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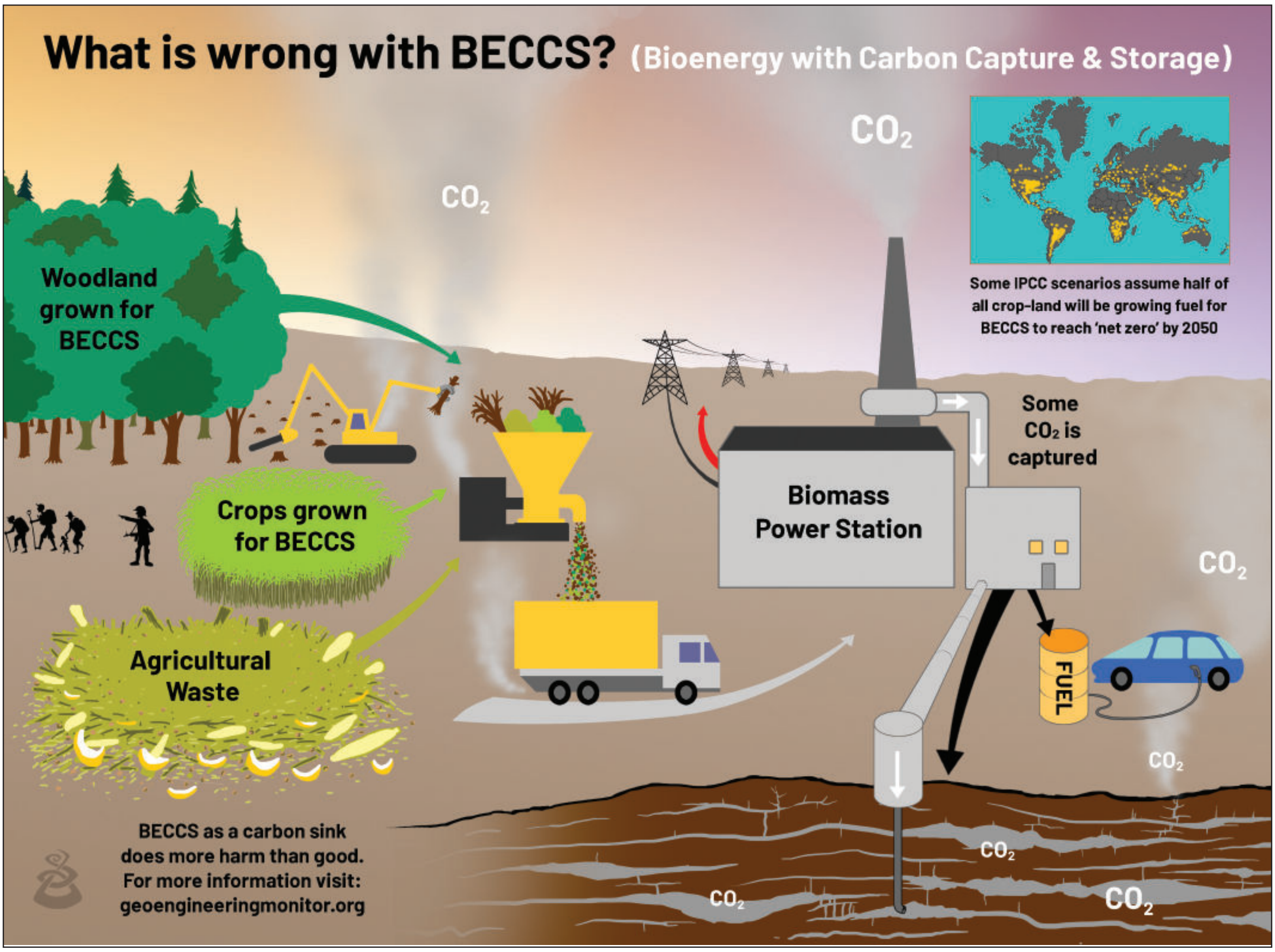
Bioenergy with Carbon Capture & Storage (BECCS)



Description and purpose of the technology

BECCS aims to capture CO_2 from bioenergy applications, and store it through either Carbon Capture and Storage (CCS) or reuse it with Carbon Capture, Use and Storage (CCUS).

