Bioenergy with carbon capture and storage

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Policy brief by Rob Bellamy, Mathias Fridahl, and Anders Hansson

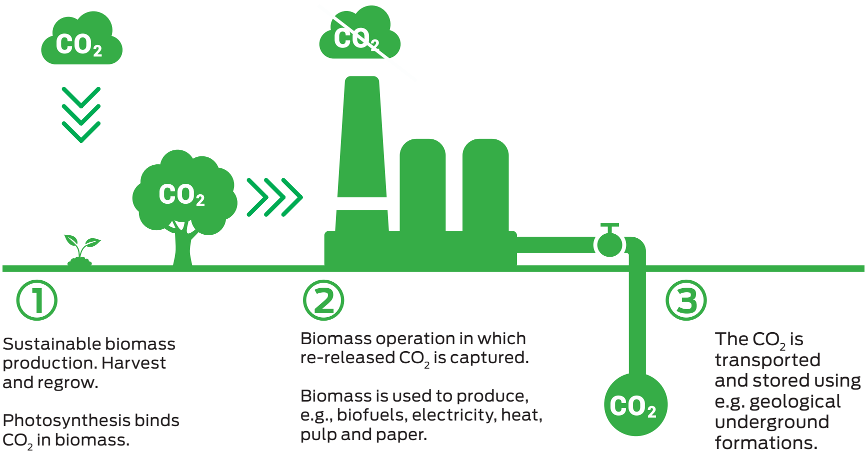
As greenhouse gas emissions continue to rise globally, reaching the 1.5 °C temperature goal of the Paris Agreement seems increasingly distant. If emissions are stabilised at the 2017 level, the Intergovernmental Panel on Climate Change (IPCC) concludes that the carbon dioxide budget for 1.5°C will be depleted as soon as the year 2028. Moving from today's relentless growth in global emissions to peaking, declining, and achieving zero emissions in less than ten years from now is understandably considered infeasible.

This has led integrated assessment modellers to show an increasing interest in technologies that generate net-removals of carbon dioxide from the atmosphere: negative emissions technologies (NETs). The carbon removal prospects of NETs enables models to introduce near term lending of emission space from future generations in the carbon budgets. In essence, the global carbon budget for 1.5 °C is allowed to run with a deficit that accumulates until 2050, with a payback period from 2050 onwards allowing the budget to be balanced at budget closure in year 2100. The key NET used by the models to restore this budget deficit is bioenergy with carbon capture and storage (BECCS).

This policy brief summarises the findings from the recent book "Bioenergy with carbon capture and storage: From global potentials to domestic realities" which explores the extent to which BECCS could help in addressing climate change.

What is bioenergy with carbon capture and storage?

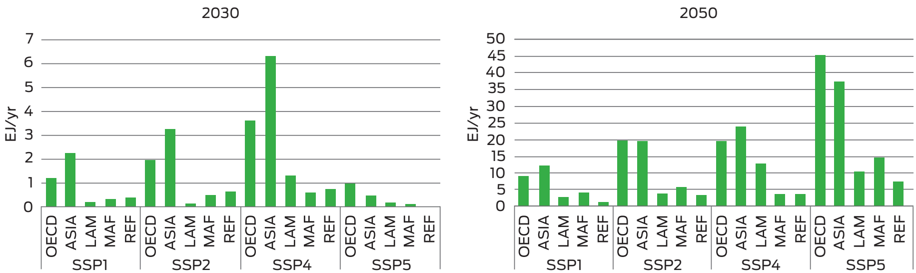
BECCS has emerged as a key technology for climate change mitigation. Various proposed BECCS technology systems exist, all of which exploit the ability of plants to absorb carbon dioxide (CO_2) from the atmosphere when growing (through photosynthesis). The biomass is then used in various operations in which the re-released CO_2 is captured, transported, and stored geologically. Implementing BECCS in order to achieve global "net negative" emissions could make it possible to buy time for the transition to a low carbon economy.



What is the role for BECCS in climate scenarios?

BECCS can be considered a key technology for meeting both the 2°C and 1.5°C goals in integrated assessment models' global energy scenarios. They show a median global deployment of about 50 EJ/yr of primary biomass with BECCS by 2050. Nearly half of the primary energy with BECCS in these scenarios is deployed in the electricity sector. Regionally, OECD and Asia are expected to have the largest BECCS deployment, with the Europe-focused AMPERE study foreseeing about 5 EJ of BECCS in primary energy terms in EU27 by 2050 with about 2 EJ of it being deployed in the electricity sector. However, the models mainly consider techno–economic potentials, taking limited account of socioeconomic factors that may facilitate or hinder BECCS deployment.

Average deployment of BECCS in the SSPs and regions.



Note: the scales differ between the graphs.

How do integrated assessment modellers view BECCS?

