OFFICE OF THE ENVIRONMENT
PRINCIPALITY OF LIECHTENSTEIN

NET RAPIDO

MÄLARDALEN UNIVERSITY SWEDEN

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Climate Strategies

Negative Emissions: The Emerging Debate

COP25 Madrid

4 December 2019

18:30-20:00

Side Event Room 1

@climatestrat

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Negative Emissions: The Emerging Debate

Welcome and Introduction

Dr Heike Summer, Office of the Environment, Principality of Liechtenstein

CO_2 removals: the political and governance challenges

Janos Pasztor, Carnegie Climate Governance Initiative (C2G)

Carbon removals using nature

Dr Jo House, University of Bristol

Carbon removals and the Paris Agreement

Matthias Honegger, Perspectives Climate Research

Technology developers and the NETs debate

Helen Atkinson, C-Capture

Civil society in the NETs discussions

Speaker tbc

Moderation: Andrzej Błachowicz, Climate Strategies

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Negative Emissions: The Emerging Debate

Thank you!

www.negative-emissions.info

Carbon Removals Using Nature: IPCC Special Report on Climate Change and Land:

Dr Jo House

Jo.house@bristol.ac.uk

@Drjohouse

INTERGOVERNMENTAL PANEL ON climate change

WMO UNEP

University of BRISTOL

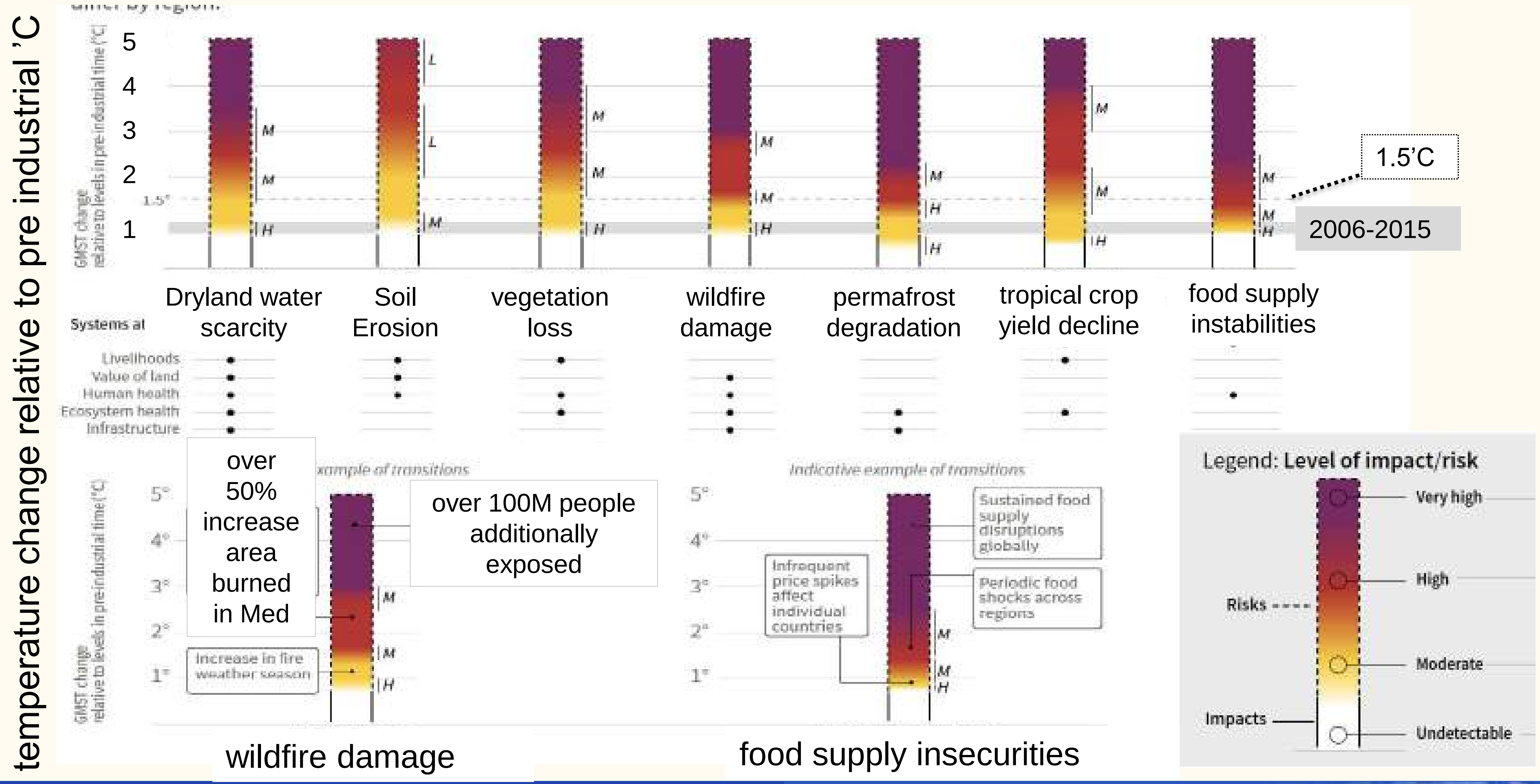
Land is where we live

Land is under growing human pressure

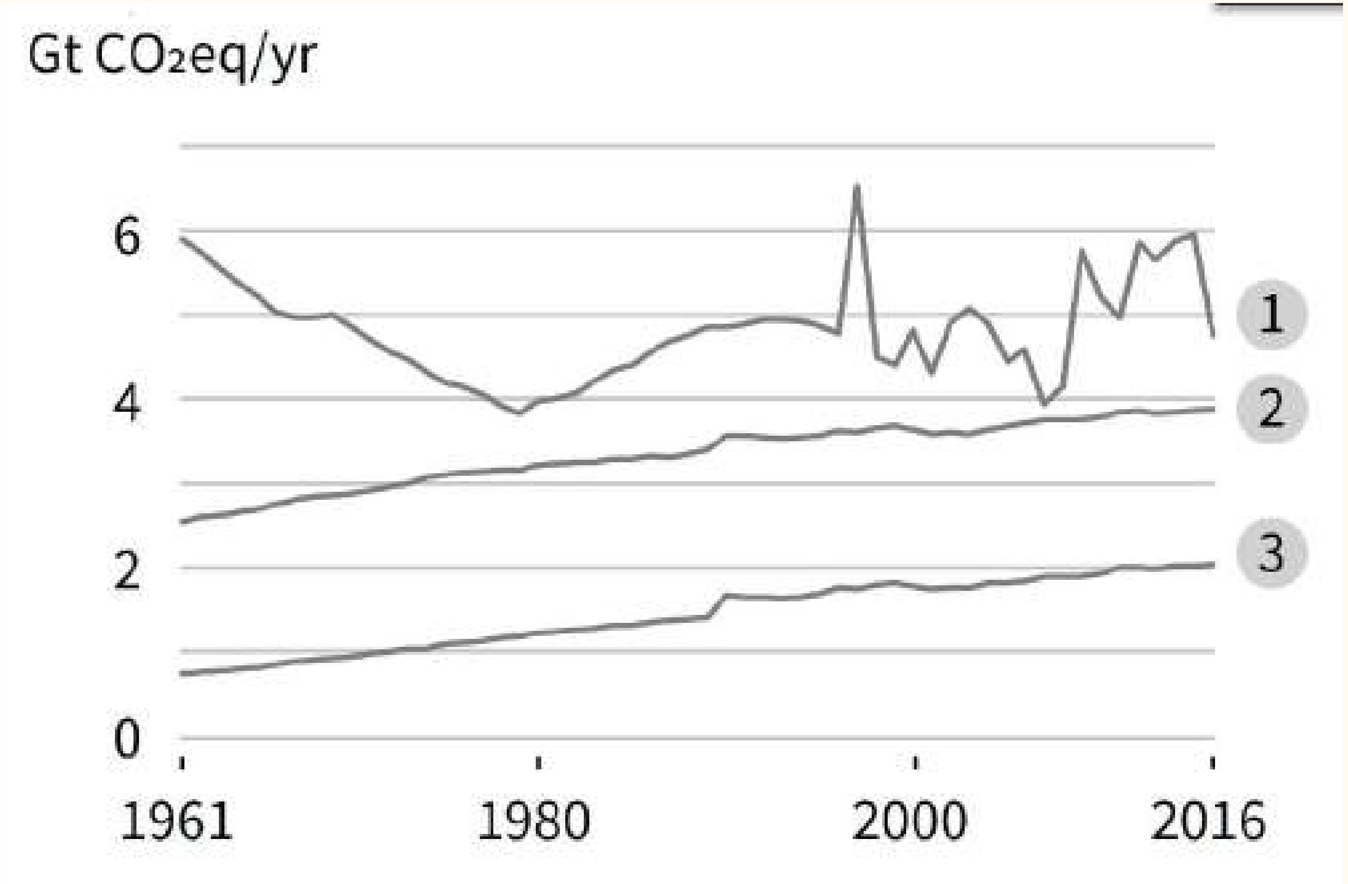
Land is a part of the solution

Land can't do it all

Risks to humans and ecosystems from climate change



Change in anthropogenic greenhouse gas emissions 1961-2016



Agriculture, Forestry and Other Land Use (AFOLU) activities accounted for 23% of total net anthropogenic emissions of GHG during 2007-2016

1. 13% of carbon dioxide CO_2 from deforestation, afforestation, and other land cover change
2. 44% of methane CH_4 from agriculture
3. 82% of nitrous oxide N_2O from agriculture

Including pre- and post-production activities in the global food: 21-37% of total net anthropogenic GHG emissions

