ZERO

New business models for carbon capture and storage

Carbon capture and storage as a means of tackling climate change is crucial in achieving the world's climate goals. A breakthrough for carbon capture and storage will require new financing solutions for the coming decade, including market-stimulating measures.

Published by the Zero Emission Resource Organisation (ZERO)
March 2019

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Carbon capture and storage is essential to achieving the 1.5 degree target

The world is heading towards a global temperature increase of three degrees. The longer we postpone the implementation of emission cuts, the faster the emission reductions have to be implemented, and the more CO_2 will have to be removed from the atmosphere.

The UN Intergovernmental Panel on Climate Change special report on the 1.5 degree target points to carbon capture and storage (CCS) combined with bio-energy with carbon capture and storage (BECCS) as a potential solution for removing CO_2 from the atmosphere in scenarios where global initiatives are implemented too late to keep emissions below a carbon budget for the 1.5 degree target.

The greenhouse gas emission projections towards the year 2100 (figure 1) show four paths to achieving the 1.5-degree target. With a massive global change in policy it might be possible to cut emissions as shown in paths P1 and P2. However, even in these scenarios, with the fastest and largest emission cuts, vast quantities of CO_2 will still have to be removed from the atmosphere in the period following 2050. If such massive cuts are being delayed internationally, as shown in scenarios P3 and P4, we will need to remove CO_2 from the atmosphere at a scale which is both technically and economically unrealistic, and which will clash with other sustainability goals.

The development of infrastructure for transport and storage of carbon as well as a rapid implementation and distribution of full-scale carbon-capture plants in the industrial and waste management sectors can make massive emission cuts possible in the years leading up to 2050, and may enable us to remove CO_2 from the atmosphere (BECCS). Without CCS, reaching the climate goals might involve significant economic expenditure (IPCC, 2014).

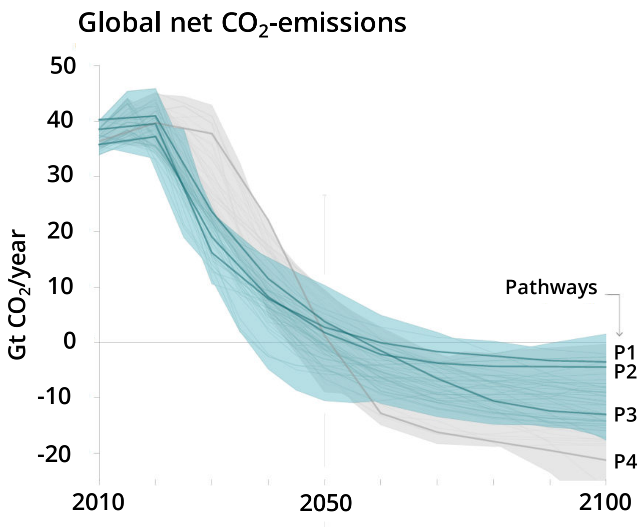


Figure 1: *Four illustrative paths (P1 to P4) to reaching the 1.5 degrees target. (IPCC, 2018)*

Carbon capture – from policy to implementation

In the Granavolden Declaration, the Government pledged to:

«Contribute to developing technology for capture, transport and storage of CO_2, with the ambition of achieving a cost-effective solution for full-scale CO_2 processing facilities in Norway, provided that this will result in dissemination of technological solutions and drive technological developments on an international scale»

Along with the review of the parliamentary White Paper on energy policy (Energimeldingen, Meld. St. 25 (2015–2016)), Stortinget asked the government to investigate alternative financing models for CCS. In the government's proposed national budget for 2019 it was announced that a motion on the issue would be made to Stortinget in the spring of 2019. This report is partly intended to be a direct contribution to this initiative.

ZERO aims to contribute to expanding the knowledge base and offering concrete proposals for measures that can drive the implementation of CCS projects in both the short and medium term. This memorandum considers various measures for stimulating the market so that the cost of CCS can be included in the value chain of the products. That is to say, the CO_2 capturing costs for manufacturing companies can be passed on to the end users in the form of higher prices for manufactured goods. This work is based on the two specific carbon capture projects in Norway, which are linked to cement production and waste management.

New socio-economically efficient business models for CCS

Carbon capture and storage is a costly, yet important climate change mitigation measure (IPCC, 2014). Two main factors will determine the adoption rate for this initiative: the cost of emissions and the cost of capturing emissions. Figure 2 shows the projected developments in the carbon price and carbon capturing costs over time.

The carbon price is expected to increase gradually by 2050, while the cost of CCS is expected to decrease with greater distribution and volume (KS1, 2016).

The carbon price is expected to trigger CCS investments at some point between the year 2030 and 2050.

