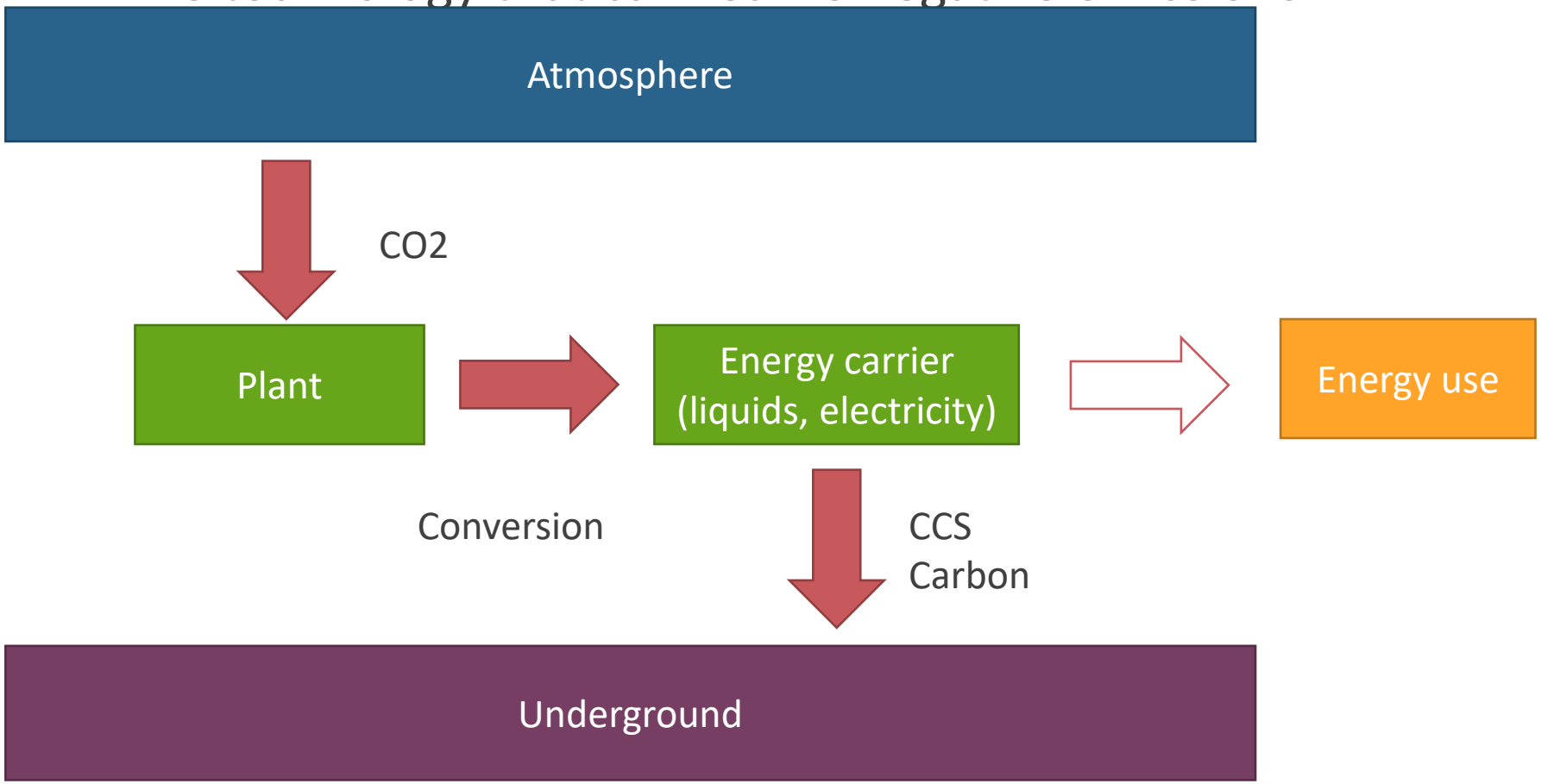
Long-term challenges

- Net zero
- Massive negative emissions/ drastic transformation of energy system
  - ✓ Land-related issues

BECCS

- Bioenergy combined with CCS
- The technology that can realize negative emissions



SDGs and climate change

Possible failure of climate policy

- How bioenergy is produced
  - ✓ If the land is freely used, forest trees could be cut down.