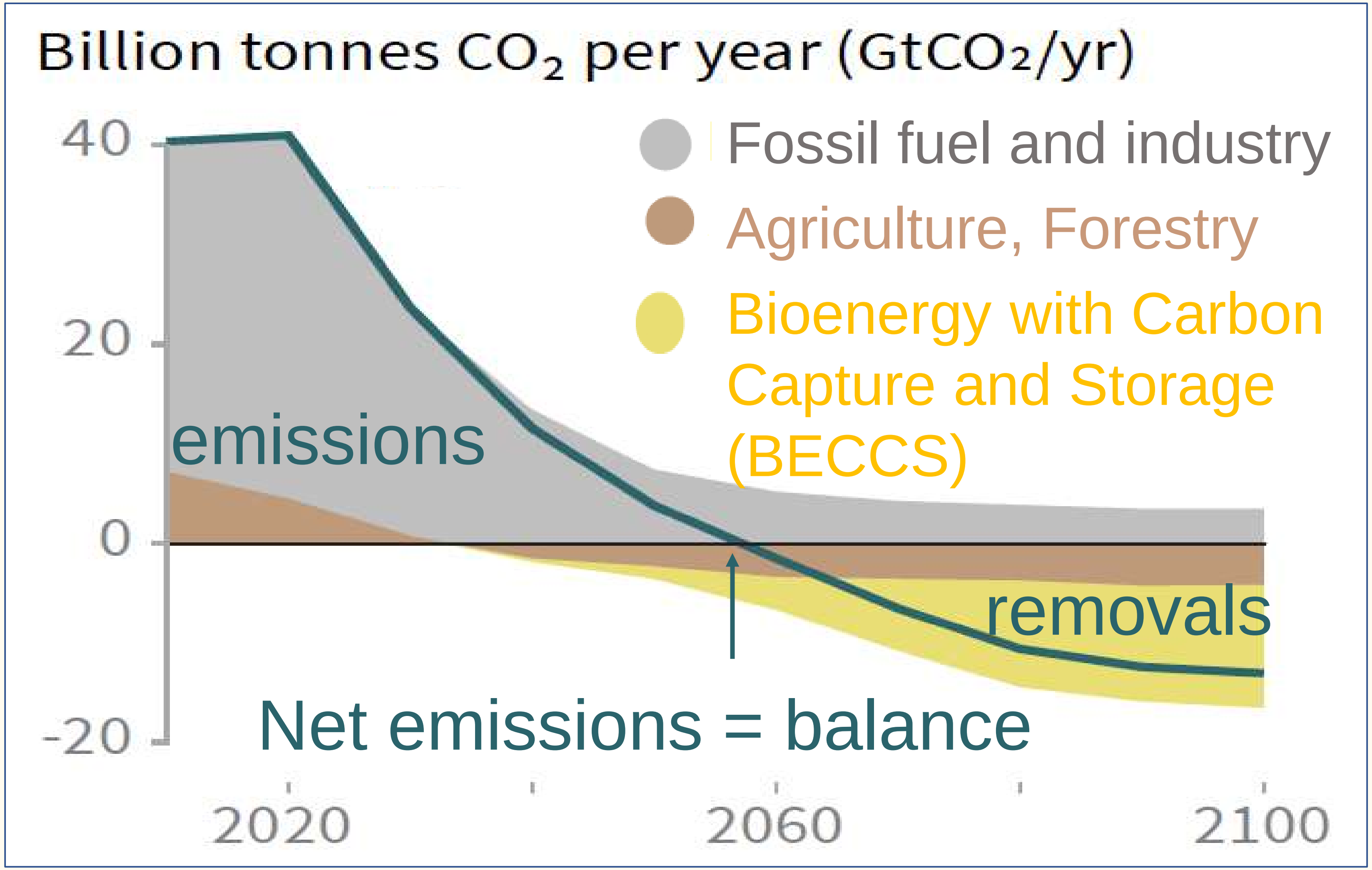
Natural land sink of CO_2

The natural response of land to human-induced environmental change caused a net sink of around 11.2 $GtCO_2$ yr-1 during 2007-2016 (equivalent to 29% of total CO_2 emissions) (*medium confidence*)

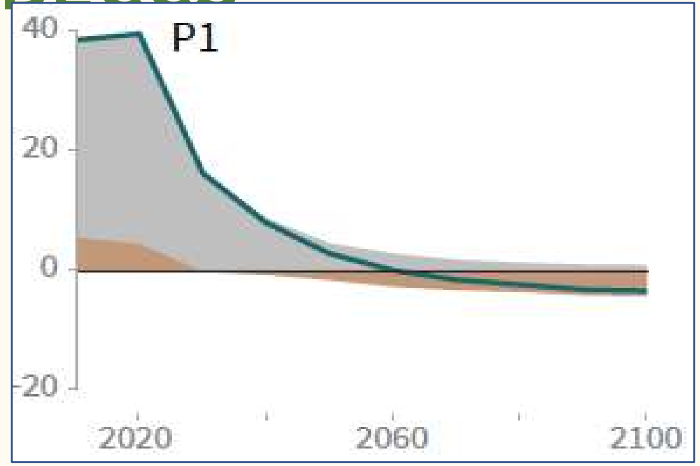
The persistence of the sink is uncertain due to climate change (*high confidence*).

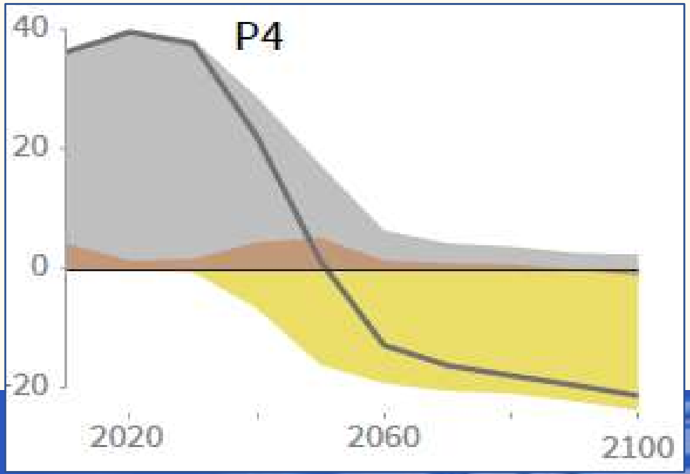
Borneo, Central Kalimantan photo Jo House

How do we get to 1.5 degrees?



Multiple different pathways: Less fossil fuel action requires more BECCS



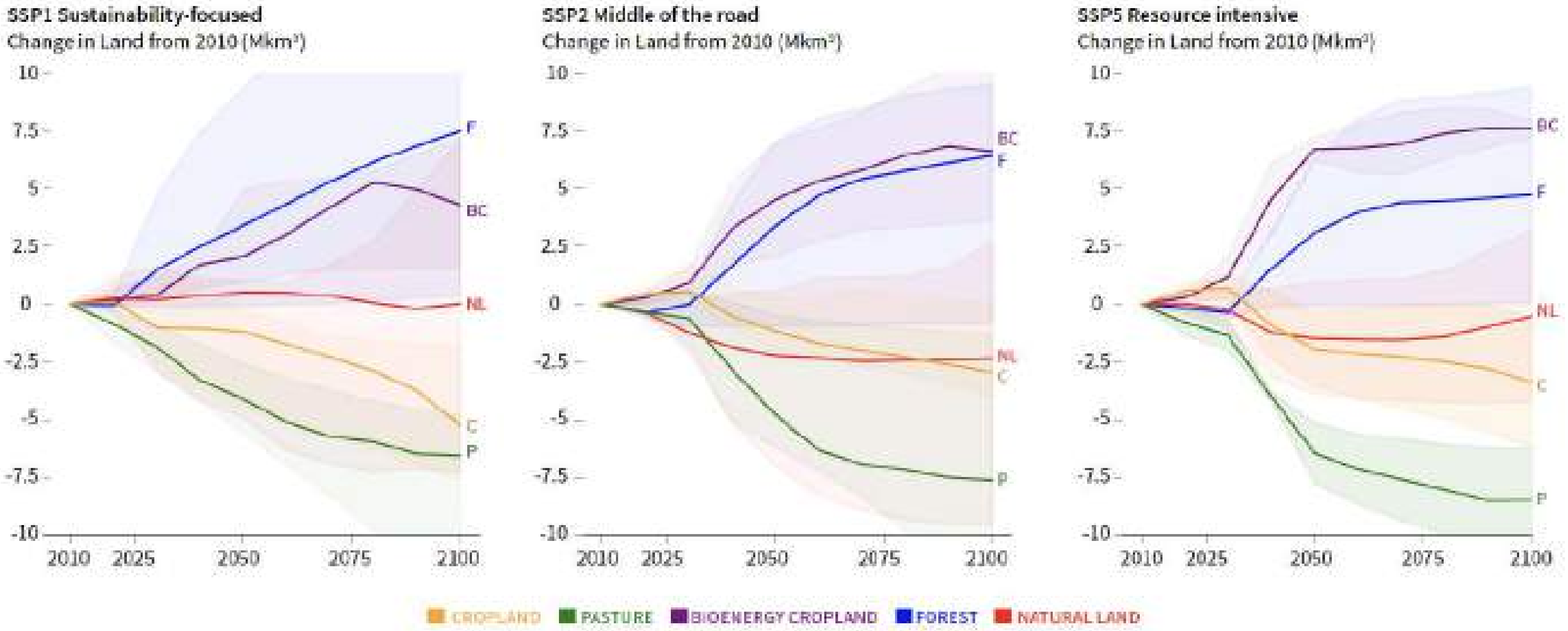


Change in land(Mha) area from 2010 across scenarios RCP 1.9, RCP2.6 RCP4.5 for different SSPs

A. Sustainability-focused (SSP1)
Sustainability in land management, agricultural intensification, production and consumption patterns result in reduced need for agricultural land, despite increases in per capita food consumption. This land can instead be used for reforestation, afforestation, and bioenergy.

B. Middle of the road (SSP2)
Societal as well as technological development follows historical patterns. Increased demand for land mitigation options such as bioenergy, reduced deforestation or afforestation decreases availability of agricultural land for food, feed and fibre.

C. Resource intensive (SSP5)
Resource-intensive production and consumption patterns, results in high baseline emissions. Mitigation focuses on technological solutions including substantial bioenergy and BECCS . Intensification and competing land uses contribute to declines in agricultural land.



