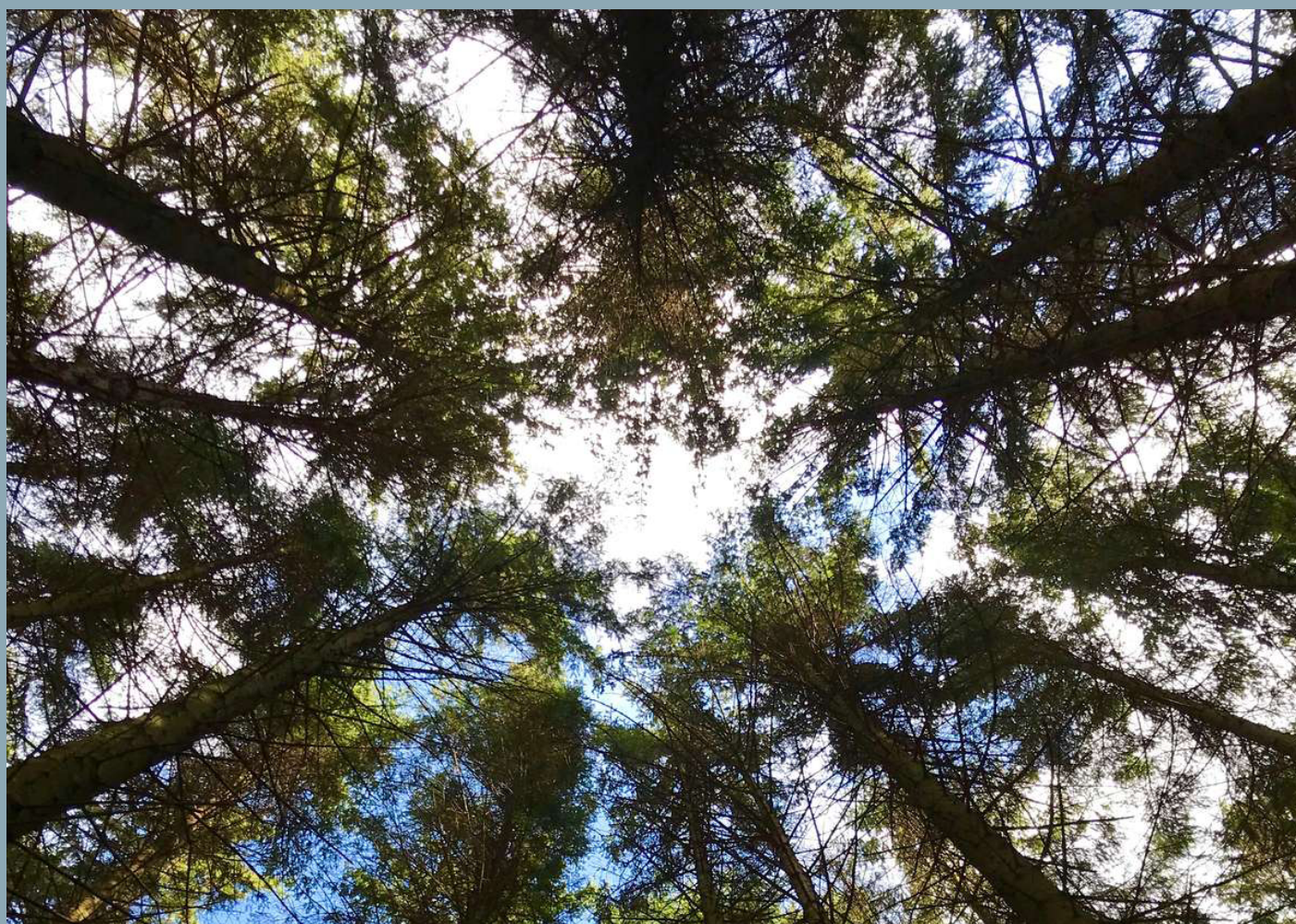


Climate Neutral Nordic

Policy recommendations:

Carbon capture and storage on waste incineration



Skift

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Climate
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Business Climate Leaders



ZERO



**Nordic Council
of Ministers**

Context

To enable a faster and substantial implementation of CO₂-capture technology at Nordic waste to energy facilities, a common and cross border approach seem necessary. This paper investigates what this could be based on inputs from Nordic stakeholders during a webinar held on December 14th 2021. Stakeholders from Sweden, Denmark and Norway participated in the discussion and the policy paper therefore reflects these viewpoints. Insights from the rest of the Nordic countries should be explored in future work.

