TOWARDS A SUSTAINABLE DEPLOYMENT OF BIOCCS IN THE EU

CONCITO

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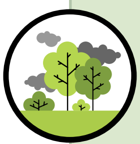
Key findings and recommendations

BioCCS will be needed to a limited extent to contribute to EU climate targets (e.g. for biogenic emissions from waste incineration, biogas upgrading, and cement).

Creating incentives for BioCCS should be approached in full consideration of the associated risks for climate (potential negative impact on land carbon sinks) and the environment (possible pressures on biodiversity and food production).

The higher the financial incentive for BioCCS, the higher the risks involved, unless other regulation/restrictions are put in place.



Prioritisation and stronger regulation of the rising and competing use of biomass is needed in parallel with incentivizing the deployment of BioCCS to avoid lock-in of high biomass use for purposes that could be served by other means, e.g. electrification.

Policies to ensure a sustainable deployment of BioCCS could be:

- **Consider separate reduction and removal targets in EU climate policy**.
- **Create appropriate financial incentives for BioCCS deployment** (e.g. through a careful and gradual integration/linkage with emissions trading).
- **Put in place pricing mechanisms to reflect losses in the land sector when biomass feedstocks are utilised** (e.g. covering net-emissions of biomass use by emissions trading) and **other regulation on biomass use** (e.g. limiting the role of biomass and biofuels in EU energy regulation).
- **Improve monitoring and reporting of BioCCS and biomass use** (e.g. a robust certification methodology for BioCCS and obligations for all facilities to report and account biogenic CO_2 emissions from the biomass feedstock used).

Introduction

While rapid and deep emission reductions must be the cornerstone of European climate action, carbon removals will play a role to counterbalance the limited amount of residual emissions to achieve climate neutrality by 2050 at the latest and to provide net-negative emissions hereafter. Notably, permanent carbon removals methods, including capture and storage of biogenic CO_2 from power plants or industrial processes (BioCCS) and direct air carbon capture and storage (DACCS), currently sit outside of the EU's climate policy architecture, and the policies needed to ensure a sustainable deployment of these technologies in the EU are missing.

The recently recommended 2040 climate target from the European Commission assumes the deployment of both DACCS and BioCCS to reach the target. According to modelling from the European Commission, permanent carbon removals will need to deliver up to 75 million tons of CO_2 in 2040 (33 Mt CO_2 from BioCCS and 42 Mt CO_2 from DACCS)[1]. This will require, among other actions, an assessment of how best to provide incentives for permanent carbon removals either in existing EU legislation (e.g. the EU Emissions Trading System) or through new instruments. At the same time, the European Commission recognises that bioenergy should be prioritized in sectors where the potential for electrification is limited. The biomass consumption for energy purposes in the EU is already at a level that could be considered at odds with a sustainable level of bioenergy use in a global context.

A recent report by Ea Energy Analyses on the potential of CCS in the Danish heat and power sector investigates the business case for establishing CCS on biomass combustion and waste-to-energy facilities. The study includes an assessment of how economic incentives for carbon removals and increasing biomass prices affect deployment of CCS and use of biomass in heat and power plants. The report provides valuable lessons learnt applicable to the deployment of BioCCS in the EU.

Financial incentives and BioCCS deployment

The need and deployment of BioCCS depends on many factors such as financial incentives, technology costs, infrastructure development, availability of sustainable biomass as well as political and social acceptance. Currently, there is a lack of financial incentives to establish BioCCS projects in the EU. The report by Ea Energy Analyses looks, among other things, into how financial incentives for capture and storage of biogenic CO_2 affects the deployment of BioCCS in the heat and power sector.

The report states that, today, the primary incentive to deploy CCS on biomass heat and power plants is the payment for carbon removals from state subsidies and/or voluntary carbon markets. As shown in Figure 1, installed BioCCS capacity significantly varies at different levels of payment for carbon removals. In the Danish case, investing in BioCCS on biomass facilities becomes attractive at a payment for carbon removals of approx. 160 euros per ton of stored CO_2[2]. For waste-to-energy facilities, CCS is profitable at a lower support level due to saved costs from national taxes and emission allowances for the fossil part of the waste[3] creating additional financial incentive for investing in CCS besides the payment for carbon removals.