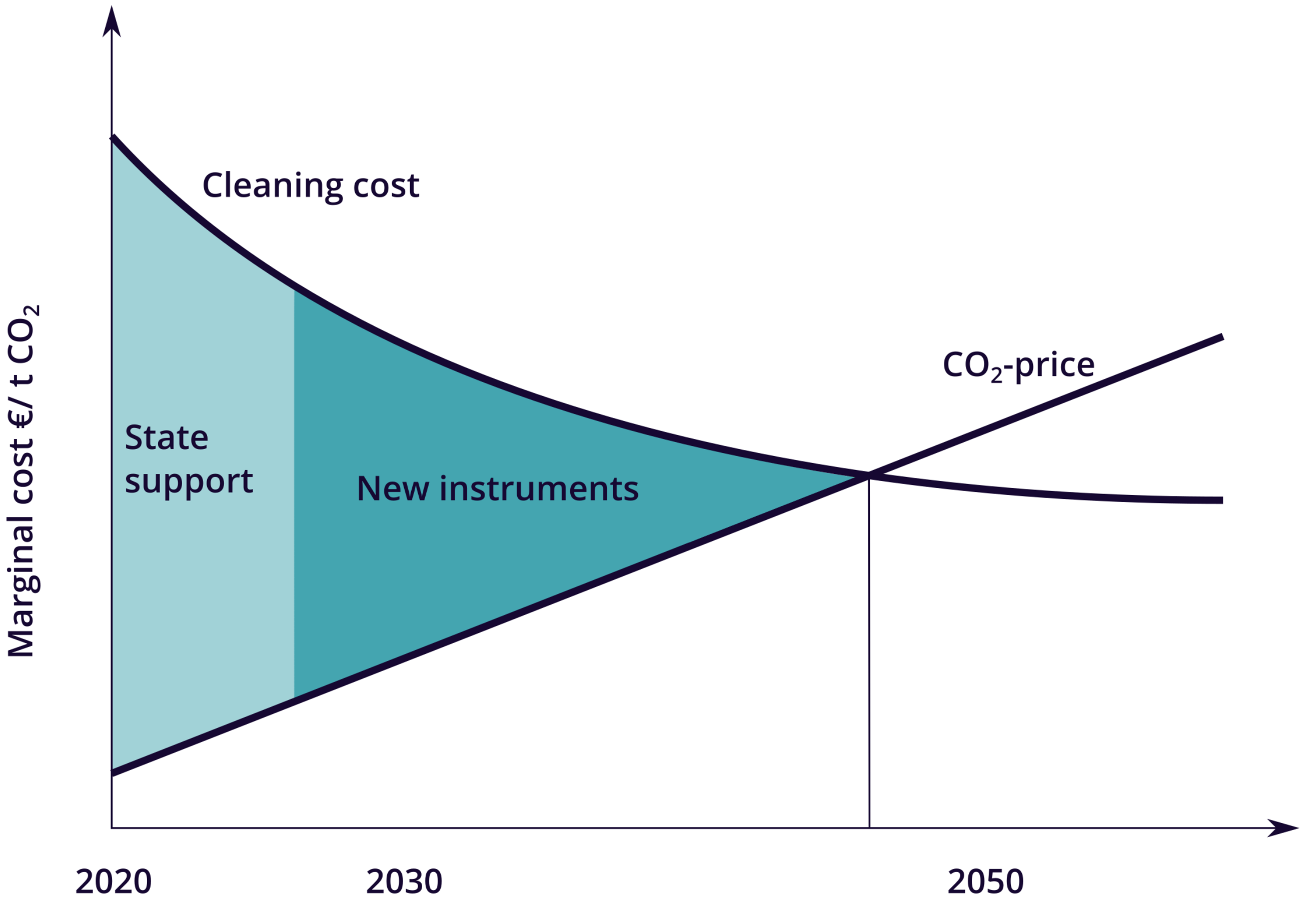


Figure 2: *Estimated development of the CO_2 cost and the cost of CO2 capture from 2020 to 2050.*

Government subsidies would be essential to trigger construction of the first carbon capture facilities, representing a socio-economically efficient instrument in terms of generating technological developments and hands-on learning which has not yet been internalized in the market (IEA, 2011).

Figure 3a shows the estimated carbon price given by a defined emission target where instituting a price on carbon is the only measure or intervention used. Initiative D, which is more cost-effective to implement than initiative C, requires for initiative DT to be implemented first. Further technological advances and development are necessary to achieve maturity for initiative D.

This will require financial support for developing technologies as well as hands-on learning upon implementation. Solar cells, electric vehicles and CCS are all measures falling under option D.

The provision of funding for technological research and development and/or creating early markets by incentivising early adoption will help facilitate the development of initiative DT. This will make it possible for the carbon cost to help trigger initiative D at a lower cost than initiative C, as shown in Figure 3b. The overall cost for climate change mitigation measures implemented to reach established carbon reduction targets will therefore be lower in a situation where state subsidies on technology are used actively in combination with carbon pricing (figure 3b), compared to a situation where the carbon price is the only used intervention (figure 3a).

A combination of implementing a price on carbon in conjunction with efficient additional measures will therefore be socio-economically efficient (IEA 2011), and will also be in line with the government's ambitions of developing CCS to stimulate technological development internationally.

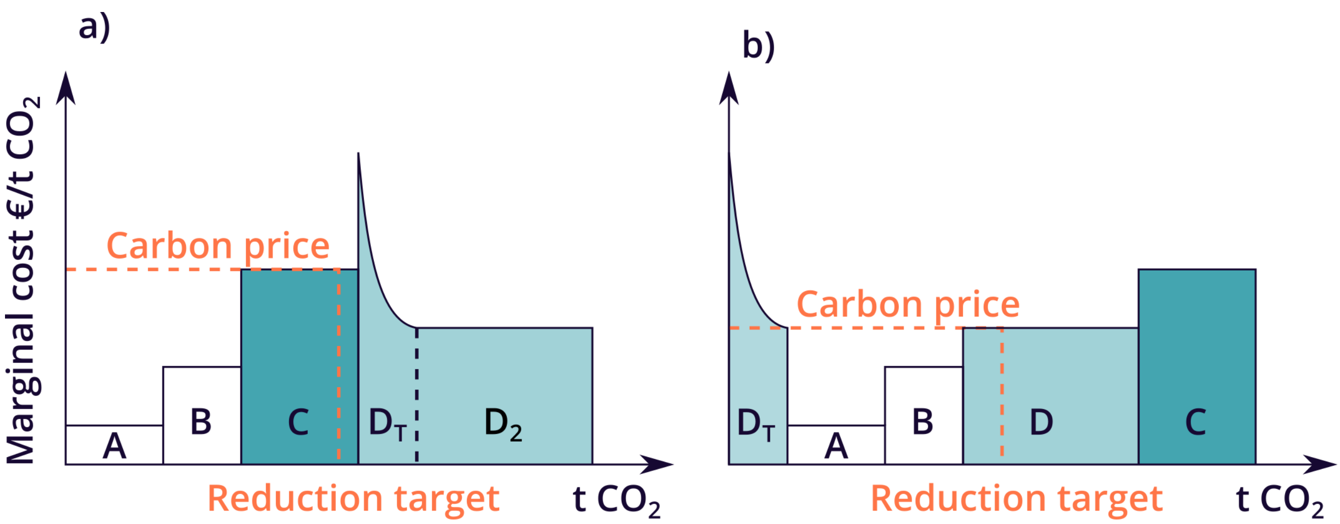


Figure 3: *A theoretical approach between carbon price and carbon reduction targets in a) with carbon pricing being the only measure and carbon pricing in combination with technological support to trigger initiative DT. Situation b) shows a more socio-economically efficient way to attain the goal with a lower total cost and carbon price.*

Green business models for emission-free production

The subsidizing of early CCS technological development is an effective instrument where the degree of effectiveness depends on the rate of technological development compared to what would otherwise have been developed without the subsidy (IEA 2011).