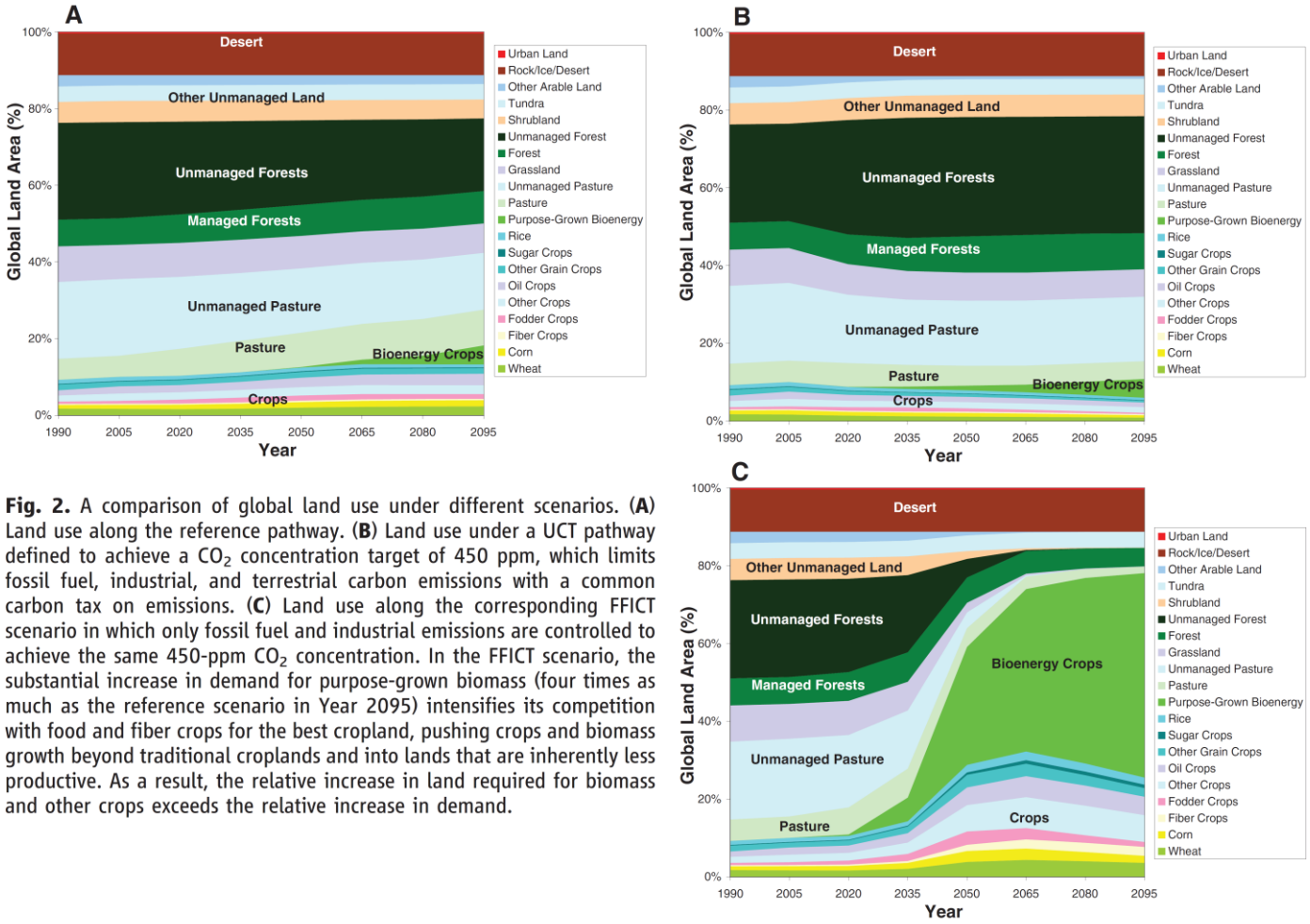


Fig. 2. A comparison of global land use under different scenarios. (**A**) Land use along the reference pathway. (**B**) Land use under a UCT pathway defined to achieve a CO_2 concentration target of 450 ppm, which limits fossil fuel, industrial, and terrestrial carbon emissions with a common carbon tax on emissions. (**C**) Land use along the corresponding FFICT scenario in which only fossil fuel and industrial emissions are controlled to achieve the same 450-ppm CO_2 concentration. In the FFICT scenario, the substantial increase in demand for purpose-grown biomass (four times as much as the reference scenario in Year 2095) intensifies its competition with food and fiber crops for the best cropland, pushing crops and biomass growth beyond traditional croplands and into lands that are inherently less productive. As a result, the relative increase in land required for biomass and other crops exceeds the relative increase in demand.

