UPDATES ON BIO-ENERGY WITH CARBON CAPTURE AND STORAGE AND DIRECT AIR CAPTURE (QUARTERLY #4, PART 2)

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BURNING BIOMASS IS A THREAT TO CLIMATE (AND NO SILVER BULLET) – THE IMPACT OF BECCS USING THE DRAX PLANT, GREAT BRITAIN'S BIGGEST POWER PLANT, AS AN EXAMPLE

Bioenergy with Carbon Capture and Storage (BECCS) is employed at the Drax Power Station in North Yorkshire in Great Britain. BECCS aims to burn biomass for energy, capture CO_2 from the exhaust gases and bury the captured CO_2 underground. In the case of Drax – Great Britain's biggest power station, generating 6 % of the British electricity – four of six units were converted to burn wood pellets instead of coal, with the goal "*to become the world's first negative emissions power station*".[1] Is this goal attainable?

The Drax plant burns about seven million tons of wood pellets annually. This is more wood than the entire UK produces every year. The majority of the biomass supply is imported from North America (~81 %), other origins are Brazilian, Estonian and Latvian forests. This means the biomass has to travel long distances to the station – via fossil-fuel powered means of transportation, such as container vessels, trucks and trains. Beside this the pellet production process is very energy-intensive, because wood as the raw material needs to be dried, grinded, palletized and packed – and again large amounts of fossil energy are consumed. This means, the above stated company goal is not attainable. It is true that trees as an energy source cannot emit more CO_2 than they have absorbed during growth, however, the entire BECCS process cannot be reduced to the combustion of wood (see figure 2).[2] Regarding the absorption of CO_2 by trees, the European Academies' Science Advisory Council (EASAC) remarks: *"Far from being carbon neutral, the burning of forest biomass actually adds CO_2 to the atmosphere during the carbon payback period, which for the most relevant trees lies between 50 and 100 years"* ***[3]***.

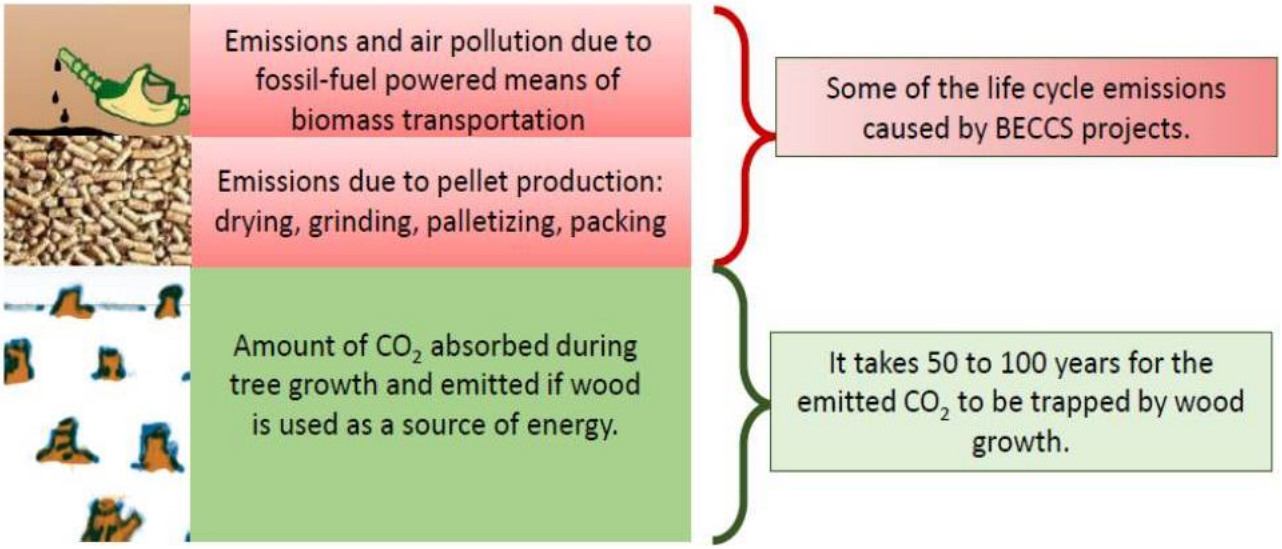

Figure 2: *Burning biomass such as wood pellets is not carbon-neutral.*

It is also for these reasons that the EASAC states that *"wood pellets are no silver bullet for providing electricity and heat without causing climate change"* and criticized that the Drax Station is heavily subsidised by the British government. Drax received £ 789 million in 2018 for burning biomass. In December 2020, British newspapers reported that the UK spent £ 1.9 billion on wood fuel subsidies in 2019, primarily to burn imported biomass at the Drax Station. In addition, the plant receives indirect subsidies, because it is exempted from paying carbon taxes. This means the British tax payer funded (and probably still funds)

the Drax Station with several million British Pounds per day.[4]