Multiple pathways: Less BECCS would require more afforestation to meet targets

- Bioenergy area change 0-750 Mha (roughly size of India)
- Forest area -200 to 7200 Mha change

IPCC SRCCL SPM4

Mitigation in the land sector

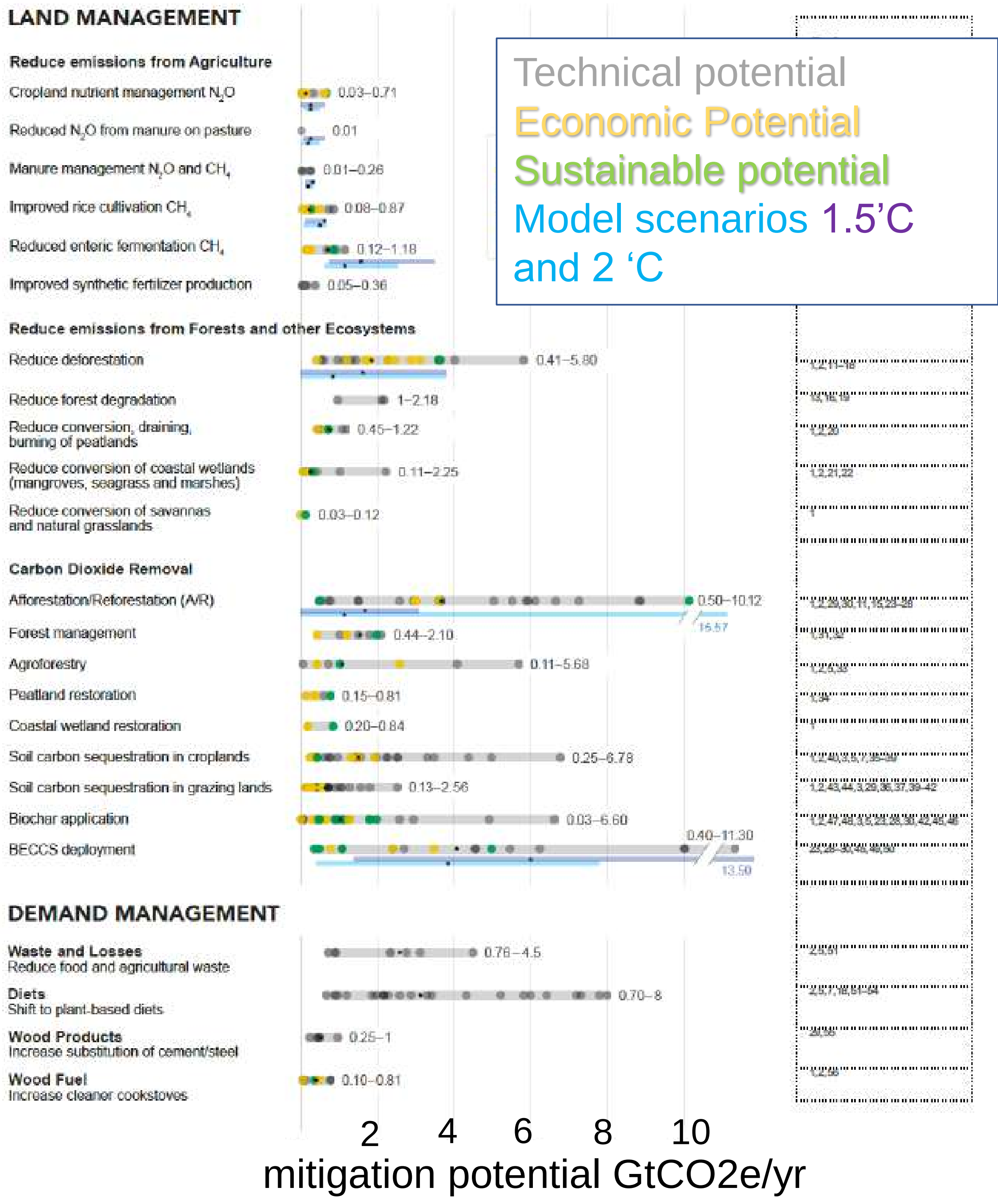
- Wide range of estimates from the literature
- Not additive
- most potential: afforestation; BECCS; Diet change

Reduced emissions from agriculture

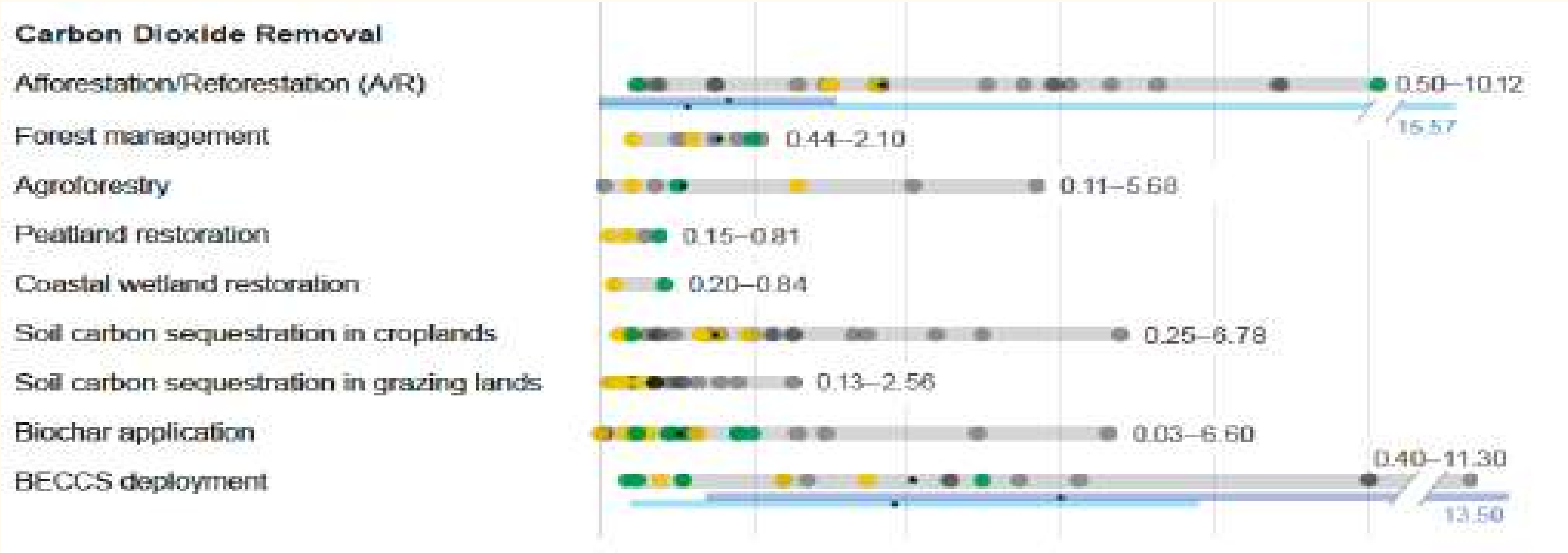
Reduced emissions from forests and other ecosystems