It is nevertheless important to stress that subsidies are inefficient on a large scale, as other supplementary measures to develop and scale up CCS are more effective. Measures that make it possible to pass on the costs of capturing CO_2 to the end user of the manufactured product would mean that in a wider sense, the polluter pays, while state subsidies can be avoided.

The state can help establish early markets for emission-free production methods, which in turn paves the way for profitable business models for emission-free processes.

Relevant political initiatives can include levying taxes on products associated with large emissions during production, or implementing regulations which set limits for emissions during manufacture or from specific products. Such measures will not trigger carbon leakage, and at the same time they will create a market for emission-free production methods and emission-free products.

Measures that help establish early markets without the use of state subsidies will also be important to ensure transferability of the climate policy to other countries that do not have the generous public budgets that Norway has.

These measures will be less politically vulnerable as they are not dependent upon annual budgetary grants, and thus limits risk and cost exposure for those who consider investing in carbon capture technology.

Billions, not millions of tonnes of CO_2

It has been established that the development and diffusion of CCS is essential in order to reach the world's climate goals. Norway can make a crucial difference in how fast this technology is adopted, and where.
By further developing the current CCS projects at the Klemetsrud waste-to-energy plant in Oslo and the Brevik cement factory, we can establish the first full-scale value chain for carbon capture and storage from both waste management and cement production.

These projects can result in the initial reduction of around 800,000 tonnes of CO_2.

While this only a small reduction in an international context, it will be a major step in handling CO_2 emissions from both cement production and waste management. The emissions from these sectors are each estimated to constitute around five percent of the world's total greenhouse gas emissions (IEA, 2018; IPCC, 2014).

The two projects can therefore contribute to vital technological developments for managing billions of tonnes of CO_2 emissions annually worldwide. This will make a great difference, and someone has to be the first to show that it is in fact possible.

CO_2 capture from waste energy recovery: The waste-to-energy plant at Klemetsrud in Oslo.

Dissemination and benefits realization

A key success factor for the development of a full-scale plant for CO_2 capture at Klemetsrud and in Brevik and associated infrastructure for transport and storage is the extent to which it will help promote and facilitate other carbon capture projects in Norway and Europe.

By linking more carbon capture projects to the CO_2 infrastructure, the cost per unit of each stored ton of CO_2 will be reduced. At the same time, an investment decision for the two initial plants will help reduce risk and make it possible to start planning upcoming plants in detail, when they know for a fact that a storage solution will be viable option. Several companies based outside Norway, such as the Preem refinery in Lysekil and the waste management facility in Stockholm, are planning to establish carbon capture plants for carbon storage in Norway. The Norwegian carbon storage facility could also be relevant for projects in other European countries, such as Great Britain.

The development of comprehensive infrastructure for CO_2 capture, transport and storage will also provide the mainland industries with new opportunities. The processing industry's own roadmap for a low-carbon economy points to CO_2 capture and storage as vital measures, where 60 per cent of the emission cuts are dependent on technology.

The case has also been made for how infrastructure for CO_2 capture could become a competitive advantage for Norwegian industrial enterprises as climate policy is tightened further around the world (Norsk Industri, 2016).

At the same time, it is essential that we consider the transferability of the applied measures to other products, value chains and countries that may require financing of CCS or other emission-free climate solutions in their industrial production. The absence of effective financing mechanisms for CCS internationally is often highlighted as being the main obstacle for the adoption of CO_2 capture and storage. After several decades where state subsidies have been the sole financing mechanism in use (beyond the EU Emissions Trading System), not a single carbon capture project in Europe has been implemented by the industrial, waste management or power production sectors.

Hence, transferability is key in two ways:

1) At a project level, with the aim of storing large volumes of CO_2 in a Norwegian value chain for transport and storage, and

2) At a policy level, with the goal of developing a model for triggering carbon capture initiatives in other countries as well.

FORTUM OSLO VARME'S CCS PROJECT AT KLEMETSRUD

CO_2 capture from waste-to-energy schemes

Owner: Fortum Oslo Varme, which is owned by Oslo Municipality and Fortum
Emission cuts: Up to 400,000 tonnes of CO_2 per year (90 percent capture rate). A carbon-negative project, where the biological share of household waste accounts for 60 percent
Technology: Shell's amine technology
Transportation: Emission-free road transport to port, ship to storage

Fortum Oslo Varme's waste-to-energy plant at Klemetsrud incinerates around 350,000 tonnes of household and commercial waste from Norway and abroad, equivalent to around 350,000 tonnes of allowance-exempt carbon emissions per annum. The heat from incineration is used to generate electricity, district heating, and cooling for buildings in Oslo. With the European ban on landfilling the aim is to recycle 65 percent of the waste by 2030. Energy recovery from household waste which can or should not be recycled will give a three- too four-time reduction of greenhouse gas emissions compared to landfilling of a corresponding amount of waste (Mepex, 2012). The remaining non-recyclable waste can be incinerated for energy recovery. Fortum Oslo Varme's plant at Klemetsrud will be the first CO_2 capturing waste incineration plant in the world.