Point of Intervention:

Reality Check:

This theoretical carbon dioxide removal (CDR) approach demands burning very large quantities of cultivated crops, trees or plant residues to generate energy – such as electricity, or heat – or converting them into ethanol to be burned. The CO_2 arising from the combustion process is then – so the theory goes – filtered from the exhaust gases, usually with energy-intensive post-combustion capture.

If a CCS approach is used, the captured CO_2 is compressed into liquid form and transported to sites where it can be pumped underground, theoretically, for long-term storage. CCUS is a proposal to “store” captured CO_2, usually temporarily, in manufactured goods or synthetic fuels. BECCS has been called “carbon negative” because bioenergy is wrongly assumed to be “carbon neutral”, based on the idea that plants will regrow to fix the CO_2 that has been emitted. Several scientists have pointed out that this claim overlooks emissions from land use change as well as life cycle emissions, like the CO_2 emitted during cultivation, harvest and transport.[1]

Although unproven and socially and ecologically inviable, BECCS has wrongly taken center stage among CDR apoproaches.[2] Nearly all modelling scenarios limiting global warming to 1.5°C considered by the Intergovernmental Panel on Climate Change (IPCC) in its 2018 climate assessment report assume that a technology like BECCS will be technically and economically viable and can be successfully scaled up.[3] Depending on the mitigation pathways' ambition, carbon dioxide removal on the order of 100-1,200 gigatons is required – equal to 3-30 times current global annual emissions. Such numbers translate into land requirements of 0.1 to 0.8 billion hectares. For comparison: The world's total cropland area is around 1.5 billion hectares today. In the IPCC's scenarios, a large fraction – up to half – of global cropland would have to be turned over to bioenergy crop production.[4]

Actors involved

Most existing BECCS projects are small-scale studies, operated at biomass-based ethanol production plants in the USA.The largest project is located at Archer Daniels Midland's (ADM) Decatur corn-to-ethanol refinery. In 2011, the Decatur Project started as a “proof of concept” study. In 2017, the Illinois Industrial CCS Project added further capacity and now captures ~0,5 million tons of CO_2 annually from the fermentation process and injects the captured CO_2 underground. The demonstration project is funded by the U.S. Department of Energy (US-DOE) in addition to support from other government agencies, ADM and other corporations.

> **Fantasy technologies like BECCS are the perfect excuse for polluters to keep using fossil fuels, betting on unproven “negative emissions” technologies to remove emissions at a sufficiently large scale in the future. The false promise of future negative emissions is one of the most dangerous impacts of BECCS.**

The project claims to reduce CO_2 emissions at the Decatur facility. In reality, the refinery emits more than it removes because the refinery is powered by fossil fuels and the life cycle assessment for the energy-intensive crop corn is not accounted for by ADM.[5]

Additional BECCS projects at ethanol plants, with CO_2 capture capacities from ~0.1 to ~0.25 million tons annually, operate outside the United States, e.g. in Canada, Belgium, the Netherlands, Saudi Arabia and Sweden.[6]

Another BECCS approach is based on power generation from biomass. Since 2012, the United Kingdom's biggest power plant, Drax power station, converted four of its six units to burn wood pellets instead of coal. Drax cooperates with several carbon capture start-ups. One of these is C-Capture, incubated at Leeds University. Despite the long project term and more than £7 million of funding provided by the UK government, the project captures less than 0.001 million tons of CO_2 annually.