Integrated assessment modellers are often criticised for making the scientifically faulty assumption that BECCS could work on a large scale and that they thereby risk justifying delayed mitigation in the eyes of policymakers. This claim is opposed by modellers who argue that any mitigation strategy must be based on the visualization of viable alternatives, which is provided by climate scenarios. On the other hand, the modellers insist that their scenarios are only hypotheticals. Contradictory notions therefore surround IAMs, as they are explicitly geared towards policy influence, while also portrayed modestly as being pure hypotheticals.

At the same time, political action on BECCS is by and large lacking, which makes it relevant to question whether IAMs really do have the policy influence striven for by those who produce them and assumed by those who regard them as engendering moral hazard. This raises the question of how much more knowledge can be gained from exploring imaginary worlds when the real world of policymaking is so clearly lagging behind and, more importantly, what difference such knowledge can make. The scientific certainty or consensus is convincing enough to justify immediate deep global emission reductions while simultaneously exploring the potential for future BECCS deployment.

What and where is the potential for BECCS in Europe?

European pulp and paper industries emitted more than 70 Mt of CO_2 in 2015, with an estimated average biogenic fraction of 85–95%. A total of 48 facilities emitted more than 0.5 Mt of biogenic CO_2 each. Many of these facilities are clustered in Sweden, Finland, and Portugal, potentially enabling economies of scale. Additional clustering with fossil fuel CCS is often possible. While the cumulative biogenic CO_2 emissions from combined heat and power production may be comparable to those from the pulp and paper industry, the number of high-emitting facilities appears to be smaller. Biogenic CO_2 emissions originating from the production of ethanol are significantly smaller than those from the pulp and paper and the combined heat and power industries but have substantially lower costs for separation of CO_2. This makes them of potential use alongside other options, especially if CO_2 transport infrastructure could be shared with those of CCS-systems form other large point sources.

How should we govern BECCS research and development?

BECCS is often portrayed as threatening a "slippery slope" from research to deployment, and that deployment will bring undesirable consequences. The argument is deeply engrained in a dominant governance narrative that seek to constrain or even proscribe research, but it is in fact deeply flawed. This is because we know from other real world cases that technological research often does not lead to deployment, and we know that BECCS technology may develop in ways that are not as undesirable as first thought. What is more, expert scenarios of future research and development project no such slippery slope, but instead what we might call an "uphill struggle" of manifold technical, political and social challenges for BECCS. The only conclusion then is for governance to shift in the direction of incentivisation, which crucially must be done responsibly through broad societal involvement in the tools – and terms – of that incentivisation.

Governance implications of different research and development framings.

R&D framing	← Slippery slope				Uphill struggle →
Governance implications	Proscribe	Constrain	Responsibly incentivize	Incentivize	Prescribe
Example proposals	(Inter)national moratoria	(Inter)national regulations	Participation in definition	Remunerative instruments	Coercive instruments

What policy incentives exist for BECCS at different scales?

The most relevant instruments at all scales—from the UN, through the EU, to domestic Swedish policy levels—are economic, yet they mostly fail to act as incentives, threatening to impede rather than encourage BECCS research and development. The pattern of regulatory instruments is more supportive, with a slight emphasis on incentivization across all scales. However, this is partly undermined by high transaction costs related to administering carbon storage. Regulatory and economic instruments are also counteracting each other. For example, the EU CCS Directive seeks to facilitate the cross-border transportation of CO_2, while the IMO's London Protocol prohibits the same if the purpose is sub-seabed storage. There is therefore a great need to harmonize policies across scales.

How might BECCS be implemented at a city scale?

District heating systems could be pioneers in the realm of negative emissions. The company Stockholm Exergi is currently planning for how this could be done and has identified a potential for reaching net-negative emissions of up to 1 million tonnes of CO_2 annually by 2040. If extrapolated to all district heating systems in Europe, the theoretical potential of NETs is roughly 80 million tonnes of CO_2 removal every year. Technically, district heating systems could pioneer negative emissions using BECCS and biochar production; commercially, however, the challenges are much greater, and policies supporting operational costs will be needed if BECCS is to be realized at scale.

What does the book conclude and recommend?

1

BECCS is a key mitigation technology in climate scenarios resulting from integrated assessment modelling but their theoretical potential should be interpreted cautiously.

2

Existing European point sources of biogenic CO_2 indicate a substantial potential for BECCS, particularly the paper and pulp industry.

3

Evidence suggests that BECCS research and development will not be a 'slippery slope' in need of constraint, but instead an 'uphill struggle' in need of incentivization.

4

Policy makers should turn their attention to incentivising BECCS research and development, starting with the harmonization of existing climate policies at different levels of governance.

5

There should be broad societal involvement in defining the tools – and terms – of incentivising BECCS research and development.

6

Policymakers should refrain from using the absence of BECCS as an argument for holding back instruments that could create demand for them.

About us

The book was a collaboration between researchers at Linköping University, Chalmers University of Technology, Lund University, the University of Manchester, the KTH Royal Institute of Technology and Stockholm Exergi.
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