NORCEM'S CCS PROJECT AT BREVIK

CO_2 capture from cement production

Owner: HeidelbergCement. Partners: Norcem, HeidelbergCement and ECRA (European Cement Research Academy)
Emission cuts: 400,000 tonnes of CO_2 per year (50 percent capture rate)
Technology: Aker's amine technology
Transportation: Ship to storage

Norcem in Brevik emits 800,000 tonnes of CO_2 which is included in the EU carbon allowance system. The plant produces around 1.2 million tonnes of cement annually, with emissions of a little over 600 kg of CO_2 per tonne of cement produced. This is lower than the global average due to the fact that biomass is used in the production, and flue ash is mixed into the cement. Around two-thirds of the emissions come from the de-carbonization of limestone ($CaCO_3$ to CaO), while the remaining third comes from the combustion of fossil fuels for process heating (Norcem, 2019). With its carbon cleaning plant at Brevik, Norcem can become the world's first cement plant with full-scale carbon capture. Cement production is well suited for CO_2 capture; it involves high concentrations of CO_2 and generates excess heat which can be utilised in the capturing process.

From capturing costs to a product price increase

What additional costs due to full-scale capturing of CO_2 emissions from cement production and energy recovery from waste will apply to the cost of a building or a road or the waste collection fees around the country? In this section we will highlight the economic consequences of passing on the cost of CCS to the end user of the manufactured product.

Small additional charges for emission-free concrete in the construction sector

Figure 4 describes the material flow for cement in Norway. The Norwegian cement production largely covers the demands of the domestic market. Around 20 per cent of the cement used is imported, and around ten percent is exported. Cement is mixed with sand, water and other minor additives to make concrete.

Concrete is mainly used for infrastructure such as roads and railways, as the foundation of residential houses and apartment buildings, and for public and private commercial buildings. All in all, this amounts to 90 percent of the total usage; niche products account for the remaining ten per cent. The public sector's share of the total concrete usage constitutes 40 percent.

If we conservatively assume a carbon capturing charge of NOK 2.000 per ton of CO_2 from the cement production, in line with the projects' quality assurance reports (KS1, 2016; KS2, 2018; KS2, 2018b), the additional costs associated with the traded volumes of concrete in Norway will constitute around NOK 2.8 billion per year.

Distributing these costs across six million cubic meters of concrete (14 million tonnes of concrete) will give a price of NOK 450 per cubic meter of concrete.

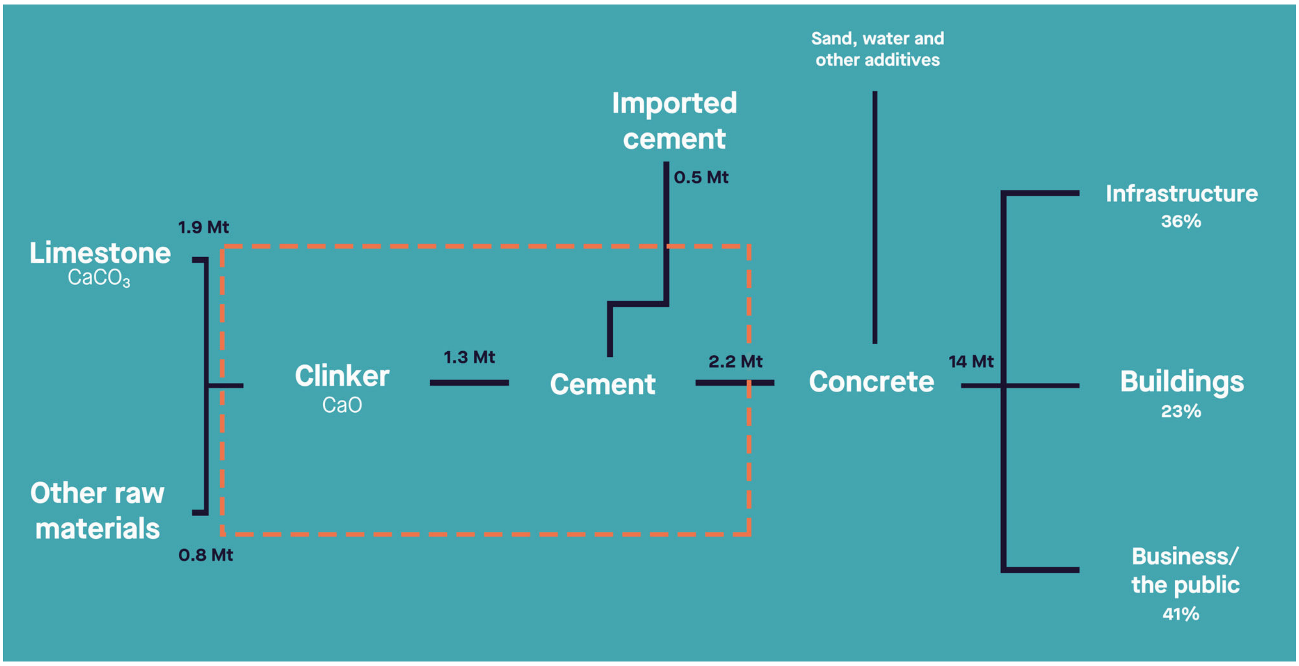


Figure 4: *Material flow and calculated cost increase for cement and concrete. The production of cement in Norway results in emissions of more than 1.1 million tonnes of CO_2.*

For large consumers, the price of concrete is around NOK 1,000 per cubic meter, which gives an additional cost of over 40 percent for emission-free concrete.

If we assume a future carbon capturing cost in line with KS2 (2018) of NOK 1,000 per tonne CO_2, the overhead charge will be reduced by 50 percent. International literature on the topic has established 20 to 30 percent price increase for concrete with CCS (Rootzén & Johnsson, 2016; ETC, 2018), and our calculations are therefore consistent with these findings. For a standard freeway this will constitute a mere one to two percent cost increase (estimated total cost:
NOK 150,000 per meter of road; total volume of concrete used: five square meters of concrete per meter of road (Veidekke, 2019).
For construction the additional cost will be less than one percent (estimated total cost of construction: NOK 26,000 per square meter of concrete, total volume of concrete used: 0.16 cubic meters of concrete per square meter of a building (Aspelin Ramm, 2019)).
This is in line with findings documented in the international literature of a cost increase in the range of one to three percent (Rootzén & Johnsson, 2016; ETC, 2018).

CO_2 capture from cement production: Norcem's CCS project in Brevik, Telemark.