Summary

There are several policy instruments and business models for CCS on waste, in Sweden, Denmark and Norway, either as existing policies or in the pipeline. Of these there are possibly three models, who may have a potential of cooperation and a further Nordic cross border facility:

- Reverse auctions
- A CO₂-tax on the fossil part of the emissions
- Extended producer responsibility for waste

Background

Emissions from waste incineration stands for approximately 5% of the global CO₂ emissions.

To implement CCS on these facilities will be key for the Nordic countries as nations, and as a whole, to reach their climate targets for 2030 and beyond.

There are a whole range of solutions to tackle this rather complex challenge. First and foremost we will have to minimize the amount of waste in itself. By producing less packaging, and longer lasting products. Then we must minimize the amount of residual waste being burnt in an incineration facility. This is done by reuse, recycling and source sorting. Still there will be some waste left, preferably for waste-to-energy, but with huge CO₂ emissions that only the technology of carbon capture and storage (CCS) can mitigate.

The good news is that these point sources of emissions are relatively few. They are in many cases in cities that already have ambitious climate goals, and the stakeholders are mostly open to share knowledge and experiences.

Carbon capture and storage in the Nordics

The Nordic countries have a common market when it comes to waste, and could therefore benefit greatly from a joint approach and cooperation between the waste facilities planning to do CCS. The stakeholders on waste also face the same barriers on how to be able to invest in CCS and make a business at the same time.

Nordic countries are well suited for CCS and technologies for negative emissions as plenty of storage options are available, as well as relevant researchers and companies.

State subsidized CCS should be limited to only the first projects. Now it is essential that supplementary measures are introduced for CCS beyond implementing a price for carbon emissions. If the world is to succeed with CCS, the technology must be developed further both in terms of scale and volume, and a profitable market must be created for emission-free waste management. For the waste market this means creating increased willingness to pay for zero emission waste management.

Norway has come a long way when it comes to developing CCS in general. The Government decided in 2020 to subsidise building an infrastructure for capturing CO₂ from [Heidelberg Cement, Norcem](#), in Brevik and storing it in a reservoir outside of Øygarden. The project is called "[Langskip](#)", and will have a storage capacity of 1,5 mill tonn CO₂ a year.

The CCS project at the waste management facility Klemetsrud was to receive Norwegian state support subject to funding from the EU Innovation fund. This was not realised, but the municipality of Oslo decided in March 2022 to sell their share in Fortum, and by this securing new owners willing to finance the CCS project – and partial state funding.

The total GHG emissions from the Klemetsrud waste to energy plant represent in excess of 14 percent of the municipality's total greenhouse gas emissions (equivalent to the annual emissions from about 200,000 cars).

When CO₂ capture from the Klemetsrud plant are implemented, this will be one of the world's first full-scale CO₂ capture associated with energy recovery.

The other larger cities of Norway (Bergen, Trondheim and Stavanger) have all started developing CO₂ capture projects at their waste to energy facilities. Also smaller cities like Kristiansand are planning to mitigate their CO₂ emissions from waste incineration.

For the next CCS projects in Norway the need for long term business models is essential. State aid is too politically vulnerable, and should in any case be an unnecessary measure, since this industry needs to be commercially viable to contribute with its potential for mitigation.

To schematically distribute the cost of CCS for waste to energy plants, the environmental foundation ZERO has suggested a principally fair distribution between state and municipality. About 50/50 percent of emissions from waste incineration is fossil and biogenic, with some variations between sites. CCS on biogenics emissions results in CO₂ removals, and such removals should be financed publicly as they are needed because of lack of historic emissions reductions in the last decades. Financing of CO₂ removals is therefore a national and public responsibility. Financial mechanisms for CO₂ removals from waste management facilities can be through climate credits in the voluntary market, and national CO₂ removal policies, such as a reverse CO₂ tax, a reversed auction or feed-in system. The voluntary market and a national policy could work separately or in combination.