There are various reports that the logging for Drax leads to environmental problems. The campaign group 'Cut Carbon Not Forests', a coalition of UK- and US-based NGOs, reported that the subsidized UK biomass imports cause clear-cuts of mature and highly biodiverse hardwood forests and demands that "*the UK Government should immediately phase out all subsidies for large-scale biomass use for electricity production and redirect the savings to true clean and renewable energy sources like wind and solar*".[5] A recent report published by the Estonian Fund for Nature and the Latvian Ornithological Society describes intensive negative clearcutting impacts on climate and wildlife in Estonian and Latvian forests – caused by wood pellet exports, mainly to the UK, Denmark and the Netherlands.[6]

Despite pollution and forest degradation the Drax Group continues to receive public funding. In addition to the subsidies and tax reductions, Drax also received grants worth millions to study the feasibility of carbon capture at its Drax Station. The latest test started in September 2020: Mitsubishi Heavy Industries Engineering installed its solvent-based CO_2 capture technology, aiming to test it during a 12-month pilot trial. In October, Drax selected the Australian company Worley for a pre-FEED (early front-end engineering and design) contract. The contract covers the plant layout, cost estimation and schedules for the first two CO_2 capture units at the power station. Once operational, these units are expected to capture around 8 million tonnes of CO_2 annually. The fate of the captured CO_2 is not yet fully clarified.[7]

While burning biomass is heavily subsidized in Great Britain, the advisory board of the Dutch government urged the Dutch government to phase out the use of biomass for generating electricity or heat, because burning biomass is wasteful and sustainably produced biomass too scarce. Importing wood pellets for the production of heat or electricity was not considered sustainable too, instead, biomass should be replaced with existing low-carbon and renewable alternatives.[8]

EXTENSIVE SUBSIDIES FOR, HIGH ENERGY DEMAND OF AND ATTEMPTS TO GREENWASH DIRECT AIR CAPTURE (DAC)

DAC, a technology that aims to remove greenhouse gases, especially CO_2, from the earth's atmosphere on a large-scale, continues to make headlines with generous subsidies. Already in the previous years the sector received large private and public investments – many donors are associated with industries that produce or use fossil fuels on a large scale.[9]

In June 2020, **the British government** announced up to £ 100 million of funding to help develop DAC technologies in the UK. The competition is presently ongoing and will fund design studies looking into evolving DAC and other Greenhouse Gas Removal (GGR) technologies in the first phase. The second phase will be based on the most promising results from phase 1 and aims to "*pilot key components or further develop the design of the new direct air capture and other greenhouse gas removals technologies*".[10]

In the US, the Trump administration had already announced US$ 22 million in financing for commercializing DAC in March 2020. In September, the U.S. Department of Energy (US-DOE) has published a list of 18 projects that will benefit from this amount of funding. Most projects aim to develop new sorbents and filters to capture and release atmospheric CO_2. Electricore, a California-based company, aims to optimize the Swiss DAC process developed by the Swiss Climeworks AG.[11]

One of the **market access barriers for large-scale DAC** is that the CO_2-capture process is very energy intensive. It is very unlikely that new filters and sorbents will change this fact, because CO_2 is an inert gas (due to the complete oxidation of the carbon). The term 'inert' can also be described as chemically inactive or not very reactive. Due to this chemical property of CO_2, all forms of CO_2 – DAC are extremely energy- and therefore cost-intensive, because the CO_2 – capture process requires large amounts of energy, e.g., to release CO_2 from a filter or sorbent.

In the U.S., DAC projects can benefit from the 45Q credits– a tax provision to subsidize power plants and further industrial sites with DAC or CCS. If the captured CO_2 is used for EOR, the 45Q pays US$ 35 per ton of captured CO_2. If the captured CO_2 is injected underground, into saline formations, the 45Q pays US$ 50 per ton.[12]

Carbon Engineering Ltd. is a company headquartered in Squamish, B.C., Canada and founded by David Keith (Harvard University). Keith is also advocating for solar radiation management (SRM) and pushing to advance SRM through open-air experiments. His company Carbon Engineering is closely tied to the fossil fuel sector and in 2020, the company's long list of fossil fuel dependent donors has grown once again. Since 2018, Carbon Engineering Ltd. has raised more than CAD 100 million from multiples investors, among them BHP, Chevron, Occidental Petroleum, Pale Blue Dot Energy, United Airlines and the tar sands billionaire N. Murray Edwards. Carbon Engineering is using a share of the extensive funding to construct an innovation

center in Squamish, British Columbia, aiming to further improve its DAC as well as its patented fuels synthesis technology. The center will include a DAC and an AIR TO FUELS™ plant.[13]

In July 2020, **Carbon Engineering and Aerion** announced a joint synfuel project, based on Carbon Engineering's DAC and AIR TO FUELS™ technology. Aerion is based in the U.S., in Reno, Nevada and a developer of supersonic business jets. The companies signed a Memorandum of Understanding to explore the use of Carbon Engineering's synfuel as well as a potential synfuel plant for Aerion jets. The patented synfuel production process is based on the energy-consuming Fischer-Tropsch process. As for DAC, synfuel production based on CO_2 is very energy demanding, due to the chemical properties of CO_2 (as described above). Using captured CO_2-based fuels means, that