A limited increase in waste collection fees

Figure 5 shows the waste flows from domestic and commercial waste broken down by energy recovery and other processes (recycling, biogas production, landfilling). To calculate the cost increase of waste collection fees with full carbon capture from incineration of household waste, we rely on the amount of household waste that goes to energy recovery.

The amount of waste produced annually amounts to 1.3 million tonnes, resulting in emissions of over 1.5 million tonnes of CO_2 (measurements conducted by Fortum Varme Oslo indicate that one kilogram of waste corresponds to 1.14 kg of CO_2 emissions).

With a 90 percent capture rate, the result is a one-to-one ratio (Fortum, 2019) with a capturable amount of 1,3 million tonnes per annum, of which approx. 0.5 million tonnes of CO_2 is fossil in origin (Carbon Limits, 2017).

With an estimated full-scale carbon capturing socio-economic cost of NOK 1,000 per ton CO_2 in the long term (KS2, 2018), this will result in an annual additional cost of NOK 1.3 billion with full-scale CCS from all household waste. With 2.4 million households in Norway and an average waste disposal fee of NOK 2,750 (SSB, 2017), this will entail an average increase of 20 percent for emission-free and carbon negative household waste management. This calculation does not include commercial waste, but the costs for commercial waste will increase equivalent to NOK 1,000 per tonne of waste.

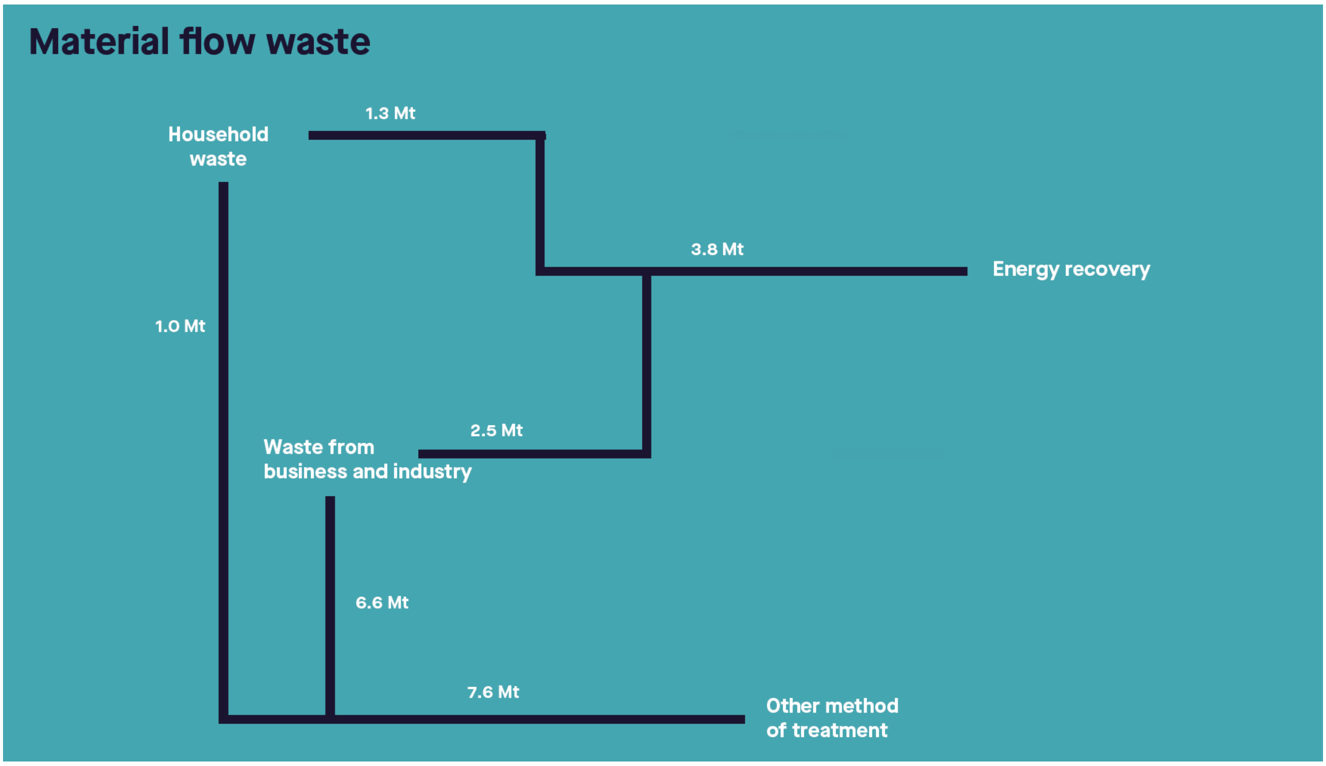


Figure 5: *Material flow of waste in Norway.*

Measures to create a market for CCS projects

This chapter examines what ZERO considers to be the most relevant measures for implementing CCS projects for cement plants and energy recovery from waste. The measures are evaluated in terms of their efficiency as instruments for triggering investments in carbon capture, the extent to which they create new a new impetus for climate change mitigation and drive changes in climate policy in Norway and Europe, and if they help to create a profitable business model for CCS.

The grading is indicated on a scale from a small extent (red) to a large extent (green).

CCS STIMULATING GREEN REQUIREMENTS FOR PUBLIC PROCUREMENT

Governance efficiency	green
Change drivers and benefits realization	green
Creates a business model	green
Conclusion	green

Design

The state and municipal purchasing power is a very effective instrument for stimulating the market in a more environmentally friendly direction.

About 70 percent of the waste collected from households is subject to public tenders, and the volume amounts to around half of the incineration capacity in Norway (Avfall Norge, 2019).

Waste from government agencies, such as Statsbygg, comes on top of that. Correspondingly, the public sector purchases around 40 percent of all traded concrete, for use in construction, roads, railways and other public infrastructure projects. There is considerable potential for applying environmental requirements to public procurement.