(Wise, 2009)

Food security implications

nature climate change

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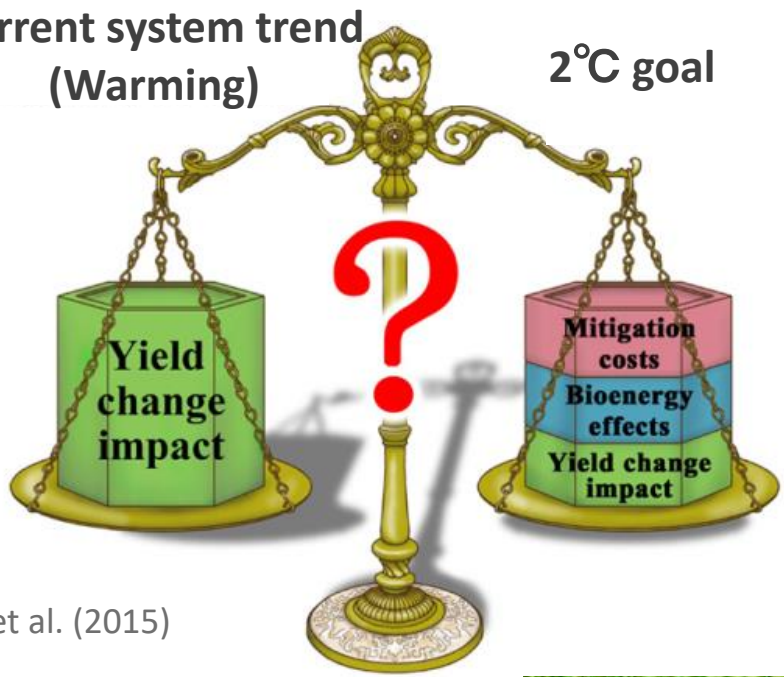
https://doi.org/10.1038/s41558-018-0230-x

Risk of increased food insecurity under stringent global climate change mitigation policy

Tomoko Hasegawa[1,2*], Shinichiro Fujimori[1,2,3], Petr Havlík[2], Hugo Valin[2], Benjamin Leon Bodirsky[4], Jonathan C. Doelman[5], Thomas Fellmann[6], Page Kyle[7], Jason F. L. Koopman[8], Hermann Lotze-Campen[4,9], Daniel Mason-D'Croz[10,11], Yuki Ochi[12], Ignacio Pérez Domínguez[6], Elke Stehfest[5], Timothy B. Sulser[10], Andrzej Tabeau[8], Kiyoshi Takahashi[1], Jun'ya Takakura[1], Hans van Meijl[8], Willem-Jan van Zeist[5], Keith Wiebe[10] and Peter Witzke[13]

