



Separating CO2 emission
from removal targets
comes with limited cost
impact

*Anne Merfort – Potsdam Institute for Climate Impact Research
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“Separating CO2 emission and removal targets comes with limited cost impacts”

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Outline

0. Introduction to **Carbon Management** terminology

1. Motivation

2. Scenario design

3. Results

4. Discussion and policy implications

0. Introduction to *Carbon Management* terminology

CDR – Carbon Dioxide Removal

- Carbon is from the atmosphere (or biogenic)
- Carbon is durably stored
- Removal is additional (caused by dedicated human intervention)

Conventional CDR on land

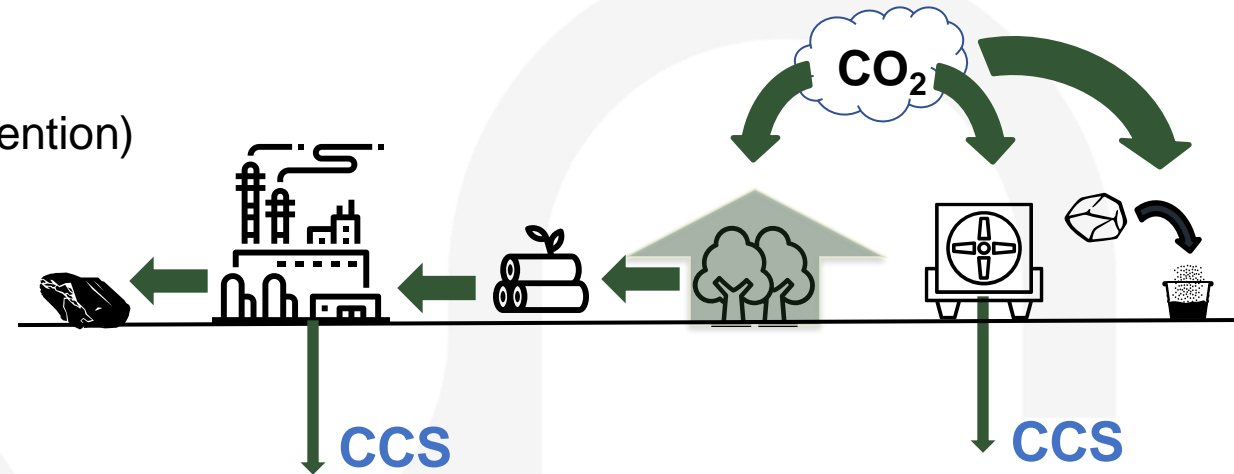
- enhancing the land sink, storing carbon in the biosphere
- high maturity and low costs of methods
- reversible

novel CDR (focus of this analysis)

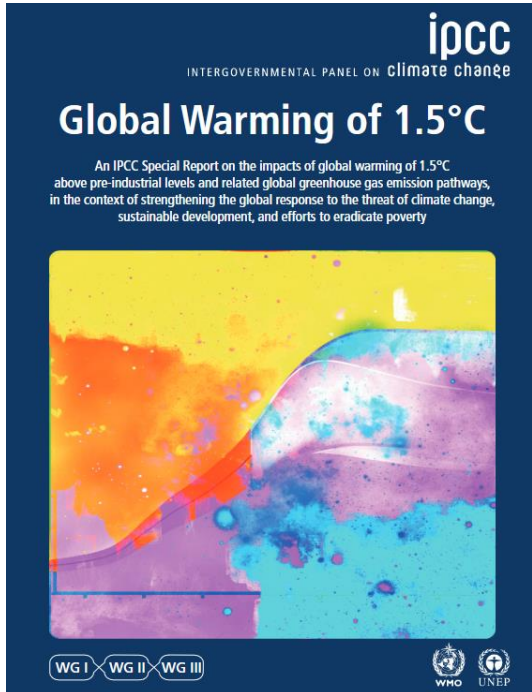
- low or medium maturity and high costs
- high permanence

CCS – Carbon Capture and (geologic) Storage - indifferent to the source of CO₂

CCU – Carbon Capture and Utilisation - using captured carbon for fuel or products

