THE STATE OF
Carbon
Dioxide
Removal

Current CDR activity, and gaps in existing IPCC guidelines

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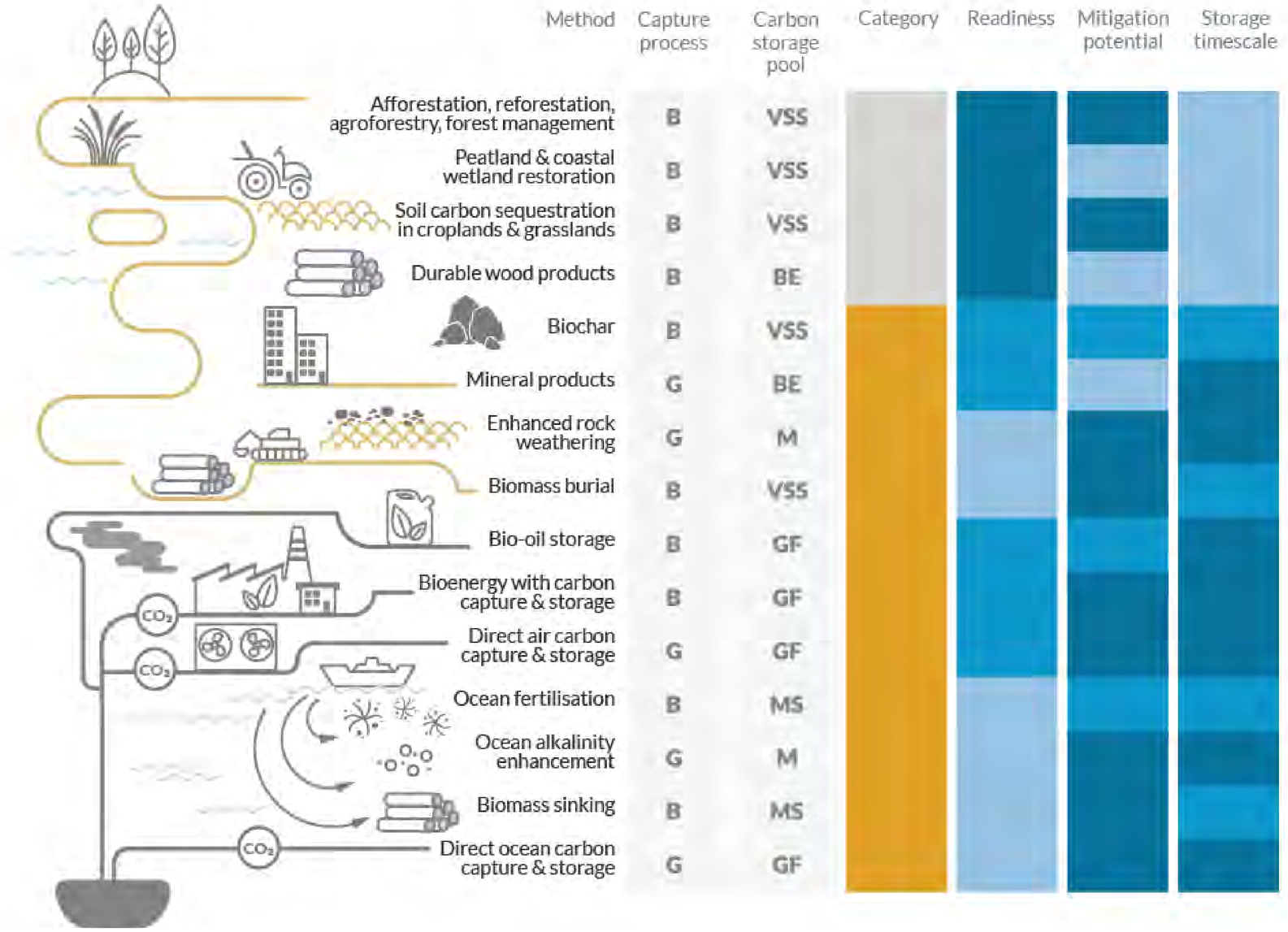
Proposed criteria in the background paper for assessing new methods

1. **gaps** in existing IPCC Guidelines for specific anthropogenic sinks or sources; or where elaboration is desirable;
2. **delineation** of the anthropogenic sink or source to be estimated;
3. **current and expected significance** of the anthropogenic activity;
4. knowledge available to **generalize an IPCC Tier 1 methodology**;
5. feasibility of being able to specify **higher tier methods**;
6. guidance as to how to devise appropriate **verification** activities.