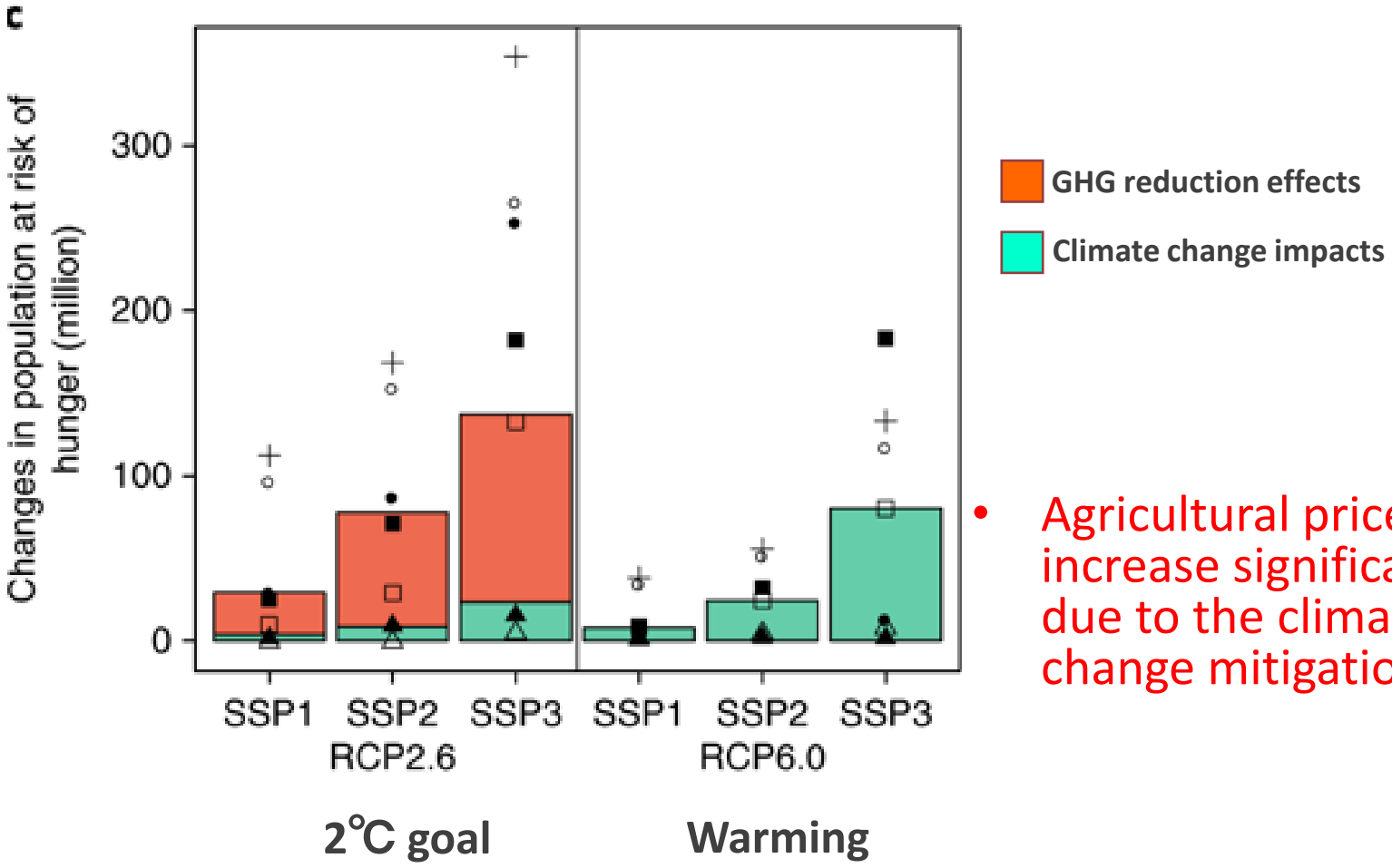
Food consumption and risk of hunger



Hasegawa et al. (2015)

https://www.lettuceclub.net/news/article/119053/
http://www.biofuels.co.jp/page5.html
https://www.cnn.co.jp/fringe/35020107.html

