BECCS

WHAT IS BECCS?

Bioenergy with carbon capture and storage (BECCS) is a carbon removal technique that depends on two technologies. Biomass (organic material) is converted into heat, electricity, or liquid or gas fuels (the "bioenergy" step), and the carbon emissions from this bioenergy conversion are captured and stored in geological formations or embedded in long-lasting products (the "carbon capture and storage" step). Because the biomass draws carbon from the atmosphere as it grows, BECCS can be a negative emissions technology when it is implemented well. That is, BECCS could serve to draw down the concentration of carbon dioxide (CO_2) in the atmosphere. However, care must be taken to ensure that emissions from the growing, harvesting, transporting, and processing of the biomass do not outweigh the captured carbon, and that the storage of captured carbon is reliable over long timescales.

CO-BENEFITS AND CONCERNS

+ **Energy:** BECCS produces energy, potentially including carbon-negative fuels for hard-to-decarbonize sectors.

− **Food security:** devoting large areas of land to bioenergy crops could raise food prices.

− **Displacement:** moving communities for land conversion threatens livelihoods, human rights, and social identity.

− **Biodiversity loss:** land conversion for growing biomass could alter habitats and threaten biodiversity.

− **Water resources:** growing dedicated bioenergy crops would increase demand for water.

− **Increased fertilizer use:** fertilizer for growing biomass could further stress nitrogen-saturated ecosystems.

− **Soil carbon loss:** land conversion for growing biomass could release carbon stored in soils or existing biomass.

− **Air pollution:** combustion of biomass and biofuels creates local air pollution.

− **Concerns about geologic storage:** transporting and injecting CO_2 into geological reservoirs raises concerns about pipelines, CO_2 leakage, seismic activity, and water pollution.

Many of these issues would arise only from very large-scale adoption of BECCS. Smaller scale applications using agricultural residues or marginal agricultural land generally pose fewer risks.

POTENTIAL SCALE AND COSTS

Estimates for the potential scale of BECCS vary widely. A recent expert assessment estimates potential sequestration rates of 0.5–5 billion metric tons of CO_2 per year in 2050 with the possibility of much higher rates by 2100. Scenarios compiled by the Intergovernmental Panel on Climate Change (IPCC) suggest that limiting warming to 1.5°C or 2°C at the end of the century could involve sequestering roughly 5–10 billion metric tons of CO_2 ($GtCO_2$) per year via BECCS by 2100. Such projections have been met with intense skepticism, partly because of land-use requirements. A recent study from the U.S. National Academy of Sciences estimates a **global potential to sequester 3.4–5.2 $GtCO_2$ per year via BECCS without large adverse impacts**. Cost estimates vary widely, with **one recent expert assessment projecting costs of US$100–200 per ton of CO_2 sequestered and another projecting costs of US$20–100 per ton.**

BECCS

TECHNOLOGICAL READINESS

Bioenergy and biofuels are already widely used. The other component technology for BECCS, carbon capture and sequestration, is relatively well understood, but, for economic reasons, it has mostly struggled to move beyond demonstration projects for saline sequestration and limited commercial projects that use CO_2 in enhanced oil recovery. Efforts to combine the two technologies remain limited: besides various pilot projects and small-scale BECCS projects at various kinds of facilities (e.g., waste-to-energy, ethanol, cement, electrical generation, etc.), the American agribusiness firm Archer Daniels Midland operates a commercial facility in Decatur, Illinois; the British electrical power generation company Drax has converted a large coal-fired power plant in North Yorkshire to run on wood pellets, with plans to add carbon capture and storage; and Toshiba is adding carbon capture and storage to its Mikawa biomass-fired power plant in Japan.

GOVERNANCE CONSIDERATIONS

- □ **Research, development and demonstration (RD&D):** support and guidance for RD&D is needed to promote sustainable bio-feedstocks and supply chains and reliable methods of carbon storage or utilization.
- □ **Life cycle analysis:** processes and standards need to be developed for ensuring that BECCS operations sequester more carbon than their supply chains emit.
- □ **Agricultural policy:** creative agricultural policies and processes can support sustainable biomass production and sourcing on large scales.
- □ **Finance:** mechanisms such as cost-sharing can promote global benefits by helping to manage local costs of BECCS projects.
- □ For **cross-cutting considerations,** see the What Is Carbon Removal? fact sheet on our website.

FURTHER READING

Fajardy, M. & N. Mac Dowell. 2017. "Can BECCS Deliver Sustainable and Resource Efficient Negative Emissions?" *Energy & Environmental Science* 10 (6): 1389–1426. doi 10.1039/C7EE00465F.

Gough, C. et al. 2018. "Challenges to the Use of BECCS as a Keystone Technology in Pursuit of 1.5C." *Global Sustainability* 1. doi 10.1017/sus.2018.3.

Baik, E. et al. 2018. "Geospatial Analysis of Near-Term Potential for Carbon-Negative Bioenergy in the United States." *Proceedings of the National Academy of Sciences* 115 (13): 3290–95. doi 10.1073/pnas.1720338115.

National Research Council. *Negative Emissions Technologies and Reliable Sequestration: A Research Agenda*. Washington, DC: National Academies Press, 2019.

For more fact sheets on carbon removal, visit https://carbonremoval.info/factsheets.