Carbon dioxide removal

Demand management



IPCC SRCCL fig 2.24, from Roe et al Nature climate change 2019

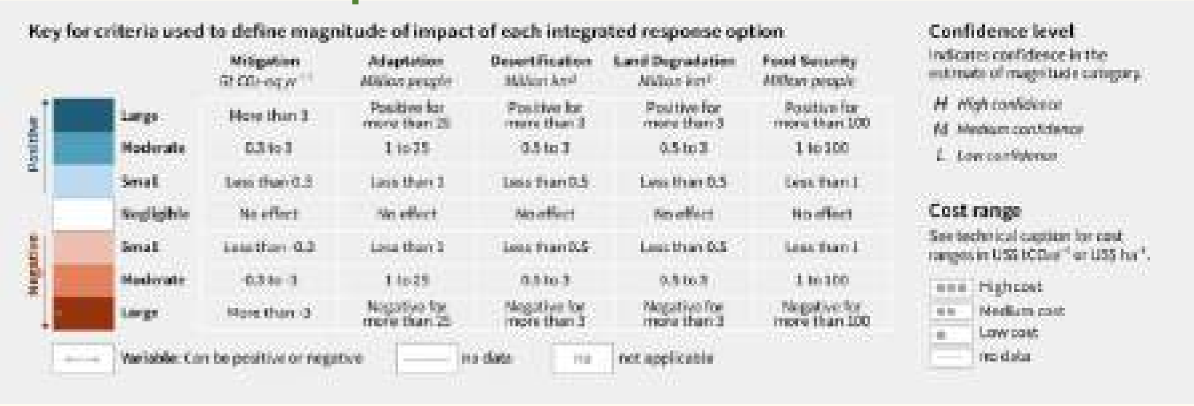


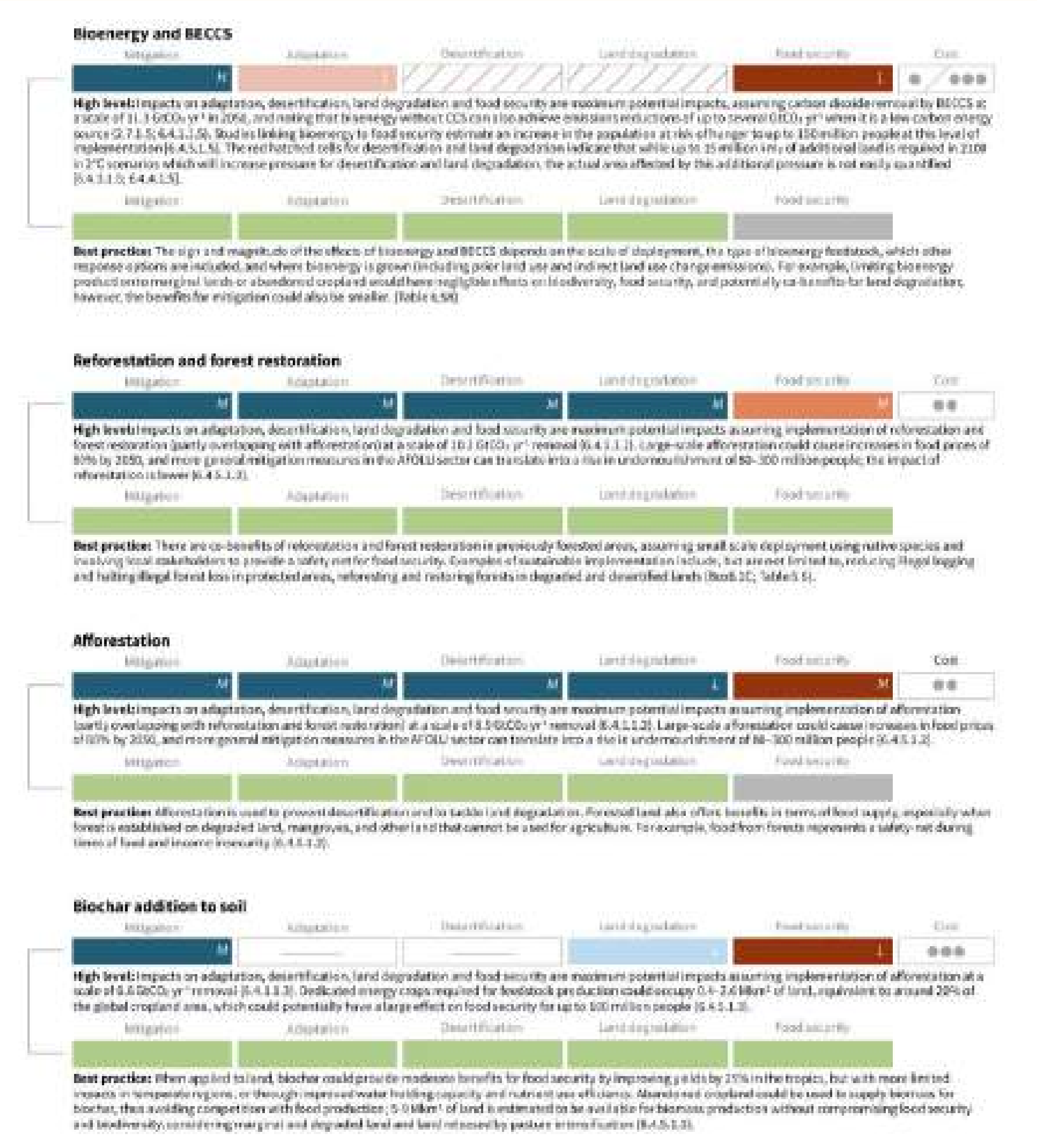
mitigation potential GtCO2e/yr

IPCC SRCCL fig 2.24, from Roe et al Nature climate change 2019

CO-benefits and trade-offs

- Lots of options have positive impacts (blue) across all of climate change mitigation and adaptation, delivering food security and tackling land degradation and desertification
- Some free up land, while others take up land

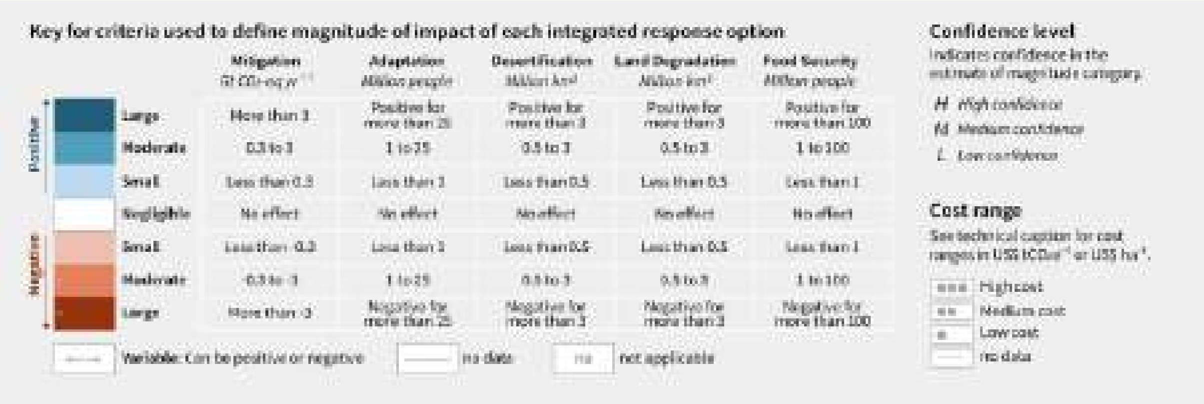




Some NETS have both positive of negative impacts based on the context (location, scale, sustainability).

Negative effects for NETS can occur when applied at scales, ways and in places that lead to high land competition for food and other ecosystem services (e.g biodiversity), or high water demand.

In appropriate contexts and scales, there can be many co-benefits



Land is where we live

Land is under growing human pressure

Land is a part of the solution

Land can’t do it all

Thankyou

Jo.house@bristol.ac.uk. @Drjohouse

Carbon removals and the Paris Agreement

Matthias Honegger
Research Associate
Perspectives Climate Research

UNFCCC COP25 Side Event „Negative Emissions: The Emerging Debate"
Madrid, 04.12.19

Definitions

- **Mitigation**: *limiting anthropogenic emissions of greenhouse gases and protecting and enhancing greenhouse gas sinks and reservoirs* (UNFCCC, 1992, Art. 4.2.a).
- **Sinks**: "any process, activity or mechanism which removes a greenhouse gas (...) from the atmosphere" (UNFCCC, 1992, Art. 1.8).
- To reach the PA temperature targets, Parties are to "… achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century." (PA Article 4.1)

Carbon Dioxide Removal and NDCs

- All reference to "mitigation" applies to CDR
- Incl. stipulations on **NDCs**
  - Parties' communication on mitigation activities
  - and their alignment with global temperature goals
- Expectation and **pressure to undertake CDR** as part of NDCs likely to grow with awareness of net-zero emissions necessity
  - Current NDCs are not systematically building a basis for CDR other than by forest protection and ecosystem preservation
  - Some working on CCS capacities (building blocks for some CDR), but falling short of IPCC projections

Envisioning stabilization of atmospheric GHG

- 1.5 – 2°C: Net-zero emissions: how to mobilize CDR potential
- Low emission development strategies (**LEDS**) to 2050 – ideal to explore and envision “distant” future
- Sketch milestones e.g. in 2030, 2040 and 2050
  - Dedicated R&D programs
  - Sector-specific actions
  - Deliberation processes
  - Explicit targets for CDR rates in 2030, 2040 and 2050?

Planning for stabilization of atmospheric GHG

LEDS and/or continued NDC revision process:

- Dedicated **longer-term dialogue process** with diverse range of **mitigation (incl. CDR) experts** & other private sector and civil society stakeholders
- Continuous **deliberation and reality checks**: trade-offs and side-effects of mitigation (incl. CDR) policies
- **Accelerate research, development and piloting** of CDR approaches via a dedicated publicly funded R&D program
  - Enable competitive development
  - Meet R&D needs at their respective development stage
  - Continuously explore sustainable development implications

Pledging Net-Zero emissions in the NDC

- Set **specific CDR targets** alongside emissions reductions targets in NDCs
- Define sector-specific targets and policies
  - Forestry, agriculture sector, ecosystem preservation: nature-based CDR (CO2-storage in soils, biomass)
  - Energy Sector: BECCS or (biomass-)waste-to-energy-CCS.
  - Materials, construction and housing: new CO_2-binding materials
  - Waste treatment with CCS

- Aim for **net-zero** emissions within each **sector**
- Some sectors could deliver net-negative emissions (e.g. energy sector?)
- Others might keep residual emissions (agriculture)

Implementing CDR on the way to Net-Zero emissions

- Dedicated **policy instruments** needed: mandated action (e.g. emissions standards) or monetary incentives:
- ”**Carrots”** or **“sticks”**:
  - Direct RDD&D funding
  - Direct subsidies or tax exemptions for CDR
  - Emissions trading scheme (allowing CDR to generate offsets)
  - Tenders for the provision of public CDR infrastructure
  - Direct public investments (e.g. state-owned utilities)
- Communicate sector-wide policies as “NAMA”?
- Follow/develop best-practice MRV approaches!

MRV - Monitoring Reporting and Verification

- **Credible MRV** is precondition for long-term **success**
- Reporting on CDR can in principle be done via **national inventories** – but detailed MRV might be needed for policies
- CDR defined as "removal from atmosphere" – over entire lifecycle of an activity!
- **Carbon markets** (Art. 6.2 or 6.4) could help mobilize CDR – require international MRV methodologies
- Menu of established **MRV methodologies** or elements
  - for CCS MRV elements (EUETS, EU CCS directive, CDM, 45Q, Carbon Capture and Sequestration Protocol under California's Low Carbon Fuel Standard, …)
  - for forestry sinks MRV (REDD+)
- Novel MRV baseline and crediting methodologies needed for other removals