1 Estimates from the S3 scenario in the impact assessment accompanying the Communication from the European Commission.

2 The total costs of transport and storage of CO_2 alone are assumed to amount to a minimum of about 500 DKK/ton by 2040, and the cost of capturing the CO_2 is at the same level for a facility operating 8.000 hours. The report only assumes offshore storage. Realising land-based CO_2 storage could bring down costs.

3 Denmark has opt-in emissions from municipal solid waste incineration in the scope of the EU Emissions Trading System.

Figure 1: BioCCS deployment in the Danish heat and power sector in 2040 depending on levels of payment for carbon removals

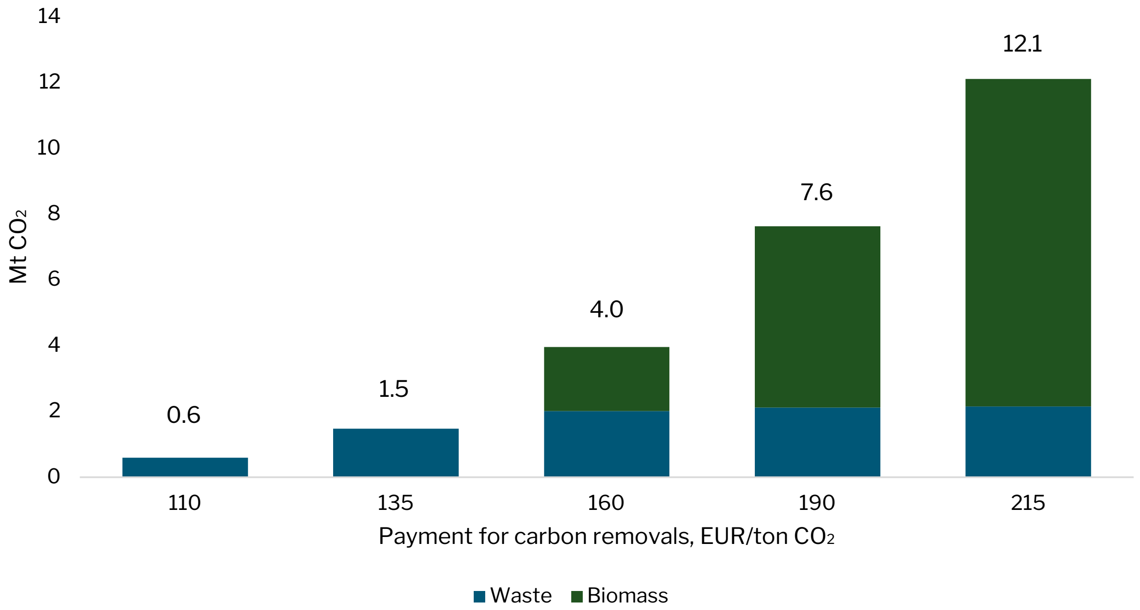


Figure 1 shows the additional BioCCS deployment in the Danish heat and power sector in 2040 depending on payment for carbon removals and assuming offshore storage. The figure shows additional deployment and does not include already decided investments in CCS in the Danish heat and power sector, such as the contract that Ørsted was awarded for two of their biomass-fired combined heat and power facilities in the first Danish CCS tender. The figure shows there will be no additional CCS on biomass combustion until payments of approx. 160 EUR/ton. From this rate, large amounts of BioCCS become economically viable.

The report clearly shows that BioCCS deployment sharply increases the higher the payment for carbon removals. Given the assumed costs, BioCCS is not profitable with the current levels of state subsidies for CCS in Denmark (approx. 105 euros per ton on average). This means developers are currently unlikely to carry out investments and engage in BioCCS projects without either additional public funding, payments from the voluntary carbon market, and/or lower costs for transport and storage (e.g. by realising onshore CO_2 storage) than assumed in the report.

Risk of sustained high biomass consumption with BioCCS deployment

Creating incentives for BioCCS should be approached in full consideration of associated risks for climate (potential negative impact on land carbon sinks) and environment due to excessive biomass use. Some investments in BioCCS entail the risk of locking-in the use of biomass for purposes that otherwise could be served by other mitigation options, e.g. electrification. In this light, BioCCS will only be necessary to a limited extent to contribute to EU climate targets (e.g. for biogenic emissions from waste, biogas, and some industries with limited mitigation options and continuous production).