In the State of CDR we identified 15 different CDR methods



Legend:

B Biological
G Geochemical

VSS Vegetation, soils and sediments
BE Built environment
GF Geological formations
MS Marine sediments
M Minerals

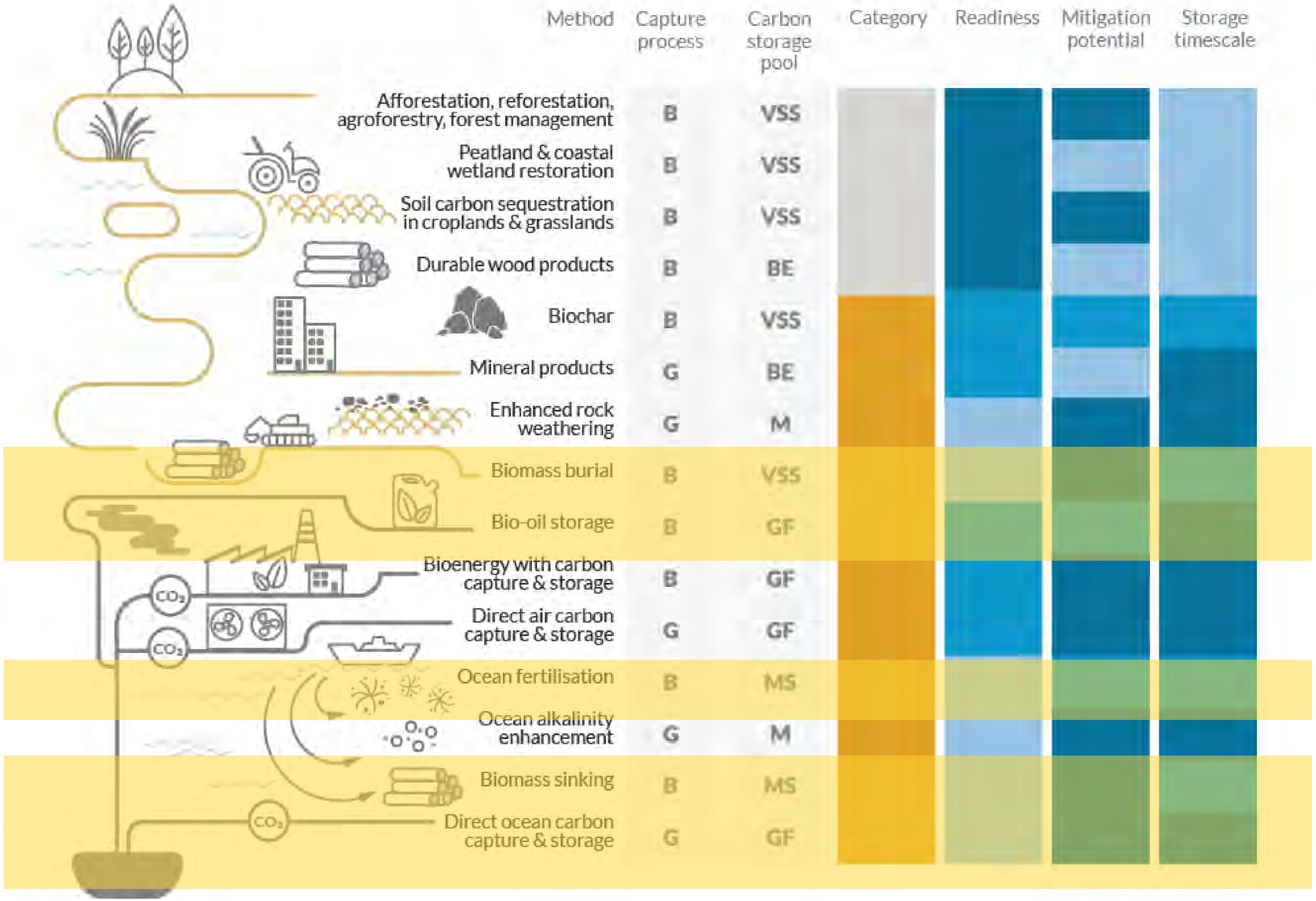
Conventional
Novel

High
Medium
Low

Large
Moderate
Small

> Ten millennia
Centuries to millennia
Decades to centuries