In 2018, in order to generate only 6% of the UK's electricity, Drax burned 7.1 million tons of pellets – more wood than the entire UK produces every year. The majority (79%) of the biomass supply is imported from North America.[7] The alleged goals of achieving a “negative carbon footprint” are implausible: pellet production is an energy-intensive process, because the biomass feedstock needs to be dried, grinded, palletized and packed.[8]

Biodiversity-destroying eucalyptus plantations would undoubtedly provide much of the raw material for BECCS
Photo by Allysse Riordan via Flickr

Additionally, shipping 5.67 million tons of pellets by container vessel across the Atlantic annually generates pollutants and greenhouse gas emissions, among them around 600million tons of CO_2.[9]

The Mikawa Thermal Power plant in Japan is yet another example: The plant is replacing coal with palm kernel shells and a small-scale CO_2-capture trial started in 2009. The capture capacity at this site will be increased from ~3.5 tons to 200,000 tons of CO_2 per year.

Currently-existing BECCS projects use captured CO_2 for Enhanced Oil Recovery (which in fact leads to even more fossil fuel emissions), pump it into greenhouses, sell it for use in foodstuffs or continue to research possible uses (see briefings on CCS and on CCUS).[10]

Despite all the emphasis on BECCS from industry and policy-makers, it is clear that the technology is not keeping up with expectations.

Impacts of the technology

Large-scale deployment of BECCS would come with large-scale adverse impacts on the climate, ecosystems and biodiversity, as well as profoundly negative social effects.

Generally, optimism around BECCS is based on two mistaken beliefs: 1) that bioenergy itself is "carbon neutral" because the CO_2 released from bioenergy will be offset by the CO_2 absorbed by new biomass growth and 2) CO_2 emissions from bioenergy can be effectively and reliably stored below ground.

A large body of peer-reviewed literature indicates that many, perhaps most, bioenergy processes result in even more CO_2 emissions than burning the fossil fuels they are meant to replace. BECCS is certainly not carbon neutral.[11] This is mainly due to emissions from: land-use changes and soil disturbance for bioenergy crops, the degradation and overharvesting of forests and wooded landscapes, fossil fuel emissions along the value chain from harvesting and transport, biomass-to-energy conversion, and increased production and use of fertilizers and agrochemicals.

Capturing CO_2 from bioenergy processes such as a biomass-fired power stations is technically even more challenging and energy intensive than capturing CO_2 from coal plants, which has been attempted many times - at great cost and with little success. A unit of electricity generated in a dedicated biomass power plant results in up to 50 % more CO_2 emitted than if generated from coal.[12] Higher CO_2 emissions mean that yet more energy must be dedicated to the carbon capture process itself.

BECCS proponents also trust that geological storage of CO_2 in empty oil and gas reservoirs, or in deep saline aquifers, will be effective and reliable. Yet there is little real-world experience on which to base that faith and it appears unlikely that geological storage can ever guarantee reliable and durable storage. (see briefing on CCS)

Scaling up bioenergy to the extent envisaged by even the lightest IPCC scenario for BECCS would have devastating impacts on ecosystems, water supply, soil and water quality, biodiversity and livelihoods, and compete directly with food production and food security. Fast-growing, industrial monoculture tree plantations would likely provide much of the raw material for BECCS.[13]

Estimates for delivering a relatively modest 3 Gigatons of CO_2 removal range from 380 to 700 million hectares in 2100, which is to say, 25-46% of the world's crop area. Such demands on land would lead to significant competition over land, increase prices for basic food crops, lead to conflicts over land and land tenure rights, and effectively force millions of people off their land. A recent example of how bioenergy crops drive up food prices is the increase in corn-to-ethanol production in the U.S., which increased prices for tortillas, a staple food in Mexico, by 69%.[14]

BECCS also has a very large water and fertilizer footprint. In times of climate change, the number of people suffering from water shortages could grow by billions.[15] Large-scale water-intensive technologies such as BECCS would exacerbate these dynamics. Furthermore, BECCS deployment could lead to more than doubling global chemical fertilizer consumption.[16] The additional nitrous oxide emissions from fertilizer production alone could wipe out any potential CO_2 removal benefit from BECCS.