For the fossil part of the emissions, all these measures are suggested: a waste incineration tax in combination with export duties, a CO₂-fund, an inclusion in the EU ETS, support from the municipality (of Oslo), a higher renovation fee, climate incentives in public procurement, plus extended producer responsibility for waste to cover the cost of CO₂ capture from incineration of fossil plastics.

On a longer term a carbon takeback obligation (CTBO) will be a wise measure: By obligating producers to permanently store as much carbon as they produce, the CTBO can induce new investments in CCS and other negative emissions technologies. The CTBO offers the industry and policymakers a complementary and pragmatic route to ensure that any remaining fossil energy use will be 'net zero' compliant by 2050 and beyond.

In **Denmark** as much as 2/3 of the CCS potential is from biogenic sources (waste and biogas). The Government says that CCS has a technical potential of 9 mill tonnes of CO₂/year. Their climate fund gave support for 0,9 Mt/y in 2020, and the national budget for 2022 supports means for 0,5 Mt/y. Which is a start, but the Danish think tank Concito recommends 5 Mt/ to be built to be able to reach national climate goals.

There seems to be a common agreement that incentives must be driven by tax and subsidies in combination. For fossil emissions stemming from burning of waste the Danish authorities are also considering a CO₂-tax, inclusion in EUs ETS, and a negative tax for negative emissions.

Long term prices must be driven down, says Concito. This will be especially important since Denmark aims to become a European hub for CO₂ storage, much of this will be onshore/ nearshore storage, and the transport will be by pipeline. This will be costly, and should be financed by a state – business cooperation.

The waste management facility [Amager Resource Center \(ARC\)](#) in Copenhagen – works to cut their CO2 emissions by 500 000 t/y by 2025. The Danish authorities have reached a settlement in which they set aside 16 billion Danish kroner for CO2 capture, storage and use from 2024 on. It is expected that some of the funding will be allocated to a project by the end of 2022.

In June 2017, **Sweden's** Riksdag decided by a large political majority to introduce a climate policy framework with a climate act for Sweden. By 2045, Sweden is to reach net zero emissions of greenhouse gasses into the atmosphere and should thereafter achieve negative emissions.

Sweden is very advanced when it comes to the technologies for combining the natural CO2 cycle and, amongst other things, CCS technology. They have suggested implementation of reverse auctions, for incentivising technologies enabling CO2 removal.

Reverse auctions, means that stakeholders place bids to which cost they can capture and store a given amount of carbon dioxide. The auction is max 2 Mt CO2/year, which constitutes 3–5 facilities. The time horizon of an agreement is 10–20 years. They will open up other technologies than bio-ccs in the long term, but for now they are not considered mature.

Stockholm Exergi:

A full-scale Bio Energy CCS plant is to be retrofitted to the KVV8 district heating plant, aiming to capture up to 8 million tons of CO2 a year. They have plans for transportation and sub-sea storage in the North Sea, in the Norwegian project Northern Lights.

The project will demonstrate and promote negative emissions (CO2 removal) and received 180 million euro in funding from the EU Innovation fund.

Policy reflections going forward

For the next CCS projects in the Nordics, the need for long term business models is essential. State aid is too politically vulnerable, and should in any case be an unnecessary measure, since this industry needs to be commercially viable to contribute with its potential for mitigation.

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On a longer term a carbon takeback obligation (CTBO) will be a wise measure: By obligating producers to permanently store as much carbon as they produce, the CTBO can induce new investments in CCS and other negative emissions technologies. The CTBO offers the industry and policymakers a complementary and pragmatic route to ensure that any remaining fossil energy use will be 'net zero' compliant by 2050 and beyond.

Nordic infrastructures incentives investments

By linking more carbon capture projects to the CO2 infrastructure, the cost per unit of each stored ton of CO2 will be reduced. Also the investment decisions for the two initial plants, Norcem in Breivik and FOV Klemetsrud, helps reduce risk and make it possible to start planning upcoming plants in detail. Now we know for a fact that [a storage solution](#), with the needed infrastructure, is a reality and a viable option for reducing CO2 emissions from the Nordic waste facilities. The next phase of the Northern Lights project will ensure a storage capacity of further 5 million tonnes of CO2 a year.