Gaps in guidelines: we find several (some not in the background paper)



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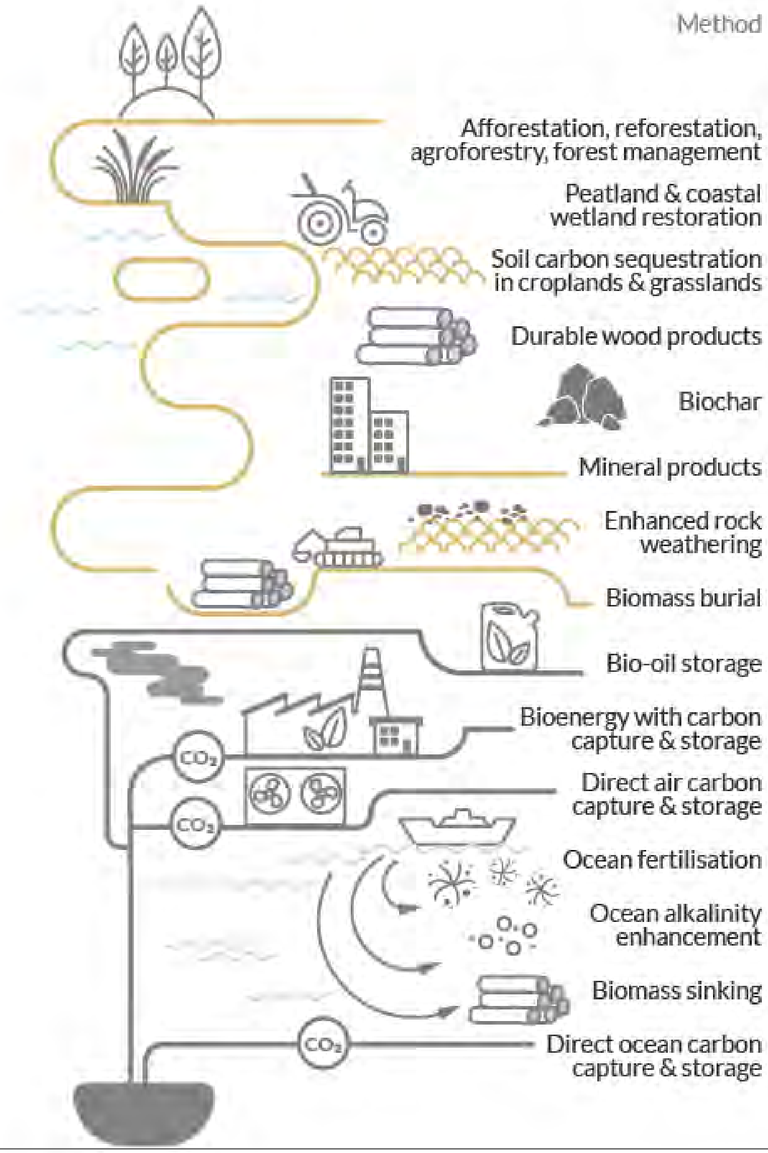
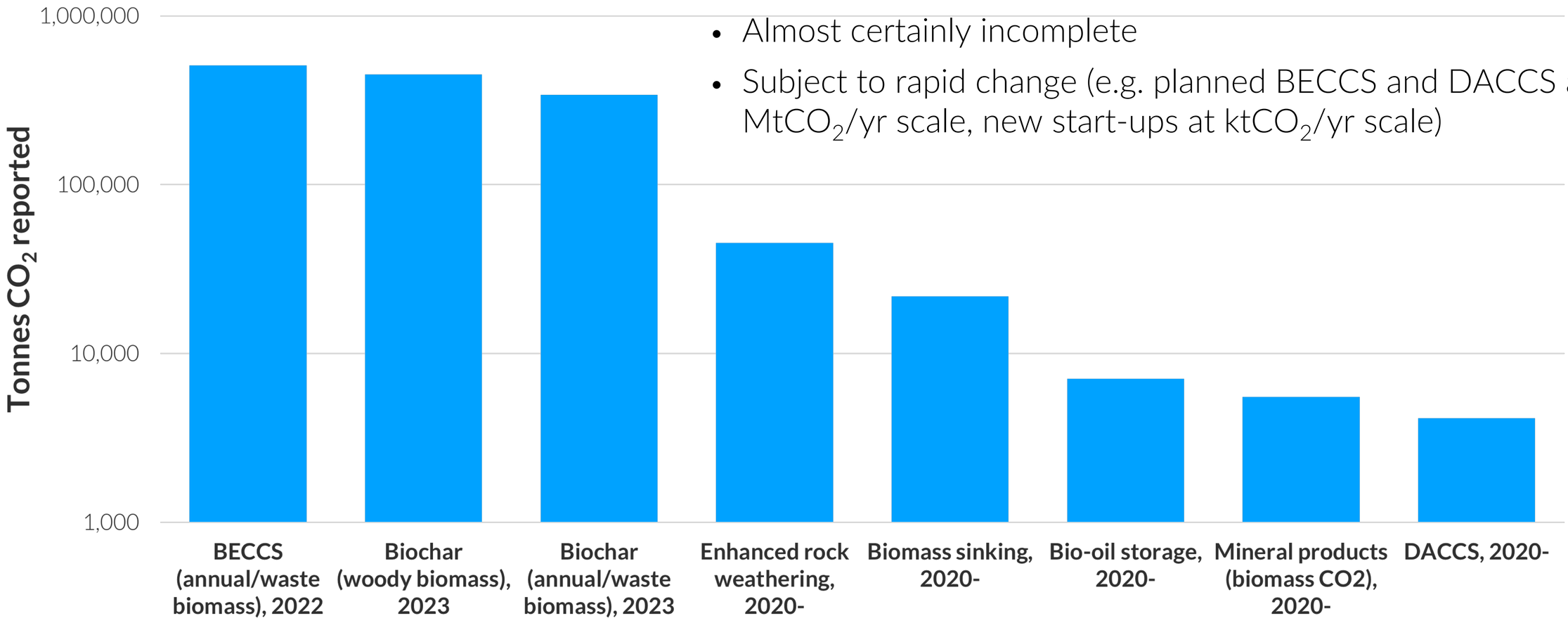