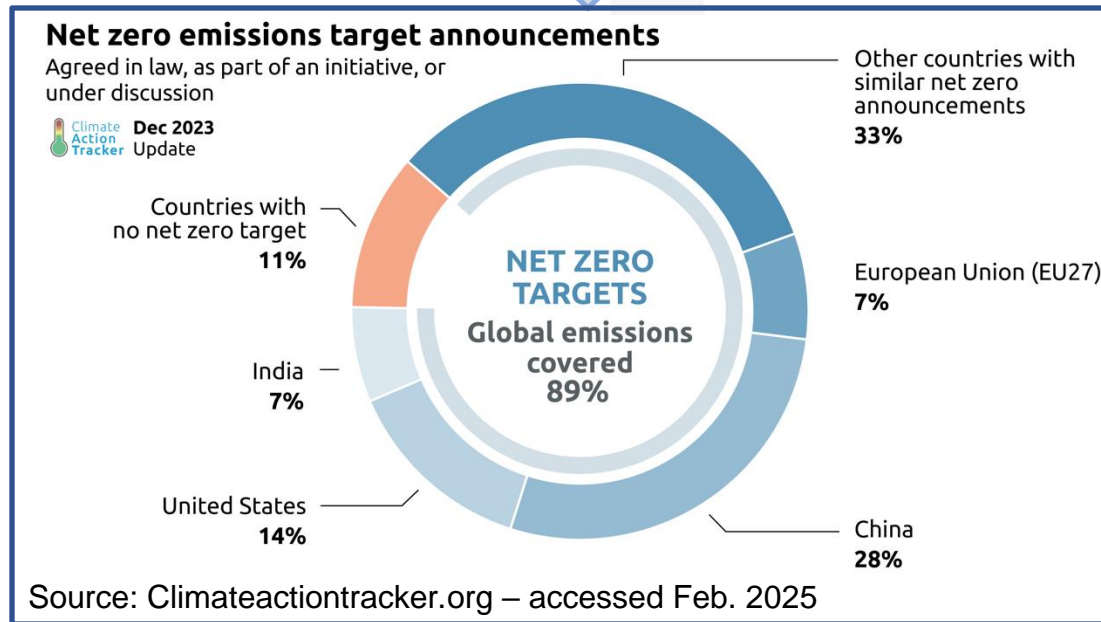


1. Motivation

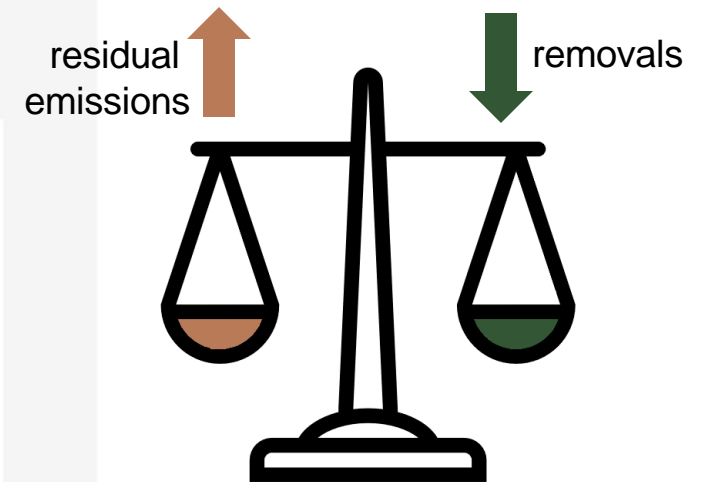


“ Global net-zero CO₂ emissions have to be achieved in the early 2050s to limit global mean temperature increase to 1.5°C by 2100 with low overshoot ”

Many countries pledged “net-zero” targets

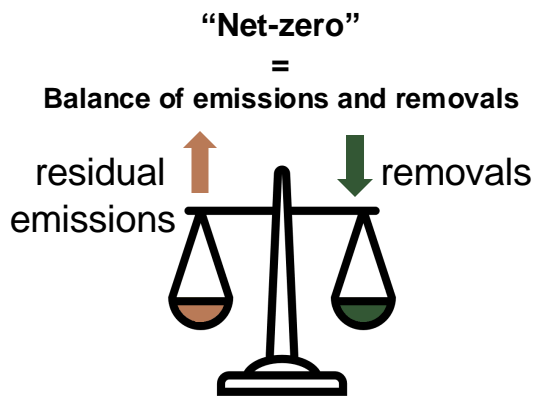


“Net-zero”
=
Balance of emissions and removals



1. Motivation

“How much shall we avoid, how much shall we offset with removals?”



Part of model output

Model output can inform ex-post analysis

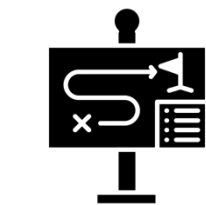
Not captured by the model

1) Economic efficiency:
Emissions should be avoided until it is cheaper to offset the next ton of CO2
-> **An integrated market** for emissions and removals with a uniform carbon price would deliver this outcome