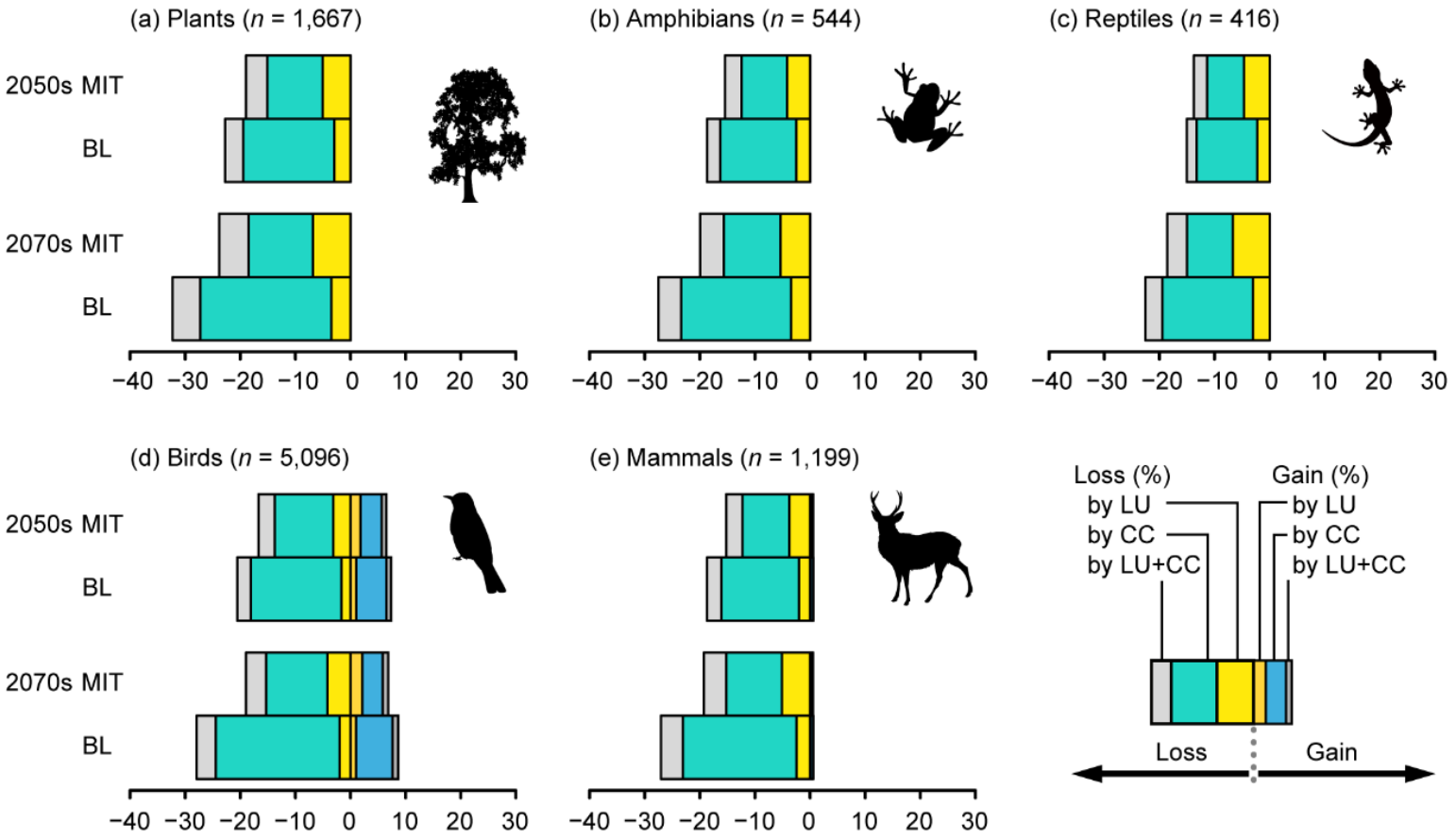
Emissions reduction or warming?