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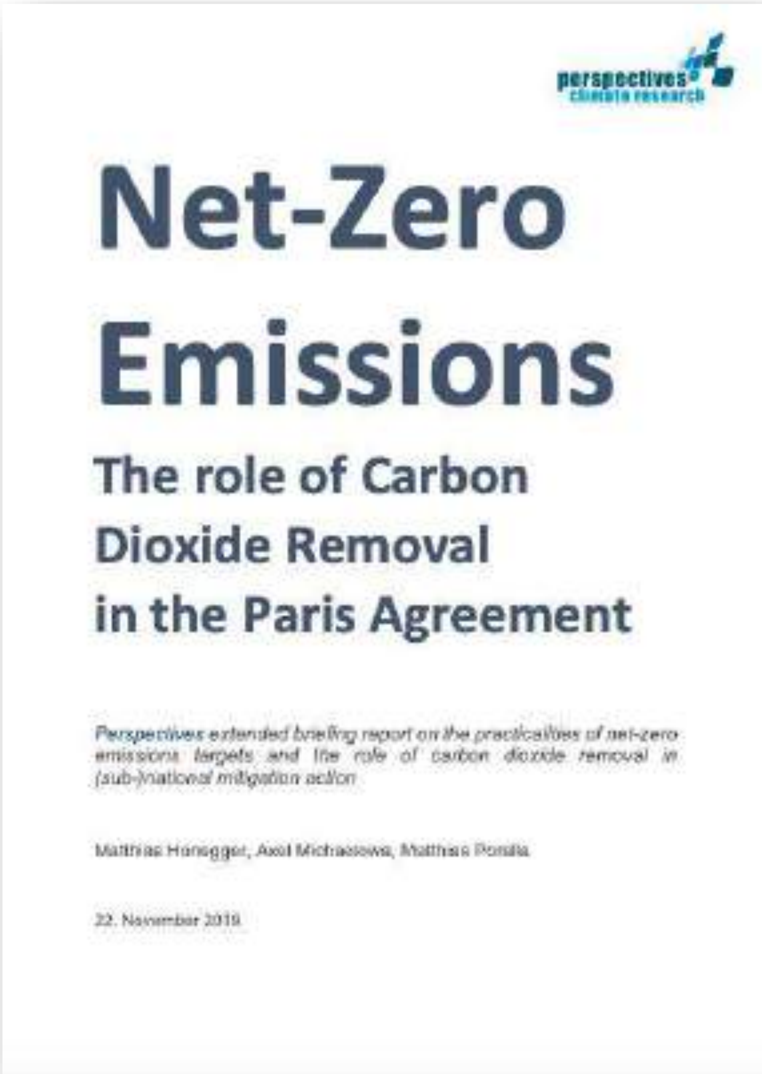

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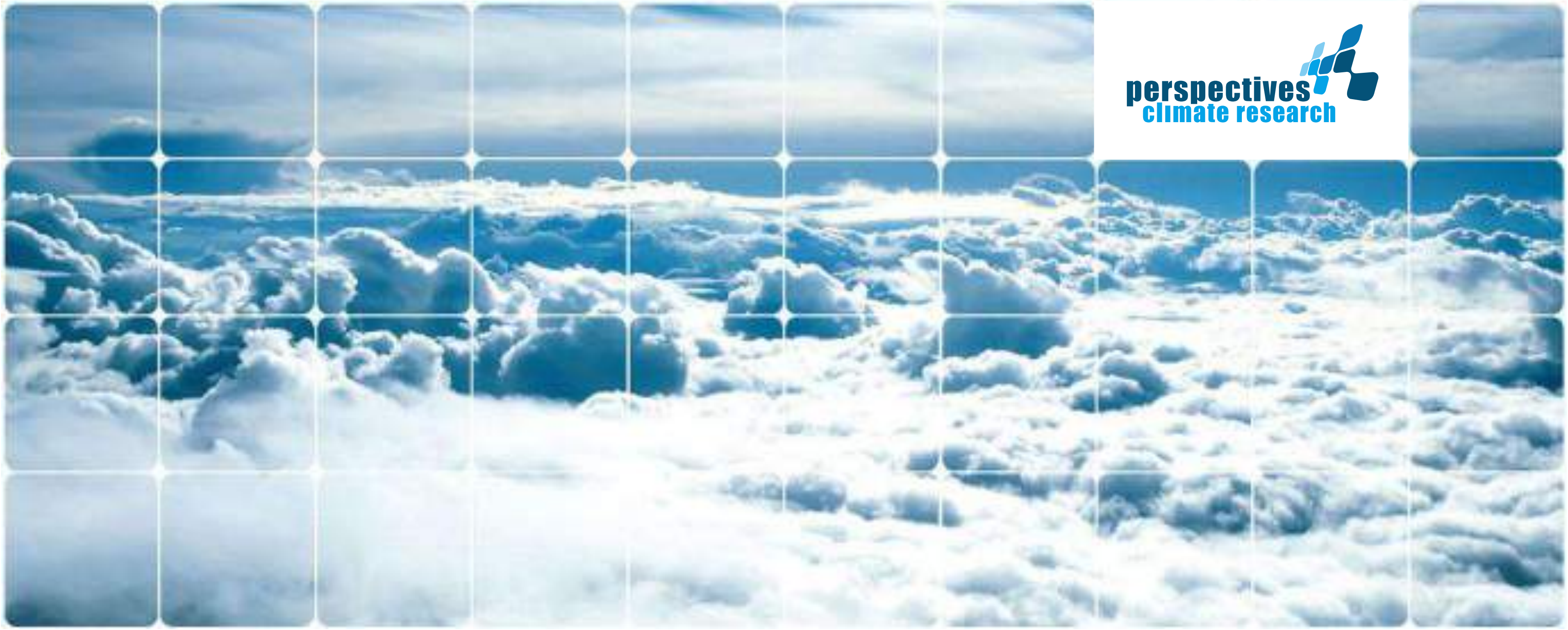

Matthias Honegger

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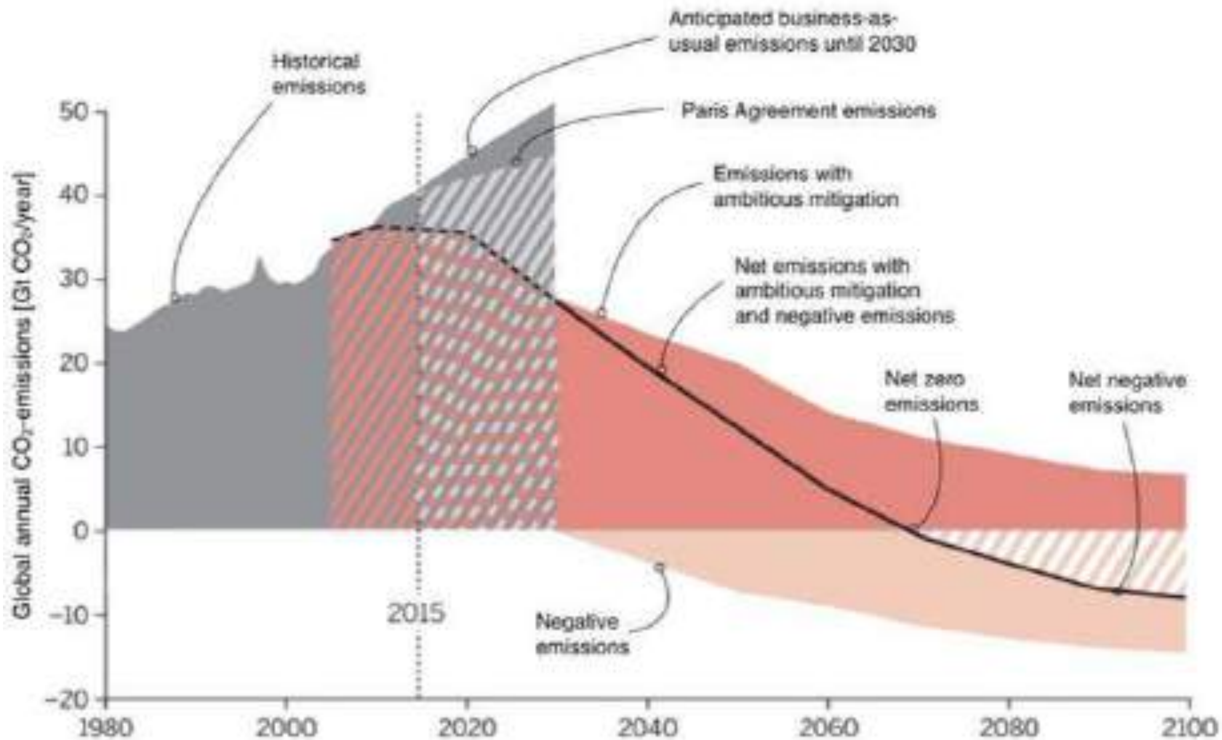
www.perspectives.cc

...well below 2°C & if possible 1.5°C...

- Paris 1.5 – 2°C target: billions of tons of net CO_2-removal annually 2050-2100
- That's removal "on top of" net-zero emissions:
  - USA: -1Gt/y
  - EU: -0,42Gt/y (Germany: -0,12Gt/y)
- Developing countries: positive emissions budgets up to 2100



Honegger et al., 2017[1]; *adapted from: Anderson, K., & Peters, G. (2016). The trouble with negative emissions. Science, 354(6309), 182-183*

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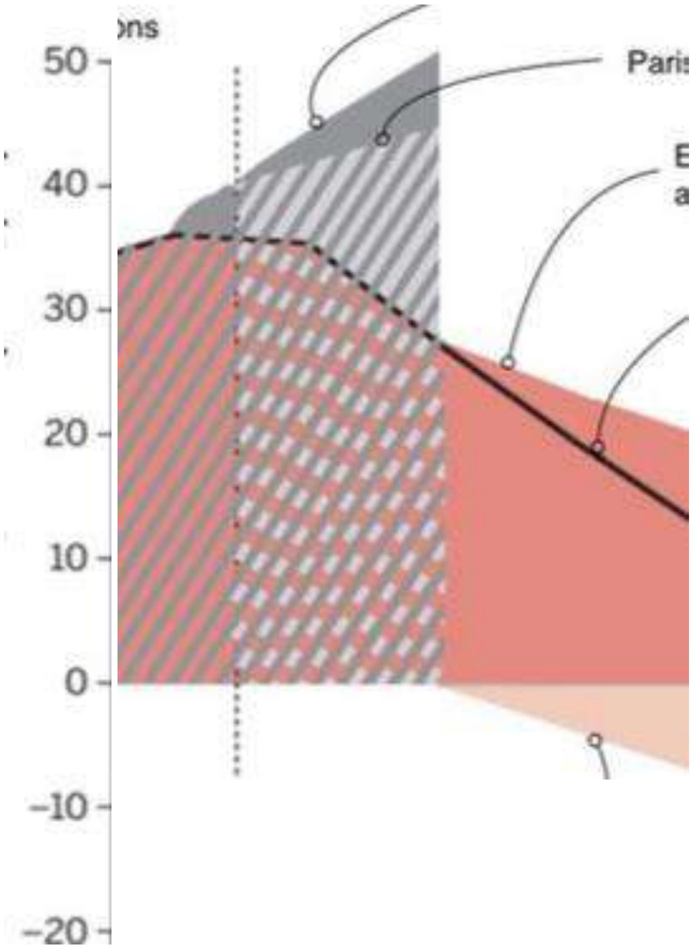
Immediate action presumed