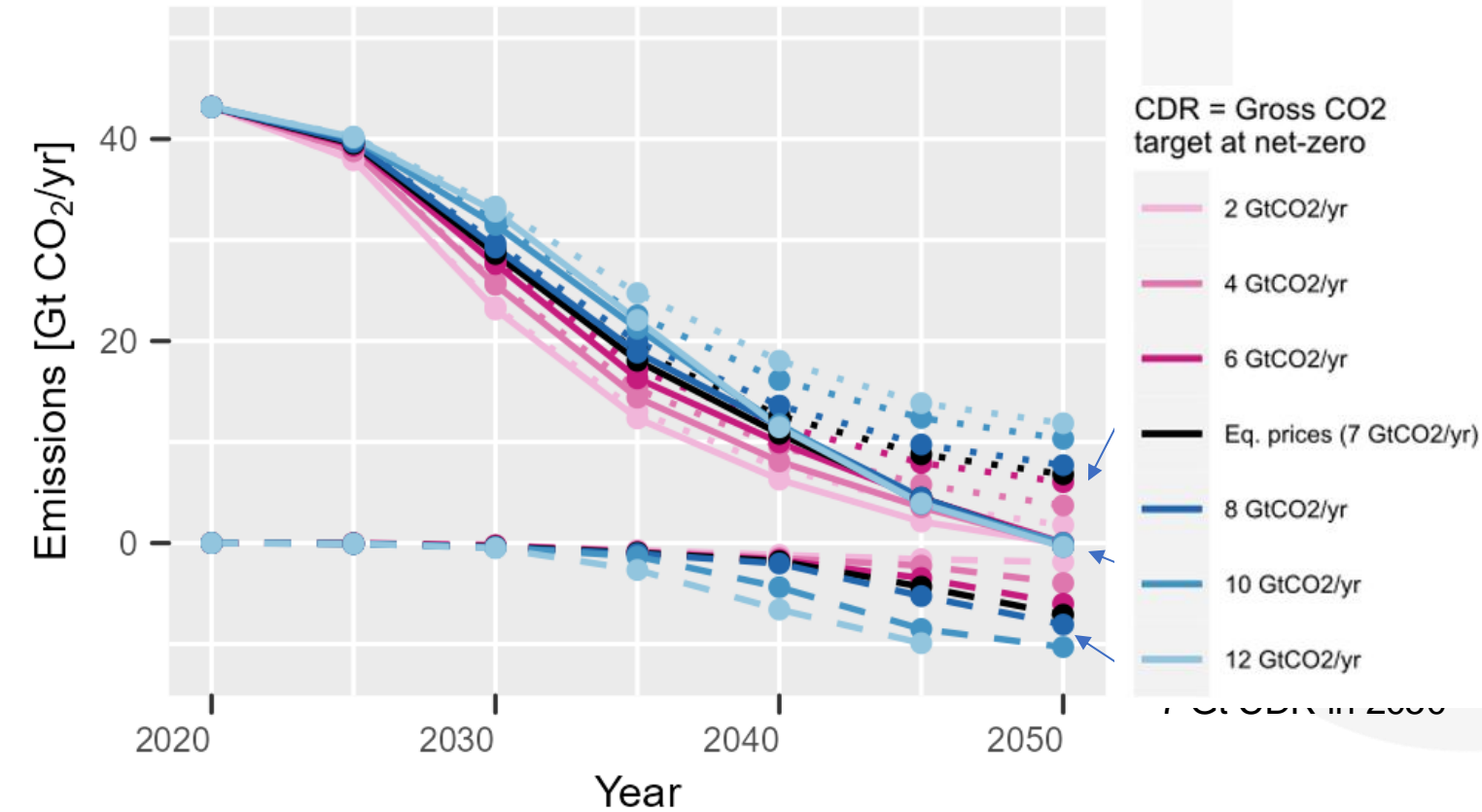
2) Legal framework and governance:
As CDR specific legal frameworks and governance structures are still largely missing, experts started to outline possible inclusions into existing frameworks
-> EU-ETS as an **integrated market**

3) Policy credibility:
Separate targets on emissions and removals are proposed to increase trust in climate policy targets (enable their independent evaluation, stir investment to ensure sufficient decarbonisation alongside CDR scale up)

4) Environmental side-effects of CDR:
Environmental side-effects might not be captured by an integrated market such as the EU-ETS (e.g. by incorporating the risk of high biomass demand and its effect on the land-system) and **separating targets** on emissions and removals to avoid the overuse of CDR.



2. Scenario design



Integrated Assessment Model (IAM) REMIND Energy-Economy-Climate model

- All scenarios achieve global net-zero CO₂ emissions in 2050
- Gross CO₂ and respective **novel** CDR contribution to net-zero is prescribed
- novel CDR options: BECCS, DACCS, Enhanced Weathering, Industry CDR
- 7 GtCO₂/yr is the case where prices on emissions and removals are identical
-> regulator guessed perfectly
- Span the scenario range from 2-12 GtCO₂/yr
- **Blue scenarios**: CDR contribution to net-zero is higher than what would emerge from an integrated market
- **Pink scenarios**: CDR contribution to net-zero is lower than what would emerge from an integrated market

Research question:

“If targets for emission reduction and removals were to be separate to achieve net-zero, how should they be chosen?”