- Agricultural prices can increase significantly due to the climate change mitigation

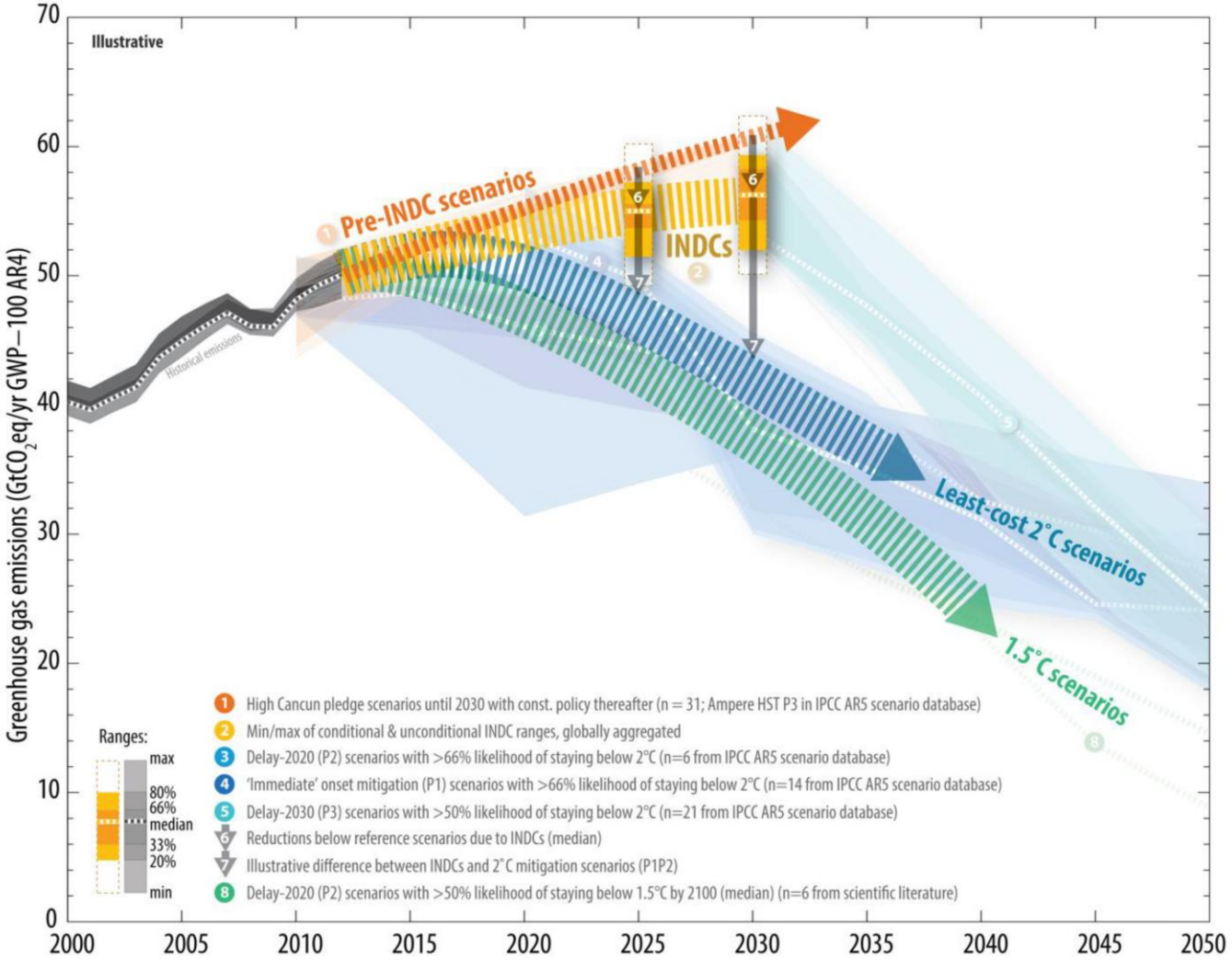
Hasegawa et al. (2018)

Climate Change and Biodiversity



Ohashi et al. (2019) *Nature Communications*

Near term issue



Sources: Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report scenario database, 1.5 °C scenarios from scientific literature (see footnote 19), IPCC historical emission database and intended nationally determined contribution quantification.