In the Granavolden Declaration, the government states that it will:

«Use public procurement and regulatory frameworks to stimulate demand for products manufactured using low-emission technologies, such as cement and asphalt»

The regulation on public procurements states that the contracting entity should focus on minimising their environmental impact and promote climate friendly solutions in their procurements. There are different ways to design the requirements of the tender to meet environmental requirements. Limits can be set for greenhouse gas emissions in the tender, and environmental criteria can be weighted in the competition (30 percent weighting as a main rule, if used), and it is also possible to add a green bonus for achieving results beyond the minimum requirements.

Assessment

The qualification requirements for public tenders cannot be so stringent that a monopoly situation will arise in the tenders (in full or in part). For CCS, this specifically means that the qualification requirements cannot be so stringent as to make concrete with CCS or waste incineration with CCS the only way to win the tender (DIFI, 2019). However, the law allows for an increased price for low-emission concrete or carbon negative waste management through the use of environmental weighting and green bonuses.

With an environmental weighting system, greenhouse gas reductions will be favoured, as it will be possible to submit a higher-priced tender which scores higher on the reduction of greenhouse gas emissions. The use of a "green bonus" in combination with imposing environmental requirements can also be an effective tool. The green bonus can be used to incentivise specific emission cuts which are related to certain technologies, or it can have a broader focus. This means specifically that the government can put a price on emission cuts from concrete and waste (DIFI, 2019), which the CCS stakeholders can pass on to the end user in the form of a higher product price. The level of the bonus can also be linked to the cost of domestic emissions (the CO_2 tax).

ZERO believes that it is important for state and municipal entities to adhere to the procurement regulations, and that clear environmental requirements in procurement is an important means to promote CCS in the short term.

VOLUNTARY MARKETS FOR LOW-EMISSION SOLUTIONS

Governance efficiency	
Change drivers and benefits realization	
Creates a business model	
Conclusion	

Design

Create voluntary early markets for low-emission cement production and waste management utilizing private, green demand.

Early markets for green products can be created through the use of certification schemes employing the mass balance principle. The buyer receives a certificate that the product has been produced with CCS. The principle of mass balance involves a decoupling between the physical product with lower emissions and the economic certificate. Certificates can be sold for the same amount of manufactured green products. An independent certification authority should be responsible for audits, and should be organized by the industry itself.

Assessment

Early markets that leverage private, green demand will be a driver for green products at the early stage, and will contribute to the necessary market development. Certificates would make it possible to charge higher prices for products produced with less emissions, and by employing the principle of mass balance the market is expanded geographically, so the demand for green products increases.

For cement, this means that certificates can be traded for low-emission cement all over Europe, while the physical cement produced at Norcem in Brevik can be sold locally.

The system for waste management will be based on the same principles: The waste can be disposed locally, but will be sold to carbon capturing plants.

A comparable voluntary arrangement exists for the production and use of bioplastics and biofuels, and **ZERO considers** equivalent voluntary schemes for green industrial products and waste to be a reasonable measure.

TAX ON WASTE

Proceeds	750 mill. kr p.a
Governance efficiency	
Change drivers and benefits realization	
Creates a business model	
Conclusion	

Design

A tax on generated waste is introduced.
This is done by introducing a tax on the energy recovery of waste at incinerator plants without CCS, where the tax rate is on par with the domestic CO_2 tax. This would be equivalent to around NOK 200 per tonne of waste at the current level (based on average emissions per tonne of waste (Fortum, 2019; Carbon Limits, 2017)).

Simultaneously, an export tax based on the Dutch model should be introduced, which should be on par with the domestic tax. It should be designed to avoid taxation of imported waste in order to leverage the capacity of Norwegian incineration plants and to incentivise energy recovery beyond the borders of Norway.

This extra tax on waste originating in Norway 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 Norwegian Environment Agency. A secondary measure could be to levy the fee directly on the waste owners who are sending their waste for incineration.

Assessment

A CO_2 tax on incineration of waste without the concurrent application of export duties will have a limited effect, as waste plants have little influence on the composition of waste, and at the same time it will distort competition in favour of exporting waste, and thus create carbon leakage. On the other hand, charging a tax on the incineration of waste without carbon capture in combination with export fees will create an incentive for the stakeholders to pass on the increased costs to those who create the waste in Norway.

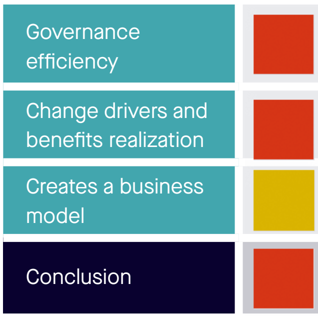
Such a tax arrangement would ensure profitability for the Klemetsrud carbon capture plant from the moment the tax is introduced, while the increased revenues will help finance CCS through the state budget. In this way, the waste industry in Norway can join forces to generate the momentum required to cut emissions from waste incineration.

An increase of the domestic CO_2 tax will increase the incentive for future CCS projects linked to energy recovery from waste in Norway.

An alternative model is where the tax is collected directly from the waste owner. This model is considered to be harder to implement in practice, and does not create a profitable/viable business model for CCS.

Based on this, **ZERO recommends** implementing a tax on waste generated in Norway. The tax should be in the form of a charge for incinerating waste without CCS, in combination with export duties.

WASTE IS INCORPORATED INTO THE CARBON ALLOWANCE SYSTEM



Design

Waste can be incorporated into the EU emissions trading scheme (the carbon allowance system), where the most relevant methods would be either to redefine waste facilities as co-incineration plants based on the Swedish model, or to opt-in through applying to the European Commission (the Danish model).

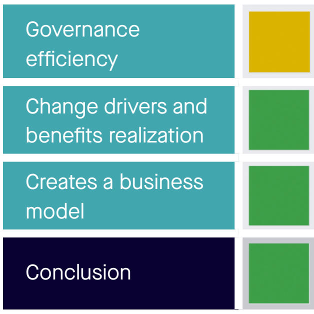
Assessment

Upon incorporation into the EU emissions trading system, Norway relinquishes its sovereignty over climate policy related to waste management, as well as the opportunity to become a pioneer in the field of CO_2 capture.
The cost of emissions in EU ETS currently, and in the foreseeable future, is far too low to trigger CCS projects, but can help create somewhat better profitability for CCS in the long term.

