Biomass energy with CCS: Unlocking negative emissions

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Understanding negative emissions

BECCS at a global scale: some challenges and assumptions

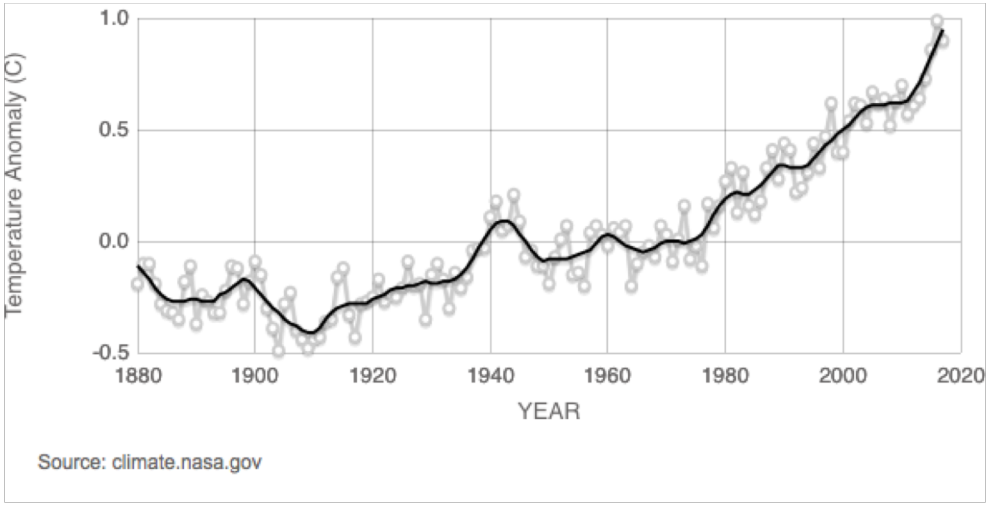
BECCS: new research

Concluding remarks – unlocking negative emissions

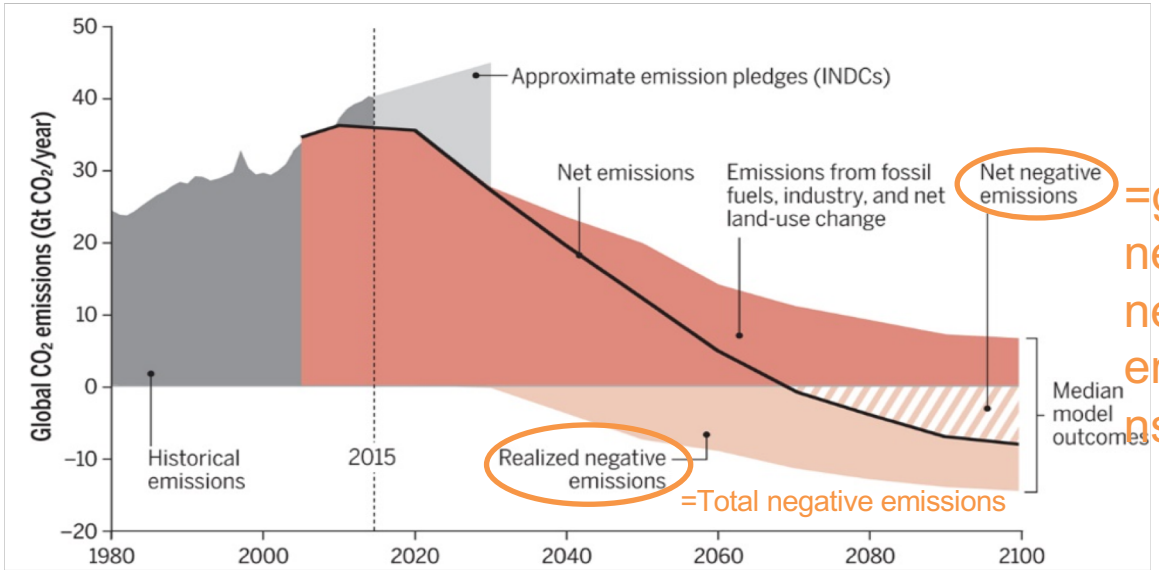
Context

The Paris agreement

"… hold the increase in the global average temperature to well below 2 °C and to pursue efforts to limit the temperature increase to 1.5 °C"