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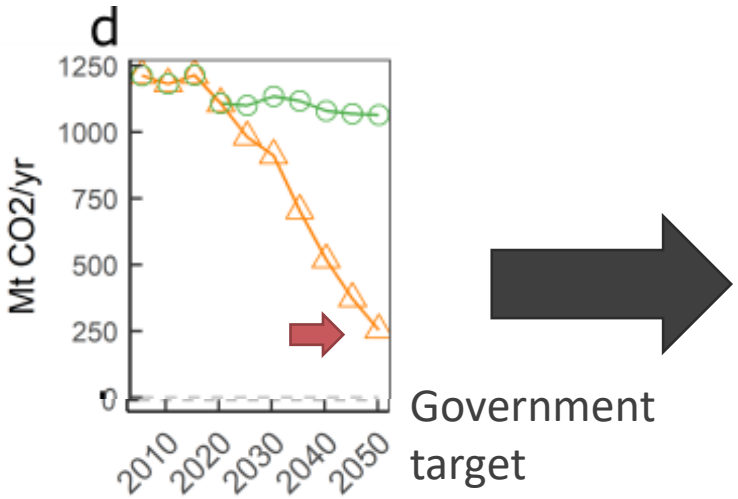
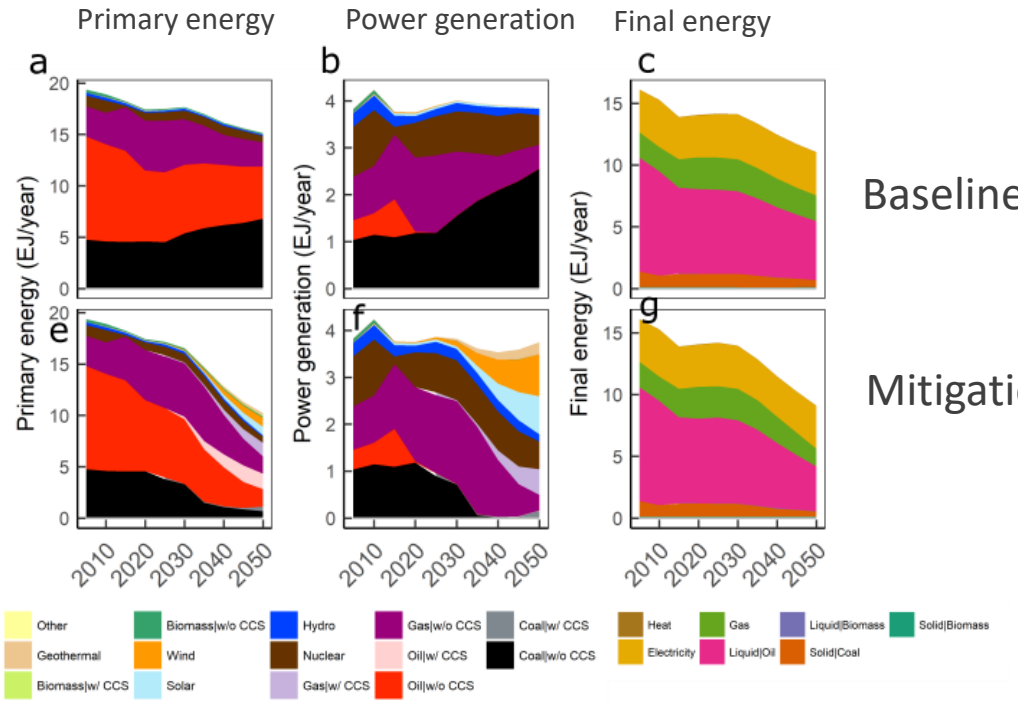
What for Japan? National modeling example



