Carbon Dioxide Removal Modelling Overview

- Focusing on integrated assessment models (IAMs), and energy systems optimisation models (ESOMs) -

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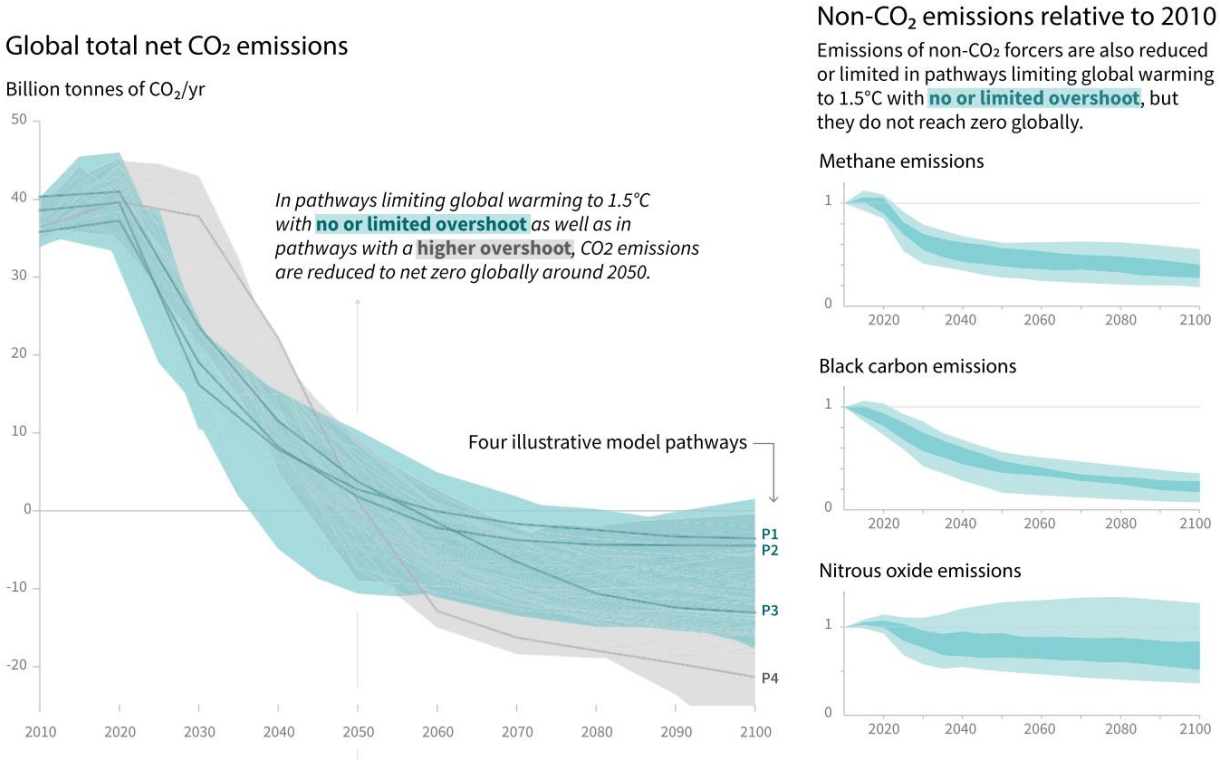
WHY Carbon Dioxide Removal (CDR)?