Credits and applying pricing on negative emissions from waste is not currently possible through the carbon allowance system.

ZERO does not recommend implementing waste management in the EU carbon allowance system, but rather recommends introducing a tax on waste in line with the proposition above.

FINANCING CCS THROUGH EXTENDED PRODUCER RESPONSIBILITY FOR WASTE MANAGEMENT



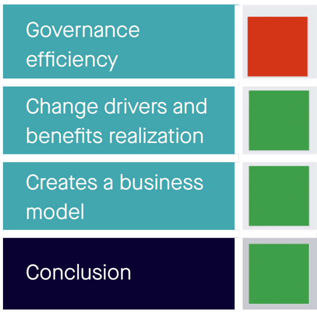
Design

Extended producer responsibility means that producers are held responsible for waste management for the products they introduce to the market.

This scheme has been implemented across the EU through the EU Waste Framework Directive, but different products are subject to it across different countries. In Norway, extended producer responsibility has been introduced for areas such as packaging and electronic waste.

ZERO suggests extending producer responsibility to include carbon emissions from the waste generated from the introduction of fossil-based products to the market.
This can be done by levying a CO_2 tax on fossil-based products that end up as waste with resulting emissions (primarily fossil-based plastics), which then is earmarked for financing CCS. The financing should take place through a private fund operated by those who currently oversee the producer responsibility scheme. For maximum effect, producer responsibility must be expanded to include more products.

GREEN REQUIREMENTS FOR MATERIALS IN THE REGULATION ON TECHNICAL REQUIREMENTS IN CONSTRUCTION WORK (TEKNISK BYGGEFORSKRIFT/TEK)



Design

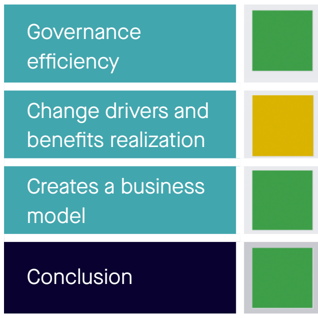
Regulating the maximum emissions permitted from materials used in new constructions through the construction regulations/building codes. The energy use in new constructions has been reduced as a result of the increasingly stringent requirements in the regulation on technical requirements in construction work (TEK). Now that energy consumption has been reduced in the operational phase, the indirect emissions from material use now comprise the largest climate footprint from construction. With the introduction of the Norwegian standard «Metode for klimagassberegninger for bygninger» (method for greenhouse gas calculations for buildings) (NS 3720), there is consensus in the industry about how emissions from construction materials should be calculated.

Assessment

ZERO thinks that the construction regulations should introduce requirements for limiting greenhouse gas emissions from construction materials. The authorities should adopt goals for zero emissions from construction materials by 2050, and gradually tighten the requirements for emissions linked to material use in the years to come. This measure will probably have little effect on triggering CCS from cement production in the short term, but will provide a clear direction for the industry. Other climate requirements for construction of a building would most likely be more cost-effective than a requirement of using emission-free concrete.

ZERO thinks imposing green requirements for construction materials is an important long-term measure which over time can become a driver for CCS.

PRODUCER RESPONSIBILITY FOR CARBON



Design

Introducing a statutory requirement for companies that extract fossil carbon in Norway to deposit a certain amount of CO_2 annually, starting in 2030. The required amount of CO_2 deposited should be increased over time, and should reach 10 million tonnes by 2035.
This arrangement should be organised by the industry itself, for example through a fund, independently of the state and the state budget. A tax on upstream carbon should be paid to the fund (by the oil and gas and mineral industry sectors). The fund's mandate will be to purchase captured CO_2 on long-term contracts, so that enterprises with large point emissions will have the opportunity to compete in a market.

Assessment

This measure establishes a market for CO_2 and provides a stable source of funding for several CCS projects in Norway. By imposing requirements that those who extract fossil resources should also deposit emissions, a long-term and predictable business model for CCS will be created. The costs will primarily be funded by the oil and gas industry (outside of the Budgetary Rule (Handlingsregelen), and will not be subjected to the political priorities of the annual state budget.

ZERO thinks that such a fund would work well in combination with the other proposed measures

Assessment

Price regulation of fossil-based products that are introduced to the market can have a major effect on the composition of the waste, and thereby on the greenhouse gas emissions from incineration. This proposal will also generate increased profitability for using renewable raw materials, while the use of fossil-based raw materials which will end up as waste will be subject to an additional cost which can finance CCS. This scheme would create an entirely new business model for CCS for waste management.

Recent amendments to the EU waste directive stipulate that producers should be charged with at least 80 percent of the costs associated with waste management.

A recent legal study carried out by the Norwegian Environment Agency concludes that the purposes and minimum requirements in the waste directive do not apply to the costs for management of the CO_2 emissions from the products that the producers introduce to the market, and that the producers that are subject to the extended producer responsibility should therefore not be charged for the carbon management of their respective waste (the Norwegian Environment Agency, 2019).

The directive only provides minimum criteria, and it is therefore quite possible for Norway to impose stricter requirements for the producers to assume responsibility for the costs associated with greenhouse gas emissions from the products they introduce to the market (the Norwegian Environment Agency, 2019).

ZERO thinks that Norway should lead the way here, and at the same time work to make climate issued and waste emission management a central part of the EU waste policy. This means that the minimum requirements for producer responsibility should be extended to include the costs of managing greenhouse gas emissions from products.

CLIMATE TAXATION OF ALL TRADED CONCRETE BASED ON CARBON FOOTPRINT

Proceeds	NOK 700 million, NOK 500 million for startup of CCS at Brevik
Governance efficiency	
Change drivers and benefits realization	
Creates a business model	
Conclusion	

Design

Introducing a climate tax on par with the domestic CO_2 cost of concrete based on the CO_2 emissions in the value chain for all traded concrete, including imported cement/concrete.