- NETs a sub-category of mitigation
- NETs not done without incentives

  => require policy instruments
- Lots of NETs potential in developing countries
  (but burden is on industrial countries)

  => NE-transfers are needed
- “Hidden magic” between 2020-2050
  - NE at Gt-scale
    - from 2030 for 2°C
    - from 2020 for 1.5°C
- To work, policy instruments needs to:
  - Maintain acceptability in donor and recipient country
  - Ensure compatibility with SDGs
  - Provide credible NE in return for a reliable financial flow



Financial challenge of NETs

- Mitigation action generally motivated by non-GHG reasons
  - Saved energy-costs
  - Energy independence
  - Jobs
  - Health benefits (reduced pollution in households e.g. coostoves)
- Most NETs don‘t seem to have those ‚co-benefits‘
  - Without GHG-revenue NETs will not be deployed
  - Credible NE-transfers require a centrally organized measuring, reporting and verification (MRV) system that ties into the international GHG-accounting infrastructured
- 90% of BE estimated to be equipped with CCS at carbon price > $150
- Currently 13% of global GHG emissions are priced
  - of which over 75% are at less than 10$/t$CO_2$-eq (World Bank, 2016)

In addition: Economics isn‘t everything! NETs deployment requires consideration of Sustainable Development!

The Paris Agreement and the SDGs

- **The Paris Agreement by tackling climate change embodies the operationalization of SDG 13**

- **AND**

- **it contains an instrument to operationalize SDGs.**

*„...some Parties choose to pursue voluntary **cooperation** […] in their mitigation and adaptation actions and to **promote sustainable development** and environmental integrity.“ (Art. 6 paragraph 1)*

*„A mechanism to contribute to the mitigation of greenhouse gas emissions and **support sustainable development** is hereby established...“*
(Art. 6 paragraph 4 – SDM)

SD-Lessons learned from classical mitigation

- Kyoto Protocol‘s key mechanism (CDM):
  - **Host countries define** criteria, indicators, decisionmaking process to approve proposed actions
  - **Critizised by NGOs** for lack of consistency and absence of consequential stakeholder consultation processes
- Voluntary carbon markets:
  - Hiqh-quality assessments of SD contributions is **costly**
  - Remains a **niche market**
- National **mitigation policies** and climate **finance** institutions:
  - Donor organizations have **different approaches** to SD
  - Countries‘ efforts to mitigate are often driven by expected results toward **few very specific sustainable development outcomes**

SD-Lessons learned II

- **Ambiguity** of Sustainable Development concept was both[1]
  - an **advantage**
  - a **barrier** to action
- 17 SDGs and 169 Targets are a **breakthrough** toward policy operationalization
- Differences remain:
  - Developing countries emphasize
    - **Development**
    - **National sovereignty** in defining SD criteria
  - Industrialized countries, many donors & NGOs emphasize
    - **Sustainability**
    - **International approach** to SD

([1]For an overview over SD-related discussions and procedures within climate governance, see Dransfeld et al. 2017)

NETs-relevant lessons learned

- Past technology cases (e.g. Biofuels, CCS) provide a **cautionary tale**:
  - Political support for- and public perception of technologies is intertwined
  - Deploying "mitigation-only" technologies without obvious co-benefits might not (ever) become a **politically attractive** choice?
  - Not in my backyard type of opposition in addition also to be expected, when more global SD-concerns are addressed (yet may be more easily addressed if economics add up; e.g. renewables).

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Next steps for Paris Mechanisms - Article 6

- Parties are working on the **rulebook** for the Paris Mechanisms with a view to adopt it in 2018
- **Multitude of instruments** possible under Article 6 para 2 & 3 only subject to **guidance**
- **Specific mechanism** established in Article para 4 subject to UNFCCC **rules and oversight**
- **How** will the **mechanisms operate to generate GHG units**, transfer them and how will they be accounted for?
- **What** will be the **process of ensuring sustainable development** contributions of actions under the Mechanism?
  - **Will there be common criteria** to be used ex ante to accept/reject proposed actions?
  - **Who accepts/rejects** proposed actions?
  - **Who reports** on SD contributions of actions ex post and **how**?

Joint operationalization of SDGs & Art. 6

- A **direct link to policy instruments** to yield demonstrable results on SDGs and prevent harm
- Requires elaborating **criteria and indicators suitable for article 6**
- A direct link to SDGs would strengthen **legitimacy** of proposed actions

How?

- Parties could request the UNFCCC secretariat to prepare a technical paper on the **experiences with SD-safeguards** of multilateral and financial institutions
- The COP could establish a **working group** under the **UNFCCC** and facilitate establishment of a corresponding body under the **2030 Agenda**
- **NGOs** should come up with **their own safeguard proposals** to fuel the debate

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Consequences of policy instrument design

- Develop SDG criteria to evaluate NET deployment options helps **understand volumes of NE that might be feasible**
  - This would fill severe knowledge-gaps in **mitigation pathway scenarios**
    => likely result in a **downward correction of NETs potential** contributions
- Ensuing discussion of mitigation and ambition to achieve sufficient carbon pricing would clarify further aspects of the **mitigation ambition gap**
  - Realization regarding appropriate levels of mitigation targets (>100% in industrialized countries by 2040's)

References

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COP25

Negative Emissions: The Emerging Debate

Dr Helen Atkinson
Business Development Manager
h.atkinson@c-capture.co.uk

C-Capture

designing world-leading chemical processes for carbon dioxide removal

Our Vision

- To create the most energy efficient CO_2 capture solutions through chemistry & engineering innovation
- To create solutions which are viable on a large scale
- To play in role in saving the planet

Patented Dec. 2, 1930 **1,783,901**

UNITED STATES PATENT OFFICE

ROBERT ROGER BOTTOMS, OF LOUISVILLE, KENTUCKY, ASSIGNOR TO THE GIRDLER CORPORATION, OF LOUISVILLE, KENTUCKY, A CORPORATION OF DELAWARE

PROCESS FOR SEPARATING ACIDIC GASES

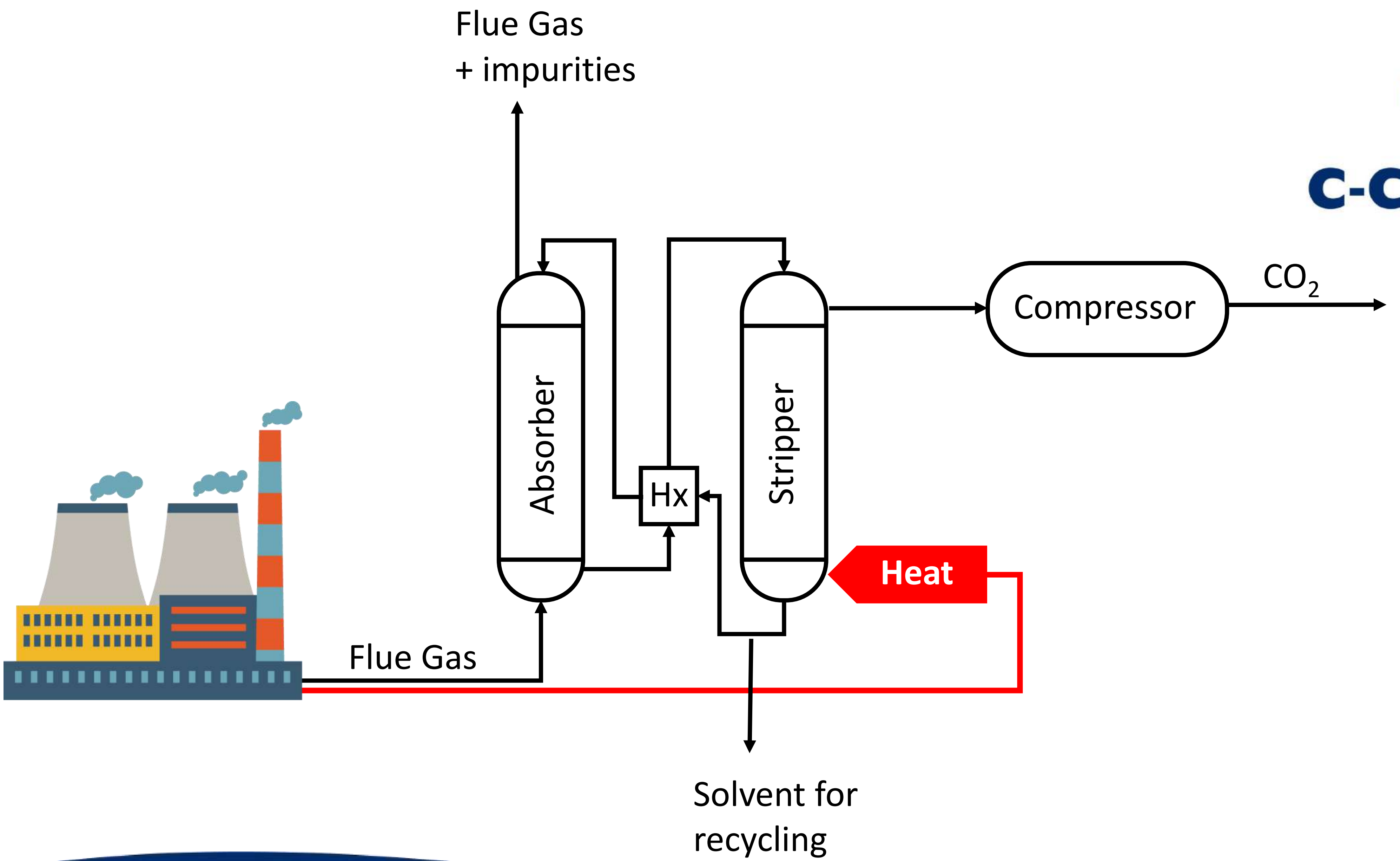
REISSUED

Application filed October 7, 1930. Serial No. 486,918.