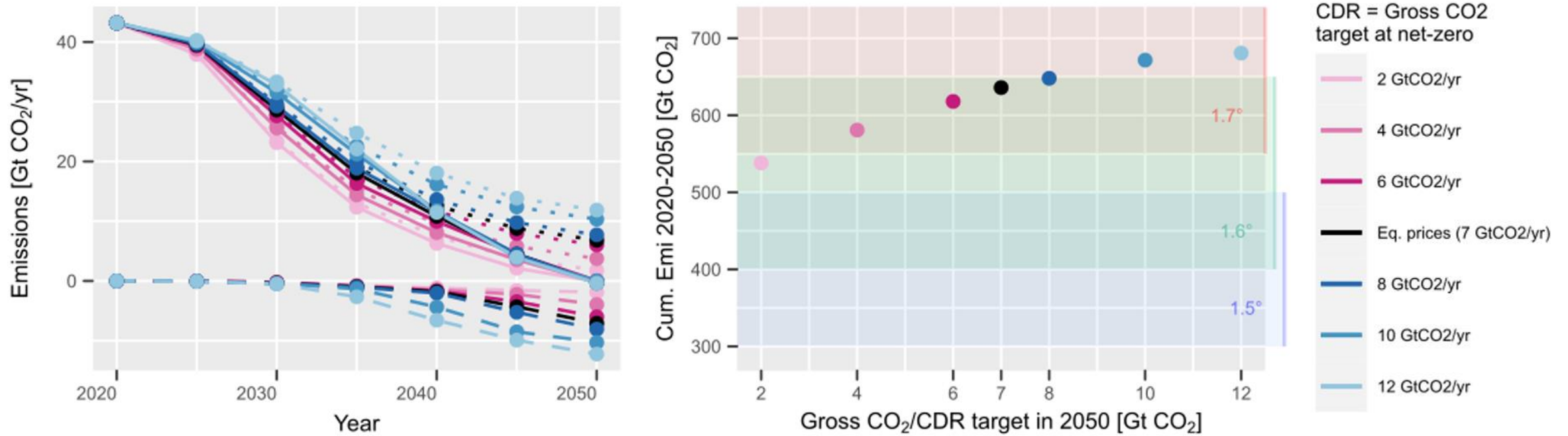
Consequences on

1. emission trajectories
2. emission and removal prices
3. financiability of CDR
4. on economic efficiency
5. for the energy system