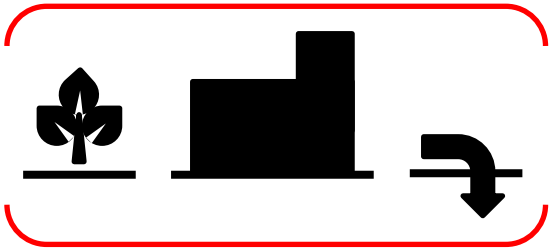
Negative emissions and carbon budgets



Source: Anderson, K., Peters, G.(2016) 'The trouble with negative emissions', Science, 354 pp. 182-183.

BECCS: CO_2 stored vs. negative emissions

1. CO_2 stored



2a. Negative emissions

Figure 1. Gough *et al* (2017) Introduction. In (Eds) Gough *et al* (2017) Biomass Energy with Carbon Capture and Storage: Unlocking negative emissions. Wiley

Reaching global net negative emissions

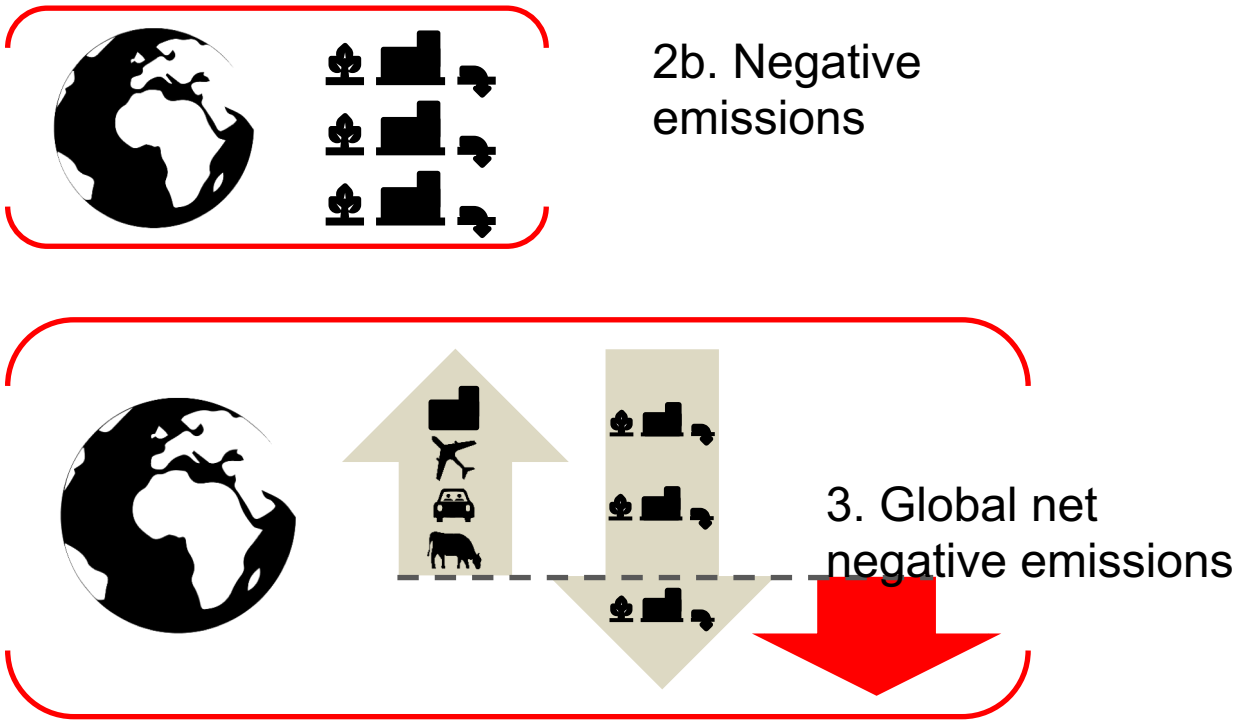


Figure 1. Gough *et al* (2017) Introduction. In (Eds) Gough *et al* (2017) Biomass Energy with Carbon Capture and Storage: Unlocking negative emissions. Wiley