Charging a tax on concrete will create an opportunity for raising the price of cement/concrete produced with CCS, while at the same time counteracting carbon leakage. The tax can later be scaled down in the event of higher carbon allowance prices.

Assessment

Levying a climate tax on manufactured products will make it possible to charge a tax on industrial production and pass costs further on in the supply chain, without leading to carbon leakage, and would thus be a new taxation arrangement which can be used for generating green industrial developments in Norway and Europe.

The Norwegian Environment Agency confirms that there would be no legal barriers for introducing such a tax (the Norwegian Environment Agency, 2019b). In addition, a tax on concrete would make alternatives to concrete more profitable. Climate taxation of a product can have a high transfer value for other products and to other European countries.

ZERO recommends imposing a graded climate tax on concrete.

ZERO's recommended measures for incentivising CCS

This report highlights new business models for CCS with the goal of establishing new projects across the industrial sector, with a particular focus on the cement production and waste management sectors.

New business models will help create profitability for new and existing projects, as well as for the value chain at large, including storage.

Due to the risk of carbon leakage, it is challenging to impose special requirements on zero-emission solutions or charge high taxes on the production of manufactured goods, which are produced for and in an international market.

Business models and requirements that would generate a market for zero-emission solutions are therefore essential in achieving a shift to a carbon neutral industrial production towards 2050. Several of the proposed measures have high transfer value to other industrial products (such as plastic, steel, aluminum and mineral fertiliser), in particular special climate requirements for materials used in public procurement for roads and construction, developing new construction regulations and imposing taxes on the use of products, rather than the production thereof.

Creating new financing solutions and new policies will probably represent a bigger challenge than the technical challenges faced in reducing production emissions. History has shown that technology will be readily adopted when it creates profitability.

Figure 6 illustrates how the discussed measures can work together. The priority should be on implementing measures which contribute towards making CCS profitable within a short time, particularly requirements for public procurement, and taxes on residual waste and concrete production.

It should also be a goal to adopt strategic measures which allow for the implementation of CCS in the climate policy over the long term, which includes TEK requirements for construction materials, and expanding producer responsibility for waste.

A combination of state subsidies for the first plants and for the CO_2 storage value chain, combined with market instruments and a commercial CO_2 fund, will contribute to making CCS an attractive and profitable climate change mitigation measure.

REALISING THE KLEMETSRUD AND BREVIK PLANTS & RELEVANT INFRASTRUCTURE (2020–2023):

State support is essential for realising the two first facilities and the infrastructure for storage. At the same time, the introduction of supplementary measures such as green requirements for public procurement and charging a tax on waste management and concrete will both have a risk reducing effect on these projects and contribute to financing the associated operating costs. Carbon taxation will also yield positive revenue which may help finance CCS over the state budget.

BUILDING MARKETS FOR CCS AFTER IMPLEMENTING THE FIRST PLANTS (2023–2040):

State subsidized CCS should be limited to only the first two projects. After 2020, it is essential that supplementary measures are introduced for CCS in addition to 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 manufactured products. A voluntary market for mass balance for low-emission concrete and waste can contribute to generating an expanded international market with higher willingness to pay for green solutions.

EFFECTIVE REGULATION IN COMBINATION WITH CARBON PRICING TRIGGERS CCS (FROM 2040 ONWARDS):

CCS for industrial emissions is among the most costly climate change mitigation measures, but is a necessary measure for achieving emission-free industrial production. Regulations for emission-intensive manufactured goods for use in construction, infrastructure, cars, and other consumer goods through extended producer responsibility in combination with a high carbon price will trigger the establishment of the plants required to be able to eliminate greenhouse gas emissions from the industry sector.

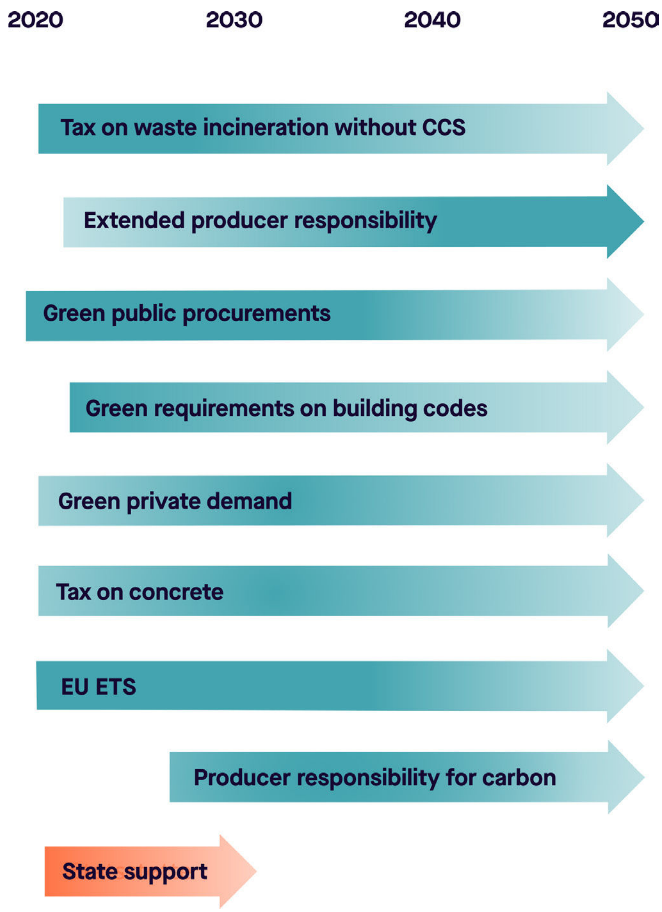


Figure 6: *Market measures for CCS in combination with carbon pricing (EU ETS). The starting point of the arrow indicates when the measure must be implemented, while the dark blue shade indicates when the measure will have a triggering effect on CCS.*

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FUNDING AND CONTENT:

ZERO is solely responsible for all content and recommendations herein.
We are grateful for funding from:

fortum Oslo Varme

NHO

NORCEM HEIDELBERGCEMENT Group

Oslo kommune
Klimaetaten