3. Results

Consequences on

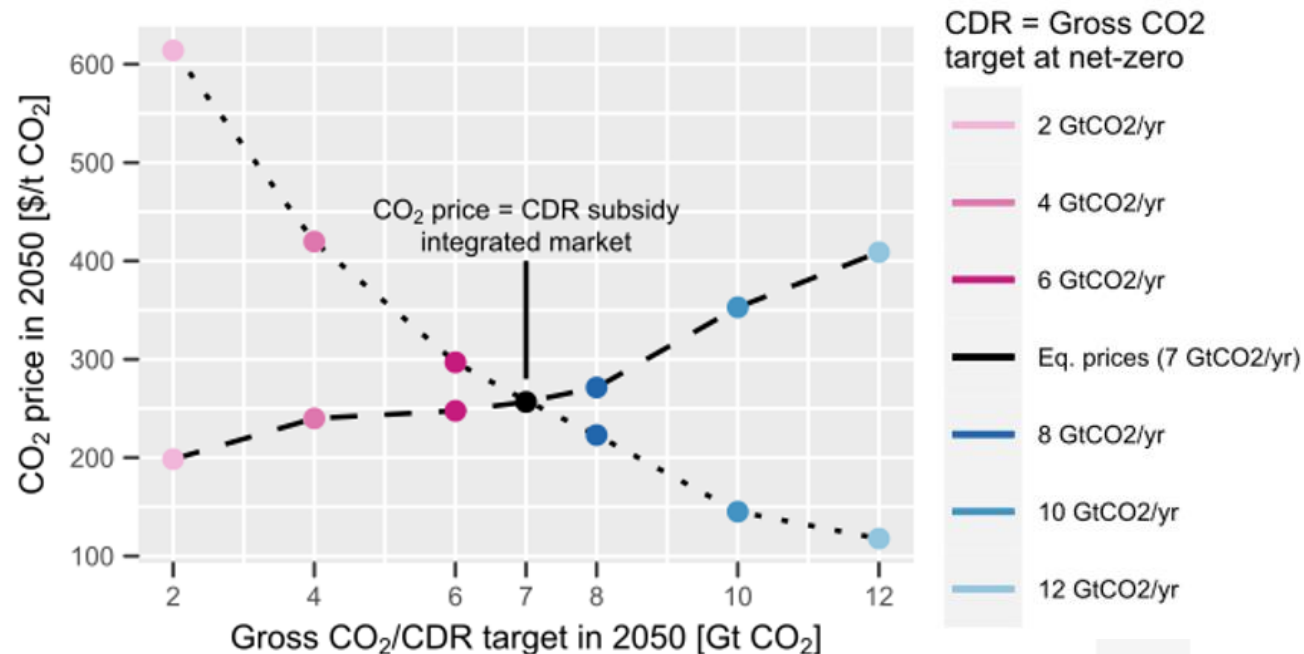
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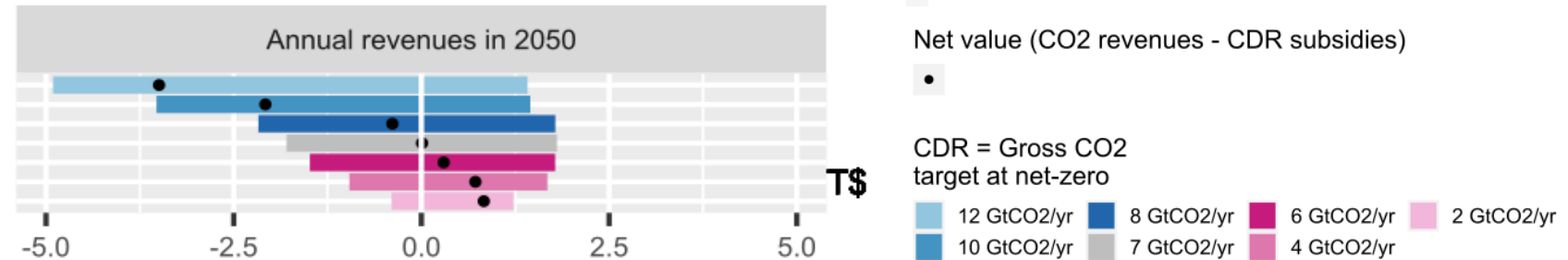
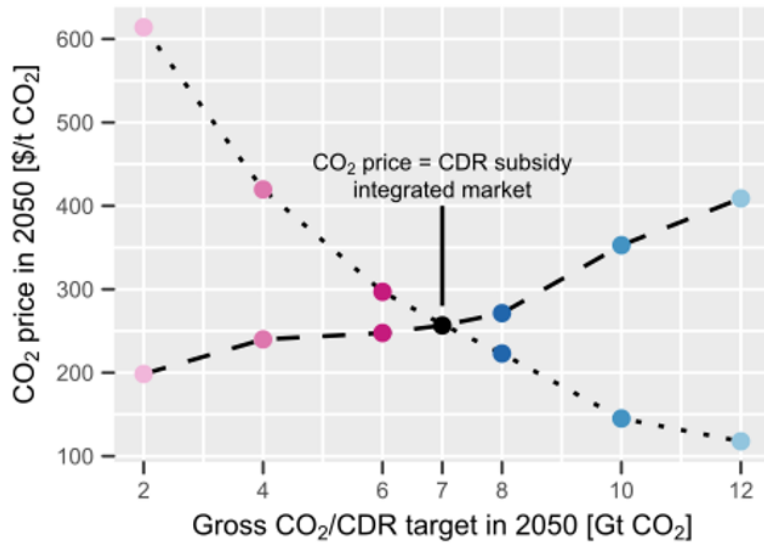
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Consequences on

1. emission trajectories – lower cumulative emissions for more **ambitious reduction targets**
2. emission and removal prices – prices diverge. CO₂ price might be more sensitive than CDR price to the target
3. financiability of CDR – More financial leeway if CDR price is below the CO₂ price in **ambitious reduction target**
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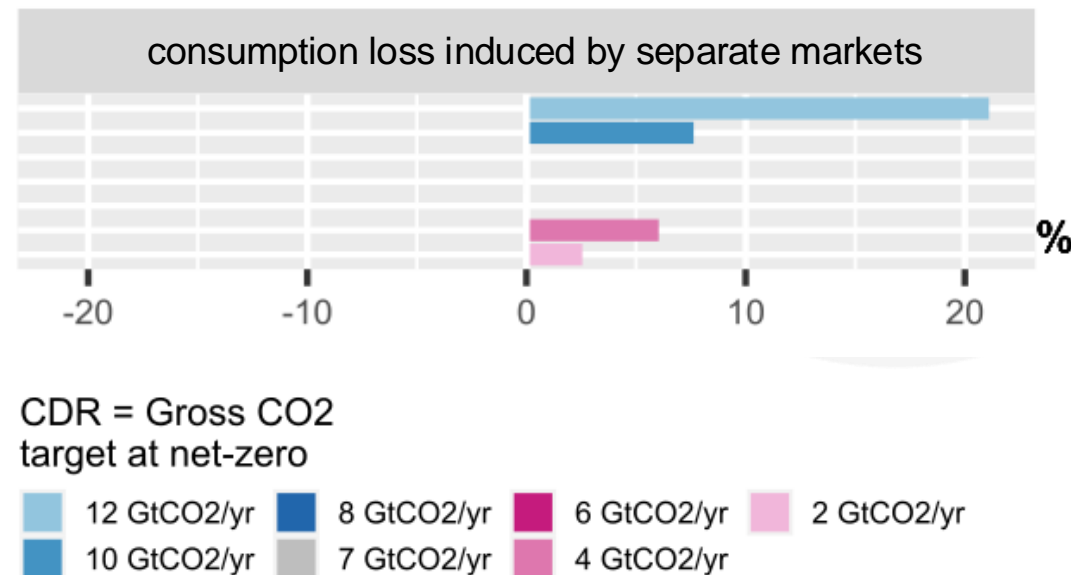