The role of BECCS in carbon budgets

Offsetting ‘hard-to-abate’ sectors

- e.g. aviation, agriculture
- few technical options, large social/political challenges
- Likely to always be some ‘residual emissions’

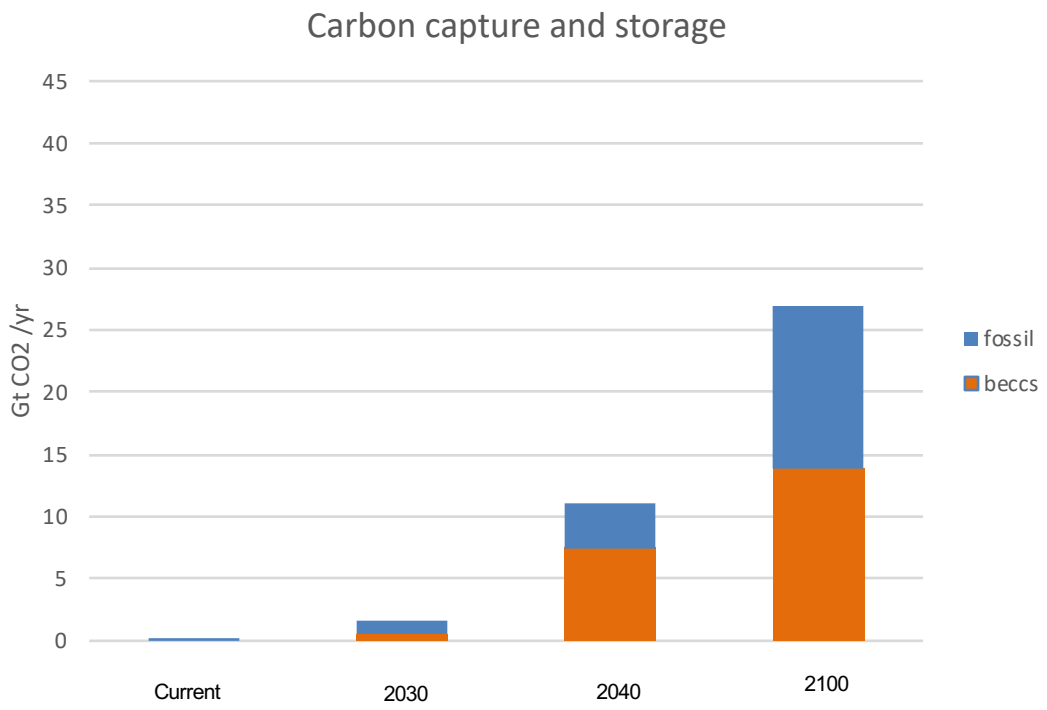
Allowing “overshoot”

- BECCS potentially provides secure storage and energy while removing the ‘overdraft’
- High uncertainties e.g. relating to magnitude and duration of overshoot