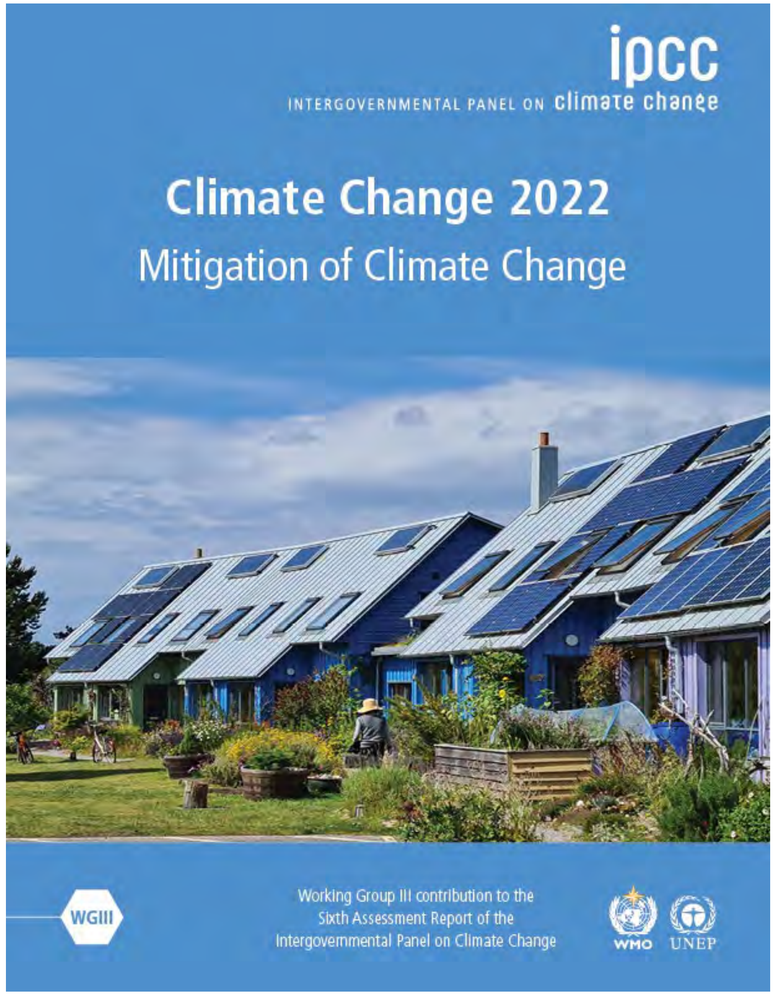
Method	Capture process	Carbon storage pool	Existing IPCC Guidelines?	Comments
Afforestation, reforestation, agroforestry, forest management	B	VSS	Yes (AFOLU)	
Peatland & coastal wetland restoration	B	VSS	Yes (AFOLU)	
Soil carbon sequestration in croplands & grasslands	B	VSS	Yes (AFOLU)	
Durable wood products	B	BE	Yes (AFOLU)	
Biochar	B	VSS	Yes	Annex only
Mineral products	G	BE	No	Noted in 2006 as area for future work
Enhanced rock weathering	G	M	No	Noted in 2006 as area for future work
Biomass burial	B	VSS	No for storage	
Bio-oil storage	B	GF	Yes (AFOLU, Energy)?	Injection of biomatter into geological storage covered?
Bioenergy with carbon capture & storage	B	GF	Yes (AFOLU, Energy)	In situ mineralisation covered?
Direct air carbon capture & storage	G	GF	No for capture?	In situ mineralisation covered?
Ocean fertilisation	B	MS	No	
Ocean alkalinity enhancement	G	M	No	Noted in 2006 as area for future work
Biomass sinking	B	MS	No for storage	
Direct ocean carbon capture & storage	G	GF	No for capture?	In situ mineralisation covered?