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4. on economic efficiency – consumption losses are moderate for moderate CDR contributions
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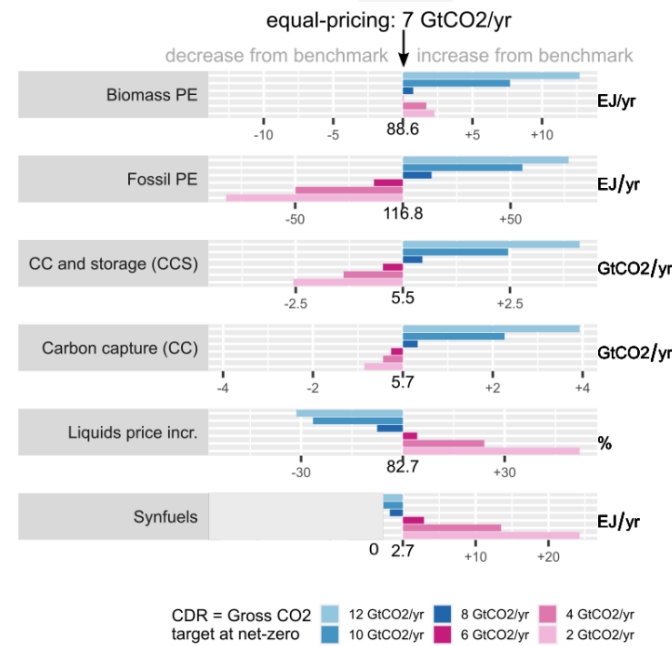


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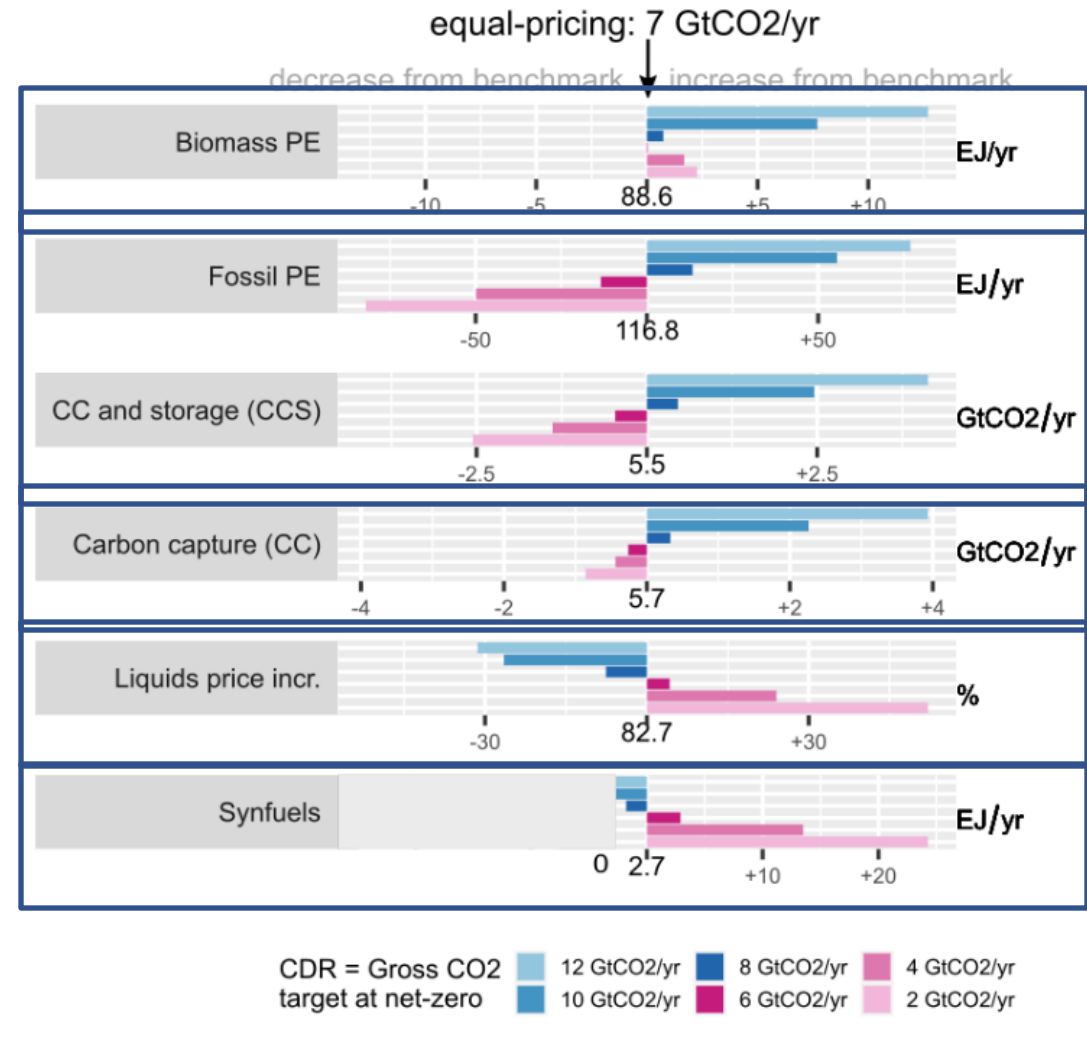


