

Rightsizing expectations for carbon dioxide removal towards ambitious climate goals

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Country-Level Emissions and GDP – The Relationship to Break



Source: United Nations; CDIAC; Le Quéré et al 2015; Global Carbon Budget 2015

Emissions from Fossil Fuel Use and Industry



Global Carbon Proje

Estimates for 2015 and 2016 are preliminary. Growth rate is adjusted for the leap year in 2016. Source: <u>CDIAC</u>; <u>Le Quéré et al 2017</u>; <u>Global Carbon Budget 2017</u>





THE PARIS AGREEMENT: HOLD WARMING "TO **WELL BELOW 2 °C** ... AND TO PURSUE EFFORTS TO LIMIT THE TEMPERATURE INCREASE TO 1.5 °C"

Universal, binding agreement
Pledge from every country
Finance and technology
Role for non-State actors

Oroville Reservoir, August, 2014, Justin Sullivan/Getty

Paris Pledges: A First Step or a Last Step?



Carbon Quota for a >66% Chance to Keep Below 2°C



Source: IPCC AR5 SYR (Table 2.2); Le Quéré et al 2016; Global Carbon Budget 2016

Different Negative Emission Technologies





Source: Smith et al 2015; Global Carbon Budget 2015

Rightsizing Expectations for Carbon Dioxide Removal



Field & Mach Science (2017). Baik et al. PNAS (2018). Sanchez et al. PNAS (2018). Turner et al. Nature Sustainability (2018). Turner et al. Climatic Change (2018).

Rightsizing Carbon Dioxide Removal Expectations

A sampling of CDR technologies

Comparative features of three widely discussed, potentially large-scale strategies for carbon dioxide removal (2, 7).

	FOREST AND SOIL Stewardship	BECCS	DIRECT AIR CAPTURE
Level of engineering complexity	Low	Medium	High
Environmental cobenefits	High	Low	Low
Land area required for large-scale deployment	High	High	Low
Risk of later carbon dioxide release	High	Low	Low
Energy status	~Neutral	Production	Consumption

Rightsizing Carbon Dioxide Removal Expectations

- Feasible at scale? Game changing?
- Limits to deployment? (Land, water, reservoirs, energy)
- Does overshoot limit impacts? Why 2100?
- Can-kicking ethics?
 - shifting responsibility vs preserving flexibility
- What problem are we trying to solve?

Limits to Negative Emissions



Smith et al. (2015). Global Carbon Budget (2016).

Understanding Rates of Land-Use Transformation





Understanding Rates of Land-Use Transformation





Turner et al. Nature Sustainability (2018).

Global Overlap of Bioenergy and Carbon Sequestration Potential



Turner et al. Climatic Change (2018).

Global Overlap of Bioenergy and Carbon Sequestration Potential



Turner et al. Climatic Change (2018).

Carbon-Negative Bioenergy Potential with "Low Transport"





Baik et al. *PNAS* (2018).

Carbon-Negative Bioenergy Potential with "Low Transport"



Baik et al. PNAS (2018).

Carbon-Negative Bioenergy Potential with "Low Transport"



Baik et al. *PNAS* (2018).

CCS at US Ethanol Biorefineries



Sanchez et al. PNAS (2018).

Rightsizing Stewardship Opportunities



Field and Mach Science (2017).

Forest Offsets Partner Mitigation & Conservation



Anderson et al. *Frontiers in Ecology and the Environment* (2017). Anderson et al. (in review).

Forest Offsets Partner Mitigation & Conservation (Then: Environmental Justice & Air Quality Implications)





Anderson et al. *Frontiers in Ecology and the Environment* (2017). Anderson et al. (in review).

Thanks to the team



Funding: Alexander von Humboldt, Packard, & Bechtel Foundations