Current significance: (reported) deployment is small-scale and diverse



- Largely self-reported estimates (except BECCS from US EPA)
- Almost certainly incomplete
- Subject to rapid change (e.g. planned BECCS and DACCS at $MtCO_2$/yr scale, new start-ups at $ktCO_2$/yr scale)

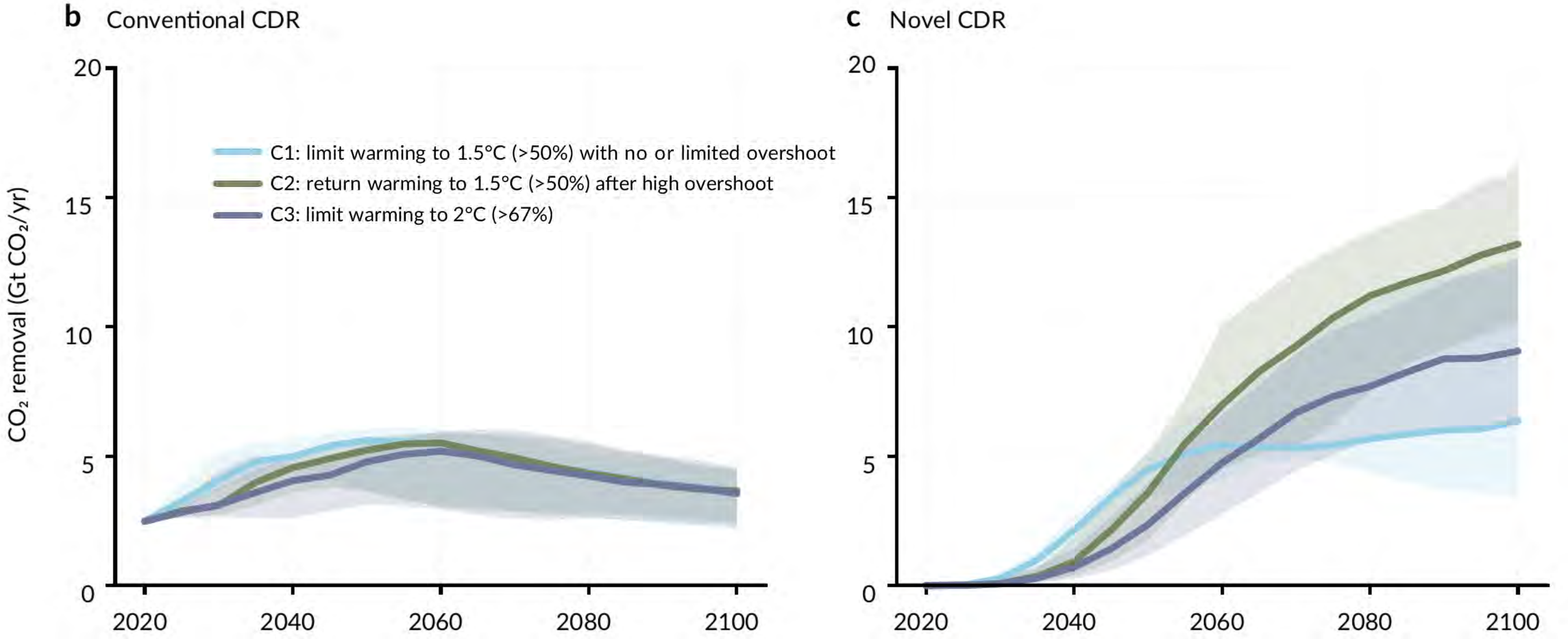
Expected significance: scenarios from Integrated Assessment Models currently include a subset of CDR methods…



	Total number of 1.5–2°C scenarios (number assessed)	Number of scenarios with conventional CDR[a] (number for which CDR estimated)	Number of scenarios with novel CDR			
			BECCS	DACCS	ERW	Biochar
Scenarios in the AR6 database	*540 (407)*	*530 (407)*	*516*	*146*	*4*	*1*
New scenarios since AR6	*90 (48)*	*90 (48)*	*85*	*71*	*11*	*0*