Government target

Emissions in japan



Energy system change

- Large scale renewable energy
- CCS is needed

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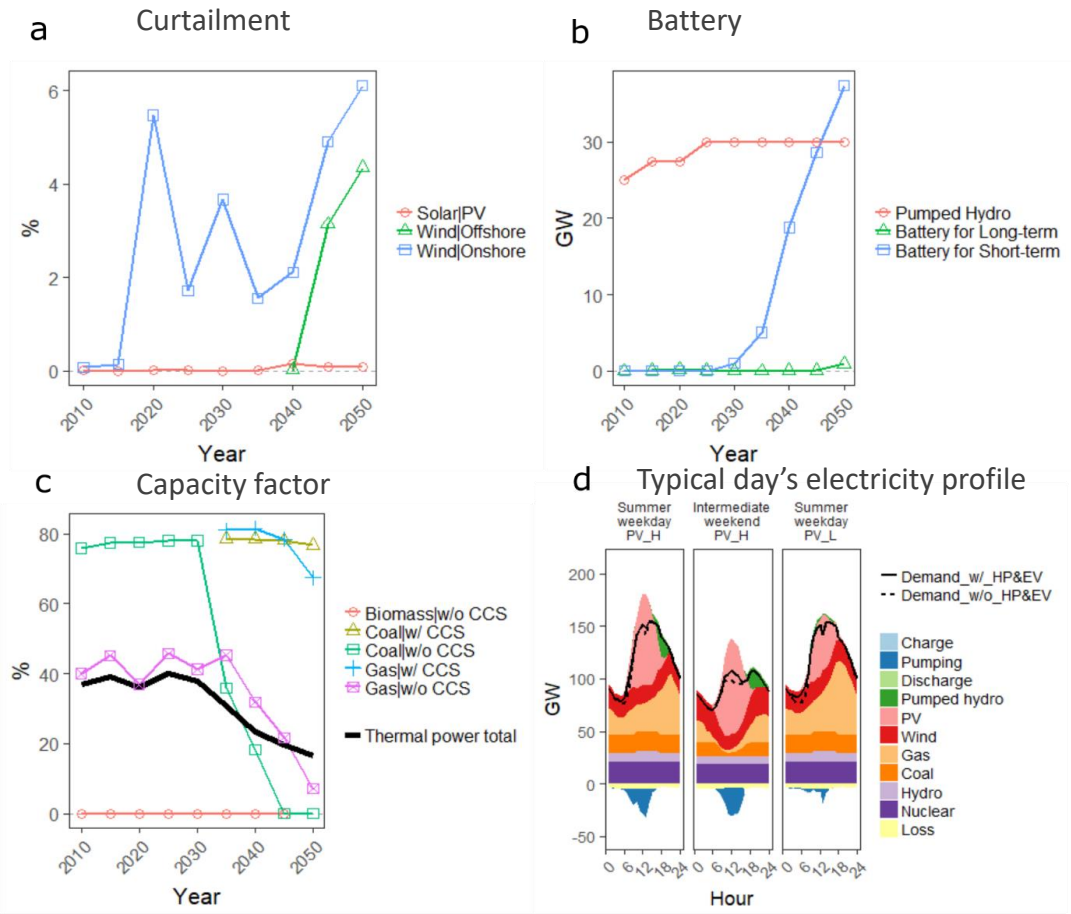
Fujimori et al. (2019) *Nature Communications*

What for Japan? Adjustment in electricity is needed



- Large scale renewable energy penetration requires adjustment for the variability

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Fujimori et al. (2019) *Nature Communications*

Discussions

- Need for societal debate for potential trade-offs
  - ✓ Negative emissions would be technologically feasible but what about social acceptance?
    - ➢ Long-term continuous negative emissions
    - ➢ Large-scale CCS and bioenergy implementations or large-scale afforestation or geoengineering
  - ✓ Climate change impacts are already observed (e.g. flood, sever heat wave etc)
- Challenges in energy system transformation
  - ✓ Many new technologies will play vital roles
  - ✓ Are we able to anticipate the sufficient speed to decarbonize the energy system?
    - ➢ Technological diffusion speed
    - ➢ Capacity turn over? Prematurely retired?