Several companies based outside Norway, such as the waste management facility in Stockholm, are planning to store their CO2 in Northern Lights. The development of comprehensive infrastructures for CO2 capture, transport and storage will also provide the mainland industries and waste facilities with new opportunities.

Policy recommendations

There seems to be a cross Nordic understanding of the need to use both "stick and carrot" to ensure a faster implementation of CCS on CO2 emissions stemming from waste to energy facilities. Some instruments even seem to be common in design, with some national adjustments only. Here listed are those we touched upon during the webinar, listed in all countries either as existing policies or in the pipeline, who may have a potential of cooperation and a cross border facility.

Reverse auctions

Reverse auctions involve a buyer purchasing a product or service, with sellers competing by lowering their bid price to provide the product or service. For CCS the government would in effect procure the storage of CO2 captured. The waste to energy facilities then compete against one another by reducing the price to carry out the project and store the CO2. The lowest incentive price bid into the auction, expressed in cost per ton stored, would win the auction. Among other benefits the auction would help ensure that the deployment program deployed as much CCS capacity and store as much CO2 as possible given the available funding, increasing the cost effectiveness of the program. Other benefits are minimising risk of over compensation, it complies with state aid rules, and (most) stakeholders are in favour of reverse auctions.

A CO2-tax on the fossil part of the emissions
Introducing a tax on the energy recovery of waste at incinerator plants without CCS, where the tax rate is on par with the domestic CO2 tax. Simultaneously, an export tax should be introduced, which should be on par with the domestic tax.

This extra tax on waste will create a business model based on the principle that incineration plants with CCS could charge extra for waste. The fee is collected when the waste is handed off for incineration or when declaring exports of waste at the national environment authorities.

Extended producer responsibility for waste
This scheme has been implemented across the EU through the EU Waste Framework Directive, but different products are subject to it across different countries. By extending producer responsibility to include carbon emissions from the waste incineration, means placing it at producers introducing fossil-based products to the market. The financing could take place through a private fund operated by those who currently oversee the producer responsibility scheme.

Concluding remarks

Long-term predictable frameworks are crucial to boost the speed of needed investments and development. Short-term challenges are important but must not take the focus away from putting long-term policy instruments in place.

In order to ensure large-scale deployment of CCS, a mix of instruments is needed. At the core, we need instruments giving sufficient incentive to make business cases for CCS viable and trigger investments in deployment and innovation.

For CCS to deliver on its significant potential, concerted government action at the regional, national and international levels is needed in order to provide a stable market signal and investor certainty.

More large-scale integrated projects need to be deployed to a degree that will enable movement beyond the initial high-cost phase inherent to any technology that has not yet achieved widespread use. Regulatory, policy and market conditions need to drive widespread CCS investment and cost-reductions through learning and economies of scale.

ZERO made in 2019 this report analyzing potential business models making CCS viable for industry and waste facilities: <https://zero.no/wp-content/uploads/2019/09/rapport-eng-ccs-v6.pdf>

Formalia

“Climate Neutral Nordics” is a collaboration between [Skift – Business Climate Leaders](#) (Norway), [Hagainitiative](#) (Sweden) and [Climate Leadership Coalition, CLC](#) (Fin) aiming to facilitate collaboration between business and policy to contribute to the vision in the Nordic region to become the most sustainable and integrated region in the world in 2030. The 4 year project is financed by the Nordic Ministry of Councils, and started out in 2021.

This policy paper is a part of the project “Nordic Innovation Power” which focuses on discussing what policy changes are needed to quickly scale up green innovations in the Nordic region through regionally wide meetings with the discussion summarized in a policy paper.

[ZERO](#) and Skift accounts for all conclusions and recommendations. That also goes for any errors in the policy paper.

The focus of 2021 was carbon capture and storage (CCS) on waste incineration. As part of this, a webinar on the theme took place in December. Most of the content in this paper is based on [this webinar](#).