- large quantities of energy are required for the production process;
- the captured CO_2 is re-released back to the atmosphere within a short period of time – as soon the fuel is consumed.[14]

In September 2020, **Carbon Engineering and Pale Blue Dot Energy** signed a Memorandum of Understanding and announced a joint DAC project. The project partners aim to deploy a commercial DAC plant and consider building the plant close to the Acorn CCS project at the St. Fergus Gas Plant in Scotland, among other possible locations. The project partners hope to commission the DAC plant by 2026. The promise of government funding in the UK was a trigger for the partnership and the proposed location.[15]

Carbon Engineering Ltd. and Oxy Low Carbon Ventures LLC, a subsidiary of the international gas and oil company Occidental, announced their joint plan to design and construct the world's largest DAC facility in the United States already in 2019. In 2020, **Rusheen Capital** – a company with investments in CCUS and biofuels and a long list of business partners from the fossil fuel sector – joined as a new partner and, along with Oxy Low Carbon Ventures, **formed the company 1PointFive** as a mean to finance and deploy the announced DAC facility. The new DAC – plant will be located at an Occidental oil field in the Permian Basin in Texas and will require an area of ~40 hectares. The captured CO_2 will be used for EOR. Occidental employs CO_2 – EOR since 2010, but up to now, the captured CO_2 needed transport, e.g., via pipelines. Future plans include multiple DAC plants. In December 2020, **United Airlines** announced a multimillion-dollar investment in 1PointFive.[16]

Carbon Engineering's CO_2-capture process is based on a **potassium hydroxide solution** that acts as a chemical absorbent. Carbon Engineering describes the sorbent as "*non-toxic solution*".[17] According to ECHA, the European Chemical Agency, potassium hydroxide causes severe skin burns and is highly corrosive. ECHA also expects potassium hydroxide to have acute toxic effects on fish and invertebrates.[18] This means that leaks during the capture cycle as well as during transport and disposal would not be without danger for the biotic environment. Moreover, the company's goal of commercializing DAC would imply that large quantities of potassium hydroxide solution will be required. And not only the DAC process, but also the production of potassium hydroxide is energy consuming.[19] Carbon Engineering seems not to be aware of the risks involved in handling potassium hydroxide or the risks are intentionally concealed (by those who want the technology financed)?

The impression that geoengineering technology is being greenwashed and its environmental risks and effects are being downplayed solidifies when reading further: On its website, 1PointFive declares: "*By implementing Carbon Engineering's DAC facilities in the United States at scale, we intend to showcase the critical role this technology can play in reducing the global carbon footprint*". In addition, Occidental is described as a "*carbon manager*", storing millions of tons of CO_2 by Enhanced Oil Recovery (EOR) and Carbon Engineering claims "*that CO_2 captured at the facility will be permanently, safely and securely stored deep underground in geological formations by Occidental*".[20] For the following facts contradict these claims:

- EOR was developed by the oil industry to recover otherwise inaccessible oil by pumping pressurized CO_2 into oil reservoirs or by pumping pressurized CO_2 into declining oil wells to increase output. The reasons for the development of the EOR process were strictly economic. EOR is a process that leads to the extraction and combustion of more fossil fuels and thus more carbon.[21]
- Oil industry estimated that about 30 percent of the CO_2 injected for EOR will be directly emitted back into the atmosphere.[22]
- The DAC capture process is very energy-intensive. To capture only one million tons of CO_2 annually, as announced, the Carbon Engineering capture process requires 1.300 million kWh. This amount of energy is sufficient to cover the energy needs for the nearly 20,000 inhabitants of Squamish, the Canadian town where Carbon Engineering is headquartered, for almost 5 years.[23]

The Swiss **Climeworks AG** raised more than € 90 million in its 2020 funding round. Since its foundation, more than € 135 million in public and private grants became publicly known.[24] The Climeworks DAC – technology is trialed in the **European CarbFix project**, at Reykjavik Energy's Hellisheidi heat and power plant, located in a geothermal area nearby

Reykjavik. End of 2019, CarbFix announced plans to double the amount of CO_2 and H_2S captured at Hellisheidi plant and injected underground in the nearby injection sites. In December 2020, Climeworks started constructing a larger DAC plant. The new plant has been named Orca, will be based close to the Hellisheidi plant and is expected to capture 0,004 million tonnes of CO_2 annually, starting in 2021.[25] To capture 4.000 tonnes of CO_2 annually, the Climeworks capture process requires up to 10 million kWh of thermal energy and ~2,4 million kWh of thermal energy. This amount of energy is sufficient to cover the energy needs for the ~ 11,000 inhabitants in Hinwil, the Swiss place where the Climeworks AG is headquartered, for about two months.[26]

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