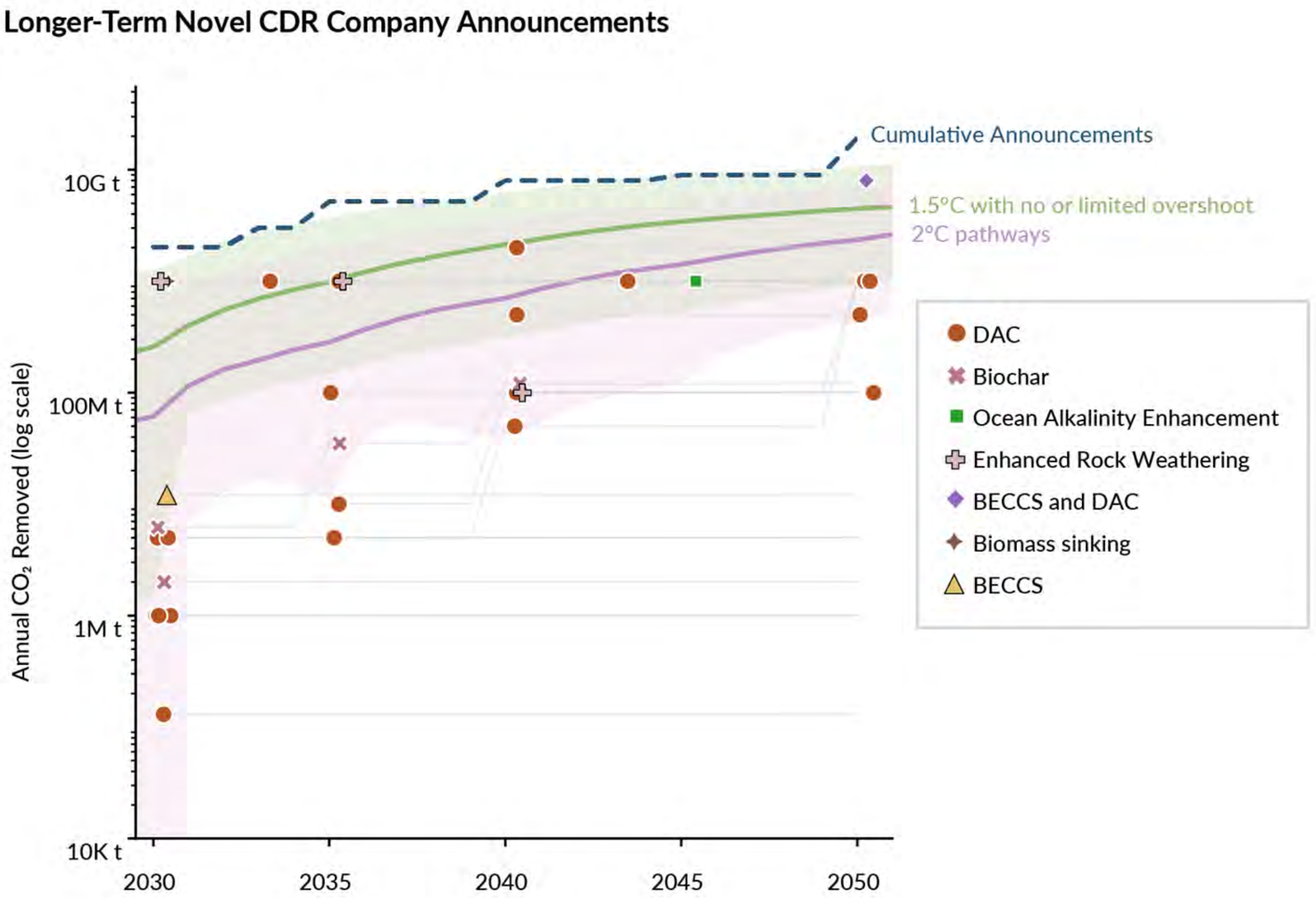
[a] Scenarios are considered to include conventional CDR if this value can be estimated using the methodology in Gidden et al., 2023.[336]

Expected significance: scenarios from Integrated Assessment Models currently include a subset of CDR methods… which they do deploy significantly in total

