



2021-IP04

ICEF roadmap on biomass carbon removal and storage (BiCRS)

Since 2014, the Government of Japan is hosting the annual Innovation of Cool Earth Forum (ICEF) in Tokyo with the aim of tackling climate change through technological innovation. ICEF's mission is to nurture discussion and collaboration among participants and to disseminate innovations in energy and environmental technology to participants and beyond. ICEF also develops roadmaps on how key innovative technologies can contribute to a transition to clean energy, considering industrial, academic and governmental perspectives. The roadmaps are collaborative documents developed from the annual conference and refined by reviews and suggestions from international experts. Previous roadmaps were published on CO₂ utilisation, energy storage, direct air capture (DAC), industrial heat decarbonisation and other topics. The most recent roadmap on biomass carbon removal and storage (BiCRS) was launched in a webinar on 2nd February 2021.

The main findings include:

- Using biomass, several gigatons of CO₂ (2.5-5.0 GtCO₂/y) could be removed from the atmosphere and stored underground or in long-lived products each year.
- Energy production is not the only way that biomass can be used in combination with carbon capture to store CO₂ underground or in long-lived products.
- Governance and accounting issues are key challenges to BiCRS and may set its practical limits.
- The carbon removal value of biomass may increasingly exceed its energy value, see Figure 1.
- Many technologies and practices required for BiCRS are already mature.
- A few key technologies and practices require deliberate focus to speed development and provide insight into BiCRS governance and scale-up (e.g. biomass to hydrogen conversion, modular fast pyrolysis, forest and farm monitoring/accounting (sensors, artificial intelligence, remote sensing), genetic modification of common crops to enhance carbon uptake).
- Without proper governance and standards, BiCRS could be counterproductive with respect to climate mitigation, biodiversity conservation, food security and rural livelihoods.

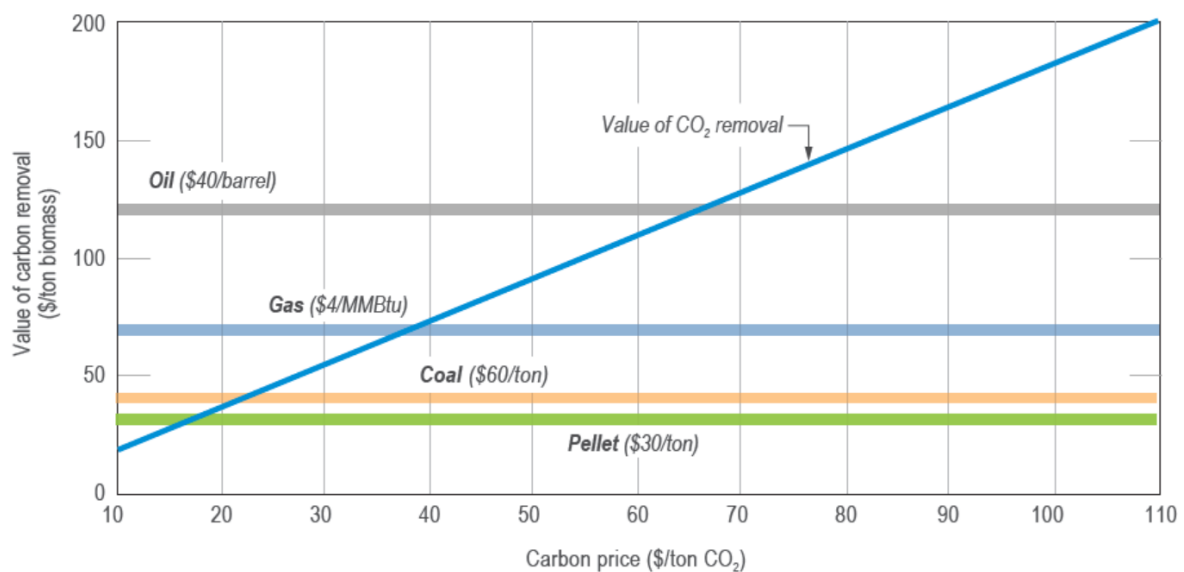


Figure 1 Comparison of the carbon-removal value of biomass with the energy content equivalent value of biomass for a range of carbon prices (ICEF BiCRS Roadmap, 2021)