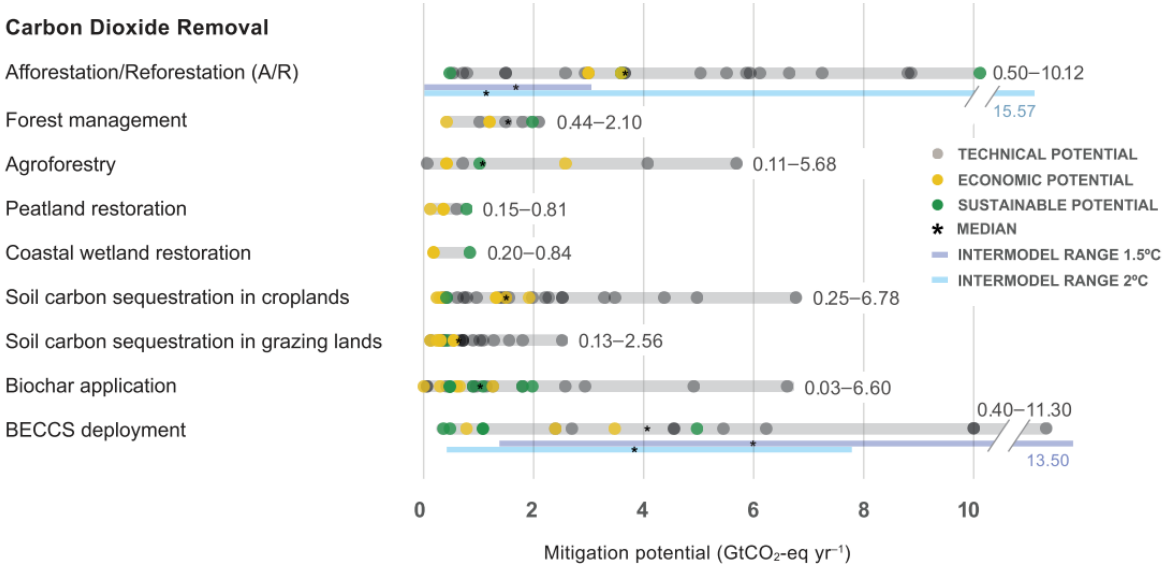


- To <u>avoid overshooting</u>, emission removal needs to <u>complement</u> aggressive mitigation for achieving Net Zero on a <u>scale of decades</u>
- There are options for removing CO_2 at scale, but not CH_4 and N_2O

Source: IPCC. (2018). *Summary for Policymakers. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to. Ipcc - Sr15*. Geneva, Switzerland. Retrieved from http://www.ipcc.ch/report/sr15/

Are CDRs captured in the models?

Land-based CDR options suggested by the IPCC SR on Land Use:



Source: Shukla, P. R., Skea, J., Slade, R., Diemen, R. van, Haughey, E., Malley, J., … (eds.), J. P. P. (2019). Technical Summary, 2019. In: Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems.

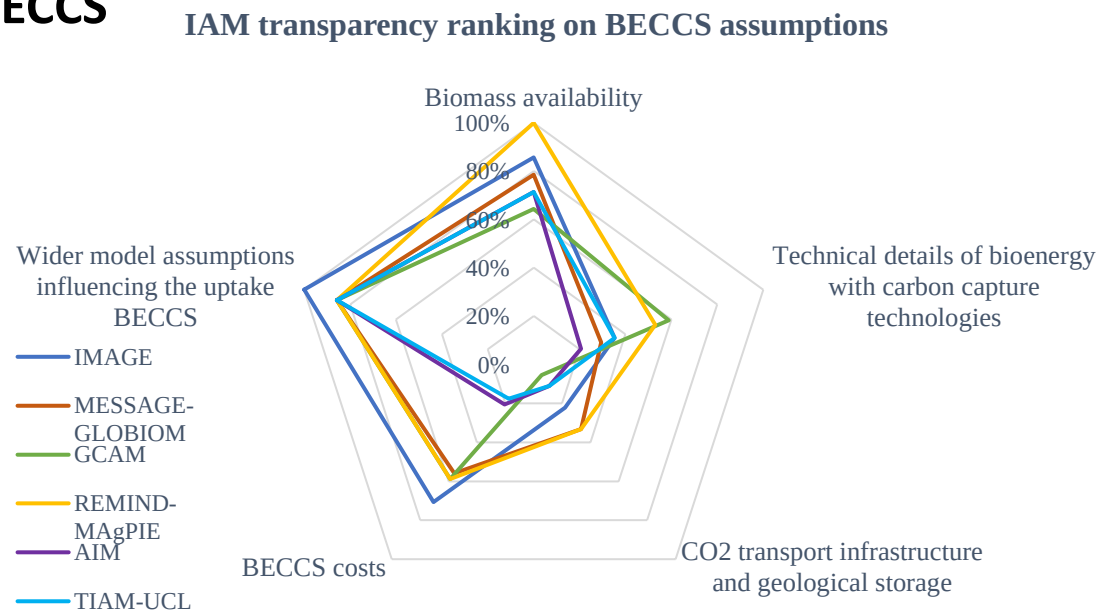
- Usually only AR and BECCS feature in IAMs (and UKTM and TIAM-UCL)
- Both seem to be "used" beyond their sustainable potential (recent UCL work testing resource and technology potential)