Land conversion on such a scale would result in the large-scale degradation of ecosystems, loss of biodiversity, severe competition with food production, depletion of freshwater resources, and vastly increased demand for fertilizer and agrochemicals – along with increased adverse impacts such as fertilizer run-off and eutrophication, among other problems.[17]

Given the technical challenges, it is unlikely BECCS will ever scale up. But the damage done by false confidence and the legitimization of big bioenergy may be irreparable. Fantasy technologies like BECCS are the perfect excuse for polluters to keep using fossil fuels, betting on unproven "negative emissions" technologies to remove emissions at a sufficiently large scale in the future. The false promise of future negative emissions is one of the most dangerous impacts of BECCS.

Reality check

BECCS is aspirational, unlikely to ever be technically or economically feasible, and, contrary to faulty assumptions about the carbon impacts of bioenergy processes, it will never effectively remove greenhouse gases from the atmosphere. In fact, massively scaled-up BECCS would exacerbate climate chaos, is not compatible with sustainable development, and leads to food security and food sovereignty concerns and conflicts over land.

Further reading

Biofuelwatch & Heinrich Böll Foundation, "***Summary BECCS report: Last ditch climate option or wishful thinking?***" http://www.biofuelwatch.org.uk/2016/beccs-report-hbf/

Biofuelwatch, "***Full report - BECCS: Last ditch climate option or wishful thinking?***" http://www.biofuelwatch.org.uk/2015/beccs-report/

Global Forest Coalition, "***The risks of large-scale biosequestration in the context of Carbon Dioxide Removal***" http://globalforestcoalition.org/risks-of-large-scale-biosequestration/

Endnotes

1 Gough, et al. (2018) Challenges to the use of BECCS as a keystone technology in pursuit of 1.5^{0}C, in: Global Sustainability, Vol. 1, Cambridge University Press, https://www.cambridge.org/core/journals/global-sustainability/article/challenges-to-the-use-of-beccs-as-a-keystone-technology-in-pursuit-of-15c/5E8AE2ECC9DCACB5DFE4B97BBE70476D/core-reader

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6 ETC Group and Heinrich Böll Foundation (2020) Geoengineering Map: BECCS (Bio-Energy with Carbon Capture and Storage), https://map.geoengineeringmonitor.org/

7 ETC Group and Heinrich Böll Foundation (2020) Geoengineering Map: Drax Project, https://map.geoengineeringmonitor.org/Carbon-Cioxide-Removal/drax-project/; Harrabin (2019) Climate change: UK carbon capture project begins, in BBC News, published online: February 8, 2019, https://www.bbc.com/news/science-environment-47163840; Drax (2020) Sustainability. Sourcing sustainable biomass. Summary performance – Drax Power Station Biomass Pellet Feedstock Sources in 2018, published online, accessed: February 3, 2020, https://www.drax.com/sustainability/environment/#sourcing-sustainable-biomass; Drax (2020) Sustainability. Towards Carbon Negative, published online, accessed: February 3, 2020, https://www.drax.com/sustainability/towards-carbon-negative/

8 Padilla-Rivera, et al. (2017) Environmental Performance of Eastern Canadian Wood Pellets as Measured Through Life Cycle Assessment, in: Forests, Vol. 8(9), 352, https://www.mdpi.com/1999-4907/8/9/352/pdf

9 Calculation is based on: 7,000 km transport distance for 79% of the total amount of pellets burned in 2018. Transport via container vessel, generating 15,1 g of CO2 per km and ton (https://www.nabu.de/umwelt-und-ressourcen/verkehr/schifffahrt/containerschifffahrt/16646.html)

10 ETC Group and Heinrich Böll Foundation (2020) Geoengineering Map: BECCS (Bio-Energy with Carbon Capture and Storage), https://map.geoengineeringmonitor.org/

11 A compilation of peer reviewed literature is available at: biofuelwatch, Resources On Biomass, http://www.biofuelwatch.org.uk/biomass-resources/resources-on-biomass/

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