From the findings, several recommendations are drawn:

- Introduction of a new term: biomass carbon removal and storage (BiCRS).
- The development of BiCRS technologies and projects should focus first on waste biomass.
- Use a framework in which BiCRS projects start with the guiding principle “Do no harm.”
- Develop an innovation roadmap for BiCRS, focusing on hydrogen, fast pyrolysis and selected non-energy pathways.
- Undertake a targeted effort to develop monitoring, reporting and verification (MRV) for BiCRS.
- A set of nations and companies need to lead development of the frameworks, methodologies and standards that must underlie gigaton-scale BiCRS as an industry. The UN Framework Convention on Climate Change (UNFCCC) could launch a BiCRS Platform modeled after its REDD+ (reducing emissions from deforestation and forest degradation) platform.

The roadmap also sets out more specific proposed actions for the near-, medium- and long-term:

- Near-term (1-3 years):
 - Study benefits to biomass-exporting nations and communities from BiCRS projects.
 - National governments adopt incentives for BiCRS.
 - Establish UNFCCC BiCRS platform.
 - Detailed regional models of BiCRS logistics optimisation (energy, feedstock, CO₂).
 - Analyse optimum uses of waste biomass and identify best candidates for BiCRS feedstocks.
 - Pilot modular fast pyrolysis across a small set of designs and feedstocks.
 - Analyse removal capacity of current dedicated energy crops.
 - Assess co-location of biomass feedstocks and geological storage.
- Medium-term (2-8 years):
 - Improve methodology for assessing indirect land use change from BiCRS projects.
 - Leading nations to adopt initial BiCRS biomass standards.
 - Develop a multinational platform for sharing of satellite land use data.
 - Plan key infrastructure elements, e.g. port infrastructure.
 - Develop unconventional biomass, including GMO (genetically modified organisms), wet and marine feedstocks.
 - Accelerate improvement for fast pyrolysis and demonstrate pilot projects for non-energy BiCRS pathways.
 - Identify/develop removal-optimised dedicated terrestrial feedstock crops.
 - Expand remote sensing capabilities for land use monitoring.
- Long-term (7-17 years):
 - Implement multinational monitoring, reporting and verification (MRV) protocol for BiCRS.
 - Implement biomass sustainability procurement standards based on MRV system.
 - Construct BiCRS infrastructure with an emphasis on local carbon storage.
 - Demonstrate unconventional BiCRS feedstocks.
 - Demonstrate multi-megaton CO₂ removal projects using BiCRS in key geographies.
 - Deploy remote sensing capabilities as a core technical element of BiCRS accounting.

Overall, the roadmap provides a very good summary of all the known issues and challenges that arise when considering biomass based carbon removal and storage processes. However, the question arises why the authors felt the need to create the new acronym BiCRS. Their justification is that this is a more



extensive term than BECCS, with BECCS referring only to bioenergy CCS applications, while BiCRS is more widely applicable to any biomass based process (e.g. biochar, bio-based building materials). However, there already is a term used in the literature (and by IEAGHG) for this: Bio-CCS (biomass with carbon capture and storage). One explanation could be that this is an attempt to de-link from any previous negative publicity of the term CCS. The use of waste or so-called additional biomass for Bio-CCS projects has been proposed since quite some time, those feedstocks could be significantly affected by future waste reduction efforts, change in consumer behaviour and competition. One aspect that is surprisingly not mentioned or well connected into the roadmap is the context of BiCRS within the sustainable development goals (SDGs). Although the roadmap raises awareness about sustainability issues in general, the authors missed the chance to specifically include SDG mappings or the development and improvement of frameworks/methods of such exercises.

The roadmaps are available for download at:

<https://www.icef-forum.org/roadmap/>

For IEAGHG work in the concerned areas, please see:

- 2011-06 'Potential for biomass and CCS'
- 2013-11 'Potential for biomethane production with CCS'
- 2014-05 'Biomass and CCS – Guidance for accounting for negative emissions'
- Kemper, 2015. Biomass and carbon dioxide capture and storage: A review. IJGGC 40, 401-430
- 'Biorefineries with CCS' (estimated publication date: February/March 2021)

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