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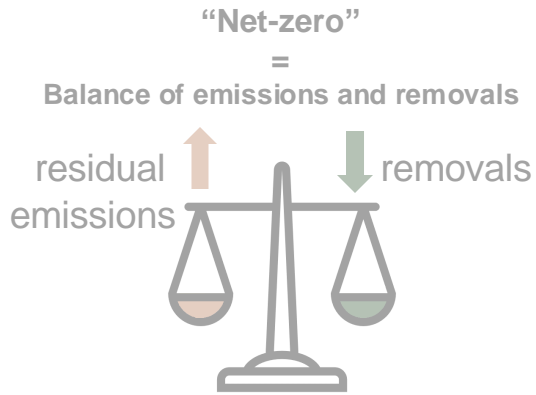
Consequences on

1. emission trajectories – lower cumulative emissions for more
2. emission and removal prices – prices diverge. CO2 price n
3. financiability of CDR – More financial leeway if CDR price i
4. on economic efficiency – consumption losses are moderate
5. for the energy system
 - **Ambitious reduction targets** lower the dependency on Fossil fuels and geologic storage of carbon
 - **High CDR contributions** can prevent strong increases in liquid fuel prices
 - especially as synthetic fuels will be needed in very low CDR scenarios
 - Transformation relies on nascent carbon capture technologies, also for low CDR targets (for synthetic fuels)
 - A low CDR target alone does not reduce the pressure on biomass demand: use is almost identical for scenario ranges 2-8 Gt CDR



4. Discussion and policy implications

“How much shall we avoid, how much shall we offset with removals?”



Part of model output

Model output can inform ex-post analysis

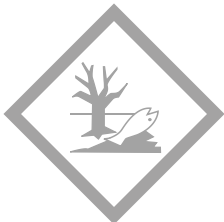
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Economic efficiency:
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Legal framework and governance:
As CDR specific legal frameworks and governance structures are still largely missing, experts started to outline possible inclusions into existing frameworks
-> EU-ETS as an **integrated market**

Policy credibility:
Separate targets on emissions and removals are proposed to increase trust in climate policy targets (enable their independent evaluation, stir investment to ensure sufficient decarbonisation alongside CDR scale up)

Environmental side-effects of CDR:
Environmental side-effects might not be captured by an integrated market such as the EU-ETS (e.g. by incorporating the risk of high biomass demand and it's effect on the land-system) and **separating targets** on emissions and removals to avoid the overuse of CDR.



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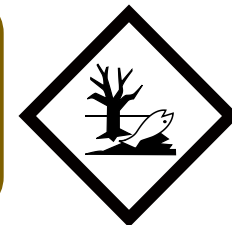
Part of model output

Economic efficiency losses are moderate for all but the highest CDR contribution to net-zero

A low CDR target alone might not be sufficient to prevent unsustainable biomass demand

Model output can inform ex-post analysis

Environmental side-effects of CDR:
Environmental side-effects might not be captured by an integrated market such as the EU-ETS (e.g. by incorporating the risk of high biomass demand and its effect on the land-system) and **separating targets** on emissions and removals to avoid the overuse of CDR.



Should CO2 emission and novel CDR targets be separate?

Our modelling framework is not equipped to answer this question but we provide two important arguments to be considered in the discourse.

Economic efficiency losses are moderate for all but the highest CDR contribution to net-zero

A low CDR target alone might not be sufficient to prevent unsustainable biomass demand

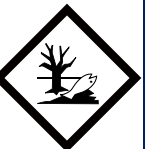
If targets were to be separate, how should they be chosen?