There are increasing and competing demands for biomass use in the EU. The modelling for the 2040 climate target assumes that the use of biomass will increase by approx. 30% by 2040 compared to 2021. Based on the environmental risk level indicated by the European Scientific Advisory Board on Climate Change (ESABCC), the modelling assumes an overall cap on the gross available energy from biomass at 9 EJ and introduces restrictions on the use of harvestable stemwood, forest residues, and imports of bioenergy.

Without a cap, the biomass consumption could increase even more. Recently, the European Commission stated with reference to the European Environmental Agency that by 2050 the supply of sustainable biomass falls short by 40-70% compared with the projected demand. Furthermore, previous analysis from the European Commission's impact assessment for the 2030 Climate Target Plan and the Joint Research Centre (JRC) Energy Scenarios shows that if regulation in the EU remains unchanged, the use of biomass could more than double towards 2050 in some scenarios.

High levels of BioCCS deployment in the EU could further increase/maintain demand for bioenergy with the risk of negative impact on the natural sinks in the Land Use, Land Use Change and Forestry (LULUCF) sector. If high financial incentives for permanent carbon removals are put in place (e.g. through emissions trading), a larger deployment of BioCCS than DACCS could possibly occur in the beginning due to relatively lower costs[4]. In the European Commission's modelling for the 2040 target, considerations of sustainable biomass availability cap the deployment of BioCCS. Relaxing this cap shows a stronger deployment of BioCCS and very limited deployment of DACCS[5].

The report by Ea Energy Analysis showcases the risk of high biomass use due to BioCCS deployment. Denmark has one of the highest consumptions of bioenergy per capita in the EU, and bioenergy represents more than two thirds of the overall consumption of renewable energy in Denmark. The report shows that with the current projected biomass prices and existing levels of CCS support (frozen policy scenario), biomass consumption in the Danish heat and power sector will decrease by approx. 50% by 2040, primarily due to heat pump deployment.

However, if CCS is installed on biomass facilities, a significant risk of locking in a high level of biomass use for district heat and power production occurs. In a scenario with high payment for carbon removals at approx. 190 EUR/ton CO_2, biomass consumption will only decrease slightly compared to 2025 and remain relatively high (Figure 2). CONCITO has recommended that targets should be set for the reduction of biomass consumption for electricity and district heating in Denmark to keep aggregate demand for biomass within sustainable limits. In this light, biomass would only play a limited role as back-up in an electrified energy system.

The report also considers a second scenario with higher biomass prices ("LULUCF pricing") [6]. This scenario assumes a pricing mechanism, where LULUCF targets are translated into effective price incentives for temporary storage of CO_2 in the LULUCF sector, which then leads to a significant price increase of up to 40 percent[7] for some biomass feedstocks. In this scenario, biomass consumption is further almost halved in 2040 compared to the frozen policy scenario.

4 This is assuming that other regulations/restrictions (e.g. on biomass use) are not put in place, and other permanent carbon removals are not covered by emissions trading.

5 In the main scenario (S3) in the impact assessment, considerations of sustainable biomass availability limits BECCS expansion in the PRIMES model to 33 Mt CO_2 in 2040. The remaining needs for removals are fulfilled by DACCS, which appears as complementary to BECCS. In a sensitivity analysis using the POTEnCIA model with a relaxed cap on BECCS and bioenergy, a stronger deployment of BECCS, reaching up to around 80 Mt CO_2 in 2040, and very limited deployment of DACCS is modelled.

6 The report considers a scenario with higher biomass prices, where the lost value of CO_2 storage in the forest is included in the price of biomass for energy purposes (a LULUCF pricing mechanism). Based on several assumptions (e.g. a carbon price of 1000 DKK/ton CO_2 and a market efficiency of 70%), there is a price effect of 20 DKK/GJ for wood chips, 18 DKK/GJ for wood pellets, and 7 DKK/GJ for straw, when the climate benefit of leaving the biomass in the forest is added to the price of biomass.

7 The price of straw increases by approx. 20 percent, while wood pellets prices increase by 30 percent, and wood chips prices increase by 44 percent in 2040.