Negative emissions is not an alternative to mitigation

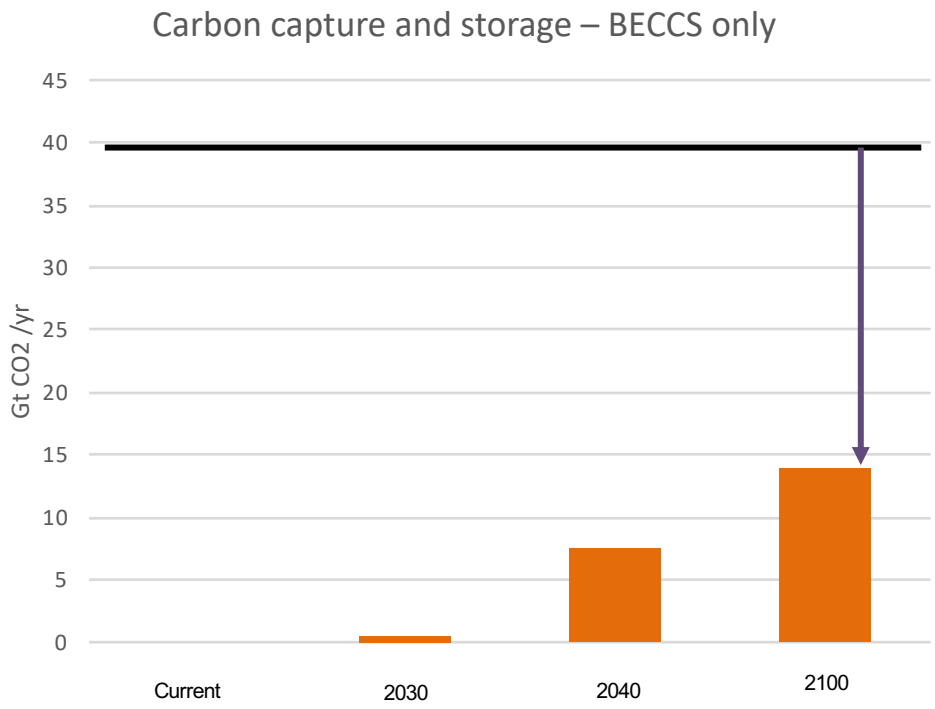
Even with ambitious / optimistic use of BECCS radical reductions in emissions are still required….

BECCS at scale?



Plotted using data from: Vaughan et al (2018) Evaluating the use of Biomass Energy with Carbon Capture and Storage in low emission scenarios. (2018), *Environmental Research Letters* (13) 4

BECCS at scale?



Current global emissions

Plotted using data from: Vaughan et al (2018) Evaluating the use of Biomass Energy with Carbon Capture and Storage in low emission scenarios. (2018), *Environmental Research Letters* (13) 4

Global scale negative emissions using large scale BECCS

Challenges and assumptions…..

How good are the assumptions about BECCS?

- Biomass resource
- Land use
- Technology uptake
- CO_2 storage
- Social responses
- Policy frameworks
- Net negative emission?

It is all a question of scale….

CO_2 storage in the IMAGE model

Three low emission scenarios (66% 2°C; 50% 2°C; 66% 1.5°C)

By 2100:

- Total global cumulative storage (fossil and biomass applications) **620 and 1295 Gt CO_2**
- **55-59%** of this is in **five** regions:
  - » USA, China, India, W Europe, Russia/Mexico
- Maximum storage rate **5.64 Gt CO_2/yr** (USA, 1.5 °C scenario) range **1.7–3.0 Gt CO_2 /yr** in the top regions across all three scenarios

Vaughan et al (2018) Evaluating the use of Biomass Energy with Carbon Capture and Storage in low emission scenarios. (2018), *Environmental Research Letters* (13) 4

CO_2 storage in the IMAGE model

- Within estimated potential in all key regions except Russia (limited assessment of storage potential) Global Storage Portfolio estimates (GSP) (GCCSI 2016)
- Accounts for only 10% of estimated capacity in USA and China
- Regional estimates are, at best, based on "effective potential" not "fully practical" or matched assessments

Note:

- Primary bioenergy regions in the scenarios different to primary CCS regions
- Implications in high BECCS scenarios for both biomass energy trade and emissions accounting

Vaughan et al (2018) Evaluating the use of Biomass Energy with Carbon Capture and Storage in low emission scenarios. (2018), *Environmental Research Letters* (13) 4

How good are the assumptions about BECCS?

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- Net negative emission?

How do we know BECCS is genuinely negative?

BECCS supply chain has multiple stages:

growing, harvesting, treating and transporting biomass; conversion processes (e.g. energy and industrial process to produce biofuels or chemicals); CO_2 capture, compression, transport and storage

Life Cycle Assessment of greenhouse gas emissions along the supply chain

No standardised methodology for accurately accounting for the life cycle emissions associated with BECCS


New Research
FAB GGR Feasibility of Afforestation
& BECCS for Greenhouse Gas Removal
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Feasibility of Afforestation and BECCS for Greenhouse Gas Removal (FAB GGR)

Real world feasibility and **consequences of** large-scale afforestation and BECCS approaches to greenhouse gas removal.