I have discovered that certain organic nitrogen compounds of the class known as amines may be employed for this purpose. An amine may be considered as an ammonia substitution compound in which one or more of the hydrogen atoms of the ammonia are replaced by a group containing carbon and hydrogen.

There are challenges associated with the amine- based systems which our technology has sought to overcome

Our solvent is amine free & N free: no danger of increased reactive N in surrounding environment. We must ensure that as we deploy CCS technology on a large scale, we don’t negatively impact farmland & the health of people who near CCS plants


Flue Gas
+ impurities
Absorber
Hx
Stripper
Compressor
CO_2
Heat
Flue Gas
Solvent for
recycling

C-Capture

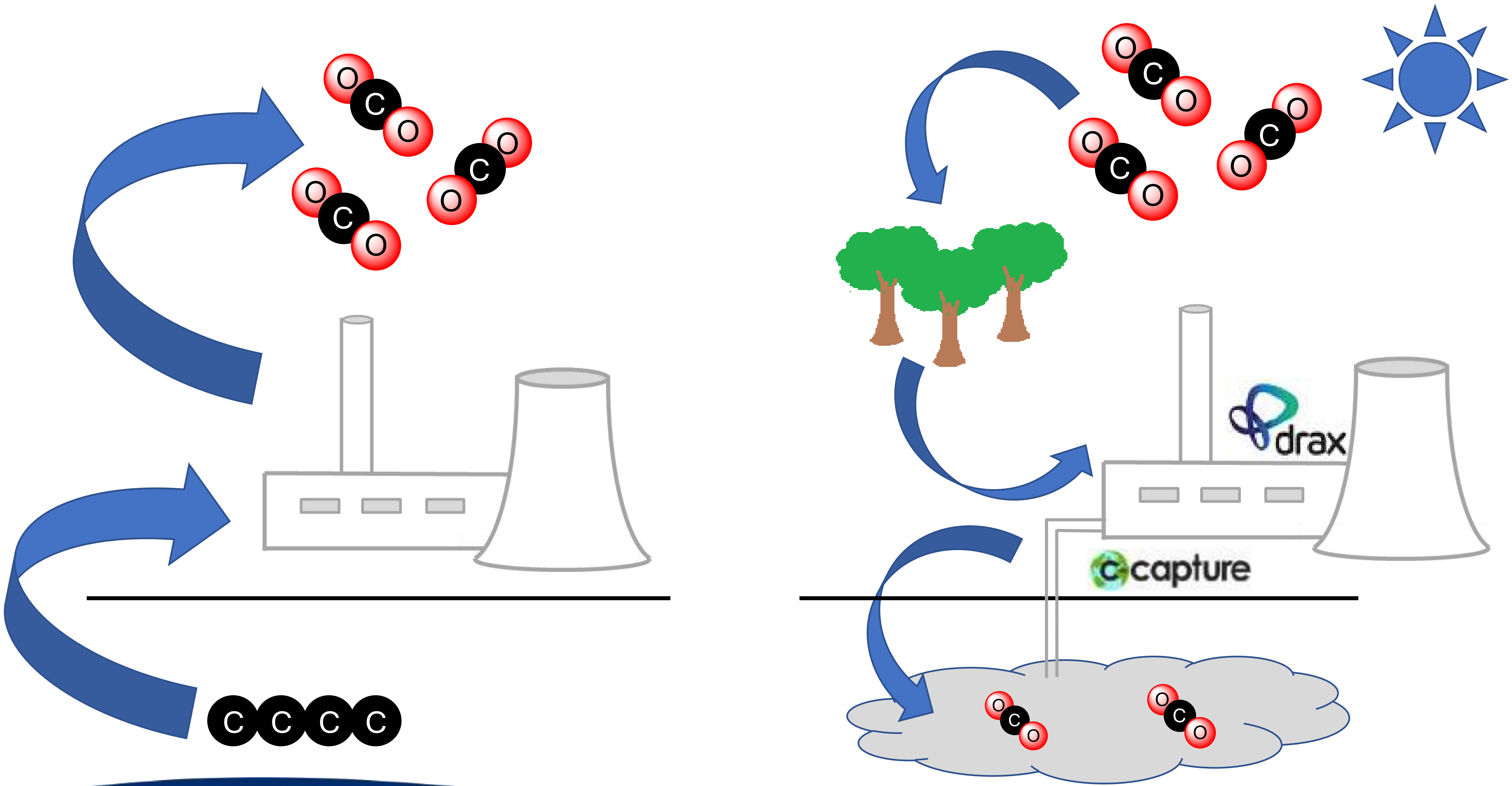
grams CO_2/day - lab

kgs CO_2/day - miniplant

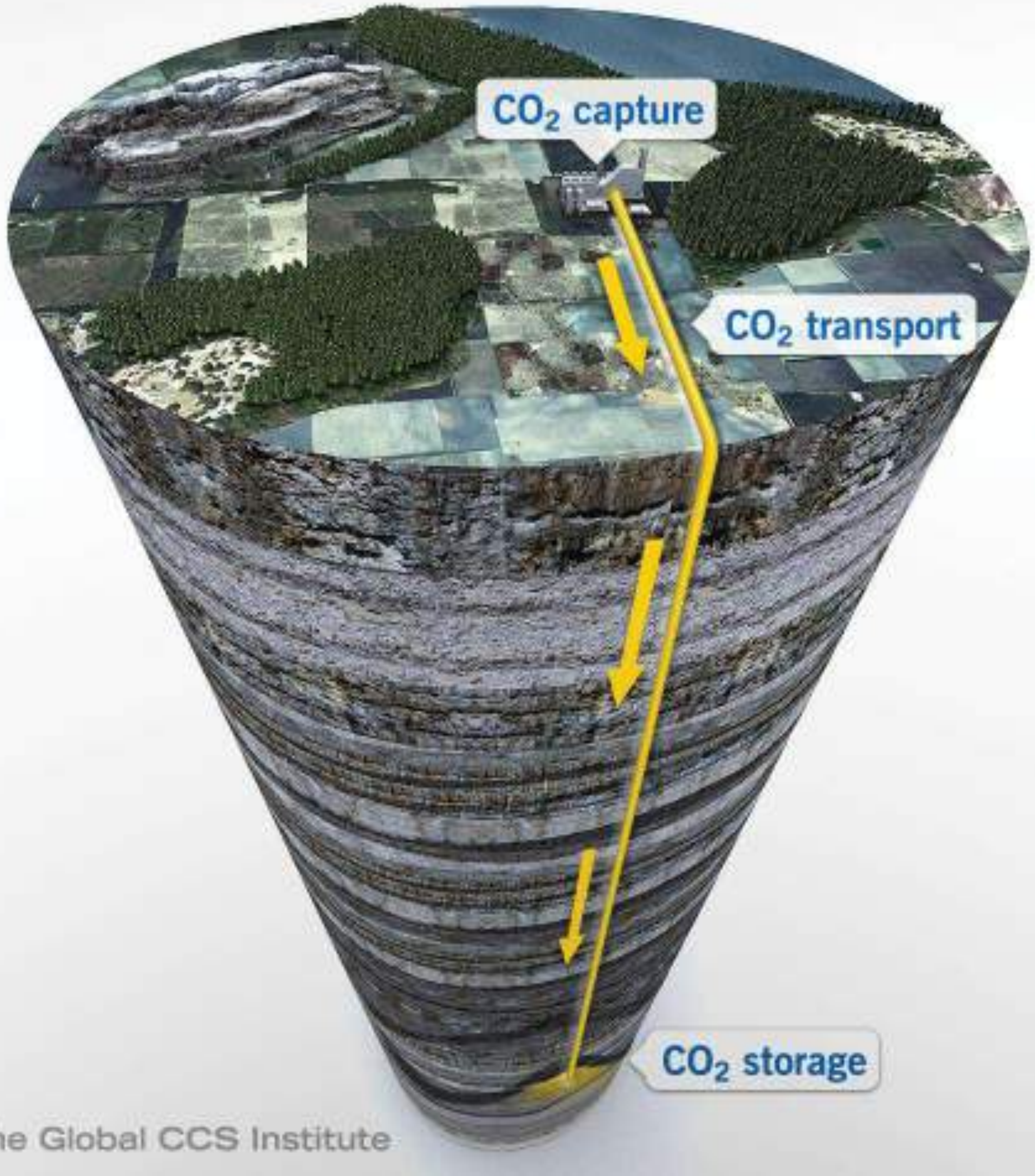
100s kgs CO_2/day - biogas trials

1 tonne CO_2/day - biogas trials

C-Capture


drax
capture

THE CARBON CAPTURE AND STORAGE PROCESS



Provided by the Global CCS Institute

C-Capture is working with Drax as it scales up CCS technology to become the UK's first negative emissions power station

New 10 column absorber allows more flexibility and accessibility in the system as we carry out our tests