Strong arguments for ambitious reduction targets:

- lower cumulative emissions
- more financial leeway
- reduced risk of failure of large-scale CDR
- but comes at higher mitigation costs and higher CO2 prices

Flexibility depends on the objective:

- Policy credibility: Targets should be decisive and fix
- Environmental side-effects: targets should be adjusted, once more knowledge becomes available



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www.cdr-uptake.eu

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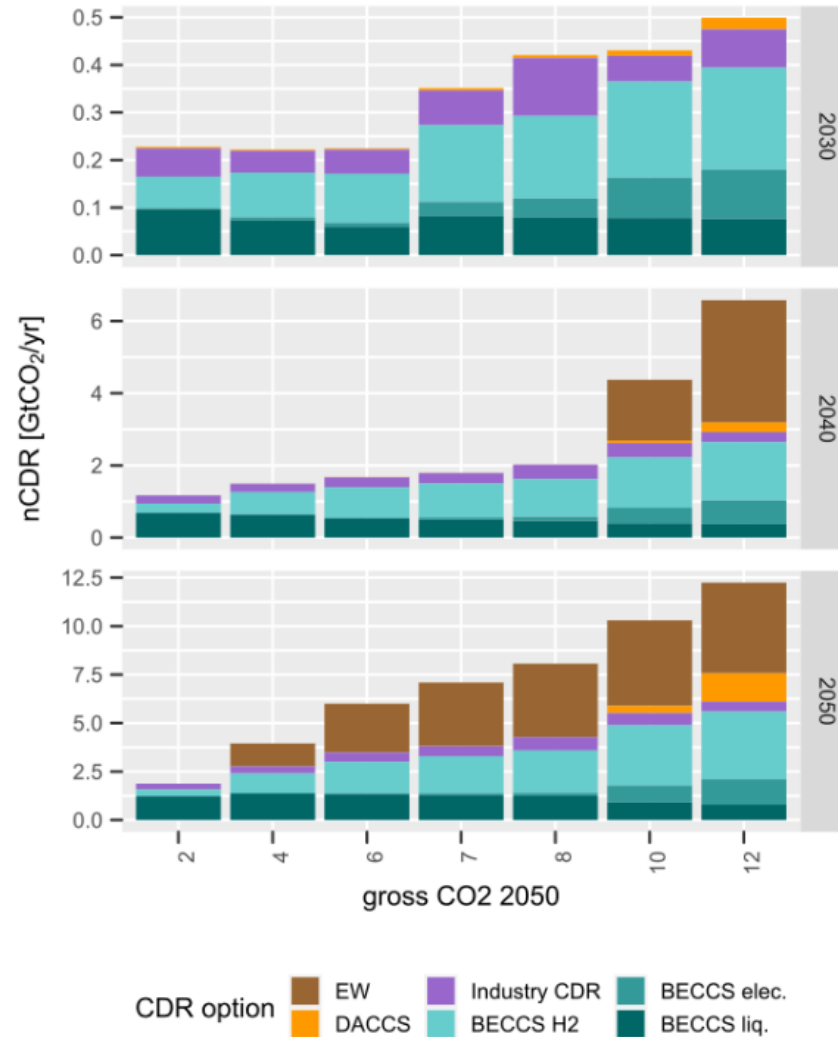
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3. Results

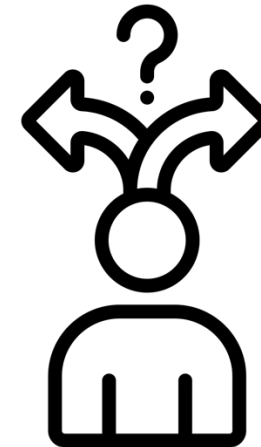


novel CDR deployment over time for different net-zero target formulations

3. Results

Consequences on

1. emission trajectories: **lower cumulative emissions** for more **ambitious reduction targets**
2. emission and removal prices: prices diverge. Nonlinear increase in **CO2 price** for **ambitious reduction target**.
3. financiability of CDR: More **financial leeway** if CDR price is below the CO2 price in **ambitious reduction target**
4. on economic efficiency: **consumption losses** are moderate for all but the highest CDR contribution
5. for the energy system
 - **Ambitious reduction targets** lower the dependency on Fossil fuels and geologic storage of carbon
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“If targets were to be separate, how should they be chosen?”

4. Discussion and policy implications

	Near term risks: quantities not realised yet	Consequences at net-zero if quantities are realised
Higher than market efficient contribution of CDR to net-zero	<ul style="list-style-type: none"> • Not enough reduction: higher overshoot • Envisioned CDR quantities cannot be realised • Mitigation deterrence enshrined in climate policy 	<ul style="list-style-type: none"> • CDR expenditure exceeds CO₂ tax revenues: heavy burden on public finance or additional burden on emitters
Lower than market efficient contribution of CDR to net-zero	<ul style="list-style-type: none"> • Potentially very high CO₂ prices -> higher transitional challenges • Envisioned emission reduction cannot be realised 	<ul style="list-style-type: none"> • CO₂ price > CDR subsidy could evoke pressure from high emitting industries to relax reduction target



“If targets were to be separate, how should they be chosen?”

Summary from scenario results:

Strong arguments for ambitious reduction targets:

- lower cumulative emissions
- more financial leeway
- reduced risk of failure of large-scale CDR

But comes at the cost of

- Higher CO₂ prices