Looking at lifecycle emissions across four supply chains, all ending in the UK

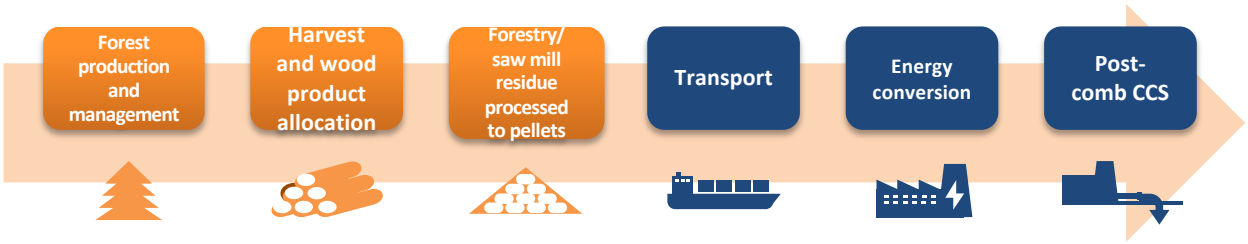
Wider global climate and environmental effects & trade-offs

Effect on ecosystem services provision, economics and policy at the UK scale

Social and governance-related uncertainties, implications and bottlenecks

FAB GGR: supply chains

- UK electricity generation with forestry residues from North America with post-combustion CCS
- Miscanthus grown in the UK with post-combustion CCS medium scale CHP with post-combustion CCS
  Variant: replace miscanthus feedstock with straw
- UK electricity production with domestic short rotation coppice with pre-combustion (IGCC) CCS
  Variant: Hydrogen production



The main science questions …

- (How) can CCS / BECCS be scaled up to deliver global net negative emissions
  - » Understanding key 'net negative' supply chains
  - » Land use implications of producing sufficient sustainable biomass
  - » Understanding earth system responses with respect to carbon budgets
  - » *Inter alia…..*
- The social science questions (including governance, policy, ethics …) are as important as the physical science questions….

The main barriers to development….

… are primarily non-technical

- Delivering a sufficiently ambitious climate policy
- Establishing adequate governance and regulatory frameworks
- Supplying enough biomass sustainably
- Lack of CCS infrastructure at scale

The implications for policy or regulation…

- Implementing the Paris agreement!
  - » An ambitious drive to reduce global carbon emissions
  - » Developing fair and robust accounting for negative emissions
  - » Global coordination and governance mechanisms to deliver a global solution

- BECCS demonstration programme: political, social, ethical and governance as well as technical challenges
  - » Gains made at national or project level may be scaled up to deliver global (net) negative emissions requiring…..
  - » Financing of utility and infrastructure projects

Thank you....

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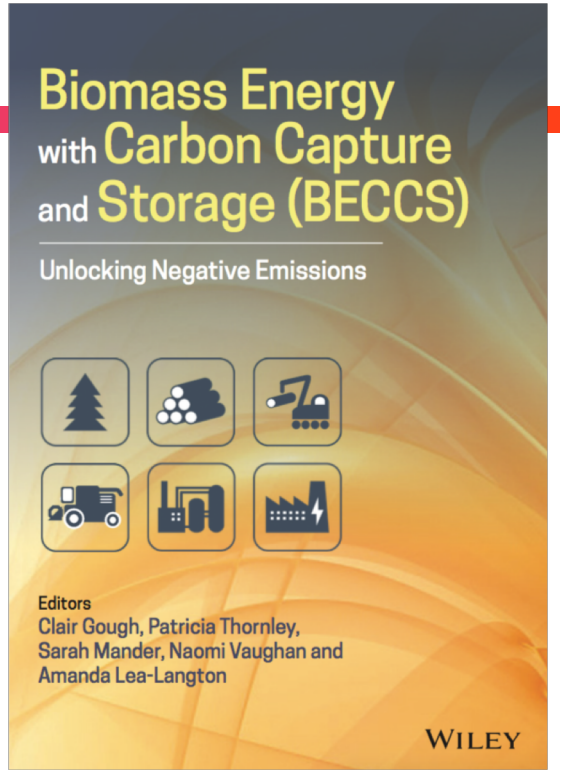
Biomass energy with CCS - Book out now!



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