SINTEF

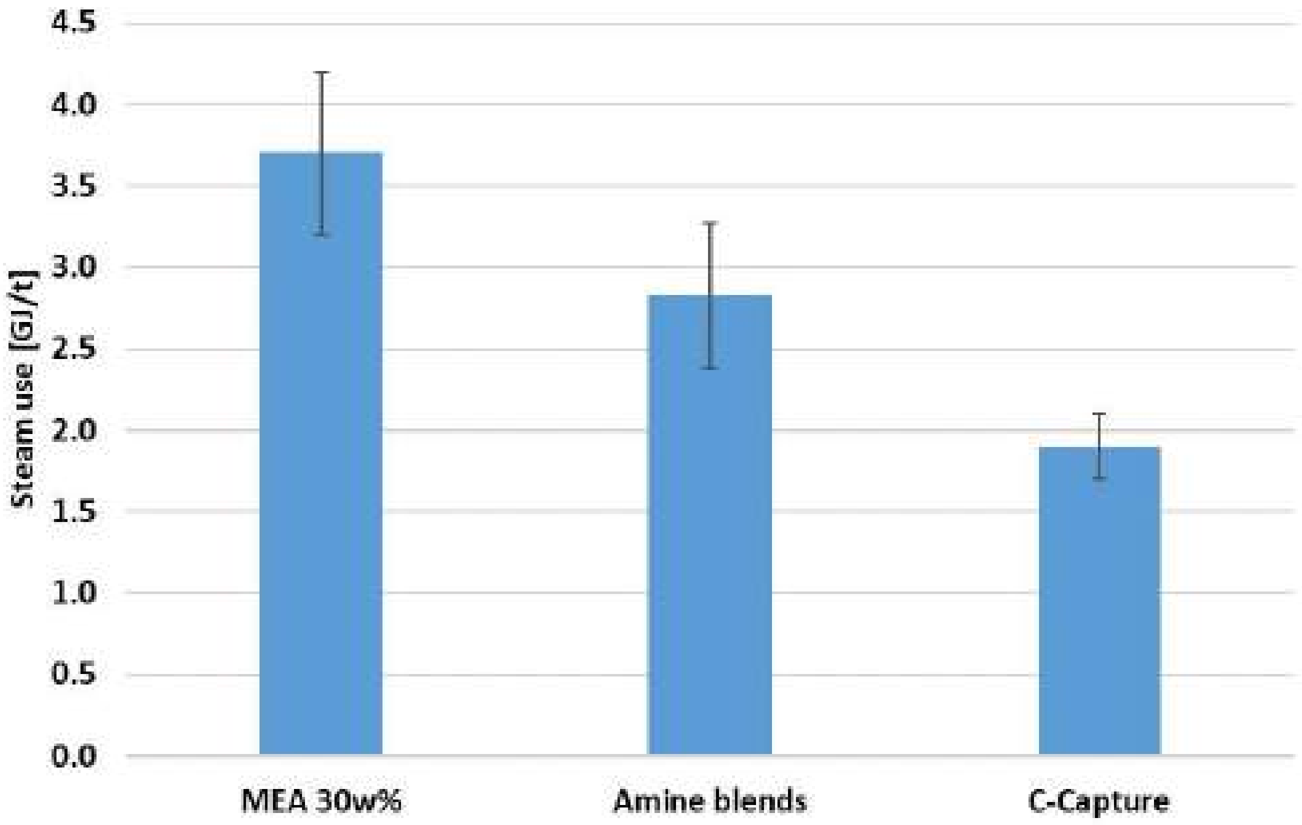
CO_2 TECHNOLOGY CENTRE MONGSTAD

C-Capture’s unique solvent

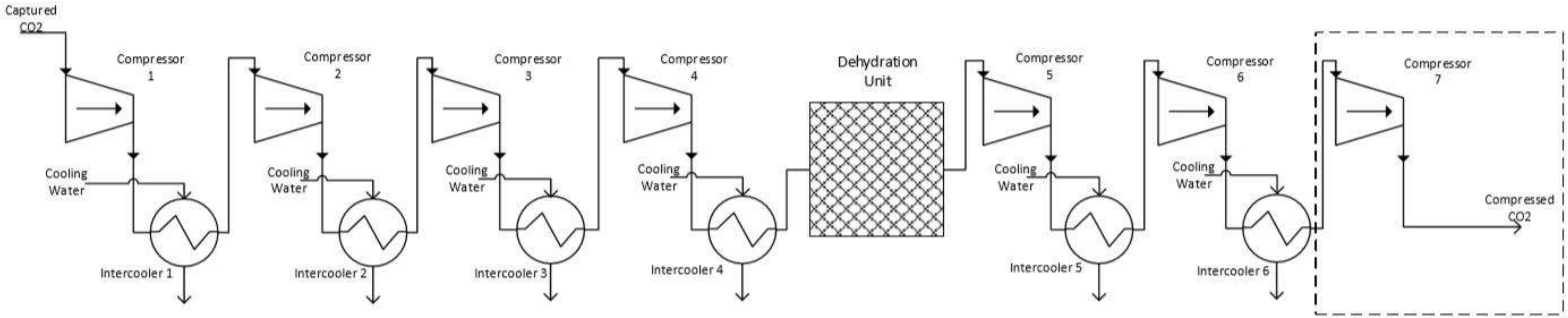
Low corrosivity avoids having to replace equipment frequently, reduces maintenance time, reduces capital expenditure and avoids ever seeing pipework like this

Less volatile than amine alternatives, less likely to react with any particles that pass through the absorber, leading to reduced emissions

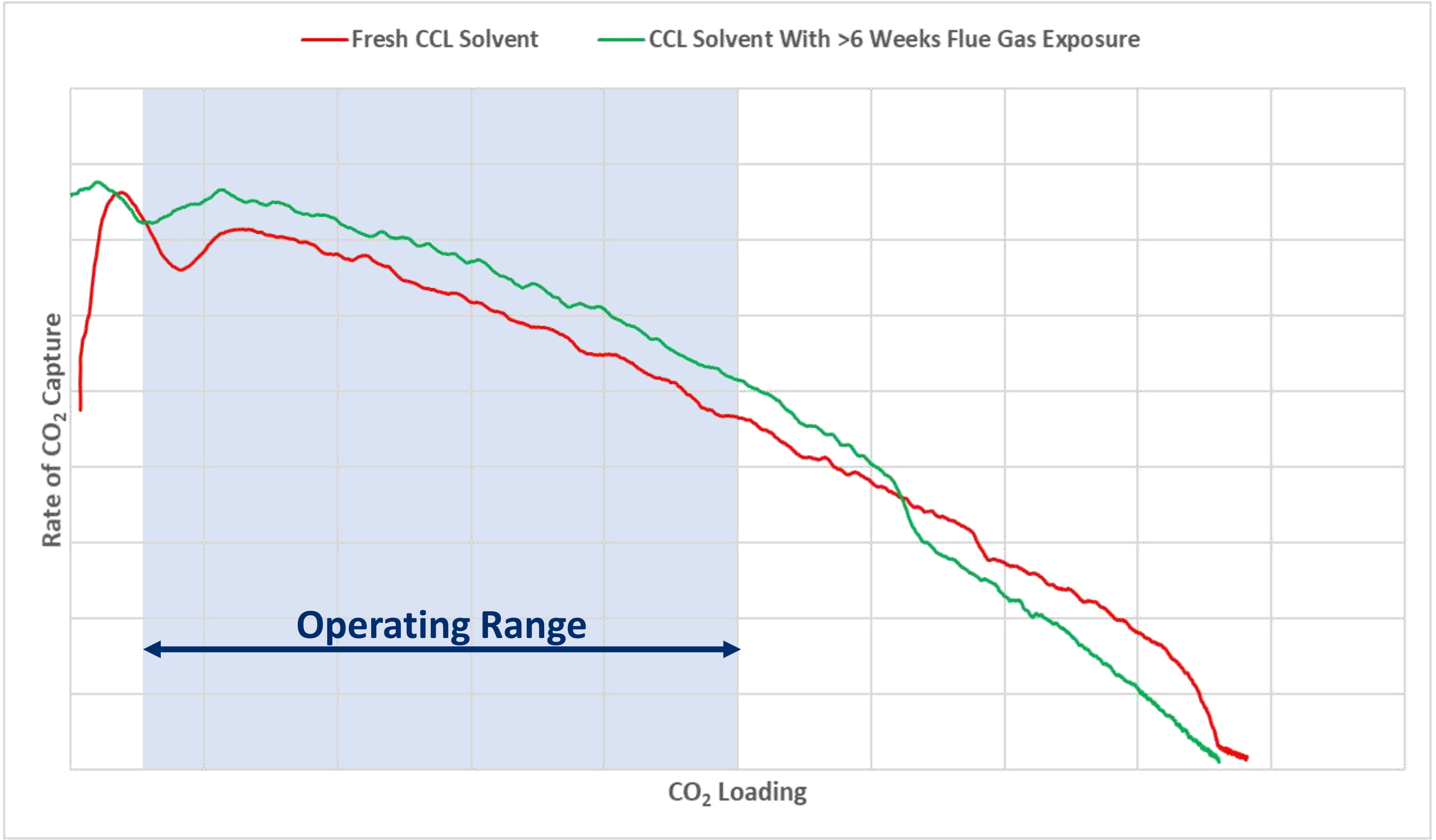
Lower energy penalty, lower parasitic load on the power station. Heat of reaction is lower, heat capacity of the solvent is lower, there are lower heat losses in overall system



Vapour pressure is lower, higher CO_2 release pressure reducing the energy needed for compression. Less compressors are needed therefore less cost involved



Minimal aging demonstrated via rate of CO_2 capture vs loading with a fresh solvent vs one that had been exposed to flue gas at Drax for 6 weeks



Accelerated aging rig used to demonstrate resistance to oxidation

$$R + O_2 \rightarrow RO_2$$

Summary

C-Capture

- C-Capture have developed a completely new, innovative technology with minimal environmental impact
- Our solvent has many unique properties including low corrosivity, low VOC emissions, resistance to oxidation and aging
- Results in low CAPEX and OPEX, reduced costs of compression, long equipment lifetime and reduced maintenance costs
- Lab data, small scale trials and Drax pilot have demonstrated the technology
- Independent validation with collaboration with SINTEF
- Our technology is well suited to the large-scale capture of CO_2, especially from biomass.

Thank you

drax

bp

ipgroup

UNIVERSITY OF LEEDS

Department for Business, Energy & Industrial Strategy