Figure 2: Biomass consumption for district heat and power production in Denmark

Figure 2 shows biomass consumption in Denmark in 2025 and for three selected scenarios in 2040. Consumption is halved by 2040 with current, low biomass price projections (from 116 PJ to 59 PJ) compared to 2025 ("Frozen policy"), primarily due to heat pump deployment. A higher price on biomass will further almost halve consumption (to 34 PJ in "LULUCF pricing"). Assuming CCS support at approx. 190 EUR/ton and low biomass prices, biomass consumption will only decrease slightly and remain relatively high ("High CCS support + frozen policy").

As such, putting in place pricing mechanisms to reflect the lost value of CO_2 storage in the land sector when biomass feedstocks are utilised contributes to a decline in biomass use, in particular for sectors where technologically mature alternatives are available (such as heat pumps). Further, higher biomass prices lead to a worsening of the economics of investments in BioCCS, requiring more economic support to make CCS on biomass combustion profitable[8].

The CCS value chain is capital intensive but has limited operational expenses[9]. This makes CCS suitable for plants operating continuously, such as waste incineration facilities. In Denmark, many biomass facilities have limited operating hours, as most facilities primarily operate during winter months for combined heat and power production. Due to the high capital expenditures and low operating expenses, investments in CCS on biomass facilities incentivize increased operating hours, creating a situation where biomass plants operate throughout the year instead of serving as backup for wind and solar.

This entails a risk of a sustained high use of biomass for decades based on revenues from the payment for carbon removals. Potentially, facilities could be in operation even if there is no demand for heating, which is currently the primary product of biomass-fired combined heat and power facilities in Denmark. At very high levels of payments for carbon removals, BioCCS plants could even operate when there is no need for power resulting in the curtailment of wind and solar.

Financial incentives for BioCCS in the EU

Several policy interventions are needed to ensure a sustainable deployment of BioCCS in the EU. To ensure that carbon removals do not distract from emission reductions, one potential avenue would be to establish binding and separate targets or sub-targets for emission reductions and carbon removals (possibly separately for permanent carbon removals and the LULUCF sector).

8 A LULUCF pricing mechanism increases the costs per ton of stored CO_2 by approx. 30 euros, making BioCCS profitable from around 190 euro per ton CO_2.

9 The cost of capture plants, injection wells, pipelines and to some extent ships and trucks are largely the same regardless of how much they are utilized.

Separate targets could establish the basis for a policy and obligation regime that improves the likelihood that targets are achieved. Considerations on separate targets must find a balance between ensuring environmental integrity and cost-effectiveness in the EU's climate policy.

Furthermore, it could be explored if permanent carbon removals could be covered by emissions trading and/or a separate compliance mechanism taking into account the risks involved. This could possibly contribute to stimulating the demand for permanent carbon removals and help managing the lack of incentives to establish BioCCS and DACCS today. Many options are in play such as direct/limited integration with the EU Emissions Trading System (EU ETS), linkage through an intermediary body/governance set-up (e.g. the idea of a Carbon Central Bank) or a separate compliance market (e.g. the idea of a Removal Trading System). CONCITO and Clean Air Task Force are currently analysing policy options and will publish a report with recommendations later this year.

It is critical that the final policy design focuses on ensuring the environmental integrity and predictability of emissions trading. Guardrails must be set up to ensure that the incentive to deliver emissions reductions are safeguarded, and that an unsustainable deployment of BioCCS is avoided (e.g. with specific constraints/restrictions on BioCCS). The risk that a compliance market will primarily incentivise a deployment of the cheapest permanent carbon removal methods should be further analysed.

Right now, investment decisions for permanent carbon removals mainly rely on state subsidies and/or voluntary carbon markets. Initiatives like the Innovation Fund and other EU funds will continue to play a pivotal role in fostering technological advancements in the years to come. Ensuring financing instruments and other support for innovative technologies are critical to harvest the learning curves of early efforts. Even with a financial incentive equaling the allowance price in the EU ETS, additional funding would be needed in many years to come (especially for DACCS), while avoiding weakening the support for other technologies critical to provide deep and timely emission reductions.

Prioritisation and strong regulation of biomass use in the EU

Prioritisation and stronger regulation of biomass use is needed in parallel with incentivising the deployment of no-regret BioCCS applications to avoid lock-in of high biomass use for purposes that could be served by other means e.g. electrification. The EU must prioritize biomass for high value purposes on the path towards climate neutrality and consider the impacts on the size of the natural carbon sink in the LULUCF sector.