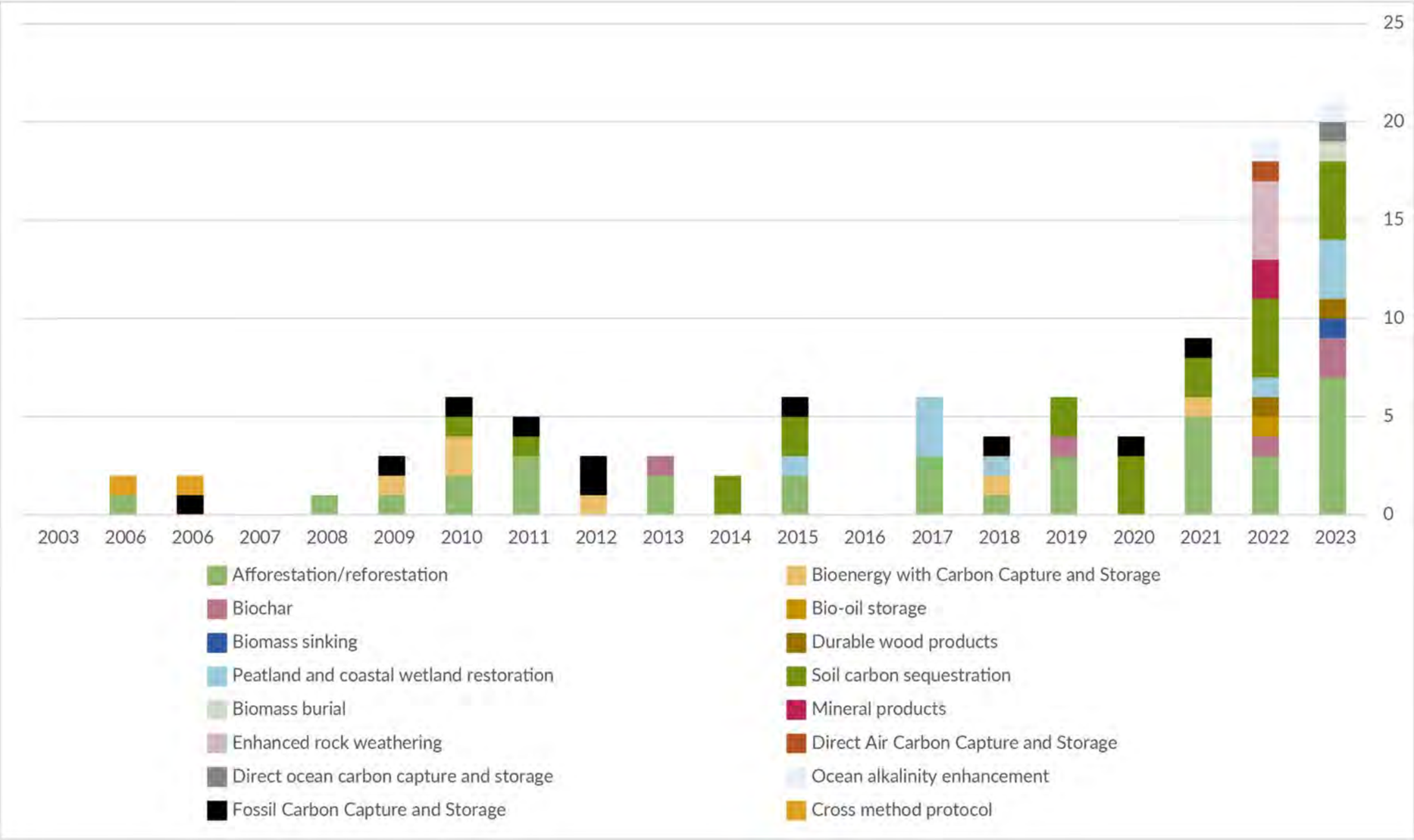


Expected significance: company announcements are ambitious and more diverse

- Again incomplete!
- Sum of company announcements is in line with CDR levels in scenarios for Paris temperature target
- Further diversity (Ocean Alkalinity Enhancement)
- But how credible?



Available knowledge: protocols are emerging, mostly in the voluntary carbon market



Summary

- Gaps in IPCC guidelines (or at least areas I'm not sure about) include:
  - *Mineral products*
  - *Enhanced rock weathering*
  - *Ocean alkalinity enhancement*
  - *Direct air capture*
  - *Direct ocean capture*
  - *Biomass burial (in deep soils, in mines)*
  - *Biomass marine sinking*
  - *In situ mineralisation*
  - *Injection of oils, slurries, etc. into geological wells*
  - *Transfers from croplands, wastes and HWPs?*
- "Novel" CDR methods are happening at kt scale or less currently (totalling just over 1 $MtCO_2$/yr)
- Sector characterised by high diversity, high ambitions, with high uncertainties
- Information from IAMs about future significance of specific methods is limited
- Protocols emerging rapidly in voluntary carbon markets
- *What does a sufficiently robust and flexible process for deciding on IPCC guidelines over the next 7-13 years look like?*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Thank you
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