Other CDR options:

Direct Air Capture, Enhanced Weathering, Ocean fertilization/alkalinization

HOW are CDRs captured in the models?

BECCS



Source: Butnar, I., Li, P., Strachan, N., Portugal-Pereira, J., Gambhir, A., & Smith, P. (2019). A deep dive into the modelling assumptions for biomass with carbon capture and storage (BECCS): A transparency exercise. Environ. Res. Lett. Retrieved from https://doi.org/10.1088/1748-9326/ab5c3e%0AManuscript

CDR options are not single technologies but involve complex supply chains

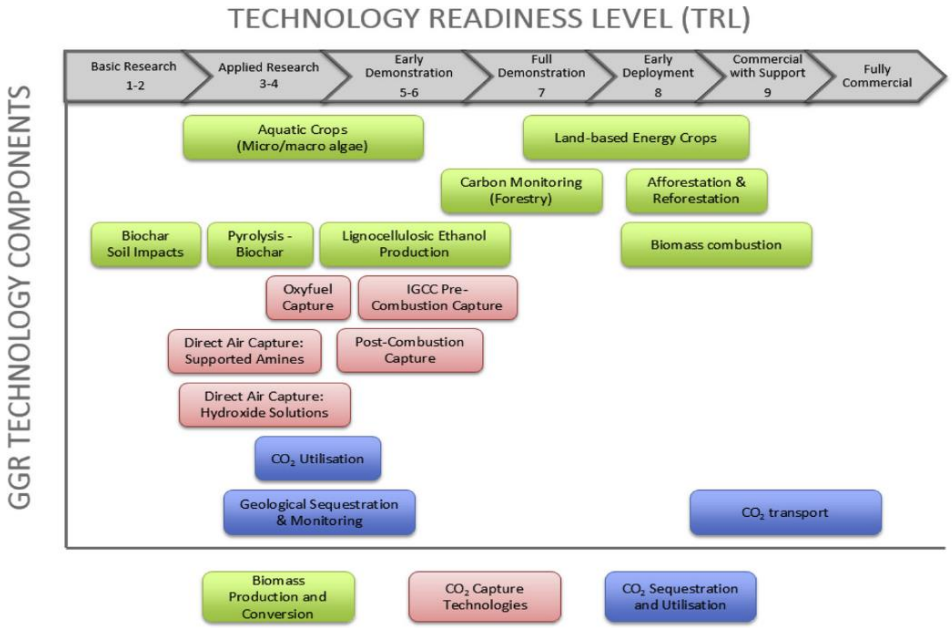
Transparency issues:

- ✓ Biomass availability
- × Carbon balances (e.g. temporal)
- × Missing processes (e.g. biomass storage, local transport)
- × Unclear technological parameters, e.g. process efficiency
- ✓ Costs along supply chain
- × CCS representation (e.g. infrastructure)

Challenges going forward

- Early and continuous engagement with other communities working on decarbonisation (e.g. for setting inputs, model constraints, analysing results): how, when, funding?
- Transparency for and key CDR assumptions and uncertainties, e.g.

- Include and "test" new developments, e.g. using renewable energy to power DACS
- Thought provoking sensitivity analysis on CDR in UK and global energy decarbonisation pathways to enable wider stakeholder conversation and debate



Source: Lomax et al., 2015