In the short term, the development of a EU certification methodology for BioCCS under the new voluntary framework for certifying permanent carbon removals, carbon farming and carbon storage in products (CRCF) should provide appropriate incentives for BioCCS. While a new sustainability requirement for BioCCS facilities is introduced[10], it is not expected that this alone would ensure a sustainable and prioritised BioCCS deployment in the EU.

The technical assessment paper to the EU Carbon Removals Expert Group acknowledges that the timing of delivery of reductions in atmospheric CO_2 concentrations (net removal of carbon) for BioCCS depends on the biomass resources used and the circumstances of their harvesting or collection (e.g. stemwood, forests residues, agricultural residues etc.), but suggests that this element should not be covered by the methodology.[11] In this sense, the certification could

10 These facilities will need to demonstrate that, as a result of the financial benefits related to the CRCF certification, their total energy capacity has not increased beyond what is necessary for operating carbon capture and storage.

11 E.g. because identifying temporality for biomass-based removals may be complex and could delay the point of revenue realisation for some projects.

possibly largely be decoupled from the possible climate impact (net-emissions) of the use of different biomass feedstocks[12].

In the implementation of the upcoming 2040 climate target, pricing mechanisms to reflect losses in the LULUCF sector when biomass feedstocks are utilised must be further explored to ensure an ambitious and cost-effective green transition and to establish more accurate incentives for the use of biomass (and BioCCS). The net-emissions[13] from burning biomass could e.g. be covered by emissions trading. This would more accurately incentivise cost-effective biomass use and address the uneven distribution of incentives for biomass combustion compared to LULUCF sinks. Pricing of biomass use in the EU ETS could complement national efforts/EU-wide regulation in the LULUCF sector[14].

Looking at the development in the negotiations of the EU Energy Taxation Directive with proposals to exempt biomass from minimum taxation rates and the subsidies for biomass in the EU (15 billion in 2022), it further underlines the need to reassess the biomass use in the EU. This is not only relevant in relation to BioCCS but could lead to a more optimal use of bioenergy overall.

Furthermore, the current amount and sources of emitted biogenic CO_2 in the EU is underestimated to some extent. To be able to make more informed decision-making and ensure optimised application of BioCCS, the European Commission could propose obligations for all facilities to report and account for biogenic CO_2 emissions (including the type of biomass feedstock used).

The above-mentioned policy interventions should be examined in the context of other possible policy interventions on the use of biomass. This could include specific constraints/restrictions on the role of BioCCS in compliance markets, further sustainability requirements for BioCCS facilities, and/or restricting the use of biomass under the EU energy regulation. The work on an agricultural emissions trading system (AgETS) and possible linkage of carbon removals in the land sector (carbon farming) also affects the policy mix. Many carbon farming activities have significant issues with impermanence and risk of reversals (e.g. through changes in land-use, droughts, pests, and forest fires). Other issues include questions of additionality (e.g. uncertainties establishing trustworthy baselines), MRV (such as limited robustness and possible high costs), and risks of mitigation deterrence, if carbon farming is included directly in an AgETS. In this light, a first step could be to disconnect an AgETS and carbon farming and instead use revenues from an AgETS for a public/private fund for LULUCF removals.

12 When energy is produced from e.g. woody biomass, the wood is burned, and the carbon content is released as CO_2 into the atmosphere. The woody biomass could alternatively have been left in the forests for natural decay or used for other purposes such as harvested wood products with long lifetimes. The additional amount of CO_2 in the atmosphere, so-called net-emissions, caused by burning biomass will decrease over time, if the biomass is replanted in the same way, but it will be high for the first several decades. The temporary shift of the carbon pool from forest to atmosphere will negatively affect the climate, and the short to medium term increases in emissions will lead to increased temperature overshoot and potentially climate tipping points being passed. The average half-life for net-emissions of biomass is similar to that of methane and so one could in principle calculate a global warming potential of biomass CO_2 (e.g. GWP20 or GWP100) taking into account the timescales considered. This would allow for a full picture of climate impacts from different biomass feedstocks.

13 See footnote 10.

14 In the same way as the EU ETS for fuel combustion in road transport and buildings and small-emitting sectors (EU ETS2) complements the Member States' emissions reduction targets under the Effort Sharing Regulation.

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We aim to help reduce greenhouse gas emissions and limit the damaging effects of global warming.

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